Elizabeth G. Klein and Rhonda J. Jones-Webb

TOBACCO AND ALCOHOL ADVERTISING IN TELEVISED SPORTS:
TIME TO FOCUS ON POLICY CHANGE

Lara Zwarun

ZWARUN RESPONDS

Vivien Davis Tsu

RECONSIDERING THE FEASIBILITY OF PAPANICOLAOU AND
ALTERNATIVE SCREENING TESTS FOR LOW-RESOURCE COUNTRIES

Eric J. Suba

SUBA RESPONDS

Jacqueline Sherris, Thomas C. Wright, Jr, Lynette Denny, Rengaswamy Sankaranarayanan, Amy E. Pollack, Harshad Sanghvi, and John W. Sellors

ALLIANCE FOR CERVICAL CANCER PREVENTION: SETTING THE
RECORD STRAIGHT

Eric J. Suba

SUBA RESPONDS

Gina Morgan-Smith

REDUCING THE ETHNIC DISPARITIES IN FOOD ACCESS

ERRATUM
Cesar Victora

**Addressing International Child Health Priorities**

Donya Currie Arias

**Allan Rosenfield: Public Health’s Noble Soul With a Big Heart**

Marian Moser Jones and Ronald Bayer

**Paternalism & Its Discontents: Motorcycle Helmet Laws, Libertarian Values, and Public Health**

Nava Blum and Elizabeth Fee

**The Polio Epidemic in Israel in the 1950s**

Jef L. Leroy, Jean-Pierre Habicht, Gretel Pelto, and Stefano M. Bertozzi

**Current Priorities in Health Research Funding and Lack of Impact on the Number of Child Deaths per Year**

Ronda C. Talley and John E. Crews

**Framing the Public Health of Caregiving**


**Malnutrition Among Children Younger Than 5 Years-Old in Conflict Zones of Chiapas, Mexico**

Mieko Yoshihama, Julie Horrocks, and Saori Kamano

**Experiences of Intimate Partner Violence and Related Injuries Among Women in Yokohama, Japan**

Jaime C. Lucove, Jay S. Kaufman, and Sherman A. James

**Association Between Adult and Childhood Socioeconomic Status and Prevalence of the Metabolic Syndrome in African Americans: The Pitt County Study**

Marcelo U. Ferreira, Mônica da Silva-Nunes, Carla N. Bertolino, Rosely S. Malafronte, Pascoel T. Muniz, and Marly A. Cardoso

**Anemia and Iron Deficiency in School Children, Adolescents, and Adults: A Community-Based Study in Rural Amazonia**
Long-Term Reductions in Mortality Among Children Under Age 5 in Rural Haiti: Effects of a Comprehensive Health System in an Impoverished Setting

Myra J. Tucker, Cynthia J. Berg, William M. Callaghan, and Jason Hsia
The Black–White Disparity in Pregnancy-Related Mortality From 5 Conditions: Differences in Prevalence and Case-Fatality Rates

Mary J. O’Connor and Shannon E. Whaley
Brief Intervention for Alcohol Use by Pregnant Women

Sam S. Kim, Jemima A. Frimpong, Patrick A. Rivers, and Jennie J. Kronenfeld
Effects of Maternal and Provider Characteristics on Up-to-Date Immunization Status of Children Aged 19 to 35 Months

Kristina M. Zierold, Jeff Havlena, and Henry Anderson
Exposure to Lead and Length of Time Needed to Make Homes Lead-Safe for Young Children

Paola Roggero, Viviana Mangiaterra, Flavia Bustreo, and Furio Rosati
The Health Impact of Child Labor in Developing Countries: Evidence From Cross-Country Data

Barbara Marlenga, Richard L. Berg, James G. Linneman, Robert J. Brison, and William Pickett
Changing the Child Labor Laws for Agriculture: Impact on Injury

Using Participant Event Monitoring in a Cohort Study of Unintentional Injuries Among Children and Adolescents

Debbie A. Lawlor, Heather Clark, and David A. Leon
Associations Between Childhood Intelligence and Hospital Admissions for Unintentional Injuries in Adulthood: The Aberdeen Children of the 1950s Cohort Study
Rachel Tolbert Kimbro, Jeanne Brooks-Gunn, and Sara McLanahan
**Racial and Ethnic Differentials in Overweight and Obesity Among 3-Year-Old Children**

Elizabeth Milne, Julie A. Simpson, Robyn Johnston, Billie Giles-Corti, and Dallas R. English
**Time Spent Outdoors at Midday and Children’s Body Mass Index**

Noreen D. Willows, Melissa S. Johnson, and Geoff D.C. Ball
**Prevalence Estimates of Overweight and Obesity in Cree Preschool Children in Northern Quebec According to International and US Reference Criteria**

Kathleen A. Daly, Phyllis L. Pirie, Kristine L. Rhodes, Lisa L. Hunter, and Cynthia S. Davey
**Early Otitis Media Among Minnesota American Indians: The Little Ears Study**

Shirley L. Porterfield and Timothy D. McBride
**The Effect of Poverty and Caregiver Education on Perceived Need and Access to Health Services Among Children With Special Health Care Needs**

Kurt L. Johnson, Brian Dudgeon, Carrie Kuehn, and William Walker
**Assistive Technology Use Among Adolescents and Young Adults With Spina Bifida**

Michele L. Allen, Marc N. Elliott, Leo S. Morales, Allison L. Diamant, Katrin Hambarsoomian, and Mark A. Schuster
**Adolescent Participation in Preventive Health Behaviors, Physical Activity, and Nutrition: Differences Across Immigrant Generations for Asians and Latinos Compared With Whites**

Hannah L.F. Cooper, Samuel R. Friedman, Barbara Tempalski, and Risa Friedman
**Residential Segregation and Injection Drug Use Prevalence Among Black Adults in US Metropolitan Areas**

Glen Kim, Rabih Torbay, and Lynn Lawry
**Basic Health, Women’s Health, and Mental Health Among Internally Displaced Persons in Nyala Province, South Darfur, Sudan**
Victor Agadjanian and Soma Sen
**Promises and Challenges of Faith-Based AIDS Care and Support in Mozambique**

Jamy D. Ard, Stephanie Fitzpatrick, Renee A. Desmond, Bryce S. Sutton, Maria Pisu, David B. Allison, Frank Franklin, and Monica L. Baskin
**The Impact of Cost on the Availability of Fruits and Vegetables in the Homes of Schoolchildren in Birmingham, Alabama**

**MARKETPLACE**

**JOB OPPORTUNITIES**
Numerous studies have provided evidence for the presence of alcohol and tobacco advertising during televised sporting events. Her follow-up to Madden and Grube’s analysis of alcohol and tobacco advertising in televised sports demonstrates that although certain types of advertisements have decreased, the alcohol and tobacco industries have adapted to advertising restrictions such as those included in the Master Settlement Agreement, the massive lawsuit between state attorneys general and the tobacco industry.

However, we believe Zwarun did not take her recommendations far enough. Although the article mentions the importance of the Master Settlement Agreement in reducing the frequency and type of ads, the author did not suggest specific policy changes that are needed to limit alcohol and tobacco marketing in televised sports. It has been estimated that youths make up 13% of the national television viewing audience for all types of programming, and most youths report watching sporting events on television. Numerous studies have provided evidence for a connection between tobacco and alcohol advertising during sporting events and use of those products.

On the basis of the growing evidence for the relationship between tobacco and alcohol advertising and youth consumption of these products, we suggest that a shift is needed to focus on policy change. The surgeon general and others have described the connection between policy and behavior change and recommend policies as a behavior change strategy. International tobacco marketing standards stipulate that tobacco ads should not “be of particular appeal to youth” or be shown at events with more than 25% young viewers; the alcohol industry marketing code prohibits ads intended to appeal to youths.

Implementation of policies to further restrict alcohol and tobacco advertising in televised sports will be challenging; therefore, it will be important for alcohol and tobacco researchers and policy advocates to work collaboratively. For example, efforts could jointly focus on developing policy to prohibit sports sponsorships for alcohol and tobacco products during televised sporting events with a youth audience of 15% or higher, a more specific and stringent standard for both industries. By working together on policy change, we believe that more substantive change can occur to prevent or reduce underage use of tobacco and alcohol. As clearly illustrated by Zwarun, the problem of alcohol and tobacco advertising in televised sports has been well described. We are overdue to move to the next step and devise effective population-level solutions to youths’ exposure to tobacco and alcohol advertising.

Elizabeth G. Klein, MPH
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to organize screening programs have failed... in spite of a coverage of over 60%.[2] Further, the authors cite as “voluminous evidence” of the feasibility of Papanicolaou screening in developing countries just 3 references: a pilot project led by Suba et al. in a city in Vietnam, a set of guidelines in South Africa that have yet to be successfully implemented, and the same International Agency for Research on Cancer document previously cited as evidence that cytology-based programs have been operational (but not effective) in low-resource countries.

Suba et al. claim that successful follow-up of screen-positive women is feasible, as proven in 6 countries they name, but all 6 countries involved limited research studies done with external resources, not routine health services where the real-life problem of poor follow-up prevails.[3,4]

On visual “screen and treat,” Suba et al. state that use of visual inspection with acetic acid (VIA) would “require performing cryosurgery on 18% to 71% of women who are screened.”[1,4,5] The 3 references they cite for this claim (all from 2001 or earlier) list screen-positive rates of 28%, 39%, and 18%. More recent studies (not cited by Suba et al.) produced test-positive rates from 7% to 33%, with most under 15%.[4-9] Although some overtreatment is inevitable (because even cervical intraepithelial neoplasia identified by cytology will often regress spontaneously), VIA would not lead to treatment of up to 71% of all women screened, as repeatedly stated by Suba et al.

Contrary to the authors’ assertion, visual screen-and-treat algorithms by Alliance for Cervical Cancer Prevention partners and others all call for referring any woman with a lesion suspicious for cancer to further evaluation, and VIA studies have missed few, if any, cancers.[5,6] In addition, many proponents of visual inspection for routine service also recommend taking a biopsy before the ablative treatment (wherever pathology services exist). 30

The drawbacks of cytology are now well understood in resource-poor settings. VIA offers a viable alternative that deserves consideration on the basis of the evidence.

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RECONSIDERING THE FEASIBILITY OF PAPANICOLAOU AND ALTERNATIVE SCREENING TESTS FOR LOW-RESOURCE COUNTRIES

Despite the commendable commitment of Suba et al.1 to cervical cancer prevention in developing countries, several key conclusions in their article are made on the basis of inaccurate and misleading use of references. For example, they cite an International Agency for Research on Cancer document2 as saying that Papanicolaou test–based programs have been “operational” in developing countries for more than 30 years. However, no operational programs of any scale were identified in Africa or Asia. The same document concludes that even in Latin America, “attempts
ALLIANCE FOR CERVICAL CANCER PREVENTION: SETTING THE RECORD STRAIGHT

The recently published article by Suba et al. advocates for expanded access to Papanicolaou testing worldwide and for analysis of obstacles to effective screening programs. We are pleased to see discussion of this important topic in the Journal.

Suba et al. criticized the work of the Alliance for Cervical Cancer Prevention (ACCP), an alliance of 5 organizations with a goal of reducing cervical cancer deaths among the world’s poorest women. The article repeats previous criticisms the authors have made, including about the safety of visual screening approaches, the ethics of several ACCP studies, the assertion that ACCP leaders are “loath to recommend” cytology, and the theoretical underpinnings of ACCP cost analyses.

We strongly disagree with the authors’ comments about our work and have responded in detail to these criticisms previously. We refer Journal readers to our most recent response to Suba et al. and to the voluminous evidence describing our work, a small portion of which is cited here. The comprehensive work of the ACCP can be reviewed online (http://www.alliance-cxca.org); we invite readers to visit the site and make their own determinations regarding ACCP’s ethical, clinical, scientific, and public health value.

Another recurring criticism that Suba et al. make about ACCP’s work is that it is influenced by private-sector interests. We would like to take this opportunity to set the record straight. The ACCP has never received funding from any commercial entity. An erroneous statement about an ACCP link with Digene Corporation in a 2004 editorial has been corrected. Suba et al. may be misinterpreting PATH’s separate START project (http://www.path.org/projects/start_project.php), which is working to develop simple, rapid, and affordable biochemical screening tests (including a simpler human papillomavirus test) in partnership with 2 private-sector companies. The START project is funded by the Bill & Melinda Gates Foundation and the National Institutes of Health; PATH receives no funding from commercial partners for START work.

It is regrettable that Suba et al. discourage new approaches to cervical cancer prevention, often with arguments based on uninformed or inaccurate information. We believe that there are multiple strategies to prevent cervical cancer, including well-run cytology-based programs, human papillomavirus DNA testing–based programs, “screen-and-treat” programs, and human papillomavirus vaccine introduction. Women in developing countries clearly will benefit from the new policies, programs, and pilot efforts related to these approaches.

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REDUCING THE ETHNIC DISPARITIES IN FOOD ACCESS

Baker et al. noted that most of the public health interventions to decrease obesity focus on creating change in individual behaviors, with few studies focusing on the social determinants of health care. The authors’ findings are consistent with previous national findings that demonstrate limited access to supermarkets and nutritious foods in most urban and rural areas.

The St Louis, Mo, Garden of Eden program was developed and implemented to provide a variety of high-quality, affordable produce to low-income African American communities. Faith-based health advocates, lay church members, academics, and business owners collaborated to establish the market. An important feature of the project was its design to maximize sustainability and community ownership. Baker et al. are still analyzing the data, but I have several questions, including questions about the impact of the intervention on the target population and any results in changing dietary behaviors; the community perception of the produce market; and any barriers to increasing participation with other faith-based institutions. A search of the literature reveals several state and regional strategies to improve access to quality produce, from converting vacant lots into fruit and vegetable gardens to the creation of urban farmers markets. The Detroit Faith-Based Healthy Living Initiative, a collaboration of 22 faith partners, has serviced more than 8500 consumers through the creation of 150 mini-marts offered by 10 churches. Surveys of consumers show a change in dietary behaviors and physical activity as a result of the intervention. In Philadelphia, The Food Trust farmers markets have reached more than 60,000 low-income residents with 15 locations.

Overall, Baker et al. delineated the need to develop and implement culturally relevant community-based solutions to reduce the ethnic disparities in food access. The overarching goals for Healthy People 2010 are to increase quality and years of healthy living and to eliminate health disparities. As Baker et al. wisely stated, it is important to recognize that the disparities in obesity are also associated with disparate access to the structures necessary to make healthy choices.

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This issue of the Journal focuses on international child health priorities. As is increasingly becoming the case for the Journal, we are publishing a mixture of international and US-based work. Our editors are actively and constantly seeking high-quality articles written by authors from low- and middle-income countries, an effort made evident by this issue.

It is widely known that 10% of the world’s expenditure in health research is for the conditions accounting for 90% of the global burden of disease (10/90 Report on Health Research 2003–2004. Geneva, Switzerland: Global Forum for Health Research; 2004). These are diseases primarily affecting poor countries and particularly the poorest individuals in these countries. The Journal is making a concrete effort to promote a more equitable balance regarding this unacceptable 10/90 gap in funding.

In this issue, Leroy et al., in “Current Priorities in Health Research Funding and Lack of Impact on the Number of Child Deaths per Year,” build upon the notion of the 10/90 gap to show that, of the scarce research funds aimed at reducing child mortality, 97% were directed at the development of new technologies, such as drugs, vaccines, or laboratory diagnostics. Only 3% were spent on operational research to determine how to best deliver existing interventions to mothers and children who need them most. This percentage is in stark contrast to the recommendations of a group of scientists and policymakers made in 2003, of which I was a part. On that occasion, we gathered detailed information on the distribution of causes of death and on the efficacy of existing interventions, concluding that two thirds of the more than 10 million annual deaths of children could be prevented by universal coverage with off-the-shelf, low-cost interventions. We argued that research on how to deliver these interventions is as important as, if not more important than, studies aimed at developing new biological tools.

If simple antibiotics for pneumonia, oral rehydration and zinc supplementation for diarrhea, and insecticide-treated mosquito nets for malaria were effectively reaching all children in the world, more than 6 million deaths would be prevented each year (Jones et al. How many child deaths can we prevent this year? Lancet. 2003;362:65–71). Yet there is considerable need for further research on the best channels for reaching mothers and children. Should antibiotics for pneumonia be prescribed by doctors, community health workers, or small pharmacists in the private sector? Should mosquito nets be sold at low cost in the market or should they be provided free of cost? How can policymakers ensure a continued supply of oral rehydration salts with zinc in the most remote parts of Africa? At the health systems level, how can one stop the cruel migration of qualified health workers from poor to rich countries? How can one effectively deploy and maintain health workers in rural areas? These are important research questions that must be answered in order to reduce global child mortality on a sustainable basis. Leroy et al. make an important contribution by showing how little is currently spent on research on intervention delivery and health systems.

With this Editor’s Choice I conclude my tenure as international associate editor for the Journal. It has been a great honor to collaborate with the Journal, its editors, and its staff over the past 5 years. My move is related to an increased role in global child health research and program evaluation, particularly in Africa and Asia, where the difficult challenges described in this issue affect the everyday lives of mothers and children.

Cesar Victora, MD, PhD
Allan Rosenfield
Public Health’s Noble Soul With a Big Heart

Editor’s Note: Allan Rosenfield is the only dean I have known in my close to 2 decades at the Mailman School of Public Health—first when I was a doctoral student in the former Division of Epidemiology and now as a faculty member in the Department of Sociomedical Sciences. Allan has been a champion of the belief that women’s health should not come UNDER child health. In other words, the key issues globally related to women’s health are much broader than those related to being a mother. Nonetheless, given the international focus of this issue, he preferred to have this feature article published alongside the important included articles on international child health priorities, but asked that I reinforce his core belief of a woman’s right to health over and above her role as mother and caretaker of her children.

Mary E. Northridge, PhD, MPH
Editor-in-Chief, AJPH

It’s that neat combination of head and heart, which is why he is so effective.
—Geeta Rao Gupta
President, International Center for Women’s Research

WHEN COLUMBIA UNIVERSITY hosted a tribute dinner to honor Allan Rosenfield’s 20 years as dean of the Mailman School of Public Health, organizers scrambled to set up an extra tent because the initial 400-member guest list soon swelled to more than twice that size.

“Everyone really likes this guy,” actor and human rights activist Richard Gere noted at the event. “Allan Rosenfield is one of the few individuals I can think of who is pretty much universally respected,” said New York City Health Commissioner Thomas Friedan. “How on earth does one do justice to the achievements of one human being which have meant so much to so many people around the world?” mused United Nations Secretary-General Kofi Annan.

Rosenfield has been praised by the likes of former President Bill Clinton and Senator Hillary Rodham Clinton, global health advocate and rock singer Bono of U2, public health workers in Thailand, HIV/AIDS advocates abroad and in the United States, women’s rights pioneers, and global health leaders.

One of the public health world’s most outspoken advocates for women’s health, human rights, and equity in health care, Rosenfield did not set out to become a public health legend or even to work in the field. He planned to follow in his father’s
footsteps and set up a private obstetrician/gynecologist (OB/GYN) practice near Harvard’s Brigham and Women’s Hospital, where he would teach on a part-time basis. However, a year as a US Air Force doctor in Korea (after the war) followed by a year at a teaching hospital in Nigeria opened Rosenfield’s eyes to the great need for improved health care worldwide. “I was, I guess, touched by the health problems of poor countries,” Rosenfield said humbly from his office in upper Manhattan, his phone ringing constantly and e-mail after e-mail flowing into his computer’s inbox.

When he finished working in Nigeria, Rosenfield still planned to return to the United States to set up a private practice and teach both medical students and OB/GYN residents. Then the Population Council came calling and hired Rosenfield as an adviser on reproductive and maternal and child health for Thailand’s Ministry of Public Health. What was supposed to be a 1-year appointment turned into 6 years and spawned a landmark model of reproductive health care access in rural areas. This changed Rosenfield’s working life forever.

“That was a turning point in my career,” Rosenfield said about his time in Thailand, where he developed a model checklist for auxiliary midwives in rural areas that allowed them to prescribe oral contraceptives in lieu of relying on hard-to-come-by physicians. Within a year, more than 3000 auxiliary midwives were prescribing birth control pills across the country. “I got more and more involved, sort of in the big picture instead of one-on-one patient care,” Rosenfield said. “It’s important to have good doctors providing good care, but I sort of felt there were plenty of people doing that in the States.”

When he arrived in Thailand, the average family had 7 children, and the country’s annual population growth rate was close to 3%. Thai health officials credit Rosenfield’s efforts with dramatically changing those figures: by 2000, the average family had 1.6 children, and the population growth rate was 0.8%. While living in Bangkok, Rosenfield and his wife, Clare, had 2 children, Paul and Jill, both of whom spent their earliest years there and then returned to work in Thailand while in college. Clare has been a steadfast supporter of her husband’s work throughout the years and believes strongly in his vision for improving public health. “He is just a noble soul with a big heart whose meaning comes from serving the needs of others,” Clare said in a video shown during the Columbia University tribute dinner.

After his time in Thailand, Rosenfield was recruited by Columbia University in New York City, where he became a professor of both public health and obstetrics/gynecology; he later founded the school’s Center for Population and Family Health (now the Heilbrunn Department of Population and Family Health in the Mailman School of Public Health). While there, he recruited Judith Jones to help him find ways to provide reproductive health services in upper Manhattan, NY, where adolescent pregnancy rates were high and access to care was low. The center’s innovative programs included the Young Adult Clinic (an evening clinic for girls and young women), the Young Men’s Clinic, and school-based clinics throughout the area. All these clinics thrive today and serve as models of health care access in lower-income urban areas.

Jones, who is now a clinical professor of population and family health at the Mailman School of Public Health, spoke at the tribute dinner about Rosenfield’s leadership skills and also his caring. She described him as “a committed physician who sees the needs of people, not places, and recognized that gaps in care can strain the healthy development of the individual. Allan deeply believes that health care is a right, not a privilege.”

Rosenfield said his view of health care boils down to equity in education and health care for all, particularly among under-served women. “I guess the bottom line is equity, and that’s in our country as well,” Rosenfield said about his long-held belief in universal access. “I find it totally unacceptable that we still have 44 million people uninsured, 70% of them working poor people, in one of the wealthiest nations in the world. I think that’s terrible.”

Throughout his entire career, Rosenfield has been passionate...
about women’s health. He and epidemiologist Deborah Maine coauthored a paper published in 1985 in the *Lancet* titled “Maternal Mortality—A Neglected Tragedy. Where is the M in MCH?” “In discussions of MCH [maternal and child health] it is commonly assumed that whatever is good for the child is good for the mother,” Maine and Rosenfield wrote. “However, not only are the causes of maternal death quite different from those of child death, but so are the potential remedies.”

In another groundbreaking paper published in the *American Journal of Public Health* in May 2001, Rosenfield addressed maternal-to-child-transmission (MTCT) of HIV and asked “Where is the M in MTCT?” He had the audacity, some might say, to question the policy of using mothers as mere vehicles for giving HIV prevention medication to developing fetuses. He also noted that when MTCT programs first started, there were no funds available for antiretroviral treatment in poor countries. “Decreasing maternal-infant transmission of HIV without treating the mother or father adds to the already high number of orphaned children,” Rosenfield wrote. “Many of these orphans have become street people, because AIDS has ravaged their traditional extended families. Do we expand treatment to decrease MTCT without treating women, only to increase the number of orphans? It is difficult to believe that this question even needs to be asked.”

Difficult, indeed, but Rosenfield has never shied away from asking the difficult questions or from seeking funding where seemingly none existed to develop programs that would work with few resources. “We’ve got to be practical and do what’s possible in the setting that exists,” said Rosenfield, who has spoken out against the “doctor-only” mindset. “What I have said publicly at a couple of OB/GYN meetings is, ‘What some of you are saying, in effect, is if there isn’t an obstetrician available, let the woman die.’” Controversial, maybe, but Rosenfield felt strongly that it needed to be said.

“I guess the bottom line is elimination of poverty, equity in health care in both the US and abroad are the core issues I believe in, where I do have some expertise and ability to talk about the issues,” said Rosenfield during a televised interview with journalist Charlie Rose in July 2006. Rather than talk about himself, Rosenfield turned the conversation back to health care access, AIDS and women’s rights, and other public health issues. “I’m a strong supporter of health care reform here. . . . If you’re very sick and need high-tech health care, this is the best place to be, but in terms of universal access, we’re way behind.”

Among the initiatives that Rosenfield has spearheaded are the Prevention of Maternal Mortality Program (a collaboration with several West African countries that linked local health providers with women who need care), the Averting Maternal Death and Disability Program (funded in 1999 by a $50 million Bill & Melinda Gates Foundation grant, which at that time was the largest grant in Columbia University’s history), and the MTCT-Plus Initiative (a family-based program that provides care and treatment to more than 100,000 mothers and children).

Rosenfield believes maternal mortality is still one of the world’s most neglected tragedies. Despite the numbers—millions of children die yearly compared with a maternal mortality rate of about 500,000—the differential in the maternity mortality ratio between poor countries and the West is far larger than for child mortality. “The bottom line is we know the cause of maternal deaths,” Rosenfield said. “It’s a question of governments deciding this is important and giving it priority.” For example, Sri Lanka has made maternal health a priority during the past 40 years, and despite the country’s relative lack of wealth, the vast majority of women deliver babies in a hospital-like setting and the maternal mortality ratios are low.
“The fact that Rosenfield is a man speaking out for women’s rights and health care issues carries particular weight in some circles,” said Mary Robinson, executive director of the New York-based Ethical Globalization Initiative and former president of Ireland. “There aren’t too many men who actually understand the link between poverty and lack of access to care and women not being equal,” Mary Robinson said. “Allan has always cared.”

Geeta Rao Gupta, another colleague of Rosenfield’s and president of the International Center for Women’s Research, said Rosenfield’s clinical experience “helps him make the case for the injustices women face. I think it also counts a lot because he’s male.” In many countries where women still are viewed as secondary to men, the cry for equality in health care and education “coming from a man has different resonance and gets more traction,” Gupta said. “He’s actually directed the field [of global public health] to change course, to think differently,” Gupta said. Yet it is not merely Rosenfield’s expertise that impressed her, she said, but also his caring. “It’s that neat combination of heart and head, which is why he is so effective.”

Rosenfield became dean of the Mailman School of Public Health in 1986, and during his leadership, the school’s budget rose astronomically from $12 million to $161 million. Joseph Graziano, associate dean for research and professor of Environmental Health Sciences at Mailman School of Public Health—and Rosenfield’s colleague since 1991—described him as a “marvelous” man. “It stems from who he is—his sense of caring for every single person under his guidance.” That extends from professional to personal, said Graziano, who awoke in his hospital bed after a sudden illness to see Rosenfield’s smiling face looming above him. “The extraordinary thing to me about Allan’s career is when the AIDS epidemic first emerged and so little was known about it, he was immediately drawn to the problem and saw it as the crisis it became,” Graziano said. Although Rosenfield could have delegated the duties of sitting on boards and committees that addressed AIDS to his subordinates, he sat on those committees and boards himself to get a frontline look at the problem. “He gave of himself in a major way,” Graziano said. “Allan personifies the public health heart.” In other words, he sees the world as his patient, particularly communities in need. “Allan sets the standard for what it means to be a public health professional.”

Rosenfield announced in mid-2006 his plans to step down as dean of the Mailman School of Public Health, a move he had been planning but that was hastened by illness. He was diagnosed in late 2005 with amyotrophic lateral sclerosis (ALS) and in April 2006 with myasthenia gravis, both of which are eroding his motor nerve function. As a result, Rosenfield has had to give up a global travel schedule that sometimes had him flying overseas and back in 2 days. Regrettably, he also has been forced to scrap his plans for devoting more time to tennis and skiing. Because of breathing difficulties, he relies on a wheelchair to get around. However, after he welcomes a new dean, Rosenfield plans to continue working on the important global public health agenda that has become his life’s work. “You either give up or you keep working,” Rosenfield said, quickly changing the subject to the need for equity. “Equity and health care and education are things I believe in very strongly, and I think it’s a major public health agenda.”

A crystal bowl filled with brightly colored condoms—a gift from Planned Parenthood—sits on a table in Rosenfield’s office underneath a watercolor painting by his wife and next to a certificate of appreciation from Ipas, a women’s health and rights group, that reads in part, “For your contribution to the women of the world. . . .” Rosenfield has almost run out of room in his office for awards and commendations, such as the engraved crystal bowl from the Global Health Council that quotes from a T.S. Eliot poem: “Do not follow “There aren’t too many men who actually understand the link between poverty and lack of access to care and women not being equal.” Mary Robinson said. “Allan has always cared.”

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References
Paternalism and Its Discontents

Motorcycle Helmet Laws, Libertarian Values, and Public Health

Marian Moser Jones, MPH, and Ronald Bayer, PhD

The history of motorcycle helmet legislation in the United States reflects the extent to which concerns about individual liberties have shaped the public health debate. Despite overwhelming epidemiological evidence that motorcycle helmet laws reduce fatalities and serious injuries, only 20 states currently require all riders to wear helmets. During the past 3 decades, federal government efforts to push states toward enactment of universal helmet laws have faltered, and motorcyclists’ advocacy groups have been successful at repealing state helmet laws. This history raises questions about the possibilities for articulating an ethics of public health that would call upon government to protect citizens from their own choices that result in needless morbidity and suffering. (Am J Public Health. 2007;97:208–217. doi:10.2105/AJPH.2005.083204)

IN THE FACE OF OVERWHELMING epidemiological evidence that motorcycle helmets reduce accident deaths and injuries, state legislatures in the United States have rolled back motorcycle helmet regulations during the past 30 years. From the jaws of public health victory, the states have snatched defeat. There are many ways to account for the historical arc; we focus here on the enduring impact libertarian and antipaternalistic values may have on US public health policy. Currently, only 20 states, the District of Columbia, and Puerto Rico require all motorcycle riders to wear helmets (Figure 1). In another 27 states, mandatory helmet laws apply only to minors (aged younger than 18 years or 21 years depending on the state), and 3 states—Colorado, Illinois, and Iowa—have no motorcycle helmet laws. Additionally, 6 of the 27 states with minor-only helmet laws require that adult riders have $10 000 of insurance coverage or that helmets be worn during the first year of riding (Table 1).1 This uneven patchwork of state regulations on motorcycle helmet use contrasts dramatically with the picture 30 years ago, when 47 states, the District of Columbia, and Puerto Rico had passed mandatory helmet laws that applied to all riders.2 The repeal of motorcycle helmet laws has occurred as the United States has moved toward greater statutory regulation of automobile safety. During the past 20 years, every state except New Hampshire has enacted a mandatory seat belt law, and since 1998, the National Highway and Traffic Safety Administration (NHTSA) has required that all new cars sold in the United States be equipped with dual air bags.3

The repeal of motorcycle helmet laws in the United States contradicts a global movement toward enacting mandatory helmet laws; as of 2003, at least 29 countries—including most European Union countries, the Russian Federation, Iceland, and Israel—had passed mandatory helmet laws for motorcycles. Developing countries, including Thailand and Nepal, also have passed helmet laws in recent years. Varying levels of enforcement and other factors, such as
the general safety and quality of the roads, influence the effectiveness of these laws in different countries. In 1991, the World Health Organization launched a global helmet initiative to encourage motorcycle and bicycle helmet usage worldwide. Why then have things taken such a different turn in the United States? We conducted a historical examination of the debates on motorcycle helmet laws in the United States to answer this question. In reporting the results, we address tensions between paternalism and libertarian values in the public health arena—tensions that have come to the fore recently with developments in tobacco policy. As efforts to articulate an ethics of public health advance, it is crucial that the question of paternalism be addressed. The history of motorcycle helmet legislation provides a unique vantage point on that issue.

THE ORIGIN OF MOTORCYCLE HELMET LAWS

Motorcycle racers used crash helmets as early as the 1920s. Helmets were more widely used during World War II, when Hugh Cairns, a consulting neurosurgeon to the British Army, recommended mandatory helmet use for British Service dispatch riders, who carried instructions and battle reports between commanders and the front lines via motorcycles. Cairns first became concerned about helmet use after treating the war hero T.E. Lawrence—otherwise known as Lawrence of Arabia—for a fatal head injury suffered during a 1935 motorcycle accident. Cairns later published several landmark articles that used clinical case reports to show that motorcycle crash helmets mitigated the severity of head injuries suffered by military motorcyclists during crashes.

After World War II, the British government’s Ministry of Transportation became the first regulatory agency in the world to establish research-based motorcycle helmet performance standards. During the early 1950s, the ministry offered the British Standards Institute “kite mark” (a diamond-shaped seal) as an indicator of helmet quality and performance. In the United States, however, no such standard existed, and ads for American motorcycles invariably showed riders without helmets or goggles. The initial market for these bikes included returning veterans who had learned to ride military-issue Harley-Davidsons while overseas. During the late 1940s and early 1950s, motorcycle clubs created an “outlaw” masculine social identity around motorbikes—part of an emerging cultural reaction to the social confines of 1950s suburbia. At the same time, the motorcycle took its place amid the variety of new postwar consumer culture offerings, and many young men took up riding motorcycles as a weekend hobby.

The 1966 National Highway Safety Act introduced drastic and unwelcome changes to US motorcycle culture. The law, which was introduced after the 1965 publication of Unsafe at Any Speed, Ralph Nader’s scathing indictment of the US auto industry’s vehicle safety standards, included a provision that withheld federal funding for highway safety programs to states that did not enact mandatory motorcycle helmet laws within a specified time frame. This provision was added after a study showed that helmet laws would significantly improve the safety of motorcycles.

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<tr>
<th>States That Require Helmet Use for All Ages*</th>
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*Required for riders aged younger than 19 years and helmets must be in the possession of other riders, even though use is not required.
†Required for riders aged younger than 21 years and for those without $10,000 of medical insurance that will cover injuries resulting from a motorcycle crash.
‡Required for riders aged younger than 21 years, riders operating a motorcycle without an instruction permit, riders with less than one year’s experience, and riders who do not provide proof of health.
§Required for riders aged younger than 18 years and for those who lack $10,000 in medical insurance coverage. Proof of such an insurance policy must be shown to a law enforcement officer upon request.
¶Required for riders aged younger than 15 years, novices, and those with learner’s permits.
‖Required for riders aged younger than 16 years and for first-year operators.
‖Required for riders aged younger than 21 years and for those aged 21 years and older who have had a motorcycle operator’s license for fewer than 2 years or who have not completed an approved motorcycle safety course.
¶¶Required for riders aged younger than 21 years and for first-year operators.
\Required for riders aged 20 years and younger and for those who have not completed a rider training course or who do not have $10,000 of medical insurance coverage.

TABLE 1—Helmet Use Requirements by State: United States, 2006
decrease the rate of fatal accidents. The National Highway Safety Act was passed without debate on the helmet law provision. Adoption of this measure drew upon a broader movement within public health to expand its purview beyond infectious disease to “prevention of disability and postponement of untimely death.” Several years later, this shift sparked debate on the role of both individual and collective behaviors in contemporary patterns of morbidity and mortality, which led to Marc Lalonde’s New Perspective on the Health of Canadians (1974), the US government’s Healthy People Initiative (1979) and, most famously, John H. Knowles’s controversial but agenda-setting article, “The Responsibility for the Individual,” which asserted that individual lifestyle choices determined the major health risks for Western society.

As of 1966, only 3 states—New York, Massachusetts, and Michigan—and Puerto Rico had passed motorcycle helmet laws, but between 1967 and 1975, nearly every state passed statutes to avoid penalties under the National Highway Safety Act. By September 1975, California was the only state to not have passed a mandatory helmet law of any kind. This resistance carried weight because California had both the highest number of registered motorcyclists and the highest number of fatal motorcycle crashes. Additionally, motorcyclists in the state had developed into a powerful anti-helmet lobby. State legislators made 8 attempts between 1968 and 1975 to introduce helmet legislation, but they were thwarted by vocal opposition from the motorcycle groups. In September 1973, when a Burbank councilman proposed a mandatory motorcycle helmet ordinance after the death of a 15-year-old motorcyclist, more than 100 motorcyclists came to the council’s chamber to protest during hearings on the ordinance. The Los Angeles Times reported that the Hells Angels planned to bring “at least 500 members” on the day of the scheduled vote. The councilman then withdrew his proposed ordinance.

**CONSTITUTIONAL CHALLENGES TO MANDATORY HELMET LAWS**

As soon as states began to pass mandatory helmet laws, opponents mounted constitutional challenges to them. Some challenges involved appeals in criminal cases against motorcyclists who had been arrested for failing to wear helmets; others were civil suits brought by motorcyclists who alleged that the laws deprived them of their rights. Between 1968 and 1970, high courts in Colorado, Hawaii, Louisiana, Missouri, Massachusetts, New Jersey, North Carolina, North Dakota, Ohio, Oregon, Tennessee, Texas, Vermont, Washington, and Wisconsin and lower courts in New York all rejected challenges to the constitutionality of their state motorcycle helmet laws.

In June 1972, a US District Court in Massachusetts similarly rejected a challenge to the state’s helmet law that was brought on federal constitutional grounds, and in November of that year, the US Supreme Court affirmed this decision on appeal without opinion. The constitutional challenges focused principally on 2 arguments: (1) helmet statutes violated the equal protection clause of the Fourteenth Amendment or state constitutional equivalents by discriminating against motorcycle riders as a class, and (2) helmet statutes constituted an infringement on the motorcyclist’s liberty and an excessive use of the state’s police power under the due process clause of the Fourteenth Amendment or similar state provisions. Only the Illinois Supreme Court and the Michigan Appeals Court accepted these arguments. The Illinois Supreme Court ruled that the helmet laws constituted an infringement on motorcyclists’ rights.

If the evil sought to be remedied by the statute affects public health, safety, morals or welfare, a means reasonably directed toward the achievement of those ends will be held to be a proper exercise of the police power [citations omitted]. However, [t]he legislature may not, of course, under the guise of protecting the public interest, interfere with private rights [citations omitted]. The manifest function of the headgear requirement in issue is to safeguard the person wearing it—whether it is the operator or a passenger—from head injuries. Such a laudable purpose, however, cannot justify the regulation of what is essentially a matter of personal safety.

The Michigan Appeals Court heard a case brought by the American Motorcycle Association, then the country’s largest organization for motorcyclists, which argued that the state’s motorcycle law violated the due process, equal protection, and right to privacy provisions of the federal constitution. The association cited the US Supreme Court’s birth control decision in Griswold v. Connecticut as authority for establishing a right to privacy. The state attorney general contended that the law did not just concern individual rights and was intended to promote public health, safety, and welfare. Furthermore, the state
argued that it had an interest in the “viability” of its citizens and could pass legislation “to keep them healthy and self-supporting.” The Appeals Court, however, countered that “this logic could lead to unlimited paternalism” and found the statute unconstitutional. The court also rejected the claim that the state’s power to regulate the highways provided the basis for imposing helmet use.

There can be no doubt that the State has a substantial interest in highway safety . . . but the difficulty with adopting this as a basis for decision is that it would also justify a requirement that automobile drivers wear helmets or buckle their seat belts for their own protection.

The plaintiff in the Massachusetts District Court case used an argument nearly identical to those that had been successful in Illinois and Michigan: a helmet law was designed solely to protect the motorcyclist. The plaintiff’s argument cited John Stuart Mill’s assertion that “the only part of the conduct of anyone, for which he is amenable to society, is that which concerns others.” The District Court rejected this line of reasoning. Although it relied on Mill’s distinction between self-regarding and other-regarding behavior, the court clearly found injuries that resulted from motorcycle riders failing to wear a helmet to be other-regarding harms. Even more striking was that the court found the psychological burden on caregivers to be an other-regarding basis for intervention.

For while we agree with plaintiff that the act’s only realistic purpose is the prevention of head injuries incurred in motorcycle mishaps, we cannot agree that the consequences of such injuries are limited to the individual who sustains the injury. In view of the evidence warranting a finding that motorcyclists are especially prone to serious head injuries . . . the public has an interest in minimizing the resources directly involved. From the moment of the injury, society picks the person up off the highway, delivers him to a municipal hospital and municipal doctors; provides him with unemployment compensation if, after recovery, he cannot replace his lost job, and, if the injury causes permanent disability, may assume the responsibility for his and his family’s continued subsistence. We do not understand a state of mind that permits plaintiff to think that only he himself is concerned.

Although others echoed the Massachusetts decision by using economic—utilitarian—arguments to reject constitutional challenges to helmet laws, some courts upheld motorcycle statutes on the basis that helmet use affects the safety of other motorists. A Florida US District Court held that a requirement for motorcyclists to wear both helmets and eye protection was not an unreasonable exercise of state police power because “[a] flying object could easily strike the bareheaded cyclist and cause him to lose control of his vehicle,” and “the wind or an insect flying into the cyclist’s eyes could create a hazard to others on the highway.”

THE BIKER LOBBY ROARS INTO ACTION

Motorcyclists had long been organized—whether they belonged to informal clubs, racing associations under the aegis of the American Motorcycle Association, or “outlaw” biker gangs, such as the Hells Angels—and the passage of motorcycle helmet laws galvanized the groups to become political. During the 1970s, the American Motorcycle Association, which was founded in 1924 as a hobbyist group, organized a lobbying arm to “ . . . coordinate national legal activity against unconstitutional and discriminatory laws against motorcyclists.” The organization serves as a sentinel on federal and state legislation affecting motorcyclists, and to be instrumental as a lobbying force for motorcyclists.
Although others echoed the Massachusetts decision by using economic utilitarian arguments to reject constitutional challenges to helmet laws, some courts upheld motorcycle statutes on the basis of the narrow ground that helmet use affects the safety of other motorists.26 Additionally, those who identified with the biker culture, including members of outlaw motorcycle gangs and thousands of other men who rode choppers (modified motorcycles with high handlebars and custom detailing), became involved in state-level and national-level groups that advocated the repeal of helmet laws and other limitations to riding motorcycles.27

In its October 1971 issue, Easyriders, a glossy magazine for chopper riders, underscored the need for a national effort.

“You, as an individual, can stand on your roof-top shouting to the world about how unjust, how stupid, and how unconstitutional some of the recently passed, or pending, bike laws are—but all you will accomplish is to get yourself arrested for disturbing the peace. Individual bike clubs can go before city councils, state legislatures, and congressional committees, but as single clubs, and unprofessional at the game of politics, their efforts are usually futile. . . We need a national organization of bikers. An organization united together in a common endeavor, and in sufficient numbers to be heard in Washington, DC, in the state legislatures, and even down to the city councils.28

The article went on to ask for $3 donations to the National Custom Cycle Association, a nonprofit organization established by the magazine. By the following February, the organization had members in 44 states and had changed its name to A Brotherhood Against Totalitarian Enactments (ABATE).29

Other state-level groups, which called themselves motorcyclists’ rights organizations, also began to form around the country. The Modified Motorcycle Association, a group of chopper riders founded in 1973 that eschewed the outlaw behavior of Hells Angels, engaged in both antihelmet law political activity and local campaigns against police harassment of bikers.30

In 1975, these groups began to turn the tide against proponents of mandatory helmet laws. Motorcyclists, who had only thus far been successful in the appellate courts of 2 states and in stopping helmet bills in California, had evolved into an organized and powerful national lobby. In June and again in September 1975, hundreds of bikers descended on Washington, DC, where they rode their choppers around the US Capitol to protest mandatory helmet laws. In the post-Watergate environment, motorcyclists found a newly receptive ear in Congress.31 Representatives of ABATE, the American Motorcycle Association, the Modified Motorcycle Association, and other motorcyclists’ rights organizations were invited to hearings held in July 1975 by the House Committee on Public Works and Transportation to discuss revisions to the National Highway Safety Act.

Recognizing that proponents of motorcycle helmet laws, in the tradition of public health, had used statistical evidence of injury and death to make their case, the first motorcyclist to speak at these hearings, Bruce Davey of the Virginia chapter of ABATE, opened with a frontal attack on such data. He charged that NHTSA had manipulated evidence about the effectiveness of motorcycle helmets. Furthermore, he asserted that helmets actually increased the likelihood of neck injuries.32 Davey then advanced a series of constitutional claims that were rooted in an antipaternalistic ethic, which enshrined a concept of personal liberty, and that bore striking similarity to those that had failed in the judicial arena. In an argument more reflective of cultural attitudes than legal precision, he stated,

The Ninth Amendment [to the US Constitution] says no law shall be enacted that regulates the individual’s freedom to choose his personal actions and mode of dress so long as it does not in any way affect the life, liberty, and happiness of others. We are being forced to wear a particular type of apparel because we choose to ride motorcycles.33

Not surprisingly, the issue of choice emerged as the central theme in the arguments of those opposed to helmet laws, similar to the arguments of women’s reproductive rights advocates. Just as proponents of legalized abortion had argued that they were not pro-abortion but were in favor of a woman’s right to choose whether to terminate a pregnancy, ABATE chapter literature stated “ABATE does not advocate that you ride without a helmet when the law is repealed, only that you have the right to decide.”34

At the end of the hearings, Representatives James Howard (D-NJ) and Bud Schuster (R-PA) said they would support revisions to the National Highway Safety Act that removed the tie between federal funding and state helmet
laws. A bill that included these revisions had already been introduced in the House by Stewart McKinney (R-CT), an avid motorcyclist, who remarked,

My personal philosophy concerning helmets can be summed up in three words. It’s my head. Personally, I would not get on a 55-mile-per-hour highway without my helmet. But the fact of the matter is that if I did, I wouldn’t be jeopardizing anyone but myself, and I feel that being required to wear a helmet is an infringement on my personal liberties.35

The prospect of ending a threat to withdraw highway funds attracted the notice of liberal Senator Alan Cranston (D-CA), who signed on as a cosponsor of a Senate bill introduced by archconservative Senators Jesse Helms (R-NC) and James Abourezk (R-SD). On December 13, 1975, the Senate voted 52 to 37 to approve a bill that revised the National Highway Safety Act. The House passed a similar measure. The revisions were incorporated into a massive $17.5 billion bill for increasing highway funds to the states, and the bill was signed by President Gerald Ford on May 5, 1976.36

HELMETLESS RIDERS: AN UNPLANNED PUBLIC HEALTH EXPERIMENT

During the next 4 years, 28 states repealed their mandatory helmet laws. The consequences of these repeals were most succinctly expressed in the September 7, 1978, Chicago Tribune headline “Laws Eased, Cycle Deaths Soar.”37 Overall, deaths from motorcycle accidents increased 20%, from 3312 in 1976 to 4062 in 1977.38 In 1978, NHTSA administrator Joan Claybrook wrote to the governors of states that had repealed their laws and urged them to reinstate the enactments. She cited studies that showed motorcycle fatalities were 3 to 9 times as high among helmetless riders compared with helmeted riders and that head injury rates had increased steeply in states where helmet laws had been repealed.39

In 1981, the American Journal of Public Health published a counterpoint to Baker’s editorial, which was unusual in that it came from a public health official. Richard Perkins of New Mexico’s Health and Environment Department attacked the argument that the motorcyclist was reducing the freedom of others by not wearing a helmet as “so ridiculous as to be ammunition for the anti-helmet law forces.”42 Noting that there were no helmet laws for rodeo contestants and rock climbers, he argued that laws should consider not only safety but also “such intangible consequences as potential loss of opportunity for individual fulfillment and loss of social vitality.”42

Baker and Stephen Teret offered a rebuttal to Perkins and stated that his argument “implies that if policy is not applied at the outer limits of a continuum of circumstances, it would be unreasonable to apply that policy at any point along the continuum.”43 They defended their reliance on Jacobson v. Massachusetts by pointing out that the decision has been used as a precedent for decisions that cover “manifest” restraints on liberty for the common good beyond the scope of contagious disease.43

During the next decade, evidence of the human and social costs of repeal continued to mount. Medical costs among

“Just as proponents of legalized abortion had argued that they were not pro-abortion but were in favor of a woman’s right to choose whether to terminate a pregnancy, ABATE chapter literature stated ‘ABATE does not advocate that you ride without a helmet when the law is repealed, only that you have the right to decide.’”

“The event was viewed with alarm. In the June 1980 issue of the American Journal of Public Health, Susan Baker, an epidemiologist and director of the Johns Hopkins Injury Prevention Center, compared the situation to one where ‘scientists, having found a successful treatment for a disease, were impelled to further prove its efficacy by stopping the treatment and allowing the disease to recur.’40 Invoking the 1905 US Supreme Court decision in Jacobson v. Massachusetts that upheld compulsory immunization statutes, Baker asserted that the state had the authority to limit individual liberty to protect the public’s health and the rights of others. In a reprise of arguments made a decade earlier when helmet laws were under constitutional attack, Baker emphasized the social burden created by motorcycle accidents and fatalities.41
Helmetless riders increased 200% compared with helmeted riders, and in some states, helmetless riders were more likely to be uninsured.\(^4\) The April 1987 issue of *Texas Medicine* published an editorial entitled “How many deaths will it take?”\(^4\) The editorial exemplified the growing frustration among physicians, epidemiologists, and public health officials with legislatures that failed to act on evidence that showed helmet law repeals increased fatalities and serious injuries. “I invite our legislators and those opposed to helmet laws to spend a few nights in our busy emergency rooms,”\(^4\) wrote the author, who was the chief of neurosurgery at Ben Taub General Hospital in Houston. “Let them talk to a few devastated mothers and fathers of sons with severe head injuries—many of whom will needlessly die or remain severely disabled.”\(^4\)

Posing a challenge to the antipaternalism that had inspired the repeal of laws, he contended, “[a] civilized society makes laws not only to protect a person from his fellowman, but also sometimes from himself as well.”\(^4\)

Other studies adopted a more narrowly economic perspective on the impact of helmet law repeals. In a 1983 article, researchers sponsored by the Insurance Institute for Highway Safety used mathematical models to estimate the number of excess deaths—those that would not have occurred had the motorcyclist been wearing a helmet—in the 28 states that had repealed their helmet laws by 1980. They then conducted an economic analysis of the costs to society as a result of these deaths. This cost calculation incorporated direct costs (emergency services, hospital and medical expenses, legal and funeral expenses, and insurance and government administrative costs) and indirect costs (the value of the lost earnings and services due to the death of the person). The researchers found that the costs totaled at least $176.6 million.\(^4\)

In Europe, meanwhile, where helmet laws were being enacted for the first time, studies were showing an opposite effect. In Italy, where a compulsory motorcycle helmet law went into effect in 1986, a group of researchers compared the accidents in 1 district (Cagliari) during the 5 months before and the 5 months after the law’s enactment. They found a 30% reduction in motorcycle accidents and an overall reduction in head injuries and deaths.\(^4\)

**Helmet Laws in the Congress Once Again**

In May 1989, against a backdrop of 34 states’ adoption of mandatory automobile seat belt laws, Senator John Chafee (R-RI) held a news conference to announce he was introducing a bill—the National Highway Fatality and Injury Reduction Act of 1989—that would empower the US Department of Transportation to withhold up to 10% of federal highway aid from any state that did not require motorcyclists to wear helmets and front-seat automobile passengers to wear seat belts.\(^4\)

The conference was strategically held during a meeting of the American Trauma Society.\(^4\)

A hearing on the bill that was held by the Senate Committee on Environment and Public Works in October 1989 provided yet one more opportunity to engage (in a federal forum) the argument about the potential benefits that would result from the enactment of mandatory helmet laws and the deep philosophical issues such laws raised.\(^5\) As had others before him, Senator Daniel Patrick Moynihan (D-NY) sought to compare the imposition of helmet requirements with the public health justification for compulsory immunization.\(^5\)

Senator James Jeffords (R-VT) responded with an invocation of the antipaternalistic argument so resonant in American political culture.

Would you urge us then, at the Federal level, to mandate diets and to investigate homes as far as diets are concerned? We would save a lot more money if we had good nutrition in this country. Do you think that is a proper role of the government? ... I think there is a vast difference in vaccination, where you are subjecting others to a health problem, ... where you are trying to protect the individual health of someone who is in a sense endangering himself and not the public. I grant the arguments are there on cost, but the arguments are there on cost in nutrition, as well. I have a hard time, philosophically, accepting that the role of the government is to tell us how to lead our lives. Why don’t we have motorcycle riders wear armored suits? Where do you draw the line? It is my understanding that the largest percentage of injuries are not by head, but are injuries to the chest and the abdominal areas and things like that. So where do you stop?\(^5\)

Senator Jeffords’ comments were echoed by Robert Ford, chairman of Massachusetts Freedom First, an auto group that had led a successful campaign to repeal the state’s seat belt law. Ford did not quibble with statistics that showed seat belts make people safer. Instead, he argued that the issue was about fundamental individual liberty.

We do not want to be told how to behave in matters of personal safety. We do not want to be forced to wear seat belts or helmets because others think that it is good for us. We do not want to be forced to eat certain diets because some think that it too may be good for us, reduce...
deaths and medical costs, and make us more productive citizens. We do not want to be forced to give up certain pleasures simply because some may feel they entail any amount of unnecessary risk.

Instead of confronting the moral arguments made by opponents of helmet laws, proponents of such measures sought once again to marshal the compelling force of evidence. In 1991, at the request of Senator Moynihan, the General Accounting Office issued a comprehensive report that documented the toll. The report reviewed nearly 50 studies and found that they overwhelmingly showed helmet use rises and fatalities and serious injuries plummeted after enactment of mandatory universal helmet laws.

Despite the fierce opposition of motorcycle groups, Senator Chafee ultimately succeeded in getting the motorcycle helmet law and seat belt law provisions added to a major highway funding bill that was passed in December 1991. Under the law—which was far less punitive than what Senator Chafee had originally proposed—states that failed to pass helmet laws would have 3% of their highway funds withheld.

**REENACTMENT AND REPEAL**

In 1991, the momentum seemed to be turning in favor of state motorcycle helmet laws. For the first time in its history, California enacted a universal mandatory helmet law, which took effect on January 1, 1992; however, this brief moment of public health optimism was short-lived. In 1995, after the “Gingrich Revolution,” in which conservative Republicans took control of Congress, the national motorcycle lobby succeeded in getting the federal 3% highway safety fund penalties repealed.

In 1997, after pressure from state-level motorcycle activists, Arkansas and Texas repealed their universal helmet laws and instead required helmets only for riders aged younger than 21 years. These repeals were followed by similar actions in Kentucky (1998), Louisiana (1999), Florida (2000), and Pennsylvania (2003). In a move that gave credence to the well-worn claim about the social costs of private choice, several of the new laws required riders to have $10,000 of medical insurance coverage policy before they could ride helmetless.

This new round of repeals of motorcycle helmet laws produced a predictable series of studies, with all too predictable results: in Arkansas and Texas, helmet use decreased significantly, head injuries increased, and fatalities rose by 21% and 31%, respectively. In 2003, a study of Louisiana and Kentucky fatalities found that after repeal of helmet laws, there was a 50% increase in fatalities in Kentucky and a 100% increase in fatalities in Louisiana. In 2005, the Insurance Institute for Highway Safety released a study that showed Florida’s helmet law repeal had led to a 25% increase in fatalities in 2001 and 2002 compared with the 2 years before the repeal.

**CONCLUSIONS**

Over the past 30 years, helmet law advocates have gathered a mountain of evidence to support their claims that helmet laws reduce motorcycle accident fatalities and severe injuries. Thanks to the rounds of helmet law repeals, advocates have been able to conclusively prove the converse as well: helmet law repeals increase fatalities and the severity of injuries. But the antihelmet law activists have had 3 decades of experience fighting helmet laws, and they have learned that their strategy of tirelessly lobbying state legislators can work. As one activist wrote, “I learned that the world is run by those who bother to show up and run it.” More important, they have learned a lesson about how persuasive unadorned appeals to libertarian values can be.

This history of motorcycle helmet laws in the United States illustrates the profound impact of individualism on American culture and the manner in which this ideological perspective can have a crippling impact on the practice of public health. Although the opponents of motorcycle helmet laws seek to shape evidence to buttress their claims, abundant evidence makes it clear—and has done so for almost 3 decades—that in the absence of mandatory motorcycle helmet laws, preventable deaths and great suffering will continue to occur. The NHTSA estimated that 10,838 additional lives could have been saved between 1984 and 2004 had all riders and passengers worn helmets. The success of those who oppose such statutes shows the limits of evidence in shaping policy when strongly held ideological commitments are at stake.

Early on in the battles over helmet laws, advocates for mandatory measures placed great stress on the social costs of riding helmetless. The courts, too, have often adopted claims about such costs as they upheld the constitutionality of statutes that impose helmet requirements. Whatever the merit of such a perspective, it clearly involved a transparent attempt to mask the extent to which concerns for the welfare of cyclists themselves were the...
central motivation for helmet laws. The inability to successfully and consistently defend these measures for what they were—acts of public health paternalism—was an all but fatal limitation.

The recent trend toward motorcycle helmet laws that cover minors, however, shows that legislators and some antihelmet law forces have accepted a role for paternalism in this debate. The need for a law that governs minors shows a tacit acknowledgment that (1) motorcycle helmets reduce deaths and injuries and (2) the state has a role in protecting vulnerable members of society from misjudgments about motorcycle safety. Ironically, then, it is the states within which the motorcycle lobby has been most effective that have most directly engaged paternalist concerns.

The challenge for public health is to expand on this base of justified paternalism and to forthrightly argue in the legislative arena that adults and adolescents need to be protected from their poor judgments about motorcycle helmet use. In doing so, public health officials might well point to the fact that paternalistic protective legislation is part of the warp and woof of public health practice in America. Certainly, a host of legislation—from seat belt laws to increasingly restrictive tobacco measures—is aimed at protecting the people from self-imposed injuries and avoidable harm.

With the latest round of helmet law repeals, motorcycle helmet use has dropped precipitously to 58% nationwide, and fatalities have risen.62 Need anything more be said to show that motorcyclists have not been able to make sound safety decisions on their own and that mandatory helmet laws are needed to ensure their own safety? ■

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Contributors
R. Bayer originated the study. M.M. Jones conducted historical research. The authors co-wrote the text.

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Human Participant Protection
No protocol approval was needed for this study.

Endnotes
14. “Compliance with the 1992


19. American Motorcycle Association v. Department of State Police, supra.

20. American Motorcycle Association v. Department of State Police, supra, at 357.


23. Ex parte Smith, 441 S.W.2d 486 (1970) at 489.


29. For more on the more activist political policymakers role of Congress during the Ford administration, see Thomas E. Croun, “A Resurgent Congress and the Imperial Presidency,” Political Science Quarterly. 95 (1980): 209–237.


36. Peterson, “Motorcyclists, Helmeted or Not, Fight Restrictions of State Helmet Regulation,” Jones and Bayer | Peer Reviewed | Public Health Then and Now | 217
The Polio Epidemic in Israel in the 1950s

THE FIRST GOVERNMENTAL rehabilitation services for children in Israel were created in the 1950s as a result of the polio epidemic of that period. The first physiotherapy school and the first government rehabilitation center for children in Israel were created in 1953 and 1954, respectively. Much of the support for these institutions came from international organizations: the World Health Organization (WHO) and UNICEF.

The need for rehabilitation services had been recognized for some time as a result of immigration and the War of Independence, which lasted from 1947 to 1949. On May 15, 1948, after the British had withdrawn their forces and administration, Israel was declared an independent state. A major priority for the new state was the encouragement of Jewish immigration into Israel, as formulated in their Declaration of Independence: “The state of Israel will be open for Jewish immigration and for bringing in the exiles.”

The absorption of a huge wave of immigration brought a significant increase in the sick and disabled population. The new immigrants were a heterogeneous group, including young and old, healthy and disabled, survivors of the concentration camps in Europe, and immigrants from Muslim countries. In addition, the War of Independence had resulted in a large number of disabled soldiers. By June 1956, the Jewish population had almost tripled. The massive numbers of disabled individuals forced the young state to focus attention on the problem of rehabilitation. Policy- and decision-makers recognized the need but did not have the resources to provide adequate rehabilitation services.

A large outbreak of polio in the 1950s led to a general realization of the huge unanswered need for rehabilitation services. The disease carried a 10% to 12% mortality rate and a 30% rate of permanent paralysis. By 1956, the number of children disabled by polio had increased to 1750; 85% to 90% of affected children were aged younger than 5 years.

These children needed rehabilitation services, such as physiotherapy and occupational therapy. At that time, one could count the number of professional occupational therapists and physiotherapists in Israel on 2 hands. The Israeli government, WHO, and UNICEF worked together to formulate a plan called “The Plan of Operation for the Rehabilitation of Handicapped Children, Israel,” and signed an agreement in the summer of 1951. The objectives of the program included establishing a general rehabilitation center for disabled children, employing modern methods of physiotherapy in the treatment of disabled children, and establishing a national school of physiotherapy.

The Israeli physiotherapy school was founded on December 8, 1953; local news:2. The development of widespread rehabilitation services in Israel.

After 1956, there was a significant decline in the polio epidemic in Israel because of successful administration of the polio vaccination. Thus, the rehabilitation center in Assaf Harofe began treating children with other forms of neurological diseases, such as cerebral palsy. This was the beginning of the development of widespread rehabilitation services in Israel.

Requests for reprints should be addressed to Nava Blum, PhD, School of Public Health, Haifa University, Mount Carmel, Haifa 31905, Israel (e-mail: navablum@hotmail.com). doi:10.2105/AJPH.2006.103986

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5. The opening of physical therapy school in Israel. Davar [newspaper]. December 8, 1953; local news:2.

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Current Priorities in Health Research Funding and Lack of Impact on the Number of Child Deaths per Year

We determined the proportion of research on childhood mortality directed toward better medical technology (i.e., by improving old technology or creating new technology) compared with research on technology delivery and utilization. We also estimated mortality reductions from a research-funding strategy focusing primarily on developing technology compared with one that also focused on delivery and utilization.

Ninety-seven percent of grants were for developing new technologies, which could reduce child mortality by 22%. This reduction is one third of what could be achieved if existing technologies were fully utilized.

There is a serious discrepancy between current research and the research needed to save children’s lives. In addition to increased research on the efficacy of treatment, there is an even greater need for increased research on delivery and use of technology. (Am J Public Health. 2007;97:219–223. doi:10.2105/AJPH.2005.083287)

AN INVESTIGATION undertaken in 2003 for the Bellagio Conference on Child Survival showed that the vast majority of deaths of children younger than 5 years, about 10 million per year, occurred in 42 low-income countries. The Bellagio Conference concluded that about two thirds of these could be prevented by interventions currently available and feasible for implementation in these countries. Other articles from the conference indicated that the systems for delivering these technologies are seriously deficient and that their utilization is inadequate, especially among the poor.

Before the Bellagio Conference, the international Commission on Health Research for Development drew attention to the imbalance in research addressing ill health in developing countries compared with research on health issues of populations in wealthy, industrialized countries. The critical finding from the commission report was that 90% of all research funding for health was devoted to the health problems of industrialized countries, whereas only 10% was for research on the health issues of low-income countries. This issue has received considerable public attention, and the imbalance is now widely referred to as the “10/90 gap.”

The findings from the Bellagio Conference and global disparities in the allocation of research resources for health issues of populations in developing countries raise other questions about current research priorities: how much research is being directed toward breaking the bottlenecks in delivery and utilization that prevent existing technology from reducing child mortality? If, as we suspect, little such research is performed, how great a reduction in mortality can be expected from new health technologies in the future, given present conditions of utilization and delivery?

We first examined the evidence for another “gap,” namely that between research investments in biological and clinical technology and research investments in delivery and utilization. Second, we estimated mortality reductions from a research funding strategy focusing primarily on the development of better health technologies compared with a strategy also focusing on delivery and utilization. These investigations were based on the premise that research leading to the development of better health technologies will not automatically be delivered to and used by the children who need them. Achieving improvements throughout this process, from basic scientific discoveries to their utilization, requires scientific research.

Applied operations research in the context of health and welfare programs is generally considered to be a national responsibility, but research to obtain general knowledge through theory development and its testing in practice is a global responsibility.

METHODS

To determine the extent to which funded research grants on the causes of childhood mortality in developing countries focused on the development of better health technology versus improvements in health care delivery and utilization, we examined the allocation of research by the National Institutes of Health (NIH) and the Bill and Melinda Gates Foundation, which are the largest public and not-for-profit sources of funds for health research, respectively. We reviewed the research grants funded by both institutions between 2000 and 2004 relating to the major killers of preschool children in developing countries.

Using the Computer Retrieval of Information on Scientific Projects system (CRISP), we searched the NIH Web site for funded studies, employing key words and phrases to identify grants in the system (Table 1). The CRISP database is maintained by the Office of Extramural Research. We reviewed P (Research Program Projects and Centers), R (Research Projects), and S (Research-Related Program) grants, excluding grants that could not be classified as earmarked for research. Grants with the following numbers were excluded: P30 (center core grants), P41 (biotechnology resource grants), P51 (primate...
TABLE 1—Key Words and Phrases Used to Identify Grants in CRISP system

<table>
<thead>
<tr>
<th>Disease or Condition</th>
<th>Key Words and Phrases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diarrhea</td>
<td>Diarrhea*</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>Pneumonia*</td>
</tr>
<tr>
<td>Malaria</td>
<td>Malaria*</td>
</tr>
<tr>
<td>HIV/AIDS</td>
<td>(HIV* &amp; maternal*), (HIV* &amp; mother*), (AIDS* &amp; maternal*), (AIDS* &amp; mother*), (breastfeeding* &amp; HIV*), (breast* &amp; feeding* &amp; HIV*), (breastfeeding* &amp; AIDS*), (breast* &amp; feeding* &amp; AIDS*)</td>
</tr>
<tr>
<td>Measles</td>
<td>Measles*</td>
</tr>
<tr>
<td>Birth asphyxia</td>
<td>Birth* &amp; asphyxia*</td>
</tr>
<tr>
<td>Sepsis</td>
<td>(Penatal* &amp; sepsis*), (neonatal* &amp; sepsis*)</td>
</tr>
<tr>
<td>Preterm</td>
<td>Preterm*</td>
</tr>
<tr>
<td>Tetanus</td>
<td>Tetanus*</td>
</tr>
<tr>
<td>Undernutrition</td>
<td><strong>Complementary feeding</strong>, <strong>complementary food</strong>, Micronutrient*, <em>micro nutrient</em>, Malnutrition*, <em>under nutrition</em>*</td>
</tr>
</tbody>
</table>

Note. CRISP = Computer Retrieval of Information on Scientific Projects; * = truncation.

TABLE 2—Potential for Decreasing Mortality Among Children Aged Younger Than 5 Years in the 42 Countries That Account for 90% of Such Deaths Worldwide

<table>
<thead>
<tr>
<th>Cause of Mortality</th>
<th>Cause-Specific Deaths That Could Be Averted, %</th>
<th>Potential Deaths Averted as Proportion of All Deaths, %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Percentage With Efficacy of Technology With Utilization</td>
<td>Percentage With Efficacy of Technology With Utilization</td>
</tr>
<tr>
<td></td>
<td>Improving Utilization</td>
<td>Improving Efficacy</td>
</tr>
<tr>
<td>---------------------</td>
<td>----------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>62.5</td>
</tr>
<tr>
<td>Diarrhea</td>
<td>22</td>
<td>88</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>21</td>
<td>65</td>
</tr>
<tr>
<td>Malaria</td>
<td>9</td>
<td>91</td>
</tr>
<tr>
<td>HIV/AIDS</td>
<td>3</td>
<td>48</td>
</tr>
<tr>
<td>Measles</td>
<td>1</td>
<td>100</td>
</tr>
<tr>
<td>Birth asphyxia</td>
<td>10</td>
<td>39</td>
</tr>
<tr>
<td>Sepsis</td>
<td>8</td>
<td>94</td>
</tr>
<tr>
<td>Preterm</td>
<td>8</td>
<td>59</td>
</tr>
<tr>
<td>Tetanus</td>
<td>2</td>
<td>81</td>
</tr>
<tr>
<td>Other neonatal</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Other postneonatal</td>
<td>10</td>
<td>0</td>
</tr>
</tbody>
</table>

*Calculations based on data are from Jones et al.1
1Method of calculation is explained in “Methods” section (equation 2).
2Percentages from second column multiplied by percentages from third column.
3Percentages from second column multiplied by percentages from fourth column.

research center grants), P60 (comprehensive center), R13 (conferences), S10 and S11 (biomedical research support), S21 (capacity building), and S22 (educational program). We also excluded all grants whose online abstracts did not provide enough information to enable their classification, as well as grants identified by our key words but clearly not related to the health of children in developing countries (e.g., “smoking and ethanol-induced defects in pneumonia defense”). We reviewed the Bill and Melinda Gates Foundation Web site for Global Health Grants.8 Because the site does not support a keyword search, all grant descriptions were evaluated.

To code the information, we set up a simple classification system for the objectives of each study: (1) category A, predelivery research; (2) category B, efficacy trials; (3) category C, diagnosis; or (4) category D, delivery and utilization research. Predelivery studies (category A) were classified as those studies aimed at the identification and characterization of diseases and conditions, the description of their clinical and functional impact, or the development of preventive or curative technologies. We counted efficacy trials (category B) separately because they often could not be clearly classified as either category A or D. The rationale for creating a separate category for diagnosis research (category C) was that the delivery of health care often requires diagnosis. Most of the diagnosis research funded by the NIH appeared to be of little relevance to child health in developing countries but might have future relevance, and these studies were therefore separated from other categories.

When a grant investigated more than 1 category, we refer to the category sums as if they were the sums of the grants.

To determine the probable impact on child mortality of continuing to focus future research primarily on developing better technologies compared with expanding the scope of research on improving the delivery and use of current technology, we began with a list of the major causes of child mortality (Table 2, first column) and the proportion each contributed to total mortality (second column) according to Black et al.6 In principle, mortality could be reduced by expanding the use of existing technology, developing new, more effective technologies, or by a combination of the 2 approaches.

For each disease and condition in Table 2, Jones et al.1 identified available technologies that were potentially feasible for widespread delivery in low-income countries and ascertained their efficacy in reducing mortality. Missing from Table 2 is malnutrition, which accounted for more than half of postneonatal child deaths because it increases mortality from infectious diseases.9–11 It would therefore be more appropriate to show the proportion of all deaths caused by malnutrition in the second column of Table 2. The high proportion of children whose lives could be saved by preventing malnutrition highlights the importance of nutrition interventions in the armamentarium of strategies to reduce mortality. For the sake of consistency with previous publications, however, we have retained the original list (without malnutrition).
Building on the work of Jones et al.,1 we then estimated how many child deaths in the 42 low-income countries identified in the Bellagio Conference could have been averted by developing better technologies if they were used at the rates then used for existing technologies. These averted deaths were calculated using equation 1:

(1) See equation box.

The “affected fraction” in equation 1 indicates the proportion of deaths for each cause that could be averted with a specific technology. For example, vitamin A was assumed to have an effect only on children aged 6 to 59 months who were deficient in this vitamin.3 We used equation 1 sequentially for all technologies that addressed the same cause, applying the equation to the remaining cause-specific mortality as shown in the product term of equation 2. This equation was used to calculate the proportion of total cause-specific child deaths that could be averted by improving efficacy and holding utilization constant. The Π (1 – deaths prevented) part of the equation ensures that children’s lives are counted as saved only once.

(2) See equation box.

With \( M_c \) = cause-specific mortality in country
\( CU_{tc} \) = current utilization of technology \( t \) in country \( c \)
\( TE_t \) = target efficacy of technology \( t \)
\( CE_t \) = current efficacy of technology \( t \)
\( AF_{tc} \) = affected fraction specific to technology \( t \) and country \( c \)
\( n \) = total number of cause-specific treatments

Proportion of deaths from a specific cause that is prevented by a single technology

\[
\text{Proportion} = \frac{\text{Cause - and technology - specific mortality prevented by improving efficacy holding utilization constant}}{\text{Total cause - specific mortality}}
\]

\[
= \frac{(\text{target efficacy} \pm \text{current efficacy}) \times \text{current utilization}}{(\text{current utilization} \times [1 \pm \text{current efficacy}]) \times \text{affected fraction of children}}
\]

Equation 1

\[
\sum_{c=1}^{42} \left[ M_c \times \left[ \frac{1 \pm \left( \frac{TE_t - CE_t}{CU_{tc}} \right) \times CU_{tc}}{1 \pm \left( \frac{1 + CE_t}{1 + CU_{tc}} \right)} \times \frac{AF_{tc}}{n} \right] \right]
\]

Equation 2

To calculate the proportion of deaths relative to total deaths that could have been averted with technology that was 100% effective if it were delivered and used at existing rates, we multiplied the proportion calculated with equation 2 by the cause-specific proportion of all deaths. Of the 994 NIH grants identified by the search, 649 were deemed relevant. Of these grants, 625 were classified in category A (predelivery research), 24 in category B (efficacy trials), 19 in category C (diagnostics research), and 17 in category D (delivery and utilization). The proportion of grants funded by the NIH on delivery and utilization issues (3%) was very low compared with the rest of research relevant to the diseases and conditions that kill children in developing countries.

In summary, from 2000 to 2004 most of the research grants awarded by the NIH and Bill and Melinda Gates Foundation went to predelivery research, whereas no more than 3% of NIH grants and 23% of Bill and Melinda Gates Foundation grants were pertinent to research on delivery and utilization. Given that the total budget appropriated by the NIH in 2001 was more than 40 times larger than the total research resources provided by the Bill and Melinda Gates Foundation, the proportion of research on health care delivery and utilization is much closer to the 3% estimate. The relative funding of health research from other agencies (such as bilateral and multilateral donors) was small compared with the combined budgets of the Bill and Melinda Gates Foundation and the NIH, although the proportion allocated to research on delivery and utilization by these agencies was likely to be higher because of their mission. This is more than counterbalanced by the fact that half of all health research is funded by the private sector, which has little incentive to invest in research on health care delivery and utilization because the results cannot be patented. The fourth column in Table 2 shows our estimates of the proportion of deaths, by cause, that could have been averted by improving the efficacy of technology to

In 2001, an estimated US$106 billion was spent globally on health research and development, roughly half of which came from the public sector. The US government alone spent US$28.6 billion, or almost three fifths of global public sector expenditures. Over 70% of the US government’s expenditure (US$20.5 billion) was provided by the NIH. Among the not-for-profit sources of funding for global health initiatives (including health research), the Bill and Melinda Gates Foundation was by far the top funder.12 The 2 institutions thus represent an influential proportion of research funding for health in developing countries.

RESULTS

In 2001, an estimated US$106 billion was spent globally on health research and development, roughly half of which came from the public sector. The US government alone spent US$28.6 billion, or almost three fifths of global public sector expenditures. Over 70% of the US government’s expenditure (US$20.5 billion) was provided by the NIH. Among the not-for-profit sources of funding for global health initiatives (including health research), the Bill and Melinda Gates Foundation was by far the top funder.12 The 2 institutions thus represent an influential proportion of research funding for health in developing countries.

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100%. The sixth column, which is the product of the second and third columns, presents the proportion of deaths relative to total deaths that could have been averted with technology that was 100% effective if that technology were delivered and used at existing rates. The sixth column sums to 21.5%, which is the percentage of all child deaths per year (i.e., 2 million) that would be prevented by optimizing the efficacy of technology alone.

Comparing the third and fourth columns shows that for each cause of death, improving the efficacy of health technology would save considerably fewer lives than improving the delivery and use of existing technology. For some causes of death, the sum of these 2 columns is more than 100%. This is because a child’s life could be saved by either increased efficacy or increased use of technology if either were improved and could not be saved twice if both were improved simultaneously. The very limited effect of improving the efficacy of technology on lowering mortality rates from HIV/AIDS or birth asphyxia is a consequence of the low availability of the technologies addressing these causes.

DISCUSSION

We made some approximations and assumptions to calculate our estimates. For example, because of the limited information available on the Bill and Melinda Gates Foundation Web site for Global Health Grants, a small number of grants may have been misclassified. In the calculations of relative impact on mortality rates, we assumed conditions of ideal utilization and maximally efficacious technology. Would changing this approximation or assumption significantly alter the results? The magnitude of the differences is so large that even major changes in the estimates would have little effect on the conclusion that there is a major imbalance between the proportion of lives that could be saved by improving delivery and use of health technology compared with creating new technology (62.5% and 21.5%, respectively) and the relative proportion of grants funded in the 2 areas (3% and 97%). We call this latter imbalance the “3/97 gap.”

The analyses presented in Table 2 raise serious questions about the wisdom of continuing the current funding policy. On the one hand, the benefits that have accrued from past investments in health technology research are clear. Future investments will continue to bear fruit, and it is critical that such investments continue. On the other hand, the effects of the failure to invest in research on delivery and implementation are also clear. Extrapolating to the future, it appears that only one fifth of child deaths per year (i.e., 2 million) are likely to be prevented by continuing to improve health technology alone. This figure is in sharp contrast to the 6 million deaths per year that could be prevented by optimizing the delivery and use of currently available technology.

The rationale for our proposition—that increasing research on the delivery and use of health technologies will make it possible to realize the potential of current technologies—is based on several arguments. First, the current problems in delivery and utilization are not inherent in the technologies themselves. Second, although a lack of adequate economic investment is an important factor, the current problems in utilization and delivery are not wholly because of a lack of economic investments to ensure their availability. Finally, research on delivery and use of technology can yield insights that lead to new strategies for identifying and breaking the bottlenecks that prevent current technologies from achieving their potential.

Regarding the first argument, there is ample evidence to support the proposition that the vast majority of currently available safe and effective technologies can be delivered and utilized. Across the world, health care workers with limited education and minimal training have been taught to safely inject antibiotics and oral measles vaccine and vitamin A capsules safely has not been a significant barrier to the delivery of these life-saving technologies. What has proved much more difficult has been the logistics of the delivery of supplies and deployment of personnel, and the systematic application of these technologies through health services and other channels.

There is strong evidence that families can use currently efficacious life-saving technologies when they receive appropriate teaching and support. Moreover, when families use these technologies—for example, packaged or home-prepared oral rehydration therapy or other home-prepared fluids to help control diarrhea—the results are reduced mortality rates; this has been shown for diarrheal disease on all continents. Programs to encourage and support breastfeeding provide another example of critical life-saving “technology.” Such programs have not encountered insurmountable technical barriers and have been successful in promoting exclusive breast-feeding in populations not normally practicing it. Even malnourished women can exclusively breastfeed, at least for 4 months, when they are given minimal counseling.

The second argument, that problems of delivery and utilization are not wholly caused by lack of economic resources, rests on interpretation of the word wholly. On the one hand, increasing health sector funding would have major, positive effects on reducing mortality. On the other hand, there is evidence that countries with similar levels of economic development and health expenditures have substantially different levels of health. It can therefore be inferred that factors other than economic resources are making the difference. These factors range from culture, governance, and the political will to use the resources well to bureaucratic and market structures delivering the interventions to household and individual behavior in both accessing interventions and complying with good health practices.

The third argument is the proposition that problems in these aspects of health care are inherently researchable, that there are research methods presently available to address them (e.g., see Gove et al.), and that such research provides insights and guidance on breaking the bottlenecks that prevent current technologies from achieving their potential. There is substantial evidence from research by medical anthropologists, sociologists, and nutritionists documenting the potentially modifiable social, cultural, and behavioral
barriers impeding the full and effective delivery and utilization of these and other existing technologies.\textsuperscript{24–27} Moreover, there is also clear evidence that delivery and utilization can be significantly improved through appropriate interventions.\textsuperscript{28–30}

There is substantial technical capacity to address these issues in the fields of social science and public health research, although development of a critical mass of investigators is urgently needed. The research agenda would focus not only on obtaining a better understanding of why the policy decisions and bureaucratic and household behaviors do not conform to expectations but also on developing theoretical frameworks that inform—and are informed by—intervention. An additional argument for increasing research on the delivery and use of technology is the probability that new technologies will encounter the same barriers that have prevented current ones from achieving their potential. Research that leads to better delivery and use of current technologies will facilitate the planning and implementation of activities to introduce and institutionalize new technologies.

**CONCLUSIONS**

Our quantification of research grant allocation shows that within the general research disparity articulated in the 10/90 gap is another serious, complicating gap. Only a small proportion of funded research designed to help reduce child mortality is directed towards doing so in low-income countries, and very little of that research concerns health care delivery and utilization. It is time to also recognize the “3/97 gap” and begin to take steps to correct it by investing adequate resources for research on the delivery and use of technology to help reduce the remaining burden of childhood mortality.

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**Contributors**

All authors participated in the conception of the study, the interpretation of the data, and the writing of the manuscript. J. L. Leroy was responsible for the data analyses.

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**Human Participant Protection**

No human subjects were involved in the study.

**References**


Framing the Public Health of Caregiving

Caregiving has only recently been acknowledged by the nation as an important topic for millions of Americans. A psychological or sociological approach to caregiving services has been most often applied, with little attention to the population-based public health outcomes of caregivers.

We conceptualize caregiving as an emerging public health issue involving complex and fluctuating roles. We contend that caregiving must be considered in the context of life span needs that vary according to the ages, developmental levels, mental health needs, and physical health demands of both caregivers and care recipients. (Am J Public Health. 2007;97:224–228. doi:10.2105/AJPH.2004.059337)

THE GOAL OF PUBLIC HEALTH in the United States is to promote healthy individuals living in healthy communities, pursuing quality of life rather than simply absence of disease. The Institute of Medicine designates the general functions of public health as assessment, policy, and assurance. Quality research is an integral part of each of these endeavors. Typically, whereas the funding and authority for public health initiatives come from the federal government or state governments, communities deal with most of the burdens and practicalities of public health issues.

Caregiving has become an issue that affects the quality of life for millions of individuals and demands attention from every community. Historically, scientists and practitioners alike rarely thought of caregiving as a public health matter. Studies on caregiving often focused on social and psychological dimensions, primarily on the stress associated with caregiving. However, over the past 25 years, considerable scholarship has addressed multiple dimensions of caregiving. Pioneering work by Shanas, Sussman, and Brody helped map an understanding of those who provide care and the richness and paucity of caregiving relationships. More recent investigations have addressed coping strategies and the demands of caring for people with dementia, and a growing body of literature has focused on health concerns associated with caregiving such as illness and caregiver burden.

However, even with this abundance of relatively new research, surprisingly little attention has been focused on framing caregiving from a public health standpoint. Therefore, we sought to conceptualize caregiving as an emerging public health issue, with the contention that there is considerable overlap in the individual needs of caregivers—the foundation of an enormous system of care in the United States and around the world—and the public health needs of many communities and their members.

DEMOGRAPHIC AND HISTORICAL FORCES

As the nature and functions of caregiving have evolved, it has become a critical and salient issue in the lives of individuals in all demographic categories. In the 19th and early 20th centuries, caregiving was typically short term. In 1900, before antibiotics were introduced, many people died before reaching the age of 45 years from infection-related complications. Today, average life expectancy in the United States is approaching 80 years, and most people die of complications resulting from chronic conditions. Improvements in medicine and technology have not only ensured longer lives but also dramatically increased the need for long-term caregiving.

Within the US health care system, a shortage of nurses and other health care workers has been accompanied by increasing costs associated with hospitalization and long-term care, leading to patients with involved care needs being discharged from hospitals more rapidly than in the past. In addition, recent medical advances are saving the lives of thousands of infants who will require lifelong care for disabilities or chronic illnesses. Since the 1960s, there has been a movement away from institutionalization and a push to provide care for individuals within the community. The Supreme Court's 1999 Olmstead decision encouraged this trend, mandating that states provide care for the elderly and individuals with disabilities in the least restrictive environment possible.

As a result of such pressure from the health care system and the courts, dependence on family and other sources of caregiving has reached a peak. In the past, the overwhelming majority of caregivers were women who were not employed outside the home. Today, women make up half of the workforce but continue to face the bulk of caregiving responsibilities. In addition, many working women are caring simultaneously for their children and their parents, and this and other variations of intergenerational care are placing increasing pressure on the home care system that women anchor. With myriad responsibilities, family caregivers need and deserve support from the nation’s public health system to maintain their own health.

The “graying” of the baby boom generation, whose members began to turn 50 years old in 1996, will drive future caregiver needs and caregiving solutions. Baby boomers are projected to live longer than any
previous generation, and the number of people aged 65 years or older is expected to double between 2000 and 2030. Elderly people will also increase as a proportion of the population, and people aged older than 85 years will be the fastest growing segment of that group. Other dynamics within the older population suggest more intensive caregiving demands as well. For example, today’s increased life expectancies mean that many 65-year-olds will be caring for their 90-year-old parents.

One of the miracles of the 20th century was the increase in life expectancy among people with disabilities. For instance, first-year survival rates of children with Down syndrome increased from 50% during 1942 to 1952 to 91% during 1980 to 1996, and people with this disability are now living into old age. Similarly, prior to World War II, the average life expectancy for someone with a spinal cord injury was 14 months. Today people with spinal cord injuries can expect to live relatively long lives. For most of our history, parents outlived their disabled children; that is no longer the case.

PUBLIC HEALTH FUNCTIONS

The framework outlined in *The Future of Public Health*, which identified a variety of public health functions at the local, state, and national levels, is instructive for conceptualizing caregiving in the public health arena. As noted earlier, a major function of public health is to create the scientific foundation necessary to inform policies and interventions. Public health science often involves epidemiological investigations addressing the magnitude, characteristics, and distribution of a given problem as well as health disparities and determinants of health.

A 2004 national survey conducted by the National Alliance for Caregiving (NAC) and the American Association of Retired Persons (AARP) gathered population-based data on characteristics of caregiving and caregivers in the United States. The survey results showed that 21% of people aged older than 18 years were caregivers, representing 44.4 million Americans. Seventy-nine percent of care recipients were aged 50 years or older; 20% were aged 18 to 49 years. Duration of care averaged 4.3 years.

The joint NAC and AARP study defined 5 levels of caregiving. “Level 1” caregivers devoted relatively few hours each week (a mean of 3.5) to providing care and provided no care in the form of help with activities of daily living (ADLs). “Level 5” caregivers were those with the heaviest burden (a mean of 87.2 hours per week), providing help with at least 2 ADLs and more than 40 hours of care each week.

Intensity of care provided predicted a number of problems related to health. For example, 35% of level 5 caregivers reported their health as fair or poor, compared with 12% of level 1 caregivers. Also, level 5 caregivers were more likely to report significant physical strain than were level 1 caregivers (46% vs 3%). Finally, level 5 caregivers were 4 times more likely than were level 1 care-

A young boy and his sibling walk around a camp for internally displaced persons (IDPs) at the Paico IDP camp in Gulu, Uganda. Nearly 2 million people have been forced to flee their homes and up to 12,000 people have been killed in 2 decades of fighting during Northern Uganda’s civil war. Photograph by Jeff Hutchens.
givers to report significant emotional strain.

Although the joint NAC and AARP investigation provides sound national data, there is a lack of knowledge about variations in caregiving health effects from state to state. Because rates of disability vary considerably between states, and because elderly populations are increasing rapidly in some states, it is reasonable to expect that caregiving demands would mirror that study’s findings by increasing proportionately.

The health of both caregivers and care recipients has been very much on the minds of investigators. It has been shown, for example, that the chief risk of institutionalization is not a decline in the health of care recipients but a decline in the health of family caregivers themselves.27 It has also been shown that individuals with good sources of caregiving support are less likely to be institutionalized than care recipients without such support.28 Absence of family caregiving is a leading predictor of institutionalization. In addition, studies indicate that levels of disability are much higher among individuals who are institutionalized than among those who are not.

Furthermore, several recent studies have confirmed disparities in health and preventive health practices among caregivers, with caregivers who provide more intense caregiving services appearing to be at greater risk. For example, Shaw et al.29 found that caregivers experiencing the physical stress of caring for family members with Alzheimer’s disease who required assistance with ADLs reported poorer health than did family members dealing with the psychological stress presented by the disease.

Schulz et al.11 and Schulz and Beach22 examined the results of the Caregiver Health Effects Study, which focused on caregivers reporting mental and physical strain associated with caregiving. In comparison with those who did not report strain, those who reported strain were 9-times more likely to report not having enough rest, 5-times more likely to report not having enough time to exercise, and 10-times more likely to report not having enough time to rest when they were sick. In a companion study, Burton et al.23 found that spouses caring for a disabled partner were less likely than spouses not caring for a disabled partner to engage in preventive health behaviors, including getting enough sleep, taking time to recuperate, exercising, eating regular meals, keeping medical appointments, obtaining flu shots, and refilling medicines.

Whereas caregiver morbidity is a primary public health concern, caregiver mortality is also an issue in assessments of end-of-life care. Christakis and Iwashyna24 showed that caregivers whose spouses received hospice care were less likely to die after their spouse’s death than those whose spouses did not receive hospice care. For example, 5.4% of bereaved wives died within 18 months of the death of their husbands when their deceased husbands did not use hospice; 4.9% died when their husband did use hospice.21,29,46,50 Such statistics reflect the need for caregiver support and interventions throughout the caregiving experience and beyond.

As noted earlier, many families struggle with caring for children with disabilities because these children are typically living longer. As with all care situations, there are obviously many dimensions of providing care for a child with a disability. One involves changing expectations and roles; such experiences are well documented, but we need to be mindful that the nature of providing care for children with disabilities is fluid and dynamic.

“Normal” expectations regarding these children’s feeding, clothing, and learning behaviors may be complicated when they do not reach milestones and exhibit ADL limitations as they grow older. As an example, unlike many 4-year-olds without disabilities, 4-year-olds with disabilities may not be able to dress themselves.

However, the youth of the parents and the child can be a protective factor early in the child’s life. The parents may be aged 30 years, the child aged 5 years, and the grandparents aged in the 60s. Conversely, 20 years later, the 5-year-old is aged 25 years old, and the parents are aged in the 50s and perhaps caring for their own parents, now aged in the 80s. Families caring for children with disabilities face ongoing adjustments and ongoing stresses, and such situations need further study to frame intergenerational care and disability issues from a public health point of view.

ROLE OF PUBLIC HEALTH IN CAREGIVING

Framing caregiving as a public health issue gives rise to a number of central concerns. First, caregiving is a life span experience, often associated with aging and the roles of spouses and adult children. Although there is, of course, great variability in caregiving experiences, many parents provide care to their children with disabilities, many adult children provide care to their frail or disabled parents, many husbands and wives provide care to their disabled spouses, and child caregivers may provide assistance to their siblings, parents, or grandparents. Thus, caregiving can take a lateral, upward, or downward form.

Second, each experience involves multiple health dynamics. It is our assertion that if the caregiver is healthy, the quality of life of the care recipient will be substantially improved. Conversely, a failure in the health of the caregiver may mean that fragile support systems collapse. In many respects, physical and mental health may be at the core of successful caregiving. For example, in the case of a wife whose husband has a terminal illness, the stress of years of providing care may reach a threshold beyond which, however strong and well meaning, she may face chronic health threats associated with caregiving.24 We also contend that the better their health, the more likely caregivers are to sustain their caregiving roles. This hypothesis applies to caregiving roles ranging from caring for a young child to caring for an elderly individual. Intense caregiving lends itself to a variety of public health concerns. For example, caregivers may not obtain routine health care or undergo health screenings, and thus they may encounter health problems that could have been averted. They may become depressed because of the overwhelming demands of caregiving. Or they may exhaust themselves providing transportation in the local community or as the long-distance caregiver of a family member or friend.

The situations just described may contribute to poorer health for the care recipient as well. For instance, if the caregiver falls
when moving the care recipient, both may be injured. If the caregiver is depressed or lacks energy and resilience, the care recipient may not get out of the house to participate in social activities, thus reducing his or her quality of life.

MOVING TO A SYSTEMIC VIEW WITHIN PUBLIC HEALTH

Over the past decade, a conceptual model of care that depicts the complex and often reciprocal nature of the care relationship has been refined. This model, which takes into account the strengths and needs of all care partners, features a triadic relationship among the family caregiver, the care recipient, and the professional caregiver. All 3 roles are acknowledged and valued in terms of associated responsibilities and needs. Each party brings to the equation a dedication to participate as a respectful and valuable care team member. Of course, more than one family caregiver or professional caregiver can be and often is involved in care coordination or provision. The triadic model of caregiving allows for recognition of current and potential care partners and their resources in planning for care provision.

We have reconceptualized the care triad within a complex system of variables that influence provision of support or services to caregivers and care recipients (Figure 1). Relationships among family caregivers, professional caregivers, and the care recipient are embedded in the triad’s framework of prominent forces affecting health and well-being. These forces can include societal, political, and scientific issues that shape the context of care, such as global disease burden, demographic changes, health insurance coverage, and scientific discoveries. Within this framework, the care triad deals with a variety of internal as well as external variables that facilitate or inhibit the care situation, enhancing the chances for success or hindering them.

We have identified health dimensions and consequences among family caregivers, professional caregivers, and care recipients, but we have not yet framed the experience of caregiving over the life span as a public health concern. If we were to think about caregiving as residing in the domain of public health, what might be some logical questions? What specific steps would be needed to integrate caregiving into the public health agenda?

First, surveillance and epidemiology are significant functions of public health, and they are concerns of central importance to those attempting to develop policies and practices for caregivers. At present, we have only fragmented population-based knowledge about numbers and characteristics of caregivers. Moreover, we have virtually no knowledge about caregivers at the state level, where policies and programs are generally implemented.

Second, an examination of the characteristics of caregivers would allow us to identify disparities in health between those who do and do not provide care. Moreover, an exploration of health dimensions might allow us to better understand care recipients’ health status, needs, and circumstances.

Third, core definitions of public health center on the use of scientific knowledge to develop and disseminate interventions intended to improve the health of various constituencies. In this case, can public health develop community-based interventions and affect national policies designed to improve the health of caregivers? And can improved caregiver health result in improved health of care recipients?

An additional part of the public health agenda involves promoting programs, services, and solutions for the problems faced by vulnerable groups. The needs of caregivers are served by federal and state legislation, government-funded programs, professionals in health care and social services, and numerous other sources. Because of budget limitations of family caregivers as well as outside funding sources, priority must be given to determining the services and interventions that are most useful to caregivers; that is, there must be an evidence-based approach to caregiver interventions.

CONCLUSIONS

The concept of caregiving is easy to grasp because it is such a familiar part of life. Although knowledge of caregiving and caregivers has increased in many areas, translation of that knowledge has not followed in caregiving practice or policy. We need to reframe our notions about caregiving to remind ourselves of its life span nature. Our attention has with reason been drawn to the needs of the elderly, but that group represents only one segment—albeit a large one—of those who receive and provide care.

The nature of caregiving will become more complex as increasing life expectancies tax the ability of caregivers to provide care. It is clear that caregivers
carry a significant burden and face many potentially serious health problems. The challenge for public health systems is to understand more about those caregivers who are particularly vulnerable and why and then to design and implement evidence-based interventions to address identified needs. Researchers need to be at the forefront in uncovering possible risk factors associated with the endless types of caregiving situations. From a public health perspective, it is critically important to identify the hazards of caregiving as well as to develop potential improvements and solutions.

Future research will provide a foundation that supports the public health system in ensuring the delivery of appropriate, targeted services to caregivers. More evidence on efficacy of services will be needed to meet public health’s commitment to ensure quality services. Linking caregivers to available health care and community services can help promote their health. Moreover, family caregiving, which depends on deep relationships within the context of family or friendship, can be strengthened through strong bonds with community, agency, or professional caregivers. Because a central goal of public health is to reduce inequities within the health care system, advocacy and legislation of public health is to reduce in-group interference.26 Because a central goal of public health is to reduce inequities within the health care system, advocacy and legislation of public health is to reduce in-group interference.26Because a central goal of public health is to reduce inequities within the health care system, advocacy and legislation of public health is to reduce in-group interference.26

Caregiving is an emerging public health concern that will personally affect virtually every individual. The needs of caregivers must be acknowledged by the country’s public health officials and addressed in state and local caregiver-directed programs. Caregiving, as a critical public health issue facing our nation, and caregivers, as an increasingly significant portion of the population, are worthy of the attention of the country’s public health system.

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References
In Chiapas, Mexico, long-standing conflicts related to land tenure, religion, and other issues have been further complicated by an armed conflict between the Mexican government and the Ejército Zapatista de Liberación Nacional (“the Zapatistas”), which began in 1994 over Zapatista demands that the Mexican government address the alarming poverty conditions among the indigenous population. Social polarization and intolerance have led to forced displacement of more than 16,000 Chiapanecan citizens, politically motivated violence (including murder), and intracommunity divisions so complete as to have produced villages within which separate governments, clinics, schools, justice systems, and other services for adherents of the separate factions operate.²⁻⁵

We postulated that chronic interparty and intracommunity conflict in Chiapas might be associated with malnutrition, particularly stunting, in children. Because no published studies have addressed this question in this setting, we sought to describe the prevalence of malnutrition in children aged younger than 5 years in the 3 Chiapanecan regions most adversely affected by the Zapatista conflict and its association with various socioeconomic and conflict-related factors.

METHODS

In the regions most adversely affected by the armed conflict in Chiapas,⁶ we conducted a cross-sectional, population-based household survey, supplemented by semistructured interviews with community-based governing councils and health teams. We investigated the health conditions of and access to care for children in the conflict zone, including rates of childhood malnutrition, pulmonary tuberculosis, and maternal mortality. The methodology of the study has been described previously.⁶

We performed a cross-sectional, community-based survey, supplemented by interviews with community leaders in Chiapas, Mexico, to examine the prevalence and predictors of child malnutrition in regions affected by the Zapatista conflict.

The prevalence rates of stunting, wasting, and underweight were 54.1%, 2.9%, and 20.3%, respectively, in 2666 children aged younger than 5 years. Stunting was associated with indigenous ethnicity, poverty, region of residence, and intracommunity division. The results indicate that malnutrition is a serious public health problem in the studied regions. (Am J Public Health. 2007;97:229–232. doi: 10.2105/AJPH.2005.070409)

In the study, we measured anthropometric parameters (for children aged younger than 2 years) and stadiometers (for children aged 2 to 4 years).⁷ Age was obtained by asking the parent for each child’s birthdate, confirming whenever possible (65% of children) with birth records or vaccination cards. Anthropometric data were analyzed with the Epi Info 2000 Epinut package (Centers for Disease Control and Prevention, Atlanta, Ga), which classified children as stunted, wasted, or underweight; standardized z scores (obtained using Epi info) of less than 2.0 for these classifications were used as the cutoff point, and participants with impulsive results (those for whom the obtained measures of height and age gave an impossible nutritional status) were excluded.⁸ We estimated the association between stunting and other variables using logistic regression (consistent confidence intervals⁹ were used to adjust for clustering within communities), weighted to reflect probability of selection. Given the transversal design of the study, and the conditions of the region during the fieldwork that impacted the nonresponse rates, the estimated odds ratios were adequate to measure the magnitude of the association between the nutritional status and factors analyzed, but did not necessarily approximate the prevalence ratio, because of the high prevalence of stunting.

RESULTS

The final sample included 21 government-aligned communities, 6 opposition-aligned communities, and 19 communities divided by political-party affiliation (government vs Zapatista-aligned).⁹ Four of the government-aligned communities were internally divided by religious or intraparty differences. We identified 2838 children aged younger than 5 years from 1779 households (20 households declined to participate).

Table 1 presents the individual, household, and community characteristics of the children in the study. All communities were predominately indigenous (89.3% of the children in the study). The overall prevalence of stunting was 54.1% (n=2666 with analyzable data) and was significantly higher in divided communities (P<.001). The overall prevalence rates of wasting and underweight were 2.9% and 20.3%, respectively. Nearly all factors associated with either poverty or intracommunity division were significantly associated with stunting in bivariate analyses (data not shown). In multivariate analyses, child’s age, dirt-floored house (a proxy for low socioeconomic status), maternal education, indigenous ethnicity, region of residence, and intracommunity division retained their significant associations with stunting (Table 2).

DISCUSSION

The overall prevalence of stunting observed was substantially greater than that reported by the Mexican National Nutritional Survey (17.8% nationally; 29.2% in Chiapas State)¹⁰ and was consistent with observations from other surveys performed in Chiapas during the Zapatista conflict.¹¹⁻¹² In fact, the prevalence of stunting present in the children we examined resembled that in child residents of conflict zones in Afghanistan and Angola (63.7% and 57.3%, respectively)¹³⁻¹⁴ more than it did that in children in northern Mexico (7.1%). Such high levels of malnutrition place these children at higher risk for diminished school and work performance, as well as mortality.¹⁵⁻²¹ These effects may worsen disparities between the rural indigenous residents of Chiapas and...
TABLE 1—Characteristics of Children Aged Younger Than 5 Years in Conflict Zones of Chiapas, Mexico, by Presence of Intracommunity Division

<table>
<thead>
<tr>
<th>Characteristics of Children and Their Households or Villagesa</th>
<th>Intracommunity Division</th>
<th>Community Divided, Other Than by Political Partyb</th>
<th>Community Divided by Political Party</th>
<th>No Community Division</th>
<th>Community Divided, Other Than by Political Partyb</th>
<th>Community Divided by Political Party</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Children (N = 2838), no. (%)</td>
<td>(n = 1295), no. (%)</td>
<td>(n = 301), no. (%)</td>
<td>(n = 1242), no. (%)</td>
<td></td>
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<td></td>
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<tr>
<td>Stunting (54.1)</td>
<td>1442 (48.5)</td>
<td>165 (62.7)</td>
<td>685 (58.0)</td>
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<td></td>
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<tr>
<td>Wasting (2.9)</td>
<td>79 (2.8)</td>
<td>6 (2.2)</td>
<td>39 (3.3)</td>
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<td></td>
<td></td>
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<tr>
<td>Underweight (20.3)</td>
<td>549 (20.3)</td>
<td>73 (26.7)</td>
<td>246 (20.6)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Maternal education, mean years completed ±SD</td>
<td>2.9 ±2.6</td>
<td>2.2 ±2.7</td>
<td>2.8 ±2.4</td>
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<tr>
<td>Whole family slept in same room</td>
<td>1764 (62.2)</td>
<td>200 (66.7)</td>
<td>835 (67.3)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Household has dirt floor</td>
<td>2186 (71.1)</td>
<td>220 (73.1)</td>
<td>1047 (84.4)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Household cooked with wood fuel</td>
<td>2738 (96.7)</td>
<td>289 (96.3)</td>
<td>1221 (98.6)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Maternal language fluency</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Mother speaks indigenous language only</td>
<td>1486 (52.6)</td>
<td>167 (55.7)</td>
<td>665 (53.8)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Mother bilingual</td>
<td>1040 (36.8)</td>
<td>74 (24.7)</td>
<td>502 (40.6)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Mother speaks Spanish only</td>
<td>297 (10.5)</td>
<td>70 (5.7)</td>
<td>406 (32.6)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Household has piped water</td>
<td>1918 (67.6)</td>
<td>126 (41.9)</td>
<td>845 (68.0)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Household has electricity from local grid</td>
<td>2476 (87.2)</td>
<td>264 (87.7)</td>
<td>1045 (84.1)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Household has toilet or latrine</td>
<td>2084 (73.4)</td>
<td>165 (54.8)</td>
<td>993 (80.0)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Household has refrigerator</td>
<td>152 (5.4)</td>
<td>19 (6.3)</td>
<td>34 (2.7)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Travel time to nearest clinic, min, mean ±SD</td>
<td>25.5 ±31.3</td>
<td>3.0 ±9.0</td>
<td>31.0 ±36.1</td>
<td></td>
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<tr>
<td>Travel time to nearest hospital, min, mean ±SD</td>
<td>147.5 ±120.3</td>
<td>106.1 ±58.7</td>
<td>133.0 ±71.9</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Region of residence</td>
<td></td>
<td></td>
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<tr>
<td>Norte region</td>
<td>1130 (39.8)</td>
<td>113 (37.5)</td>
<td>553 (44.5)</td>
<td></td>
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<tr>
<td>Altos region</td>
<td>880 (31.0)</td>
<td>188 (62.5)</td>
<td>338 (27.2)</td>
<td></td>
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<tr>
<td>Selva region</td>
<td>828 (29.2)</td>
<td>35 (12.1)</td>
<td>283 (22.8)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>History of displacement of residents from village</td>
<td>1197 (42.2)</td>
<td>163 (54.2)</td>
<td>726 (58.5)</td>
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<td></td>
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<tr>
<td>Survey only allowed to include 1 of 2 antagonistic factionsc</td>
<td>604 (21.3)</td>
<td>30 (10.0)</td>
<td>574 (46.2)</td>
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<td></td>
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</tr>
<tr>
<td>Alleged bias in provision of public services (other than health)</td>
<td>342 (12.1)</td>
<td>158 (52.5)</td>
<td>184 (14.8)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alleged bias in provision of community-level health services</td>
<td>905 (31.9)</td>
<td>301 (100)</td>
<td>569 (45.8)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Political-party affiliation of household</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Aligned with government party</td>
<td>1910 (67.3)</td>
<td>301 (100)</td>
<td>575 (46.3)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Political party affiliation not stated</td>
<td>482 (17.0)</td>
<td>0</td>
<td>482 (38.8)</td>
<td></td>
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<td></td>
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<tr>
<td>Aligned with opposition</td>
<td>446 (15.7)</td>
<td>0</td>
<td>185 (14.9)</td>
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</tr>
<tr>
<td>From systematically selected households</td>
<td>1755 (61.8)</td>
<td>209 (69.4)</td>
<td>676 (54.4)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. Results given as percentage of number of children with complete data unless otherwise indicated.

a There were no differences among the following characteristics: maternal age (mean years ±SD = 27.8 ±7.6), total number of persons living in household (mean ±SD = 7.1 ±2.7), total number of children younger than 5 years living in household (mean ±SD = 1.9 ±0.8); child had up-to-date immunizations (for age) = 72.6%.

b Division by religion, in the absence of political-party division, or division within a single political party.

c Not included in the analysis: 27 children (10 without community division; 7 community divided, other than by political party; 10 community divided by political party).

d Not included in the analysis: 94 children (30 without community division; 23 community divided, other than by political party; 35 community divided by political party).

e Not included in the analysis: 4 children (all of them without community division).

About the Authors
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TABLE 2—Association of Stunting With Child, Family, and Community Characteristics in Conflict Zones of Chiapas, Mexico: Multivariate Analysis

<table>
<thead>
<tr>
<th>Variable</th>
<th>Odds Ratio (95% Confidence Interval)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age of child, mo</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤ 5</td>
<td>Reference</td>
<td></td>
</tr>
<tr>
<td>6–11</td>
<td>3.0 (1.8, 5.1)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>12–23</td>
<td>9.1 (4.8, 17.3)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>24–35</td>
<td>8.2 (4.2, 16.1)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>36–47</td>
<td>9.0 (4.8, 17.0)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>48–59</td>
<td>12.1 (5.6, 26.1)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td><strong>Maternal education (at least 1 year)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Household had dirt floor</td>
<td>1.6 (1.2, 2.2)</td>
<td>.002</td>
</tr>
<tr>
<td><strong>Maternal language fluency</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monolingual Spanish speaker</td>
<td>Reference</td>
<td></td>
</tr>
<tr>
<td>Bilingual indigenous: Spanish</td>
<td>1.8 (1.1, 3.1)</td>
<td>.018</td>
</tr>
<tr>
<td>Monolingual indigenous language</td>
<td>1.9 (1.3, 2.8)</td>
<td>.001</td>
</tr>
<tr>
<td><strong>Region of residence</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Norte region</td>
<td>Reference</td>
<td></td>
</tr>
<tr>
<td>Altos region</td>
<td>2.5 (1.3, 4.7)</td>
<td>.006</td>
</tr>
<tr>
<td>Selva region</td>
<td>1.5 (1.0, 2.3)</td>
<td>.055</td>
</tr>
<tr>
<td><strong>Intracommunity division</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Community not divided</td>
<td>Reference</td>
<td></td>
</tr>
<tr>
<td>Community divided, not by political party</td>
<td>2.7 (1.4, 5.3)</td>
<td>.005</td>
</tr>
<tr>
<td>Community divided by political party</td>
<td>1.8 (1.1, 2.8)</td>
<td>.013</td>
</tr>
</tbody>
</table>

**Human Participant Protection**

At the time of study inception, there was no functioning institutional review board in Chiapas, and Chiapanecan researchers interpreted Mexican national regulations as meaning that minimal-risk community-survey protocols did not require formal review. However, oral informed consent was obtained at multiple levels in each community studied. Initially, consent was obtained from community authorities, generally common-lands commissioners (“comisarios ejidales”), and health and education committees. During their deliberations, community-level authorities were permitted to delete any questions they considered objectionable from the study protocol. Subsequently, an assembly of the entire adult population was called, to ask for collective consent. Finally, in each household, permission was requested of the head of the family. Communities were assured that the names of individual communities would remain confidential, as would each individual community’s survey results. The investigators also promised to present each community’s study findings to the community after data analysis. The study protocol was also approved by a panel assembled by Physicians for Human Rights, after deliberations conducted in accordance with the Declaration of Helsinki.

**Contributors**

H. J. Sánchez-Pérez originated and designed the study, performed the fieldwork, analyzed and interpreted the data, and wrote the brief. M. A. Hernán and D. Fried participated in the origination and design of the study, in the analysis and interpretation of data, and in preparing the brief. M. Arana-Cedeño participated in the origination and design of the study, in the analysis and interpretation of data, and in drafting the final version.

**Acknowledgments**

This investigation was funded by the El Colegio de la Frontera Sur, El Centro de Capacitación en Ecología y Salud para Campesinos-Defensoría del Derecho a la Salud, Universitat Autònoma de Barcelona, and the Grand Service Foundation.

We are indebted to the leaders and residents of the studied communities and to participating health workers from both the governmental and the Zapatista health sectors, for their permission, participation, and trust. We gratefully acknowledge the collaboration and participation of Physicians for Human Rights in the project on which this study was based. We would also like to thank Guadalupe Vargas, Roberto Solís Hernández, Alejandro Flores Hernández, Hércules Méndez Santiz, Juan Carlos Nájera, Julio César Arias, Blanca Coello (all at the Colegio de la Frontera Sur), Juan Manuel Canales, Jonathan Kirsch, Kerri Sherlock, and Dave McFurlane for their invaluable assistance with interviews and database management.

**References**


### TABLE 1—Experiences of Physical and Sexual Intimate Partner Violence (IPV) and IPV-Related Injuries Among Women: Yokohama, Japan

<table>
<thead>
<tr>
<th>Experience</th>
<th>Sample % (95% Confidence Interval)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical IPV</td>
<td></td>
</tr>
<tr>
<td>Slapped/object thrown at</td>
<td>9.0 (7.4, 10.6)</td>
</tr>
<tr>
<td>Pushed or shoved</td>
<td>8.4 (6.8, 10.2)</td>
</tr>
<tr>
<td>Hit with fist or with something else that could cause pain/injury</td>
<td>2.2 (1.4, 3.0)</td>
</tr>
<tr>
<td>Kicked, dragged, or beaten</td>
<td>2.6 (1.7, 3.4)</td>
</tr>
<tr>
<td>Choked or burned deliberately</td>
<td>0.1 (0.0, 0.3)</td>
</tr>
<tr>
<td>Threatened or assaulted with gun, knife, or other weapon</td>
<td>0.6 (0.1, 0.9)</td>
</tr>
<tr>
<td>Any type of physical IPV</td>
<td>12.6 (10.9, 14.3)</td>
</tr>
<tr>
<td>Probability of physical IPV by age 49 y</td>
<td>16.1 (13.7, 18.6)</td>
</tr>
<tr>
<td>Sexual IPV</td>
<td></td>
</tr>
<tr>
<td>Physically forced to have sexual intercourse without consent</td>
<td>5.1 (3.6, 6.5)</td>
</tr>
<tr>
<td>Had sexual intercourse because of fear of what partner might do</td>
<td>3.3 (2.3, 4.3)</td>
</tr>
<tr>
<td>Forced to engage in a degrading or humiliating sexual act</td>
<td>1.4 (0.6, 2.1)</td>
</tr>
<tr>
<td>Any type of sexual IPV</td>
<td>6.4 (4.8, 8.0)</td>
</tr>
<tr>
<td>Probability of sexual IPV by age 49 y</td>
<td>8.1 (6.3, 10.5)</td>
</tr>
<tr>
<td>Physical and sexual IPV</td>
<td></td>
</tr>
<tr>
<td>Any physical or sexual IPV reported</td>
<td>15.1 (13.1, 17.0)</td>
</tr>
<tr>
<td>Probability of physical or sexual IPV by age 49 y</td>
<td>19.0 (16.4, 22.0)</td>
</tr>
<tr>
<td>Any IPV</td>
<td></td>
</tr>
<tr>
<td>Any IPV-related injury</td>
<td>3.5 (2.4, 4.5)</td>
</tr>
<tr>
<td>Probability of IPV-related injury by age 49 y</td>
<td>4.0 (3.0, 5.4)</td>
</tr>
</tbody>
</table>

Note: Analyses were based on 1287 women who had been involved in at least 1 heterosexual relationship before the time of the interview.

### RESULTS

Of the 1371 respondents (mean age=35.2 years), 1287 had been involved in at least 1 intimate heterosexual relationship. The distributions of respondents' characteristics were comparable to those of Yokohama women aged 18 to 49 years as a whole with respect to age, educational level, and marital status (Japanese Institute of Nuclear Safety, unpublished data, 1994).11,12

As shown in Table 1, 12.6% of women who had ever had a partner reported having experienced physical IPV at some point in their past, 6.4% reported having experienced sexual IPV, and 15.1% reported either physical or sexual IPV or both. Women were most likely to experience their first episode of IPV before the age of 30 years, as evidenced by the steeper slope of the cumulative incidence function during this period (Figure 1). Approximately 14% of women (95% confidence interval [CI]=12.3%, 16.5%) were estimated to have experienced IPV by the age of 30 years and 19% (95% CI=16.4%, 22.0%) by the age of 49 years. The hazard function associated with experiencing IPV for the first time rose consistently from the late adolescent years until the age of 30 years, decreased sharply at the age of 30 years, and leveled off thereafter.

Among women who had experienced IPV, almost one fourth (24.4%; 95% CI=17.6%, 31.2%) had been injured, and more than one third (34.9%; 95% CI=21.5%, 48.3%) of these injured women had been injured more than twice. Estimated probabilities of women having experienced IPV-related injuries were 3.3% (95% CI=2.4%, 4.6%) by the time they were aged 30 years and 4.0% (95% CI=3.0%, 5.4%) by the time they were aged 49 years.

### DISCUSSION

We estimated that, by the age of 49 years, 1 in 5 women in Yokohama had experienced IPV, and 4% had sustained IPV-related injuries. Most had experienced IPV or sustained IPV-related injuries early in their adult lives: 14% had experienced IPV and 3% IPV-related injury by age 30 years, the average age at
which women in metropolitan areas of Japan marry for the first time.\textsuperscript{13} The risk of experiencing IPV and IPV-related injury rose steadily until just before the age of 30 years.

The major limitation of this study was the low response rate. Although we used poststratification weights, it is still possible that rates of IPV and IPV-related injuries were higher or lower among respondents than among nonrespondents. In addition, the sample was limited to an urban region of Japan, and we have no way of determining whether our results would be generalizable to rural regions.

Nevertheless, the findings of this study clearly suggest the importance of targeting both married and unmarried young adults and developing policies and prevention and intervention programs designed to address IPV in women aged 18 to 49 years. However, as mentioned, current Japanese law does not include IPV occurring before marriage in its criteria for protection orders, leaving women in such situations with limited recourse. Premarital IPV should be included in Japan’s legal definition of IPV, and intervention programs must target all women at risk regardless of their marital status.

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This article was accepted February 25, 2006.

Contributors
M. Yoshihama and S. Kamano developed and implemented the study. J. Horrocks assisted with analyses. All of the authors contributed to conceptualization of the article’s focus, interpretation of findings, and the writing of the article.

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We would like to thank the study participants, who willingly shared their experiences of intimate partner violence and health conditions. Special thanks also go to the Japan project team members (Hiroko Aikyama, Tamie Kaino, Fumi Hayashi, and Tomoko Yunosuke).

Human Participant Protection
This study was approved by the institutional review boards of the University of Michigan and the World Health Organization. Participants provided informed consent.

References
education and the metabolic syndrome was also found. Research supports an association between socioeconomic status (SES) and the metabolic syndrome among children, and the potential mechanisms are low birthweight, poor nutrition, and inadequate physical activity. Research supports a link between psychosocial stress and the metabolic syndrome. However, little is known about associations between SES and the metabolic syndrome among US adults, and no research has been done in ethnic minority populations. We evaluated the association between socioeconomic factors during childhood and adulthood and prevalence of the metabolic syndrome in African Americans.

METHODS

Study Participants

We used data from the Pitt County Study, a community-based, prospective investigation of risk factors for hypertension and related disorders in African Americans aged 25 to 50 years in Pitt County, NC, that began in 1988. A follow-up examination was conducted in 1993, during which participants provided a 12-hour overnight fasting blood sample. Only individuals who were normotensive (N = 1407) in 1988 were invited to participate in 1993, and 85% (n = 1195) did so. Of these individuals, 84% (n = 1006) participated in the fasting blood draw. A second follow-up examination was conducted in 2001 to obtain information on life-course socioeconomic resources.

Study Measures

The outcome for this analysis was the metabolic syndrome, defined as having 3 or more metabolic syndrome components as described by the Adult Treatment Panel III report. The following components were measured at the 1993 examination: fasting blood glucose, blood pressure, high-density lipoprotein, triglycerides, and waist circumference. Adult socioeconomic factors were collected by self-report in 1988 and included dichotomous measures of education, home ownership, employment status, and occupation; measures were obtained from Hollingshead scores (Hollingshead scores of 5–9 were coded as nonskilled, and Hollingshead scores of 1–4 were coded as skilled). Childhood SES was determined by parental occupation (coded the same as adult occupation, according to Hollingshead scores) and was obtained retrospectively during the 2001 follow-up using an event history calendar, an interviewing methodology whereby easily remembered past events are used to enhance recall of target events. Age and gender were determined in 1988.

Statistical Analysis

We calculated baseline characteristics as proportions. Occupation was protective for the metabolic syndrome among men but not among women in categorical analysis. We used Poisson regression with a robust variance estimator to model associations between socioeconomic variables and the metabolic syndrome (1 social exposure per model), first unadjusted and then adjusted for age (continuous variable) and gender. This method calculates prevalence proportion ratios and is preferred over logistic regression because the occurrence outcome, the Metabolic Syndrome, is not rare. Analyses were weighted to be representative of the Pitt County, NC, population. No statistical interaction was observed when a gender interaction term was included (P > .20).

RESULTS

The metabolic syndrome prevalence was 25%. Higher educational status was protective against the metabolic syndrome (Table 1). After we controlled for age and gender, we found that the metabolic syndrome was about 30% less common among those with a high-school education or greater compared with those with less than a high-school education.

A protective association was observed for a skilled occupation but not for an unskilled occupation. No associations were observed for home ownership or childhood SES variables. Among women, being employed was associated with increased prevalence (prevalence proportion ratio = 1.52; 95% confidence interval [CI] = 1.04, 2.21), whereas the converse was found for men (prevalence proportion ratio = 0.48; 95% CI = 0.12, 1.87).

DISCUSSION

Our observation that advanced education, and to a lesser degree skilled occupation, was protective against the metabolic syndrome agrees with findings in European studies. Potential mechanisms for this association include less psychosocial and material stress, better health knowledge, and better health behaviors. These results suggest that improving access to higher education among African Americans could reduce risk for the metabolic syndrome.

The differential association between employment status and the metabolic syndrome by gender could be explained by gender differences in employment motivations, employment opportunities in this cohort, or work-related stress response. Although home ownership is a reasonably good indicator of wealth for African Americans, it was not associated with the metabolic syndrome in this study. Although childhood SES, measured by parental occupation, was independently predictive of 1988 obesity status among women in this cohort, and moderately predictive of 1988 hypertension status among men, it did not predict metabolic syndrome status for either gender in our study. These differences could be a result of the selective nature of the 1993 sample compared with the 1988 sample. Additional research is needed on life-course epidemiology of the metabolic syndrome in US racial/ethnic minorities.

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At the time of the study, Jaime C. Lucove was with the Department of Epidemiology, University of North Carolina, Chapel Hill. Jay S. Kaufman is with the Department of Epidemiology, University of North Carolina, Chapel Hill. Sherman A. James is with the Terry Sanford Institute of Public Policy, Duke University, Durham, NC.

Requests for reprints should be sent to Jay S. Kaufman, PhD, CB#7435, 2104C McGravran-Greenberg, School of Public Health, University of North Carolina, Chapel Hill, NC 27599 (e-mail: jay_kaufman@unc.edu). This brief was accepted May 2, 2006.
TABLE 1—Prevalence Proportion Ratios (PPRs; With 95% Confidence Intervals [CIs]) for Associations Between Socioeconomic Status and the Metabolic Syndrome: Pitt County Study, Pitt County, NC, 1998–2001

|                                       | Weighted No. | Weighted % | Weighted PPR (95% CI) Unadjusted | Weighted PPR (95% CI) Adjusted
|---------------------------------------|--------------|------------|----------------------------------|----------------------------------
| Total                                 | 1195         | 100        |                                  |                                  |
| **Adult socioeconomic status**        |              |            |                                  |                                  |
| Education                             |              |            |                                  |                                  |
| < High school                         | 346          | 28.70      | Reference                        | Reference                        |
| ≥ High school                         | 849          | 71.30      | 0.63 (0.48, 0.83)                | 0.70 (0.51, 0.96)                |
| Home ownership                        |              |            |                                  |                                  |
| Not home owner                        | 807          | 62.63      | Reference                        | Reference                        |
| Home owner                            | 380          | 37.37      | 1.22 (0.93, 1.61)                | 1.12 (0.85, 1.48)                |
| Occupation                            |              |            |                                  |                                  |
| Unskilled                             | 954          | 83.61      | Reference                        | Reference                        |
| Skilled                               | 196          | 16.39      | 0.84 (0.56, 1.27)                | 0.85 (0.57, 1.26)                |
| Employment status                     |              |            |                                  |                                  |
| Unemployed                            | 170          | 13.22      | Reference                        | Reference                        |
| Employed                              | 886          | 86.78      | 1.17 (0.82, 1.67)                | 1.21 (0.85, 1.73)                |
| **Childhood socioeconomic status**    |              |            |                                  |                                  |
| Parental occupation                   |              |            |                                  |                                  |
| Unskilled                             | 923          | 83.25      | Reference                        | Reference                        |
| Skilled                               | 189          | 16.75      | 0.84 (0.55, 1.27)                | 0.89 (0.59, 1.35)                |

Note. Some SES variables may not equal the total sample number due to missing data. Metabolic syndrome was coded as follows: 1 = ≥3 metabolic syndrome components; 0 = <3 metabolic syndrome components. Metabolic syndrome components were defined according to Adult Treatment Panel III criteria; see the “Methods” section for additional detail. Of the participants, 235 (23%) were missing this metabolic syndrome variable because they refused the fasting blood draw or had missing values on blood pressure or waist circumference measures. No important differences were observed in waist circumference and spurious or diastolic blood pressure when we compared those who refused with those who did not refuse the blood draw.

aAdjusted for age (continuous variable) and gender.
bOccupation was coded as follows: unskilled = Hollingshead index score of 5–9; skilled = Hollingshead index score of 1–4. Parental occupation and adult occupation were defined using the same method.

References
Anemia and Iron Deficiency in School Children, Adolescents, and Adults: A Community-Based Study in Rural Amazonia

Marcelo U. Ferreira, MD, PhD, Mônica da Silva-Nunes, MD, Carla N. Bertolino, RD, Rosely S. Malafronte, PhD, Pascoal T. Muniz, PhD, and Marly A. Cardoso, PhD

We investigated the prevalence and risk factors of anemia and iron deficiency in 398 rural Amazonians aged 5–90 years in Acre, Brazil. Anemia and iron deficiency were diagnosed in 16% and 19% of the population, respectively. Anemia was likely to have multiple causes; although nearly half of anemic school children and women had altered iron status indicators, only 19.7% of overall anemia was attributable to iron deficiency. Geohelminth infection and a recent malaria episode were additional factors affecting iron status indicators in this population. (Am J Public Health. 2007;97:237–239. doi:10.2105/AJPH.2005.078121)

Because global estimates for iron deficiency prevalence are not available, anemia, which affects 30% of the world population,1 has been used as an indicator of iron deficiency and iron deficiency anemia. Hemoglobin determination, however, is neither sensitive nor specific as a screening test for iron deficiency. The former occurs because a large proportion of total body iron must be lost before hemoglobin levels fall below the laboratory definition of anemia.2 The low specificity stems from other causes of anemia, such as other nutritional deficiencies, infections, glucose-6-phosphate dehydrogenase (G6PD) deficiency, and hemoglobinopathies.3–6

METHODS

We performed a cross-sectional survey in the agricultural settlement known as Ramal do Granada in Acre, Brazil (elevation, 100–208 m above sea level). All 473 inhabitants were invited to participate, and 467 (98.7%) respondents in 113 households were enrolled. Participants aged 5 years or older were invited to contribute a 5 mL venous blood sample and a stool sample. The 389 participants who provided blood samples (96.0% of those eligible) comprised the study population we analyzed.

Two experienced microscopists examined Giemsa-stained, thick blood smears from 386 (95.3%) participants. Hemoglobin concentration in 388 (95.8%) participants was measured using a HemoCue photometer (HemoCue, Angelholm, Sweden), and anemia was defined according to World Health Organization cut-off values.6 Serum ferritin and soluble transferrin receptor concentrations in 379 (93.6%) participants were measured using an enzyme immunoassay (Ramco, Houston, TX). The normal range of soluble transferrin receptor levels, determined by the manufacturer, is 2.9–8.3 mg/L. A total of 356 (87.9%) participants were screened for G6PD deficiency using the colorimetric method of Tantular and Kawamoto (Dojindo, Kumamoto, Japan).7 Stool specimens from 363 (89.6%) participants were examined for intestinal parasites.8

We used principal component analysis to derive a wealth index from information on ownership of 13 household assets.9 We used multiple linear regression analysis to describe independent associations between concentrations of hemoglobin, serum ferritin, and soluble transferrin receptor (dependent variables) and demographic, socioeconomic, and morbidity covariates. We used natural log transformation of serum ferritin to improve the fit of linear regression models. We conducted multiple unconditional logistic regression analysis using SPSS, version 13.0 (SPSS Inc., Chicago, IL), to estimate adjusted odds ratios (AORs) for associations between anemia and the covariates. Attributable fractions5 were estimated for risk factors for anemia associated with AORs significantly greater than 1 (P<.05); AORs were converted to adjusted prevalence ratios, as previously described.10

RESULTS

Anemia (overall prevalence, 16%) was most common in school children and women (Table 1); no cases of severe anemia (hemoglobin<70 g/L) were diagnosed. Anemia was uniformly prevalent across all socioeconomic strata (16.1%) among the poorest and 18.2% among the least poor). Iron deficiency was found in 19% of subjects, with the highest prevalence among school children and women, but only 30% of iron-deficient subjects were anemic. The overall prevalence of iron deficiency anemia was 5.6%.

In addition to age and gender, pregnancy was the only significant predictor of hemoglobin levels in multiple linear regression models (Table 2). Because we did not impose prior expectations on the relation of hemoglobin to iron status indicators, the hemoglobin model did not include serum ferritin or soluble transferrin receptor as covariates (Table 2). Separate analyses identified both serum ferritin and soluble transferrin receptors as strong independent predictors of hemoglobin levels. A decrease of 2.72 µg/L (1 log unit) of serum ferritin was associated with a 4 g/L decrease in hemoglobin, and an increase of 1 mg/L of soluble transferrin receptor was associated with a 1.4 g/L decrease in hemoglobin (P<.001, for both). Geohelminth infection, i.e., infection with geohelminths (soil-transmitted helminths), and recent malaria were significant predictors of serum ferritin and soluble transferrin receptor levels, respectively (Table 2). Iron deficiency was the only significant predictor of anemia identified by logistic regression models in the overall population (OR=3.03; 95% confidence interval = 1.40, 6.10), with an attributable fraction of 19.7%. Among females aged 12–45 years (n=100), 11.9% of all cases of anemia were attributable to a current pregnancy.

DISCUSSION

As estimated by DeMayer and Adielstegman in 1985,1 half of anemic school children and women in rural Amazonia had iron deficiency. However, because more than 20% of anemia in the population was attributable to iron deficiency, widespread iron supplementation alone is likely to have only a limited
impact on the overall prevalence of anemia among subjects aged 5 years or older. The multifactorial etiology of anemia putatively includes nutritional deficiencies (folate, vitamin A), as well as genetic and infectious conditions. G6PD deficiency, which is infrequent in the African and Asian populations, had no significant impact on hemoglobin levels. Sickle-cell disease is unlikely to represent a major contributor, as low hemoglobin S allele frequencies (1.8%–2.1%) have been found in Amazonia. To our knowledge, no other hemoglobinopathies have been investigated in Amazonian populations. Malaria and geohelminth infections affect iron status indicators either because of true iron deficiency or increased erythropoiesis following hemolysis, but the contribution of malaria and geohelminth to anemia appears to be less marked in rural Amazonians than in African and Asian populations.

### TABLE 1—Iron Status Indicators and Diagnostic Categories of Anemia and Iron Deficiency Among Rural Amazonians, by Age: Brazil, 2004

<table>
<thead>
<tr>
<th>Hemoglobin (g/L)</th>
<th>School Children, 5–11 y</th>
<th>Adolescents, 12–14 y</th>
<th>Men, ≥ 15 y</th>
<th>Women, ≥ 15 y</th>
<th>All Age Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median (IQR)</td>
<td>126 (116–135)</td>
<td>131 (125–144)</td>
<td>148 (138–158)</td>
<td>133 (121–145)</td>
<td>137 (125–150)</td>
</tr>
<tr>
<td>Proportion below cut-off, % (95% CI)</td>
<td>20.5 (13.2, 30.4)</td>
<td>15.8 (7.5, 30.5)</td>
<td>9.0 (5.4,14.8)</td>
<td>21.1 (14.9, 29.2)</td>
<td>16.0 (12.7, 20.0)</td>
</tr>
<tr>
<td>SF (µg/L)</td>
<td>43.0 (30.0–75.5)</td>
<td>55.0 (38.5–73.2)</td>
<td>111.0 (56.5–179.5)</td>
<td>54.0 (33.5–105.5)</td>
<td>63.0 (39.0–122.0)</td>
</tr>
<tr>
<td>Median (IQR)</td>
<td>2.5 (0.8, 8.5)</td>
<td>2.8 (0.7, 14.2)</td>
<td>0</td>
<td>7.4 (3.6, 13.0)</td>
<td>3.2 (1.8, 5.4)</td>
</tr>
<tr>
<td>Proportion &lt; 15 µg/L, % (95% CI)</td>
<td>25.9 (17.6, 36.4)</td>
<td>8.3 (3.0, 21.9)</td>
<td>5.7 (2.9, 10.8)</td>
<td>19.0 (13.0, 26.9)</td>
<td>14.5 (11.3, 18.4)</td>
</tr>
<tr>
<td>Proportion &lt; 30 µg/L, % (95% CI)</td>
<td>5.7 (4.5–7.2)</td>
<td>4.9 (3.8–5.9)</td>
<td>4.9 (4.0–5.8)</td>
<td>4.6 (3.9–6.2)</td>
<td>5.0 (4.0–6.2)</td>
</tr>
<tr>
<td>sTfR (mg/L)</td>
<td>13.6 (7.8, 22.7)</td>
<td>2.8 (0.6, 14.2)</td>
<td>4.2 (2.0, 9.0)</td>
<td>7.4 (4.0, 13.5)</td>
<td>7.1 (4.9, 10.2)</td>
</tr>
<tr>
<td>Proportion in each diagnostic category, % (95% CI)</td>
<td>64.2 (53.3, 73.8)</td>
<td>88.9 (74.6, 95.5)</td>
<td>91.5 (85.7, 95.0)</td>
<td>77.7 (69.5, 84.2)</td>
<td>81.0 (76.7, 84.6)</td>
</tr>
<tr>
<td>Iron sufficiency</td>
<td>6.2 (27.1, 33.7)</td>
<td>2.8 (0.7, 14.2)</td>
<td>1.4 (0.4, 5.0)</td>
<td>5.0 (2.3, 10.4)</td>
<td>3.7 (2.2, 6.1)</td>
</tr>
<tr>
<td>Possible ID</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3.3 (1.3, 8.2)</td>
<td>1.1 (0.4, 2.7)</td>
</tr>
<tr>
<td>Probable ID</td>
<td>10.0 (5.2, 18.5)</td>
<td>2.8 (0.7, 14.2)</td>
<td>0.7 (0.2, 3.9)</td>
<td>9.1 (5.2, 15.6)</td>
<td>5.6 (3.7, 8.4)</td>
</tr>
<tr>
<td>Definite ID</td>
<td>8/16 (50.0%)</td>
<td>1/5 (20.0%)</td>
<td>1/12 (8.3%)</td>
<td>11/23 (47.8%)</td>
<td>21/56 (37.5%)</td>
</tr>
<tr>
<td>No. of participants with ID anemia/total no. of anemic participants (%)</td>
<td>5.6 (3.7, 8.4)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: CI = confidence interval; ID = iron deficiency; IQR = interquartile range; SF = serum ferritin; sTfR = soluble transferrin receptor.

| SF ≤ 30 µg/L and sTfR ≤ 8.3 mg/L | 25.9 (17.6, 36.4) | 8.3 (3.0, 21.9) | 5.7 (2.9, 10.8) | 19.0 (13.0, 26.9) | 14.5 (11.3, 18.4) |
| SF ≥ 30 µg/L and sTfR > 8.3 mg/L | 64.2 (53.3, 73.8) | 88.9 (74.6, 95.5) | 91.5 (85.7, 95.0) | 77.7 (69.5, 84.2) | 81.0 (76.7, 84.6) |
| Iron sufficiency | 6.2 (27.1, 33.7) | 2.8 (0.7, 14.2) | 1.4 (0.4, 5.0) | 5.0 (2.3, 10.4) | 3.7 (2.2, 6.1) |
| Possible ID | 0 | 0 | 0 | 3.3 (1.3, 8.2) | 1.1 (0.4, 2.7) |
| Probable ID | 10.0 (5.2, 18.5) | 2.8 (0.7, 14.2) | 0.7 (0.2, 3.9) | 9.1 (5.2, 15.6) | 5.6 (3.7, 8.4) |
| Definite ID | 8/16 (50.0%) | 1/5 (20.0%) | 1/12 (8.3%) | 11/23 (47.8%) | 21/56 (37.5%) |

*Results available for 81 children, 36 adolescents, 141 men, and 121 women (total, n = 379).*  
*Iron sufficiency: SF ≥30 µg/L and sTfR ≤ 8.3 mg/L.*  
*Possible ID: SF 15–30 µg/L and sTfR ≤ 8.3 mg/L.*  
*Probable ID: SF 15–30 µg/L and sTfR > 8.3 mg/L, or SF ≥ 30 µg/L and sTfR ≤ 8.3 mg/L.*  
*Definite ID: SF < 15 µg/L and sTfR > 8.3 mg/L.*  
*ID anemia = hemoglobin below WHO cut-off value for age and gender plus any evidence of ID (SF < 30 µg/L or sTfR > 8.3 mg/L). Results available for 80 children, 36 adolescents, 140 men, and 121 women (total, n = 377).*  

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### Human Participant Protection

This study was approved by the ethical review board of the Institute of Biomedical Sciences of the University of São Paulo, São Paulo, Brazil.
### TABLE 2—Multiple Linear Regression Analysis of Covariates Associated with Iron Status Indicators in Rural Amazonians: Brazil, 2004

<table>
<thead>
<tr>
<th>Dependent and Independent Variables</th>
<th>β Coefficient (95% CI)</th>
<th>P</th>
<th>R²</th>
<th>No.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hemoglobin</strong>*</td>
<td></td>
<td></td>
<td>0.190</td>
<td>327</td>
</tr>
<tr>
<td>Age in years</td>
<td>0.252 (0.150, 0.354)</td>
<td>&lt;.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>-9.676 (-13.226, -6.086)</td>
<td>&lt;.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pregnancy†</td>
<td>-15.490 (-30.016, -0.963)</td>
<td>.037</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G6PD deficiency</td>
<td>-7.091 (-15.947, -1.772)</td>
<td>.116</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>134.688 (129.439, 139.767)</td>
<td>&lt;.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Log SF</strong>*</td>
<td></td>
<td>0.233</td>
<td>0.074</td>
<td>323</td>
</tr>
<tr>
<td>Age in years</td>
<td>0.020 (0.015, 0.025)</td>
<td>&lt;.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>-0.419 (-0.597, -0.242)</td>
<td>&lt;.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Geohelminth infection†</td>
<td>-0.326 (-0.624, -0.027)</td>
<td>.033</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recent malaria‡</td>
<td>0.142 (-0.049, -0.322)</td>
<td>.145</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>3.797 (3.542, 4.052)</td>
<td>&lt;.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>sTfR</strong>*</td>
<td></td>
<td>0.074</td>
<td></td>
<td>323</td>
</tr>
<tr>
<td>Age in years</td>
<td>-0.018 (-0.030, -0.006)</td>
<td>.004</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recent malaria‡</td>
<td>0.671 (0.215, 1.127)</td>
<td>.004</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>5.852 (5.241, 6.463)</td>
<td>&lt;.001</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. CI = confidence interval; G6PD = glucose-6-phosphate dehydrogenase; SF = serum ferritin; sTfR = soluble transferrin receptor.

*The independent variables used in the multiple linear regression analysis were as follows: age (years; continuous variable); gender (1 = female); pregnancy (1 = yes); education of household head (0 = no schooling; 1 = 1–4 years of schooling; 2 = 5–8 years of schooling; 3 = > 8 years of schooling); wealth index (continuous variable); G6PD deficiency (1 = yes); current geohelminth infection (1 = yes); and recent or current malaria (1 = yes). Only variables associated with P values < .15 are shown.

†Dependent variable.

‡A separate model was built to include only women (n = 155), with similar results: B = −16.061 (95% CI = −31.100, −0.971); P = .037.

§Geohelminths (overall prevalence, 11.6%) found in this population included hookworm (prevalence, 7.2%), Ascaris lumbricoides (4.3%), Strongyloides stercoralis (3.2%), and Trichuris trichiura (2.3%); Participants may be coinfected with more than one species.

¶Malaria in the past 6 months (prevalence, 32.2%) or current malaria (prevalence, 2.1%).

### References


5. Stoltzfus RJ, Chwaya HM, Montresor A, Alboraco M, Saviole I, Tiegh JM. Malaria, hookworms and recent fever are related to anaemia and iron status indicators in 0- to 5-y old Zanzibari children and these relationships change with age. *J Nutr.* 2000;130:1724–1733.


Long-Term Reductions in Mortality Among Children Under Age 5 in Rural Haiti: Effects of a Comprehensive Health System in an Impoverished Setting

Henry Perry, MD, Warren Berggren, MD, Gretchen Berggren, MD, Duane Dowell, MD, Henri Menager, MD, Erve Bottex, MD, Jean Richard Dortonne, MD, Francois Philippe, MA, Michel Cayemittes, MD

During the past half-century, numerous advances in medicine and public health have been introduced into local health programs throughout the world. The under-5 mortality rate (the risk of death from birth until the fifth birthday) in developing countries fell by 47% (from 167 deaths per 1000 live births to 89 deaths per 1000 live births) between 1970 and 2001.1,2 The degree to which this decline can be attributed to local health programs is not well understood.3,4

It appears that a strong direct causal relation exists between program funding, staffing resources, and facilities (inputs); services and advances in knowledge and practice within programs (processes); expansion of programs (outputs); and declines in mortality rates among children younger than 5 years (impacts). Although there is substantial evidence to support the short-term efficacy of specific interventions in controlled settings,5 the evidence for a direct causal relation between the services of ongoing, long-term local programs and long-term declines in under-5 mortality in developing countries is strikingly limited. Numerous studies over the past half-century have documented that multiple underlying socioeconomic and demographic factors, generally independent of local programs, exert a strong influence on under-5 mortality.6–9

We recently reported evidence that links inputs, processes, and outputs to under-5 mortality at the Hôpital Albert Schweitzer (HAS) between 1995 and 1999.9 Here, we report the long-term trends of under-5 mortality in the HAS service area between 1958 and 1999. We summarized the findings of previously published studies on under-5 mortality at HAS, added findings from the most recent mortality assessment, and compared these findings with those for Haiti at large. We also summarized the evidence in support of the conclusion that lower mortality rates in the HAS service area can be attributed to HAS programs.

HAS is a local system of health and other community development programs on under-5 mortality (the risk of death from birth until the fifth birthday) is limited. We compared mortality in a population served by health and other community development programs at the Hôpital Albert Schweitzer (HAS) with national mortality rates among children younger than 5 years for Haiti between 1958 and 1999.

Methods. We collected information on births and deaths in the HAS service area between 1995 and 1999 and assembled previously published under-5 mortality rates at HAS. Published national rates for Haiti served as a comparison.

Results. In the early 1970s, the under-5 mortality rate at HAS declined to a level three fourths lower than that in Haiti nationwide. More recently, HAS rates have remained at one half those for Haiti nationwide. Child survival interventions in the HAS service area were substantially higher than in Haiti nationwide although socioeconomic characteristics and levels of childhood malnutrition were similar in both areas.

Conclusions. HAS’s programs have been responsible for long-term sustained reduction in mortality among children aged less than 5 years. Integrated systems for health and other community development programs could be an effective strategy for achieving the United Nations Millennium Goal to reduce under-5 mortality two thirds by 2015. (Am J Public Health. 2007;97:240–246. doi:10.2105/AJPH.2006.088732)
METHODS

In late 1999 and early 2000, specially trained interviewers carried out a household survey of 3427 women of reproductive age in the 7 HAS functional units (hereafter referred to as the HAS service area). The women interviewed represented a 10% sample of the total women of reproductive age. They were selected at random from a computerized list of households maintained by the health information system of the HAS Community Health Division. This master list is based on lists of households maintained by health agents, who visit each home every 1–3 months. The master list is updated in the computerized central system every 6 months. The questionnaire used to collect birth history information is identical to that used for the birth history component of the 1999 demographic and health survey in Haiti. This questionnaire asks for information about the date for each of the respondent’s offspring, whether the child was still living, the current age of the child, whether the child is living at home or elsewhere, and if the child died, the child’s age at death.

Two of the authors (H. P. and F. P.) trained the interviewers using a 4-day program and 1 of the authors (F. P.) provided close field supervision and daily review of the collected data. The survey was carried out in accordance with ethical guidelines present at HAS at that time, and participants were given the opportunity not to respond after receiving an explanation of why they were being interviewed and how the information would be used. The collected data were transferred into Epi Info version 6.04d (Centers for Disease Control and Prevention, Atlanta, Ga) for analysis. From these data, mortality rates were calculated for the periods 1985–1989, 1990–1994, and 1995–1999.

The risk of death from birth until the first birthday (q0) was approximated using the following formula:

\[ q_0 = 1 - (1 - q_4)(1 - q_3) \]

All rates are expressed per 1000.

For some of the references cited, 1–4 year mortality rates were reported as the number of deaths per 1000 population of that age group per year \((m_i)\). This was converted to \(q_4\) by using the formula:

\[ q_4 = 1 - \exp(-4 \times m_i) \times 1000. \]

RESULTS

Table 1 and Figures 1 and 2 show that, for more than 3 decades, the infant and 1–4 year mortality rates in the HAS service area have been substantially lower than rates for similar age groups in Haiti as a whole. In the HAS service area, infant and 1–4 year mortality rates declined rapidly between 1958 and 1970 and remained at a relatively low level through 1999. Under-5 mortality in the HAS service area fell from 249.6 deaths per 1000 live births in the period 1958–1962 to 56.9 deaths per 1000 live births in 1972 and continued in that range until 1995–1999. Infant mortality at HAS fell from 74.0 deaths per 1000 live births during 1958–1962, to 34.0 deaths per 1000 live births in 1972 and continued in that range until 1995–1999. The 1–4 years mortality rates show a similar pattern, with a marked drop from 91.5 deaths per 1000 children reaching their first birthday in the period 1958–1962, to 23.7 deaths per 1000 live births in 1972, and further decline to 15.8 deaths in the period 1995–1999.

The under-5 mortality rate for Haiti as a whole has declined much more gradually over this same period, beginning at what presumably was a level similar to that in the HAS service area in 1956. Although actual data for Haiti as a whole are not available before 1970, extrapolation of the mortality rates in Figure 2 to earlier time periods suggests that the under-5 mortality for Haiti would have been similar to that at HAS. Remarkably, infant and child mortality rates for Haiti at large continued to decline even in the face of economic deterioration and political instability during the 1990s. For the 1995–1999 period, the national infant mortality rate for Haiti was 1.7-times greater than that in the HAS service area, and the 1–4 year mortality rate was 2.6-times greater than in the HAS service area.

The median of the 95% confidence intervals for the mortality rates estimates in all cases except 2, these were computed using Computer Programs for Epidemiologists, PEPI version 4.0. The national estimates for the periods 1990–1994 and 1995–1999 had been previously calculated and reported. The number of births and deaths for rural Haiti from 1990 to 1999 were estimated from additional data provided by ORC Macro, a research company based in Calverton, Maryland (B. Barrère, BS, Macro International, personal communication, 2006).
### TABLE 1—Infant and Child Mortality Rates in the Hôpital Albert Schweitzer (HAS) Primary Health Care Service Area and Among the HAS Service Population: Haiti, 1958–1999

<table>
<thead>
<tr>
<th>Year</th>
<th>HAS Service Population (Children Under 5)</th>
<th>Infant Mortality Rate in Haiti</th>
<th>Under-5 Mortality Rate in Haiti</th>
<th>1–4 Year Mortality Rate in Haiti</th>
</tr>
</thead>
<tbody>
<tr>
<td>1958–1962</td>
<td>8820 (1305)</td>
<td>174.0&lt;sup&gt;a&lt;/sup&gt;</td>
<td>249.6&lt;sup&gt;a&lt;/sup&gt;</td>
<td>91.5&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>1963–1967</td>
<td>8820 (1305)</td>
<td>110.0&lt;sup&gt;d&lt;/sup&gt;</td>
<td>158.5&lt;sup&gt;d&lt;/sup&gt;</td>
<td>54.5&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>1968–1972</td>
<td>48.0&lt;sup&gt;e&lt;/sup&gt;</td>
<td>29.9&lt;sup&gt;e&lt;/sup&gt;</td>
<td>76.5&lt;sup&gt;e&lt;/sup&gt;</td>
<td>123.7&lt;sup&gt;e&lt;/sup&gt;</td>
</tr>
<tr>
<td>1970</td>
<td>47.0&lt;sup&gt;f&lt;/sup&gt;</td>
<td>35.4&lt;sup&gt;f&lt;/sup&gt;</td>
<td>80.7&lt;sup&gt;f&lt;/sup&gt;</td>
<td>252.5&lt;sup&gt;f&lt;/sup&gt;</td>
</tr>
<tr>
<td>1972</td>
<td>60 000 (8880)&lt;sup&gt;g&lt;/sup&gt;</td>
<td>34.0&lt;sup&gt;g&lt;/sup&gt;</td>
<td>56.9&lt;sup&gt;g&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>1971–1973</td>
<td>150.0&lt;sup&gt;h&lt;/sup&gt;</td>
<td>87.9&lt;sup&gt;h&lt;/sup&gt;</td>
<td>224.7&lt;sup&gt;h&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>1975–1979</td>
<td>137.2&lt;sup&gt;i&lt;/sup&gt;</td>
<td>77.0&lt;sup&gt;i&lt;/sup&gt;</td>
<td>203.7&lt;sup&gt;i&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>1980–1984</td>
<td>138 000 (20 424)&lt;sup&gt;j&lt;/sup&gt;</td>
<td>120.0&lt;sup&gt;j&lt;/sup&gt;</td>
<td>175.6&lt;sup&gt;j&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>1985–1989</td>
<td>150 000 (22 200)&lt;sup&gt;k&lt;/sup&gt;</td>
<td>39.2&lt;sup&gt;k&lt;/sup&gt;</td>
<td>62.3&lt;sup&gt;k&lt;/sup&gt;</td>
<td>151.2&lt;sup&gt;k&lt;/sup&gt;</td>
</tr>
<tr>
<td>1985–1995</td>
<td>165 000 (24 420)&lt;sup;l&lt;/sup&gt;</td>
<td>42.4&lt;sup&gt;l&lt;/sup&gt;</td>
<td>66.4&lt;sup&gt;l&lt;/sup&gt;</td>
<td>130.6&lt;sup&gt;l&lt;/sup&gt;</td>
</tr>
<tr>
<td>1990–1999</td>
<td>165 000 (24 420)&lt;sup&gt;m&lt;/sup&gt;</td>
<td>25.1&lt;sup&gt;m&lt;/sup&gt;</td>
<td>64.8&lt;sup&gt;m&lt;/sup&gt;</td>
<td>149.4&lt;sup&gt;m&lt;/sup&gt;</td>
</tr>
<tr>
<td>1992</td>
<td>100.0&lt;sup&gt;n&lt;/sup&gt;</td>
<td>15.9&lt;sup&gt;n&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1996</td>
<td>180 000 (26 640)&lt;sup&gt;o&lt;/sup&gt;</td>
<td>41.7&lt;sup&gt;o&lt;/sup&gt;</td>
<td>62.3&lt;sup&gt;o&lt;/sup&gt;</td>
<td>118.6&lt;sup&gt;o&lt;/sup&gt;</td>
</tr>
<tr>
<td>1995–1999</td>
<td>180 000 (26 640)&lt;sup&gt;o&lt;/sup&gt;</td>
<td>15.8&lt;sup&gt;o&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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The population of the HAS service area has gradually increased during the period of observation as a result of population growth and expansion of the geographic area of service. We have conservatively estimated the population of the HAS service area where measurements of mortality took place (Table 1). However, HAS also provided services in adjacent geographic areas not included in our mortality assessment.

**DISCUSSION**

Our findings indicate that infant mortality rates, 1–4 year mortality rates, and 0–4 year mortality rates in the population served by HAS have remained substantially less than those for Haiti as a whole over a period of 3 decades. In fact, in the early 1970s when, as comparisons were first available, the rate at HAS was only one quarter of that for Haiti as a whole. Even though HAS rates have remained relatively unchanged since 1970, the rates for the HAS service area in 1995–1999 were still approximately half as great as those nationally during that same time period. Furthermore, these mortality rates remained low during the period from 1968 until 1996, when the HAS service area gradually expanded from 8820 to 180 000 people.

These findings raise the question of whether the observed differences in mortality can be attributed to the programs provided by HAS. Elsewhere<sup>10</sup> we have assessed the level of inputs (health staff resources and health facilities), service use (number of home visits, nutritional evaluations of children, ambulatory visits, and hospital admissions as well as number of community development activities), and outputs (coverage of key child survival services) in the year 2000 and in the 5 to 10 years before that.

An extensive staff and facility infrastructure is in place and has been stable during the previous 4 decades. HAS provides a high volume of community outreach, ambulatory, and inpatient services, as well as a substantial variety of community development activities. The coverage of key child survival services (immunizations, vitamin A distribution, treatment of diarrhea, treatment for serious respiratory symptoms, prenatal care, birth assistance by a trained health provider, exclusive breastfeeding during the first 6 months of life, and family planning) is at least 1.5-times greater in the HAS service area than in Haiti at large and ranges as high as 2.8-times greater<sup>10</sup> Thus, the inputs, processes, and outputs of the health services at HAS during the late 1990s, when compared with those for Haiti nationally, support the conclusion that the differences in under-5 mortality can be attributed to the integrated system of primary health care, hospital referral care, and community development programs operated by HAS. Although data regarding inputs, processes, and outputs for earlier periods are not available, it is common knowledge in Haiti that the services present at HAS in the late 1990s were generally reflective of the volume and quality present there for several decades.

Is the entire population of Haiti an appropriate comparison group for the HAS service area? We compared data regarding the socioeconomic characteristics of the HAS population and those of rural Haiti for the year 2000 and found that the levels of education, access to electricity, and household sanitation were essentially the same for the 2 populations, although the access to protected water was substantially less in the HAS service area.<sup>15</sup> Furthermore, we found that the levels of childhood malnutrition in the HAS service area...
area as measured by height-for-age, weight-for-age, and height-for-weight were no better than in the rest of rural Haiti. 10

Haiti is a relatively small country of 8.1 million people in an area about the size of Maryland. Haiti is still largely rural, as is the population served by HAS. Furthermore, it has no major ethnic, religious, cultural, or language divisions and is relatively homogeneous in economic terms except for a very small middle class and an even smaller class of elite. In 1970, 78% of the national population was rural and in 2001, 64% was rural. 2 As Table 1 and Figure 2 demonstrate, under-5 mortality rates were not available for rural Haiti before 1985, and the rural rates that are available recently are similar to the national rates. For the above reasons, we conclude that the national population of Haiti is a suitable comparison group to the HAS service area except in terms of the availability of health and other community-development programs.

The rapid decline in under-5 mortality during the first decade of program operations at HAS can be explained largely by the decline in mortality from neonatal tetanus (almost all pregnant women were immunized against tetanus) as well as by the increased coverage of other key child survival interventions. In the late 1960s, a retrospective study found that neonatal tetanus had been responsible for 270 deaths per 1000 live births. 20 When HAS began providing services in 1956, program emphasis was on immunizing pregnant women against tetanus, hospital care of newborns with tetanus (a recovery rate of 50%), and proper umbilical cord care at the time of delivery. Only when the community health program began in 1967, which made it possible to immunize all women of reproductive age, did infant mortality attributable to tetanus fall to virtually zero. 20

Even after the dramatic initial declines at HAS in under-5 mortality from 1960 to 1970, the 1–4 year mortality rate declined by 56% between 1970 and 1999 (35.4 to 15.7) and the overall under-5 mortality rate declined by 23% (from 80.7 to 62.3) during the same period. However, the infant mortality rate has shown no consistent trend and remained between 33.0 and 47.3.

Why has there been a lack of progress at HAS in further reducing under-5 mortality since the early 1970s? The program service area gradually expanded from 8820 to 180000 people and the areas of expansion were mostly in isolated mountainous areas. There, the mortality rates are twice that of the central valley area around the hospital, where the community health program began (H.P., MD, unpublished data, 2006).

In 2000, rates of childhood malnutrition at HAS remained very high: 18.4% of children were at less than 2 standard deviations below the international mean of weight-for-age and 22.6% of the children were at less than 2 standard deviations below the international mean of height-for-age. 10 Improving household food security was difficult in the midst of Haiti’s economic and political turmoil during the 1980s and 1990s. Thus, the persistence of childhood malnutrition limited progress in further reducing under-5 mortality.

The arrival of HIV/AIDS in the population in the early 1980s is another possible explanation. We have estimated elsewhere 10 that if HIV/AIDS had not been present, the under-5 mortality rate in the HAS service area would have fallen by an additional 20% and the under-5 mortality rate for Haiti as a whole would have fallen by an additional 8%. HIV/AIDS affected 3.7% of the HAS service population of reproductive age in 1996 and 3.9%
in 2001 (H.P. MD, unpublished data, 2006) compared with 5.6% nationally in 2003.21

Haiti has one of the most mobile populations in the world. Furthermore, children are frequently moved from one household to another and away from 1 or both of their biological parents because of the death of a parent, instability of conjugal unions, changing locations for agricultural work, or opportunities for income generation in other areas.22 Field experience in Haiti suggests that children born into unstable unions have higher mortality than children born into stable households.22,23 As a result, the challenges for continuity of care in child health programs and reducing child mortality are enormous.

Between 1986 and 1999, the country remained in almost continuous political turmoil and steady economic decline. There were frequent changes of government and the per capita income declined by 3.0% during this period.2

Given the higher levels of mortality in the expansion areas, the impoverishment of the population, the low level of education, the high rates of childhood malnutrition, HIV/AIDS, the mobility of the population, and the overall political instability that were all present throughout this period, it is remarkable that the under-5 mortality rates at HAS did not increase as the service area gradually expanded.

Limitations

The main weaknesses of this study are that the mortality data are largely retrospective and that a gap existed in data collection between 1972 and 1992 at HAS. However, national data were based on a similar retrospective methodology with a gap in data collection between 1970 and 1995. The net effect of the possible biases should be negligible when comparing the differences in under-5 mortality between the HAS service area and Haiti at large. The inclusion of prospectively collected vital events data in the late 1960s at HAS along with subsequent retrospectively collected vital events data is not likely to significantly affect the quality of the data, because recent research has demonstrated a high degree of correlation when the 2 methods are applied to the same population.24

Similar Assessments Elsewhere

We are aware of only 1 other program that has documented long-term program effects on under-5 mortality: the Matlab Maternal and Child Health-Family Planning Program in Bangladesh. In Matlab, under-5 mortality in an intervention area of 100,000 people has been monitored and compared with under-5 mortality in an adjacent control area since 1965.25,26 There, under-5 mortality rates have generally been one-third lower in the intervention area than in the comparison area, and this difference has persisted since 1978.27 Although the Matlab program has a far more rigorous and intensive surveillance system and lacks a community development component, it is similar to HAS’s program in that it provides services in the home and refers patients needing hospitalization.

Other programs that have been able to document impact on under-5 mortality have reported findings for much shorter periods of time (usually 5 years or less), and these programs have usually introduced 1 or several selected interventions.28–36 One notable exception is the School for Education, Action and Research in Community Health field trial in Gadchiroli, India. In this trial, interventions by community health workers were focused on case management of childhood pneumonia and home-based neonatal care, which has resulted in a decline in neonatal mortality over a 10-year period.37 In other locations in developing countries, systems of monitoring vital events over a longer period of time have been established, but do not lend themselves to comparisons with populations that are similar in other respects except for program interventions.28,30

One health program, the Jamkhed Comprehensive Rural Health Project in India, has established a long-term infant mortality surveillance capability and reports an infant mortality rate of 20 deaths per 1000 live births, but without
an appropriate comparison group. Thus, we believe that HAS provides one of the few available demonstrations of the long-term impact of a local health program on under-5 mortality.

Conclusions

Our findings support the conclusion that a local system of comprehensive health and development activities can make a major long-term impact on under-5 mortality. Narrower, disease-specific approaches have been successful and can take justifiable credit for their role in reducing the number of child deaths globally. However, overreliance on such approaches may be one of the factors that has stalled progress in further reducing under-5 mortality. Although successful in the short term, these narrower, disease-specific approaches are not the long-term answer. The need, therefore, is to begin to strengthen integrated long-term local health and community development programs in order to achieve sustainable gains in public health.

Our findings provide supportive evidence that HAS, as an integrated system of health and development activities, has reduced under-5 mortality and sustained that reduction over 3 decades. Similar results in other severely impoverished settings should be achievable if adequate financial and technical support and professional leadership are available. Additional evidence regarding long-term effectiveness is needed from other program sites around the world. The United Nations Millennium Goal is to reduce under-5 mortality by two thirds by the year 2015. If that goal is to be reached, financial and technical support as well as professional leadership will be required to build on successful experiences such as that at Hôpital Albert Schweitzer by replicating and scaling up these programs.

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Contributors

H. Perry developed the idea for this article, directed the collection and analysis of the data, wrote the initial drafts, and coordinated the contributions of the co-authors. W. Berggren and G. Berggren designed and led the initial implementation of HAS’s community health program from 1967 to 1974 and are currently technical advisors to HAS. D. Dowell worked as a pediatrician for HAS off and on from 1970 to 2003, and served as Medical Director of the HAS community health program from 1999 to 2003. H. Menager, E. Botte, and J. R. Dortonne led community health activities at HAS during the time covered by the study. F. Philippe provided field supervision of the collection of mortality data at HAS from 1985 to 1999. M. Cayemittes directed the activities of the Institut Haitien de l’Enfance in collecting national mortality data for Haiti from 1980 to 1999, as well as for collecting the data regarding socioeconomic conditions, childhood nutritional data, and coverage of child survival services in the HAS service area for the year 2000.

Human Participant Protection

At the time data were collected, HAS did not have an institutional review board. The methods of data collection from households in the HAS service area in 2000 were all within the guidelines of HAS’s policies and procedures.

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References


The Black—White Disparity in Pregnancy-Related Mortality From 5 Conditions: Differences in Prevalence and Case-Fatality Rates

Myra J. Tucker, BSN, MPH, Cynthia J. Berg, MD, MPH, William M. Callaghan, MD, MPH, and Jason Hsia, PhD

For the past 5 decades, Black women have consistently experienced an almost 4-times greater risk of death from pregnancy complications than have White women. This increased risk of pregnancy-related death among Black women is independent of age, parity, or education. An increased risk of death from other conditions, such as breast and gynecological cancer, has also been reported for Black Women. Black women are also more likely to die from complications of pregnancy, including hemorrhage, hypertensive disorders of pregnancy, and cardiomyopathy. However, the reasons for this excess mortality remain unclear. Our lack of knowledge about what factors cause the disparity in pregnancy-related mortality between Black and White women impedes our ability to formulate appropriate research and to design interventions to eliminate this disparity.

Excess mortality from a condition can be caused by a higher prevalence of the condition, a higher case-fatality rate, or a combination of these factors. To better understand the reasons for the higher pregnancy-related mortality rate among Black women, we calculated prevalence and case-fatality rates for 5 selected complications of pregnancy among Black and White women to determine the contribution of each factor to the difference in pregnancy-related mortality ratios. These 5 conditions—preeclampsia, eclampsia, abruptio placentae, placenta previa, and postpartum hemorrhage—account for 26% of all pregnancy-related deaths. We partitioned the Black—White gap in the pregnancy-related mortality ratio into 2 parts: 1 attributable to differences in prevalence and the other attributable to differences in case-fatality rates.

METHODS

The pregnancy-related mortality ratio (PRMR; deaths per live births) for a condition is the product of the prevalence rate of the condition (cases per live births) and the case-fatality rate for the condition (deaths per cases). We calculated prevalence and case-fatality rates for preeclampsia, eclampsia, abruptio placentae, placenta previa, and postpartum hemorrhage for the years 1988 to 1999. We selected these 5 conditions because they are potentially life threatening and because they were methodologically amenable to our analytic approach.

We defined the prevalence rate for each of the 5 selected conditions as the number of pregnant women with the condition per 100,000 live births. We used data from the US National Hospital Discharge Survey (NHDS) to estimate the number of women with each selected pregnancy condition during the study period. We used the US National Vital Statistics System natality data to determine the number of live births over the same period.

Data for the NHDS are collected via an annual survey of hospital discharge records conducted by the National Center for Health Statistics and are used to calculate national statistics on inpatient hospitalizations. The NHDS uses a probability sample of nonfederal general and short-stay specialty hospitals and is representative of hospitalizations among the US civilian resident population. National natality data are also gathered by the National Center for Health Statistics and are actual counts of births compiled from birth certificates in the United States.

We defined the case-fatality rate for each of the 5 selected conditions as the number of deaths attributable to that condition per 100,000 women with the condition. The numerators of the case-fatality rates were obtained from the Pregnancy Mortality Surveillance System (PMSS) at the US Centers for Disease Control and Prevention. The denominators were prevalence estimates we calculated using NHDS data.

The PMSS is an ongoing surveillance system of all pregnancy-related deaths in the United States. Pregnancy-related deaths are defined as deaths that occur during pregnancy...
or within 1 year after pregnancy has ended and that are caused by complications of the pregnancy, a chain of events initiated by the pregnancy, or the aggravation of an unrelated condition by the effects of the pregnancy. Because the PMSS uses multiple data sources, it identifies approximately one third more deaths caused by pregnancy complications than do surveillance systems that use death certificates alone.15

We defined the PRMR as the number of pregnancy-related deaths from each of the selected conditions per 100 000 live births. The numerators for the PRMRs were pregnancy-related deaths obtained from the PMSS. The denominators were live births from the US National Vital Statistics System natality files.

We first computed the prevalence and case-fatality rates for each pregnancy condition for both Black and White women; we then estimated the Black–White rate ratios, with 95% confidence intervals (CIs), for these 2 measures for each of the 5 selected conditions. For each condition, we partitioned the excess pregnancy-related mortality found for Black women into the percentage attributable to a greater prevalence rate and the percentage attributable to a higher case-fatality rate. To evaluate the statistical significance of our findings, we first calculated the standard errors for the prevalence and case-fatality rate estimates with relative standard error curves that were obtained by the regression of the variances of the totals on the estimates of the totals of selected variables.12 Then, to calculate CIs for the Black–White rate ratios for the prevalence and case-fatality rates, we used the Taylor linearization method.13 Because the PRMR is the product of the prevalence rate and the case-fatality rate, we determined the percentage contribution of each factor to the PRMR difference by converting the Black–White prevalence rate ratios, the Black–White case-fatality rate ratios, and the Black–White PRMRs to log base 10. We then partitioned the difference in the PRMRs for Black and White women into the sum of the difference in the prevalence and the difference in the case-fatality rates.

For delivery hospitalizations, the NHDS contains fields for up to 6 diagnoses in addition to the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM)14 VM code V27, which denotes delivery of a fetus of at least 20 weeks’ gestation; the diagnoses are not necessarily ranked in order of clinical importance in the NHDS. Of records with at least 1 of the diagnoses of interest, 96% had only 1 of the diagnoses and the remaining 4% contained 2 to 4 diagnoses. For records that included more than 1 diagnosis, we used our knowledge of the progression of pathological processes in pregnancy to develop the following decision rules for selecting the condition judged most likely to be the cause of the death. If a code for placenta previa was present on the record, the case was classified as placenta previa regardless of other diagnoses. In the absence of a placenta previa code, eclampsia took precedence over preeclampsia. If a postpartum hemorrhage code existed along with eclampsia or preeclampsia, a case was classified as postpartum hemorrhage. On the other hand, if a postpartum hemorrhage code existed in combination with abruptio, a case was classified as abruptio placentae. Eclampsia and preeclampsia were selected over abruptio placentae, because the former conditions were considered the likely etiology for abortion. If eclampsia or preeclampsia, abortion, and postpartum hemorrhage were all present, the case was considered attributable to eclampsia or preeclampsia.

Overall, 21.4% of the NHDS records used in our study did not include information on race, because since 1985 a significant proportion of the NHDS data have been obtained from administrative data sources that infrequently contain this information. A prior analysis demonstrated that in the NHDS, those hospitals whose data do not include race were in areas where the population was predominantly White; therefore, White individuals were underreported in the NHDS to a greater extent than were persons of other races.15 Thus, we designated records with unknown race as White. To determine the effect of an alternate method for allocating records with this variable missing, we also calculated prevalence and case-fatality rates after proportionally redistributing cases with unknown race according to the distribution of values among those for whom the race was known. We used the z test to determine whether the Black–White prevalence and case-fatality rate ratios obtained from the 2 methods of allocating cases with unknown race were significantly different statistically.

Fewer than 1% of the PMSS records lacked race information. For these deaths, the surveillance system assigned race according to the known distribution of race among other women who died of pregnancy-related causes in the same state and during the same year as the decedent.

RESULTS

For the 5 pregnancy conditions that we selected, the Black–White prevalence rate ratios ranged from 0.8 for postpartum hemorrhage to 1.6 for eclampsia; none of these ratios statistically were significantly different from 1 (Table 1). However, case-fatality rates for all 5 conditions statistically were significantly higher among Black women. The case-fatality rate ratios for Black versus White women ranged from 2.4 for placenta previa to 3.3 for postpartum hemorrhage.

For each of the selected complications, the PRMRs for Black women were between 2.5- and 3.9-times greater than those for White women (Table 2). For each of the 5 conditions, at least two thirds of the difference in the Black–White PRMRs was attributable to higher case-fatality rates among Black women. One third or less of the difference was attributed to a higher prevalence of the condition among Black women, ranging from 0% for hemorrhage to 34% for eclampsia.

The results were not significantly affected by the method used to redistribute women of unknown race. Ratios calculated after redistributing women with unknown race to White were not significantly different from those calculated when cases with unknown race were redistributed in proportion to the distribution of known cases (data not shown).

DISCUSSION

In 2000, the United States ranked 30th in maternal mortality in the world, and our poor international standing derives in part from racial disparities.16 We undertook this study to determine the relative contribution of 2 factors to the Black–White disparity in
rates of these conditions among Black women were not significantly greater compared to those among White women. However, for all 5 complications, Black women had case-fatality rates that were 2- to 3-times greater than those of White women. This resulted in Black women having cause-specific PRMRs that were 2.5- to almost 4-times greater than PRMRs for White women.

Our decision to limit our analysis to the 5 selected pregnancy conditions was dictated by 2 methodological issues: the need to account for the design of the NHDS and inconsistencies in coding that can occur in the ICD-9-CM.14

Our first consideration was that the NHDS data were organized by occurrence of hospitalization, not by individual being hospitalized, and if an individual had more than 1 hospitalization, no identifying data were available to link the separate hospitalizations, enabling the same person to be counted more than once. Traditionally, the pregnancy complications that we selected for our analysis are almost always present during the delivery hospitalization, even if they also resulted in hospitalization prior to delivery. By limiting study cases to those present during the delivery hospitalization, we ensured that a woman who was hospitalized more than once with the same condition was only counted once—at the time of delivery.

The second consideration that led us to limit our analysis to the 5 selected conditions during the delivery hospitalization was that some complications that occur because of pregnancy can also occur in nonpregnant women. Although ICD-9-CM codes for pregnancy (630–676) should be used to code these conditions if they occur during pregnancy or the puerperium, sometimes the analogous code for the condition in the nonpregnant state is used. Limiting conditions to those that would be present during the delivery hospitalization made it less likely that we would miss complications that occurred before or after the delivery hospitalization but had not received the ICD-9-CM code indicating pregnancy.

The 5 pregnancy complications investigated accounted for a quarter of the pregnancy-related deaths reported to the PMSS during the study period.1 Other complications of pregnancy were not included, because either the NHDS does not contain a sufficient number of cases to provide a stable estimate for the study years (e.g., amniotic fluid embolism), the complications do not consistently manifest themselves during the delivery hospitalization (e.g., pulmonary embolism, cerebrovascular accident, and cardiomyopathy), or the complication may resolve and recur (e.g.,

### TABLE 1—Prevalence and Case-Fatality Rates and Black–White Rate Ratios (With 95% Confidence Intervals [CIs]) for 5 Selected Pregnancy Complications, By Race: United States, 1988–1999

<table>
<thead>
<tr>
<th>Condition</th>
<th>Prevalence Ratea</th>
<th>Black-White Ratio (95% CI)</th>
<th>Case-Fatality Rateb</th>
<th>Black-White Ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preeclampsia</td>
<td>3176</td>
<td>1.0 (0.8, 1.2)</td>
<td>73.5</td>
<td>2.7 (1.8, 3.6)</td>
</tr>
<tr>
<td>Eclampsia</td>
<td>131</td>
<td>1.0 (0.9, 2.3)</td>
<td>1536.3</td>
<td>2.5 (1.4, 3.5)</td>
</tr>
<tr>
<td>Abruption</td>
<td>970</td>
<td>1.1 (0.7, 1.5)</td>
<td>58.4</td>
<td>2.8 (1.8, 3.7)</td>
</tr>
<tr>
<td>Placenta previa</td>
<td>454</td>
<td>1.1 (0.7, 1.4)</td>
<td>40.7</td>
<td>2.4 (1.5, 3.2)</td>
</tr>
<tr>
<td>Postpartum hemorrhage</td>
<td>1428</td>
<td>0.8 (0.5, 1.0)</td>
<td>68.3</td>
<td>3.3 (2.1, 4.4)</td>
</tr>
</tbody>
</table>

Note. NHDS = National Hospital Discharge Survey.

aPrevalence rates were calculated as the number of pregnant women with the condition (obtained from the NHDS) per 100 000 live births (obtained from National Center for Health Statistics natality files).

bCase-fatality rates were calculated as the number of deaths attributable to that condition (obtained from the Pregnancy Mortality Surveillance System) per 100 000 women with that condition (obtained from the NHDS).

### TABLE 2—Pregnancy-Related Mortality Ratios (PRMRs) and Percentage of Pregnancy-Related Mortality Cases Attributable to Black–White Differences in Prevalence and Case-Fatality Rates for 5 Selected Pregnancy Complications, by Race: United States, 1988–1999

<table>
<thead>
<tr>
<th>Condition</th>
<th>Deaths, No.</th>
<th>PRMRsa</th>
<th>Black-White Ratio of PRMRs</th>
<th>Cases Attributable to Difference in Prevalence, %</th>
<th>Cases Attributable to Difference in Case-Fatality Rates, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preeclampsia</td>
<td>177</td>
<td>2.334</td>
<td>0.700</td>
<td>3.3</td>
<td>18</td>
</tr>
<tr>
<td>Eclampsia</td>
<td>153</td>
<td>2.017</td>
<td>0.517</td>
<td>3.9</td>
<td>34</td>
</tr>
<tr>
<td>Abruption</td>
<td>43</td>
<td>0.567</td>
<td>1.900</td>
<td>3.0</td>
<td>7</td>
</tr>
<tr>
<td>Placenta previa</td>
<td>14</td>
<td>0.185</td>
<td>0.075</td>
<td>2.5</td>
<td>5</td>
</tr>
<tr>
<td>Postpartum hemorrhage</td>
<td>74</td>
<td>0.976</td>
<td>0.397</td>
<td>2.5</td>
<td>0</td>
</tr>
</tbody>
</table>

PRMRs were calculated as the number of pregnancy-related deaths from each of the selected conditions (obtained from the Pregnancy Mortality Surveillance System) per 100 000 live births (obtained from National Center for Health Statistics natality files).

International Classification of Diseases, Ninth Revision, Clinical Modification codes for 5 selected complications of pregnancy

- Preeclampsia (642.4, 642.5)
- Eclampsia (642.6, 642.7)
- Abruption (642.2)
- Placenta previa (641.0, 641.1)
- Postpartum hemorrhage (666.0–666.2)
infection). We elected to include postpartum hemorrhage because, although it may occur up to several weeks postpartum, 87% of cases occur within 24 hours of delivery. Including most of those cases that are life threatening.18,19

The reporting of conditions and deaths could possibly differ by race. To calculate the prevalence rates, we used data from the NHDS. The Black–White prevalence rate ratios we estimated using NHDS data were similar to those obtained when using rates of complications for Black and White women derived from birth certificate data.20 To calculate the case-fatality rates, we used PMSS data21 to identify pregnancy-related deaths. A comparison of the PMSS data with maternal mortality data from the National Vital Statistics System did not reveal any difference between the 2 systems in their reporting of deaths from pregnancy complications for White and Black women.22 Although the prevalence and case-fatality rate estimates presented here may not be exact, our goal was the comparison of rates in White and Black women, and we have no reason to suspect that ascertainment of the selected conditions or deaths differed by race.

The fact that race was missing in 21% of the records in the NHDS during the study period was problematic. In the NHDS, hospitals that do not report race have a larger proportion of White patients than do hospitals that report race. Consequently, we chose to designate women with unknown race as White. We believe this provides estimates close to the true population distribution. In addition, our analyses of the proportional reallocation of women with unknown race yielded results that did not differ significantly from those of our initial allocation method.

Several factors may contribute to the elevated case-fatality rates among Black women, including patient attributes, such as disease severity, coexisting medical conditions, and the timing of entry into care, and health system factors, such as access to care and the quality and consistency of care. Although researchers have increasingly accepted the idea that race is more of a social rather than a biological construct, race can have biological consequences, when operating through a variety of factors, that we were unable to measure in this study.22 Compared with White women, Black women are less likely to begin prenatal care in the first trimester and less likely to receive adequate care.23 Black women, including women of reproductive age, are more likely to have a comorbidity or preexisting medical condition, such as hypertension, diabetes, or obesity,24–27 which can affect the course of their pregnancy. In addition, a recent Institute of Medicine report found that for a wide variety of medical problems, minority patients receive a generally lower quality of care, even with equal access to care and insurance coverage.28

Because the number of pregnancy-related deaths is relatively small, national data sets were necessary to obtain sufficient numbers of cases for the analyses presented here. However, these national data sets did not allow us to examine the reasons for the disparity in case-fatality rates. After stratifying the deaths by condition and race, we lacked sufficient numbers to assess modifying factors such as age, region, and urban or rural residence.

To understand why Black women have higher case-fatality rates for the pregnancy-related conditions we examined, a complex interaction of biological and health services factors must be untangled. We hope that research will advance beyond the descriptive epidemiology of racial disparities in pregnancy-related mortality to studies that will help elucidate the causes of disparity. Progress will depend on researchers’ abilities to define more precisely the mechanisms affecting complication severity and risk of death and then to apply this knowledge in designing interventions that improve pregnancy-related outcomes.

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Contributors
M.J. Tucker and C.J. Berg designed and implemented the study. M.J. Tucker was primarily responsible for preparing the article, with substantial contributions from C.J. Berg and W. Callaghan. J. Hsa provided analytic expertise and statistical oversight. All authors helped develop study ideas, interpret findings, and review drafts.

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Human Participant Protection
No human participation protocol approval was required for this study.

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RESEARCH AND PRACTICE


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Brief Intervention for Alcohol Use by Pregnant Women

Mary J. O’Connor, PhD, Shannon E. Whaley, PhD

The prevalence of alcohol use among pregnant women is more than 12%, which suggests that approximately 1 in 8 fetuses is exposed to alcohol in utero. Moreover, it is estimated that about 1 in 100 children has a fetal alcohol spectrum disorder, which is associated with substantial life-long impairments in neurocognitive and socioemotional development. Even low levels of alcohol consumption have been shown to be related to negative developmental sequelae. Furthermore, children from low-income ethnic minority populations are particularly vulnerable to the long-term effects of prenatal alcohol exposure, because their mothers are less likely to receive appropriate counseling regarding alcohol use during pregnancy. For these reasons, effective prevention of alcohol use by pregnant women has become an important national priority.

Derived from the principles of social learning theory, brief intervention is an effective methodology that has been empirically validated in a number of alcohol-related studies. The approach uses 10- to 15-minute sessions of counseling that can be delivered by personnel who are not specialists in the treatment of alcohol abuse or dependence. Most successful brief interventions include (1) feedback aimed at increasing awareness of the negative consequences of drinking, (2) advice focused on identifying risky situations and actions aimed at reducing consumption, and (3) assistance with formulating drinking reduction goals. Brief intervention has been shown to be a low-cost, effective treatment alternative for alcohol use problems. The methodology uses time-limited, self-help strategies to promote reductions in alcohol use in nondependent individuals, and in the case of dependent persons, to facilitate referral to specialized treatment programs.

In spite of the proven effectiveness of brief intervention in the general population, there have been few controlled studies on the use of this technique for counseling pregnant women. Three studies have been published to date, and in all of these studies, the interventions were integrated into obstetric care in primary care settings where advice was typically provided by physicians. With the exception of a small pilot study that used motivational interviewing, and another study that used a manual approach, intervention has typically concentrated on middle-class, White, non-Hispanic women. Given the focus of most research on nonminority, middle-class women seen in obstetric clinics, the purpose of our study was to examine the effectiveness of brief intervention in helping low-income minority women achieve abstinence from alcohol during pregnancy, in an accessible community-based setting, and by using nonmedical providers (nutritionists from the Public Health Foundation Enterprises Management Solutions Special Supplemental Nutrition Program for Women, Infants, and Children; PHFE-WIC). Gestational age, neonatal weight and length, and fetal viability served as outcome variables for evaluating the efficacy of brief intervention.

Objectives. We examined the efficacy of brief intervention as a technique to help pregnant women achieve abstinence from alcohol. A second aim was to assess newborn outcomes as a function of brief intervention.

Methods. Two hundred fifty-five pregnant women who were participants in the Public Health Foundation Enterprises Management Solutions Special Supplemental Nutrition Program for Women, Infants, and Children and who reported drinking alcohol were assigned to an assessment-only or a brief intervention condition and followed to their third trimester of pregnancy. Brief intervention consisted of 10- to 15-minute sessions of counseling by a nutritionist, who used a scripted manual to guide the intervention. Newborn outcomes of gestation, birthweight, birth length, and viability were assessed.

Results. Women in the brief intervention condition were 5 times more likely to report abstinence after intervention compared with women in the assessment-only condition. Newborns whose mothers received brief intervention had higher birthweights and birth lengths, and fetal mortality rates were 3 times lower (0.9%) compared with newborns in the assessment-only (2.9%) condition.

Conclusions. The success of brief intervention conducted in a community setting by nonmedical professionals has significant implications for national public health policies.

METHODS

Design and Procedure

PHFE-WIC in Southern California is the largest WIC agency in the country and serves more than 316,000 pregnant women, infants, and children every month in 53 centers in Los Angeles and Orange Counties. Approximately 11% of the PHFE-WIC caseload is pregnant women. For our study, 12 PHFE-WIC centers were selected and randomized into 1 of 2 conditions: assessment only or brief intervention. Within the 6 centers in the assessment-only condition, current drinkers received a comprehensive assessment of alcohol use and were advised to stop drinking during pregnancy. Within the 6 centers in the brief intervention condition, participants received the same comprehensive assessment of alcohol use plus a standardized workbook-driven brief intervention, designed specifically to help women reduce alcohol consumption during pregnancy. Women were screened at every monthly prenatal visit and, if they were still drinking, were provided brief intervention or assessment only. In this way, a controlled design was used in which participants were
From June 2001 to March 2004, 4980 women were screened for postconception drinking, and 4084 were enrolled in the study. Analyses of demographic data, using the PHFE-WIC database, revealed that women who volunteered for the study did not differ from the general PHFE-WIC population regarding major demographic variables of age, ethnicity, or education. Of the individuals who enrolled, 345 were currently drinking and were randomized to assessment only (n=183) or brief intervention (n=162). Figure 1 shows participant accountability throughout the protocol. Of the 345 women, 255 (74%) continued to return to their original WIC center into their third trimester. This number is consistent with the overall population of pregnant women in WIC, who move often. Participant attrition was not significantly related to treatment condition (assessment only n=45/183, 24.6%; brief intervention n=45/162, 27.8%; Fisher exact test, P = 1.0), alcohol risk, or consumption levels. However, women lost to follow-up averaged approximately 1 more year of education (mean = 12.15 years; SD = 2.86) than did those who were followed (mean = 11.09 years; SD = 3.42; t134 = 2.62, P < .01), and were more likely to be Black, non-Hispanic, or English-speaking Hispanic (χ2, [N=345] = 12.82, P < .01; Table 1).

### Measures

All measures were printed in English or Spanish and were understandable to women with a fourth-grade reading level. PHFE-WIC staff was available to read to those women who requested help.

Women completed a 2-page alcohol screening questionnaire that incorporated quantity-frequency measures to inquire about typical consumption patterns. Women were also queried about whether or not they had any alcohol during the previous week, the previous weekend, or the previous month. The TWEAK 5-question scale, a measure of alcohol tolerance and physical consequences of alcohol consumption, was included in the questionnaire to assess high-risk drinking.

If a woman provided a positive answer on any of the alcohol questions on the screening questionnaire, she was administered the Health Interview for Women, adapted from a questionnaire developed by Day and Robles. Maximum drinks per drinking occasion (MAX), was selected as the outcome measure on the basis of previous work that demonstrated it is a valid predictor of teratogenic effects. Estimates were taken at the first enrollment visit before the intervention (MAX1) and in the third trimester of pregnancy (MAX3). One drink was considered to be 0.60 ounces of absolute alcohol; therefore, one 12-ounce can of beer that contained 5% absolute alcohol was considered 1 drink, whereas one 16-ounce can of 8% malt liquor was considered 2 drinks.

Caffeine ingestion per day was calculated according to the procedure of Jacobson and colleagues. Cigarette smoking was defined as the number of cigarettes the woman reported smoking each day. The number of prescription, over-the-counter, and illegal drugs was estimated during a typical week. For example, marijuana and cocaine use were each coded on a scale from 0 to 2: 0 represented no cocaine or marijuana use, 1 represented use 1–2 times a week, and 2 represented use 3 or more times a week.

### Newborn Measures

To establish the gestational age of the infants, women were asked the due date that was given at pregnancy confirmation. This date was compared with the infant’s birth date. Data on twin births were also collected. Newborn birthweight and birth length are obtained routinely by WIC during the infant enrollment process, and these data were retrieved from the PHFE-WIC database. Other
training practices and to build upon the participant-centered education principles practiced by the PHFE-WIC Program. Issues related to confidentiality, reporting abuse, and referring high-risk clients were explained. After this training, the nutritionists reviewed the alcohol-use screening tool, completed it themselves, scored the results, and developed strategies to incorporate the screening tool into standard practice. Additional training included a description of ways to increase self-reporting of alcohol use, observation of the research staff as they administered the Health Interview for Women for this study, and practice administering the interview.

In a separate training session, nutritionists from the 6 WIC centers in the brief intervention condition were taught to give the intervention. Nutritionists were given a manual that included the goals of brief intervention and a step-by-step explanation of how to conduct the intervention using the brief intervention workbook. We provided live demonstrations of the brief intervention. Nutritionists practiced administering the intervention and answering problematic questions with standard replies.

**Nutritionist Reliability and Treatment Compliance**

Nutritionists were required to attain 100% reliability, as assessed by the use of fidelity checklists, in administering the Health Interview for Women before they could administer the interview to the study participants. We reviewed completed interviews daily for accurate scoring. If an interview form was incomplete or inaccurate, the nutritionist was refreshed on the correct procedure. To ensure fidelity of the administration of the intervention, and to avoid nutritionist drift, quarterly meetings were held at PHFE-WIC headquarters to observe the nutritionists practice the administration of the study protocol. In addition, we made monthly visits to participating WIC centers to assure that the protocol was being followed correctly. An independent scorer used a fidelity checklist of the primary brief intervention content to score a random sample of audiotaped sessions that were collected throughout the study period.

**Data Analysis Plan**

We examined descriptive information about participants, including ethnicity, age, language preference, marital status, education, income, number of weeks of gestation at pregnancy recognition, and weeks of gestation at enrollment in WIC. TWEAK scores and the use of substances, including prescription or nonprescription medications, illegal drugs, caffeinated drinks, and smoking, were estimated. We used $\chi^2$ and $t$ tests for independent samples to compare differences in demographic and other study variables between the assessment-only and brief intervention groups.

To test the efficacy of the brief intervention, we conducted a logistic regression analysis using a generalized linear mixed effects model in SAS version 9 (SAS Institute Inc., Cary, NC) with the GLIMMIX macro, assigning brief intervention or assessment only as the primary fixed effect. We included WIC center as a random design effect and MAX, (initial alcohol consumption level) as a fixed covariate. All demographic and other baseline study variables were examined as possible covariates.

### Table 1—Characteristics of Sample Population: PHFE-WIC, California, June 2001–March 2004

<table>
<thead>
<tr>
<th>Ethnicity (%)</th>
<th>No Follow-up (n = 90)</th>
<th>Follow-up (n = 255)</th>
<th>Assessment Only (n = 138)</th>
<th>Brief Intervention (n = 117)</th>
</tr>
</thead>
<tbody>
<tr>
<td>White, non-Hispanic</td>
<td>10.0</td>
<td>7.1*</td>
<td>6.5</td>
<td>7.7</td>
</tr>
<tr>
<td>Black, non-Hispanic</td>
<td>23.3</td>
<td>17.3</td>
<td>13.8</td>
<td>21.4</td>
</tr>
<tr>
<td>English-speaking Hispanic</td>
<td>38.9</td>
<td>26.3</td>
<td>27.5</td>
<td>24.8</td>
</tr>
<tr>
<td>Spanish-speaking Hispanic</td>
<td>25.6</td>
<td>44.3</td>
<td>46.4</td>
<td>41.9</td>
</tr>
<tr>
<td>Other</td>
<td>2.2</td>
<td>5.1</td>
<td>5.8</td>
<td>4.3</td>
</tr>
<tr>
<td>Age, y, mean (SD)</td>
<td>27.68 (6.09)</td>
<td>28.18 (5.97)</td>
<td>27.90 (6.09)</td>
<td>28.52 (5.84)</td>
</tr>
<tr>
<td>Marital status, married or has partner, %</td>
<td>63.3</td>
<td>71.4</td>
<td>71.0</td>
<td>71.9</td>
</tr>
<tr>
<td>Education, y, mean (SD)</td>
<td>12.15 (2.86)</td>
<td>11.09 (3.42)*</td>
<td>11.00 (3.42)</td>
<td>11.19 (3.44)</td>
</tr>
<tr>
<td>Income, $15,000 or less, %</td>
<td>67.9</td>
<td>67.0</td>
<td>69.6</td>
<td>63.9</td>
</tr>
<tr>
<td>Weeks at pregnancy recognition, mean (SD)</td>
<td>6.83 (4.08)</td>
<td>6.51 (3.57)</td>
<td>6.51 (3.80)</td>
<td>6.51 (3.31)</td>
</tr>
<tr>
<td>Weeks gestation at enrollment, mean (SD)</td>
<td>19.49 (8.79)</td>
<td>17.98 (7.87)</td>
<td>18.15 (7.99)</td>
<td>17.78 (7.76)</td>
</tr>
<tr>
<td>MAX, mean (SD)</td>
<td>2.48 (4.00)</td>
<td>1.90 (2.60)</td>
<td>1.73 (1.73)</td>
<td>2.10 (3.35)</td>
</tr>
<tr>
<td>TWEAK mean (SD)</td>
<td>2.08 (1.61)</td>
<td>1.81 (1.46)</td>
<td>1.84 (1.54)</td>
<td>1.77 (1.36)</td>
</tr>
<tr>
<td>Caffeine drinks mean (SD)</td>
<td>1.67 (3.20)</td>
<td>1.74 (2.40)</td>
<td>1.86 (2.70)</td>
<td>1.61 (2.02)</td>
</tr>
<tr>
<td>Cigarettes per day mean (SD)</td>
<td>1.29 (4.14)</td>
<td>0.49 (1.94)</td>
<td>0.47 (1.60)</td>
<td>0.53 (2.29)</td>
</tr>
<tr>
<td>Marijuana mean (SD)</td>
<td>0.05 (0.27)</td>
<td>0.01 (0.11)</td>
<td>0.37 (0.22)</td>
<td>0.07 (0.32)</td>
</tr>
<tr>
<td>Cocaine mean (SD)</td>
<td>0.23 (0.21)</td>
<td>0.01 (0.89)</td>
<td>0.00 (0.00)</td>
<td>0.01 (0.13)</td>
</tr>
</tbody>
</table>

*Note. MAX = maximum drinks per drinking occasion reported at first enrollment visit; PHFE-WIC = Public Health Foundation Enterprises Management Solutions Special Supplemental Nutrition Program for Women, Infants, and Children.

*P < .01.
covariates (P<.05) of alcohol abstinence at the third trimester follow-up (MAX3). Only weeks of gestation at enrollment in WIC (r=-.16, P<.01) was significantly associated with outcome, and this variable was entered into the model as a covariate. The dependent variable was drinking status at the third trimester follow-up, and women were classified as either abstinent (0) or continuing to drink (1). Degrees of freedom were estimated using the Satterthwaite approximation as implemented in the SAS MIXED procedure.

We analyzed infant outcome measures of gestational age, birthweight, and birth length using a 2 (condition: brief intervention or assessment only)×2 (initial consumption level: MAX1<2 drinks or ≥2 drinks) mixed-effects analysis of covariance (SAS MIXED) in which WIC center was a random effect and statistically significant baseline covariates were controlled. The initial consumption level (MAX1) cutpoint was selected on the basis of current research and national guidelines, which suggest that episodic drinking of 2 or more drinks per drinking occasion during pregnancy can be dangerous for the developing fetus.41 Two twin pairs (n=4) were eliminated from these analyses, because twins tend to have shorter gestations and lower growth parameters at birth, independent of prenatal alcohol exposure.

Gestational age was analyzed both as a dependent variable and as a potential covariate in the analyses of the other 2 newborn outcomes. There were no significant correlations between any of the potential covariates and gestational age, so no covariates were included in that analysis. The analysis of infant birthweight included gestational age (r=.37, P<.001), infant gender (r=.17, P<.01), maternal weight (r=.18, P<.01), height (r=.19, P<.01), and smoking (r=-.17, P<.01) as covariates. The analysis of infant birth length included gestational age (r=.21, P<.01), infant gender (r=.21, P<.01), maternal height (r=.12, P<.08), and smoking (r=-.16, P<.02). Fetal mortality rates were calculated as percentages.

**RESULTS**

The average MAX1 for the final sample (n=255) was 1.90 (SD=2.60) as shown in Table 1. Scores were not normally distributed:

54% of women drank a maximum of 1 drink per occasion, 21% drank a maximum of 2 drinks, and 25% reported drinking 3 or more drinks per occasion. The average TWEAK score for the sample was 1.81 (SD=1.46), and 61% of the women sampled scored 2 or higher on the TWEAK scale, which has been suggested as a cutpoint for pregnant women who may not be alcohol dependent but who may, nevertheless, drink at levels that place the fetus at risk.37 The use of other substances is highlighted in Table 1.

Our examination of the data found that there were no differences between women in the brief intervention and assessment-only conditions regarding demographic or alcohol variables, including initial levels of alcohol consumption (MAX1) or high-risk drinking status as measured by the TWEAK scale. There were no differences between the groups in the use of other substances (Table 1).

Our analysis of abstinence from drinking yielded a significant intervention effect, F(1,241)=4.33, P<.04. Compared with women in the assessment-only condition, women in the brief intervention condition were 5-times more likely to be abstinent by the third trimester (odds ratio [OR]=5.39; 95% confidence interval [CI]=1.59, 18.25). Table 2 shows the logistic regression coefficients for the fixed effects, SE, OR, and 95% CIs in this model.

Our analysis of gestational age revealed neither a significant main effect nor interaction associated with brief intervention; consequently, this variable was included as a covariate in the analyses of infant birthweight and birth length. Our analysis of infant birthweight revealed a marginally statistically significant condition×initial consumption level interaction, F(1,234)=3.59, P<.06. Nevertheless, these results suggest a clinically significant effect: infants in the brief intervention high-consumption group averaged 180.45 g (estimated) more than infants in the assessment only high-consumption group and, in fact, slightly reversed the pattern for the brief-intervention high-consumption group. The estimated mean for the brief intervention high-consumption group was 3486.11 g (SE=67.90) compared with 3305.66 g (SE=75.15) for the assessment-only high-consumption group. The estimated means for the brief intervention and assessment-only low-consumption groups were 3356.89 g (SE=60.46) and 3421.96 g (SE=51.76), respectively (Figure 2).

Analysis of birth length yielded a statistically significant interaction between condition and initial consumption level, F(1,194)=4.48, P<.03. For women consuming fewer than 2 drinks per drinking occasion before intervention, newborn birth lengths were the same regardless of experimental condition (estimated mean = 49.98 cm, SE=0.37; and mean=49.90 cm, SE=0.31 for brief intervention and assessment only, respectively). However, for women who were consuming 2 or more drinks, brief intervention had a significant effect on newborn birth length. Infants of women in the high-consumption group who received brief intervention did not differ in birth length from infants in the low-consumption groups (mean=50.35 cm, SE=0.42); whereas, infants of women in the high-consumption assessment-only group (mean=48.68 cm, SE=0.44) were significantly shorter than infants of mothers in the other 3 groups. Comparison of the high-consumption groups across conditions revealed that there was an average difference of 1.69 cm (estimated) in length.
between the brief intervention and assessment-only groups (Figure 2).

Five infants in the study sample did not survive. Results revealed that 2.9% (n=4; 2 miscarriages, 2 stillborns) of the pregnancies in the assessment-only condition resulted in a nonviable outcome compared with 0.9% (n=1; miscarriage) in the brief intervention condition.

DISCUSSION

Research reveals that brief intervention techniques have been highly successful in increasing an individual’s motivation to change unhealthy behavior.42 Our results strongly suggest that women who use alcohol during pregnancy are receptive to brief intervention strategies, that brief intervention can be successfully provided by nonmedical professionals, and that negative neonatal consequences of prenatal exposure to alcohol can be prevented through intervention. However, although results suggested that brief intervention was more effective than assessment alone, women in both groups reduced their drinking substantially. This may have been because the women sampled wanted to have healthy pregnancies and because of the time and attention that nutritionists provided for women in both conditions.

Nevertheless, more positive newborn outcomes were found to be associated with brief intervention, particularly for the newborns of heavier drinkers. There was also a lower rate of fetal death in the brief intervention group compared with the assessment-only group. Extrapolating from the study data, the fetal mortality rate in the intervention group would be estimated at 9 in 1000 compared with 29 in 1000 in the assessment-only group. In minority populations of Black, non-Hispanic and Hispanic women, the recorded fetal mortality rates are 11.02 and 5.57, respectively.43 A rate of 29 in 1000 is significantly higher than these population rates would predict and confirms that prenatal alcohol exposure is a significant risk factor for the fetus. In spite of the relative success of brief intervention on infant survival, the fetal death rate of 9 in 1000 in the intervention condition is almost twice as high as that found in White non-Hispanic populations, which is estimated at 4.91 in 1000. These higher rates may relate to factors associated with being an economically disadvantaged minority woman, including mistrust of medical professionals and a reluctance to seek medical care.44-45

Of special concern is the fact that many women are often unaware of their pregnancy status and may drink alcohol well into the first trimester before recognition of the pregnancy. This pattern was confirmed in our sample of low-income women: 62% of postconception drinkers reported drinking before pregnancy recognition. Because pregnancy recognition in this sample did not occur until almost the seventh week of gestation, this suggests a relatively long period of exposure. The remaining 38% of women who reported continued drinking following pregnancy recognition were not screened, on average, until 18 weeks gestation, well into their second trimester, and later enrollment was found to be associated with lower rates of abstinence. These findings suggest that more-aggressive methods of early detection are needed to identify women who require more-intensive intervention.

As with any study conducted in a community setting, certain limitations in study design are expected. In our study, PHFE-WIC centers were randomized to treatment condition, and participants were nested within centers; therefore, lack of a fully randomized controlled design represents a study limitation. A fully randomized design was seriously considered; however, discussion with nutritionists revealed that they felt it would not be feasible for them to withhold intervention from a random selection of participants. Because of this potential methodological shortcoming, the WIC center effect was examined statistically and found not to be a significant factor in treatment outcome.

Although attrition was not found to be related to treatment condition, women lost to third trimester follow-up were likely to be more educated and to be Black, non-Hispanic or English-speaking Hispanic compared with women who remained in the study. Thus, future intervention strategies should consider ways to best follow and intervene with these women throughout pregnancy.

Because this sample was drawn from women living in Southern California who volunteered to be screened, our ability to generalize the results to other populations of women in other parts of California and the United States is limited. Specifically, the sample was highly saturated with low-income Hispanic participants. Nevertheless, many sample demographic characteristics are consistent with those that have been identified in larger, stratified populations of women and in smaller samples of Hispanic women of Puerto Rican, Central, or South American descent from the northeastern United States. Furthermore, Hispanics are the fastest growing ethnic group in the United States and are expected to constitute 24.4% of the population by 2050.49
Thus, results likely have relevance for public health practices nationwide that address the prevention of drinking during pregnancy in minority women.

Brief intervention provided by nonmedically trained health professionals (WIC nutritionists) proved to be highly successful for reducing alcohol consumption during pregnancy and improving newborn outcomes. The success of brief intervention with low-income minority women who often do not have adequate health insurance or prenatal care suggests that the programs like WIC could be instrumental in preventing alcohol-exposed pregnancies. Given the nationwide presence of WIC centers and the comparable services provided across centers, there is a significant opportunity to protect a large number of children at risk because of alcohol exposure during pregnancy.

References


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Recent studies show that these goals are far from being met.6,7 More than 85% of children aged 19 to 35 months have been projected to have coverage for diphtheria, tetanus, and pertussis and varicella. In addition, more than 90% have been projected to have coverage for measles, mumps, and rubella (MMR); hepatitis B; and polio and approximately 73% are projected to have coverage for the 4:3:1:3 series (4 or more doses of diphtheria and tetanus toxoids and the pertussis vaccine [DTP/DT], 3 or more doses of poliovirus vaccine, 1 or more doses of measles-containing vaccine [MCV], and 3 or more doses of Haemophilus influenzae type b [Hib]).8–10 Although these results are promising, there are disparities in immunization rates among minority and vulnerable populations. There are also inconsistencies in administration of vaccinations during children’s first 2 years of life. Many studies have examined factors that contribute to whether or not children are up to date on recommended immunizations as well as immunization compliance rates.11–14 A study conducted by the Centers for Disease Control and Prevention showed that 18% of children in the United States receive the recommended vaccinations within their first 2 years of life.5 Luman et al. showed that 55% of children lacked the recommended vaccinations during the first 2 years of life and that 9% received all recommended vaccinations at the recommended ages.5 Hughart et al. found a strong link between the demographic characteristics of a child’s family and undervaccination.16 In addition, research has shown that minority children in general, but particularly minority children who live below the poverty line, are less likely than are White children to have received the recommended vaccines by age 2 years.17

Immunization rates are also affected by race/ethnicity, age, and type of vaccine. In one study focusing on children who entered kindergarten in 1992, immunization rates were examined retrospectively from the ages of 2 to 48 months. At age 16 months, 45% of non-Hispanic White children had been vaccinated, as compared with 25% of Black children, 30% of American Indian children, 30% of White Hispanic children, and 28% of Asian/Pacific Islander children.18 In 2001, the Centers for Disease Control and Prevention reported that 77% of children aged 19 to 35 months were up to date on the 4:3:1:3 series.19 Williams et al. reported that substandard immunization rates were most prevalent among members of disadvantaged populations.19

Some of the factors that affect whether or not children are up to date on immunizations include economic, provider, and parental variables; availability of vaccines; and vaccination policies. In addition, children in households with 2 or more other children, children with unmarried mothers having no postsecondary education, non-Hispanic Black children, whose families use public immunization service providers, and children in families in which more than 1 physician provides immunizations are at increased likelihood of experiencing immunization delays (i.e., delays of 30 days or more above the recommended vaccination point).20 Improvements in rates of compliance with national immunization guidelines are imperative. Mell et al. showed that the rate of full compliance with recommended immunization guidelines was about 35.6%, and they showed that 29.7% of children had missed opportunities for immunizations.21 Dombkowski et al. showed that children whose parents had health insurance coverage and a primary source of medical care were more likely than children with no coverage or source of care to have been vaccinated at
appropriate ages, and these factors also led to increases in up-to-date immunization rates; however, provider characteristics did not have a major influence on up-to-date status. Health insurance coverage was associated with a 13% increase in the likelihood of age-appropriate vaccination and a 2% increase in up-to-date status for MMR.25 In comparing children who had a usual source of care and received at least some of their vaccinations from that source with children who did not have a usual source of care, Santoli et al. found that the former had 1.15 times the odds of being up to date for the 4:3:1:3 series.23 Moreover, several studies have examined the role of maternal characteristics in immunization rates and found associations between undervaccination and maternal factors such as marital status, race, education, poverty, and age.24–28 Given these findings, it is essential that system-level factors (i.e., access to a usual source of care and health insurance) and maternal factors be integrated into programs designed to improve immunization rates.22,29

The purpose of this study was to assess the effects of maternal and provider characteristics on children’s up-to-date status on age-appropriate immunization series. We also expected that unforeseen factors might have effects on up-to-date status. We hypothesized that rates of completion of the 4:3:1:3 immunization series would vary according to maternal sociodemographic characteristics and number of children aged younger than 18 years in the household and that delays in completion of age-appropriate immunizations would be associated with economic barriers as well as maternal racial/ethnic background.

METHODS

We obtained data for the study from the 2003 version of the National Immunization Survey (NIS). The NIS, sponsored by the National Immunization Program, was a random-digit-dialing nationwide household survey focusing on vaccinations.30 The target population was children who were aged 19 to 35 months and living in the United States at the time their mothers were interviewed. The children covered in the 2003 survey were born between January 2000 and July 2002. Information derived from interviews was validated via mail surveys completed by the health care providers who administered the children’s vaccinations.

NIS data are gathered from 78 Immunization Action Plan areas consisting of the 50 states, the District of Columbia, and 27 large urban areas. These data provide detailed retrospective longitudinal information on vaccination completion rates and timing as well as sociodemographic characteristics of the child, mother, and family.

The original sample included 30,930 children. Our sample was selected according to the following criteria: the child had complete provider records indicating the extent to which vaccines were administered in a timely manner (n = 13,013); household records were available showing the child's up-to-date status on the 4:3:1:3 immunization series (n = 21,738); and there were no missing data on maternal characteristics included in the statistical analyses. We recognized that by including the first criterion just described children in our sample would have a higher likelihood of being up to date.30 The final sample included 11,860 children aged 19 to 35 months.

Federal guidelines recommend that children complete the 4:3:1:3 immunization series by age 18 months.31 Because all of the children in our study sample were aged 19 to 35 months, the 4:3:1:3 immunization series should have been completed by the time our data were collected. The results of preliminary analyses indicated some inconsistencies between household and provider records of children’s up-to-date status. We expected such inconsistencies as well as inaccuracy of information, because not all households reported up-to-date status using information from their written vaccination record. In all of our multivariate analyses, we accounted for these discrepancies with control for information from the vaccination record. The NIS collected information about children’s providers and verified up-to-date status through reviews of immunization records received directly from providers.

We constructed event indicators from a set of provider records that included a timetable of vaccine administrations with respect to birth date. In particular, we used providers’ records on the timing of the fourth DTP/DT, third polio, third Hib, and first MCV vaccines. We classified children as being up to date (according to national guidelines) on immunizations if they had been administered all of the vaccines included in the 4:3:1:3 immunization series by age 18 months. We classified children as not being up to date if they had not been administered all of the vaccinations in the 4:3:1:3 immunization series by their 18th month. We constructed a duration variable to determine the number of months between birth and completion of the 4:3:1:3 immunization series.

Characteristics assessed as predictors of up-to-date status included mother’s age and educational level, race and ethnicity of child, number of children in the family aged younger than 18 years, mother’s marital status, and family income-to-poverty ratio (IPR). We used child’s race/ethnicity as a proxy of mother’s race/ethnicity because the NIS does not report the mother’s race and ethnicity. Although the NIS collects data on other variables that can be used as a proxy of mother’s race/ethnicity (e.g., language in which interview is conducted), we believe that child race/ethnicity is the best alternative, assuming that all mothers are biological mothers.

We used the IPR, which compares people’s income with their poverty threshold (which was determined using family income, number of persons in the household, number of children in the household, and the 2002 US Census poverty thresholds) and is expressed as a fraction, to explore possible variations in up-to-date status according to socioeconomic status. The IPR can be used not only to categorize people as above or below the poverty line but also to measure degree of poverty. An IPR of less than 1 indicates that a family is below the poverty level; an IPR of 1 indicates that a family is at the poverty level; and an IPR of greater than 1 indicates that a family is above the poverty level. We recoded raw IPR values to construct 4 categories: less than 1, 1 to 1.99, 2 to 2.99, and 3 or more.

We calculated weighted percentages for maternal and provider variables according to children’s up-to-date status. We used univariate logistic regression analyses to assess variables in terms of their significance as predictors of up-to-date status. Variables shown to be significant univariate predictors, as well as
TABLE 1—Weighted Percentages for the Maternal and Provider Characteristics Used in the Analyses for the Full Sample, by Up-to-Date (UTD) Immunization Status: US National Immunization Survey, 2003

<table>
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<tr>
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<th>UTD</th>
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<td>Mother's age, y</td>
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<tr>
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<td>Mother’s educational level</td>
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<td>College</td>
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<tr>
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<tr>
<td>≥4</td>
<td>13.3 (0.6)</td>
<td>19.1 (1.4)</td>
<td>11.8 (0.6)</td>
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<td>61.1 (0.8)</td>
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<td>25.5 (0.6)</td>
<td>19.4 (1.3)</td>
<td>27.1 (0.7)</td>
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<td>Mother’s marital status</td>
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<td>Divorced/separated/widowed/deceased</td>
<td>7.9 (0.4)</td>
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<td>7.4 (0.5)</td>
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<td>Married</td>
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<td>1-1.99</td>
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<td>24.2 (0.8)</td>
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<td>2-2.99</td>
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<td>15.4 (0.6)</td>
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<td>≥3</td>
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<td>35.8 (0.8)</td>
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<td>Information reported from vaccination card</td>
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<td>Provider offers comprehensive care</td>
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<td>All providers</td>
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<td>Some but not all providers</td>
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<td>10.3 (1.1)</td>
<td>7.1 (0.4)</td>
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<tr>
<td>Provider offers acute illness care</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>All providers</td>
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<td>71.7 (1.5)</td>
<td>75.6 (0.7)</td>
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<td>9.0 (0.5)</td>
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<td>Provider offers follow-up visits</td>
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<tr>
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<td>73.9 (1.5)</td>
<td>78.0 (0.7)</td>
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<td>13.5 (0.5)</td>
<td>15.5 (1.3)</td>
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<td>Provider offers after-hours telephone services</td>
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<tr>
<td>All providers</td>
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<td>58.5 (1.6)</td>
<td>63.9 (0.8)</td>
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<td>Some but not all providers</td>
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<td>9.8 (0.5)</td>
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<td>No provider/provider unknown</td>
<td>26.8 (0.7)</td>
<td>28.3 (1.5)</td>
<td>26.4 (0.8)</td>
</tr>
</tbody>
</table>

Continued

those of obvious theoretical importance, were included in subsequent multivariate analyses.

We used the Kaplan–Meier method to calculate weighted quartile estimates of elapsed time before completion of the 4:3:1:3 series and assessed log-rank tests for equality over strata of 2 variables of theoretical importance, race/ethnicity and number of children aged younger than 18 years in the household. Using variables we had identified as possible univariate predictors, we constructed multivariate Cox proportional hazard regression models to examine whether maternal characteristics were predictive of variations in rates of children’s up-to-date status on the 4:3:1:3 series. In particular, we examined how each factor contributed to delays in completion of age-appropriate immunizations. All statistical analyses were performed with SUDAAN with adjustment for the substantial oversampling of Immunization Action Plan areas and members of certain minority groups in the NIS.31

RESULTS

Table 1 shows sample characteristics (n=11860) stratified according to up-to-date status, that is, by completion (n=9510) or noncompletion (n=2350) of the 4:3:1:3 immunization series by the age of 18 months. Forty-six percent of children in the sample had mothers who were aged 29 years or younger. A majority of the mothers either were high-school graduates or had completed more than 12 years of education. Hispanic and non-Hispanic White children made up 23.9% and 56.1% of the sample, respectively. Most children (61.2%) were from households with 2 or 3 children aged younger than 18 years; 26% resided in households with IPRs below 1. Sixty-three percent of households used information from the vaccination record to report immunization status. Table 1 also presents the weighted percentages for provider variables, stratified according to child’s up-to-date status. Most providers offered comprehensive care (84.7%), care for acute illnesses (74.8%), follow-up visits (77.1%), and after-hours telephone services (62.7%) and participated in the Vaccines for Children program (77.4%). Only 25% of providers offered Special Supplemental Nutrition...
Program for Women, Infants, and Children (WIC) services or other similar services. Approximately 62% of facilities were private (61.8%); only 14.8% were public.

Weighted Kaplan–Meier survival curves were assessed for number of children aged younger than 18 years in the household and child’s racial/ethnic background (data not shown). Results from log-rank tests allowed us to reject the equality assumption ($P<.001$). This finding partially supported our hypothesis that up-to-date rates would vary according to child race/ethnicity and number of children aged younger than 18 years in the household.

Figure 1 shows cumulative percentages of children completing the 4:3:1:3 immunization series according to mother’s race/ethnicity and household IPR. Children with Hispanic mothers and children residing in households with IPRs below 1 were most likely to have received the required immunizations at or before 18 months from birth.

Table 2 shows hazard ratios (HRs; ratios of median survival times) and 95% confidence intervals (CIs) derived from weighted multivariate Cox regression analyses. Longer survival times reflected delays in the timely completion of the 4:3:1:3 immunization series. Models 1 through 3 suggested that mother’s age and educational level did not have any added effects on rates of 4:3:1:3 immunization series completion among Hispanics or non-Hispanic Blacks.

Model 4 showed that children of non-Hispanic Black mothers (HR = 0.85; 95% CI = 0.75, 0.97) were significantly less likely than children of non-Hispanic Whites to have completed the 4:3:1:3 immunization series within 18 months of their birth. Also, model 4 suggested that children of young mothers had a decreased likelihood of completing the 4:3:1:3 immunization series by this point; the completion rate was 7% lower among children of mothers aged 29 years and younger (HR = 0.93; 95% CI = 0.86, 0.99) than among children of mothers aged 30 years and older. Marital status and low IPR did not contribute significantly to further variability in completion rates among children of non-Hispanic Black or Hispanic mothers.

Model 6 (Table 2) shows the full model including all of the predictors assessed. Our results confirmed previous findings indicating that the presence in the household of more than 1 child aged younger than 18 years is predictive of delay in completion of the 4:3:1:3 immunization series. Completion rates in families with 4 or more children aged younger than 18 years (HR = 0.68; 95% CI = 0.59, 0.78) and those with 2 or 3 children (HR = 0.85; 95% CI = 0.79, 0.91) were 32% and 15%, respectively (the reference group in these comparisons was families with 1 child).

Lower completion rates were associated with single motherhood; the rate among children of mothers who had never been married was 14% (HR = 0.86; 95% CI = 0.76, 0.96), whereas the rate among children of mothers in all other marital status categories combined was 17% (HR = 0.83; 95% CI = 0.73, 0.96). After we controlled for other factors, completion rates were higher among children of mothers with less than 12 years of education (HR = 1.16; 95% CI = 1.01, 1.33) than among children of mothers with college degrees. Delays in completion were associated with IPRs above 3.
Note. Dotted line indicates 18 months from birth, the age at which the children should have completed the required immunization series.

FIGURE 1—Weighted cumulative percentages of children up to date on the 4:3:1:3 immunization series, by race/ethnicity (a) and income-to-poverty ratio (IPR) (b): National Immunization Survey, 2003.

In model 7 (Table 3), we tested whether or not the relationships between mother’s minority status and rate of timely completion of the 4:3:1:3 immunization series varied according to differences in IPRs. We included interaction terms between mother’s race/ethnicity and IPR. We found that the effects of low IPRs on timely completion were significantly different among non-Hispanic Blacks and Hispanics. In a comparison of mothers residing in households with IPRs below 1 and mothers residing in households with IPRs above 3, hazard ratios for completing the immunization series were 4% higher for those of non-Hispanic Black ethnicity (HR = 1.04) and 12% higher for those of Hispanic ethnicity (HR = 1.12). Relative to mothers in the reference category, those residing in households with IPRs above 3, the hazard ratio for timely completion was 13% (HR = 0.81) lower for non-Hispanic Black mothers residing in households with IPRs between 1 and 1.99.

We then assessed degrees of variation within racial/ethnic groups in rates of 4:3:1:3 immunization completion attributable to IPR. We estimated the main effects model (model 6) separately with each racial/ethnic group (data not shown). Among non-Hispanic Blacks, IPR contributed significantly to variations in completion rates. The rate of timely completion was 74% higher among non-Hispanic Black mothers residing in households with IPRs below 1 than among non-Hispanic Blacks living in households with IPRs above 3 (HR = 1.74; 95% CI = 1.17, 2.58). There were no significant IPR-specific differences among non-Hispanic Whites or Hispanics.

DISCUSSION

Our results suggest that the presence in a household of more than 1 child aged younger than 18 years is associated with delays in completion of recommended immunizations. We found that other predictors had varying influences on completion of the 4:3:1:3 immunization series. In particular, single motherhood significantly predicted delays in completion of appropriate immunizations. Completion rates also varied according to mothers’ sociodemographic characteristics. The significant differences in immunization rates observed among non-Hispanic Blacks and Hispanics further suggest that lower rates of immunization coverage may contribute to continued health disparities in these groups.

Immunization coverage among children has increased over the years. However, as indicated in this study, disparities continue in the up-to-date status of children aged 19–35 months. Other studies have shown that such disparities are increasing and thus pose a major problem in bridging the gap in immunization rates among children in different racial/ethnic groups. Chu et al. assessed immunization coverage rates among non-Hispanic White, non-Hispanic Black, Hispanic, and Asian preschool children and showed that, from 1996 to 2001, rates of inequality in coverage between non-Hispanic White and non-Hispanic Black children increased by an average of 1.1% per year, with an increase of only 0.5% per year between non-Hispanic White and Hispanic children.

If the problem of low immunization rates is to be addressed, the many factors that contribute to low rates, including missed opportunities, inadequate provider participation in WIC services, parental beliefs, and cultural factors, must be identified. In so doing, parental, provider, and system-level causes must be recognized. Once these factors have been identified, community-level intervention programs must be developed to address the role of each of these groups in existing immunization gaps as well as the role they can play in eliminating disparities.
TABLE 2—Results of Multivariate Cox Proportional Hazard Regression Analyses (Hazard Ratios [HRs] and 95% Confidence Intervals [CIs]) Estimating Effects of Selected Characteristics on Completion of 4:3:1:3 Immunization Series: US National Immunization Survey, 2003

<table>
<thead>
<tr>
<th>Child’s race/ethnicity</th>
<th>Model 1, HR (95% CI)</th>
<th>Model 2, HR (95% CI)</th>
<th>Model 3, HR (95% CI)</th>
<th>Model 4, HR (95% CI)</th>
<th>Model 5, HR (95% CI)</th>
<th>Model 6, HR (95% CI)</th>
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</thead>
<tbody>
<tr>
<td>Non-Hispanic other/multiracial</td>
<td>0.98 (0.88, 1.09)</td>
<td>0.98 (0.81, 1.09)</td>
<td>0.98 (0.88, 1.09)</td>
<td>0.96 (0.86, 1.07)</td>
<td>0.97 (0.87, 1.09)</td>
<td>0.97 (0.87, 1.08)</td>
</tr>
<tr>
<td>Non-Hispanic Black</td>
<td>0.84 (0.74, 0.95)**</td>
<td>0.84 (0.74, 0.96)**</td>
<td>0.84 (0.74, 0.96)**</td>
<td>0.85 (0.75, 0.97)**</td>
<td>0.89 (0.78, 1.02)</td>
<td>0.89 (0.78, 1.02)</td>
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<tr>
<td>Hispanic</td>
<td>1.11 (1.02, 1.21)**</td>
<td>1.11 (1.02, 1.22)**</td>
<td>1.10 (1.01, 1.21)*</td>
<td>1.11 (1.01, 1.22)*</td>
<td>1.12 (1.02, 1.23)*</td>
<td>1.11 (1.01, 1.22)*</td>
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<td>Non-Hispanic White (reference)</td>
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<tr>
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<td>≤29</td>
<td>0.96 (0.90, 1.03)</td>
<td>0.97 (0.90, 1.04)</td>
<td>0.93 (0.86, 0.99)*</td>
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<td>30 (reference)</td>
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<td>Less than high school</td>
<td>1.04 (0.91, 1.18)</td>
<td>1.11 (0.97, 1.25)</td>
<td>1.16 (1.02, 1.32)**</td>
<td>1.16 (1.01, 1.33)*</td>
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<tr>
<td>High school</td>
<td>0.86 (0.96, 1.04)</td>
<td>0.99 (0.91, 1.07)</td>
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<td>1.03 (0.94, 1.12)</td>
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<td>Some college</td>
<td>0.99 (0.91, 1.08)</td>
<td>1.02 (0.94, 1.11)</td>
<td>1.04 (0.95, 1.13)</td>
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<td>College (reference)</td>
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<table>
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<th>No. of children aged younger than 18 years</th>
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<td>≥4</td>
<td>0.69 (0.60, 0.79)***</td>
<td>0.68 (0.59, 0.77)***</td>
<td>0.68 (0.59, 0.78)***</td>
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<tr>
<td>2–3</td>
<td>0.86 (0.80, 0.92)***</td>
<td>0.85 (0.79, 0.91)***</td>
<td>0.85 (0.79, 0.91)***</td>
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<tr>
<td>1 (reference)</td>
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<td>Divorced/separated/widowed/deceased</td>
<td>0.84 (0.73, 0.96)**</td>
<td>0.83 (0.73, 0.96)**</td>
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<td></td>
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<tr>
<td>Never married</td>
<td>0.86 (0.77, 0.97)**</td>
<td>0.86 (0.76, 0.96)**</td>
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<td>Married (reference)</td>
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<td>&lt;1</td>
<td>1.01 (0.89, 1.13)</td>
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<tr>
<td>1–1.99</td>
<td>0.97 (0.88, 1.08)</td>
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</tr>
<tr>
<td>2–2.99</td>
<td>0.93 (0.85, 1.02)</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>≥3 (reference)</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Information reported from vaccination card (control variable)</th>
<th></th>
<th></th>
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<tr>
<td>No</td>
<td>0.82 (0.76, 0.88)***</td>
<td>0.82 (0.76, 0.88)***</td>
<td>0.82 (0.76, 0.88)***</td>
<td>0.83 (0.77, 0.89)***</td>
<td>0.83 (0.78, 0.89)***</td>
<td>0.83 (0.78, 0.89)***</td>
</tr>
<tr>
<td>Yes (reference)</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Note. All variables included in the multivariate models were treated as time fixed (non-time dependent). A total of 9510 children completed the vaccination series.

*P < .05; **P < .01; ***P < .001.

Previous studies focusing on health care use have shown that Hispanics and members of other minority groups are less likely to use health care services than non-Hispanic Whites. Interestingly, we found the opposite pattern among Hispanic mothers and mothers at lower educational levels. After control for mother’s age, educational level, and marital status; number of children aged younger than 18 years in the household; and household IPR, the rate of 4:3:1:3 immunization completion was significantly higher among children of Hispanic mothers than among children of non-Hispanic White mothers (HR = 1.11; 95% CI = 1.01, 1.22). This result is noteworthy given that 72% of Hispanics in our sample lived in households with low IPRs. Interaction effects between mother’s race/ethnicity and IPR further suggested that completion rates were higher in Hispanic and non-Hispanic Black families with low IPRs.

We believe that these patterns observed among Hispanic and non-Hispanic Black low-income families are probably attributable to cultural differences and government-subsidized health care programs available to such families. One important factor that we believe best explains the interactions found involves the WIC immunization requirements. Low-income minority families tend to receive WIC services more frequently than non-Hispanic White families, and they must...
comply with the program’s immunization requirements. Environmental factors could have played a role as well. That is, providers in minority communities are more likely to offer WIC programs and services. The availability of clinics and community centers offering free vaccinations also could have contributed to these higher rates.

Cultural and ethnic difference in preventive health measures may further explain the higher rates of immunization coverage among Hispanics. Hispanic cultures involve strong family values, and parents tend to be more protective of their children. Thus, the Hispanic culture’s emphasis on well-being of children may amplify awareness of preventive health measures, leading to higher rates of immunization in this population.

**Limitations**

In 2001, results of the NIS showed that most Hispanic parents believed immunizations should be received equally by all children. Although percentage differences were not large, vaccination rates were highest among Hispanics; therefore, we expected that Hispanic parents would be more likely to seek adequate vaccination for their children. Although such data were not available from the NIS, it would be interesting to explore in more depth the ways in which parents make decisions about immunizations and to assess their attitudes toward health care.

Most studies that examine immunization rates are limited in that they use large volumes of cross-sectional data to measure whether up-to-date status varies in different subgroups. Our results present a more accurate description of rates of age-appropriate immunization over time. Additional studies can continue to improve our knowledge regarding disparities in immunization rates. Large national surveys, such as the one used in this study, are limited in that they do not provide detailed understandings of groups facing multiple social inequities. Our data were also limited in that we could not examine individuals living in non–immunization Action Plan areas, and we lacked information on Asian Americans. Future studies should address these issues.

**Conclusions**

It is imperative that we focus on maternal characteristics that are barriers to immunization. It is also important that we understand, as shown by the results of this study, that less educated mothers and poor mothers from certain minority groups (in this case, Hispanic and non-Hispanic Black mothers in families with low IPRs) can be diligent in ensuring that their children received the recommended immunizations. Encouragement on the part of medical care and Medicaid providers and increased availability of such programs as Medicaid and WIC will help increase immunization rates. Providing low-income minority mothers with the necessary information about the importance of immunization can overcome lack of formal education and empower them to take advantage of the opportunities available to protect their children from preventable diseases. Interventions that target individuals and efforts to address system-level factors such as health insurance coverage and usual source of care must work in tandem if disparities in immunization are to be eliminated.

**About the Authors**

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This article was accepted December 5, 2005.

**Contributors**

S.S. Kim completed the analyses. J.A. Frimpong planned the study and led the writing. P.A. Rivers and J.J. Kronenfeld supervised the study and contributed to the writing of the article.

**Acknowledgments**

We thank Verna M. Keith and Scott T. Yabiku for commenting on drafts of the article.

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**TABLE 3—Full Model Including Interaction Effects Between Mother’s Race/Ethnicity and Family Income-to-Poverty Ratio: US National Immunization Survey, 2003**

<table>
<thead>
<tr>
<th>Child’s race/ethnicity</th>
<th>Hazard Ratio (95% Confidence Interval)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Hispanic other/multirace</td>
<td>0.98 (0.85, 1.13)</td>
</tr>
<tr>
<td>Non-Hispanic Black</td>
<td>0.63 (0.47, 0.84)**</td>
</tr>
<tr>
<td>Hispanic</td>
<td>0.97 (0.80, 1.18)</td>
</tr>
<tr>
<td>Non-Hispanic White (reference)</td>
<td>1.00</td>
</tr>
<tr>
<td>Income-to-poverty ratio</td>
<td></td>
</tr>
<tr>
<td>&lt; 1</td>
<td>0.87 (0.74, 1.01)</td>
</tr>
<tr>
<td>1–1.99</td>
<td>0.93 (0.83, 1.05)</td>
</tr>
<tr>
<td>2–2.99</td>
<td>0.92 (0.83, 1.02)</td>
</tr>
<tr>
<td>≥3 (reference)</td>
<td>1.00</td>
</tr>
<tr>
<td>Interaction effects*</td>
<td></td>
</tr>
<tr>
<td>Non-Hispanic other/multiracial × IPR &lt; 1</td>
<td>0.89 (0.64, 1.25)</td>
</tr>
<tr>
<td>Non-Hispanic other/multiracial × IPR 1–1.99</td>
<td>1.11 (0.83, 1.49)</td>
</tr>
<tr>
<td>Non-Hispanic other/multiracial × IPR 2–2.99</td>
<td>0.95 (0.70, 1.30)</td>
</tr>
<tr>
<td>Non-Hispanic Black × IPR &lt; 1</td>
<td>1.90 (1.32, 2.74)**</td>
</tr>
<tr>
<td>Non-Hispanic Black × IPR 1–1.99</td>
<td>1.48 (1.01, 2.19)*</td>
</tr>
<tr>
<td>Non-Hispanic Black × IPR 2–2.99</td>
<td>1.20 (0.75, 1.91)</td>
</tr>
<tr>
<td>Hispanic × IPR &lt; 1</td>
<td>1.33 (1.02, 1.74)*</td>
</tr>
<tr>
<td>Hispanic × IPR 1–1.99</td>
<td>1.13 (0.88, 1.47)</td>
</tr>
<tr>
<td>Hispanic × IPR 2–2.99</td>
<td>1.13 (0.84, 1.52)</td>
</tr>
</tbody>
</table>

Note. IPR = income-to-poverty ratio. Model 7 included all variables used in the main effects model (model 6), but parameters are not shown here. A total of 9510 children completed the vaccination series.

*Interaction terms between child’s race/ethnicity and IPR.

**P < .05; ***P < .001.
Human Participant Protection
No protocol approval was needed for this study.

References
Exposure to Lead and Length of Time Needed to Make Homes Lead-Safe for Young Children

Kristina M. Zierold, PhD, Jeff Havlena, MS, and Henry Anderson, MD

Homes are major contributors to elevated blood lead levels (BLLs) in young children, and thus reducing lead levels in homes should reduce BLLs in children. Although elevated BLLs in children have decreased throughout the United States,1,2 there are still communities in which more than 20% of the children exhibit BLLs of 10 micrograms per deciliter (µg/dL) or greater.3–4

According to data from the Third National Health and Nutrition Examination Survey, Wisconsin had the third highest prevalence of elevated BLLs in children among the 19 states studied. Statewide, 13% of children tested had BLLs of 10 µg/dL or greater; however, the prevalence in individual counties throughout the state ranged from 3% to 24%.5

The most important factor in controlling lead poisoning is reducing the child’s exposure to lead. Although the number of housing units with lead paint hazards has decreased dramatically since 1990, an estimated 24 million housing units still contain this poisonous material.6 The US Environmental Protection Agency reported in 1995 that 86% of all public housing and 83% of private homes had some lead-based paint.5

Homes built before 1950 create the greatest risk for exposure to lead. In the United States, 27% of homes were built before 1950; however, in the state of Wisconsin, 37% of homes were built before that year.7 It is estimated that 700,000 housing units in Wisconsin contain some lead-based paint hazards, 120,000 of which are occupied by children aged younger than 6 years.8

Studies have shown that timely remediation of lead hazards in homes of children with elevated BLLs has a protective effect on increasing lead levels in the blood.9–11 In fact, low-cost procedures such as enclosing window wells with aluminum and wet-scraping, as well as repainting walls with latex paint, have decreased BLLs as much as 22%.11

Most local health departments are responsible for testing homes when a child has a high BLL. However, each health department follows different rules when dealing with lead-poisoned children and lead hazards. In Wisconsin, once a lead-poisoned child is identified, the local health department has the authority to inspect the dwelling. Abatement orders cannot be written until the inspection is completed, specific hazards are identified, and the needed remediation is identified. Such abatement orders always include time limits.12

The Centers for Disease Control and Prevention recommends that public health officials begin environmental intervention within 10 days of detection of a BLL of 20 µg/dL or greater. Beyond this guideline, little is known about the length of time needed to make homes lead-safe for children with elevated BLLs. Because young children spend much of their time indoors, the home is a significant target for intervention.

METHODS

Data Collection

Data came from the Wisconsin Childhood Lead Poisoning Prevention Program’s comprehensive BLL surveillance system. When a BLL test is given to a child aged younger than 6 years, Wisconsin statutes require the levels to be reported to the prevention program. In cooperation with the laboratories that conduct BLL analysis, the program has maintained a database of all BLL tests, housing interventions, and descriptive characteristics of all children tested throughout Wisconsin.

For our study, analysis was restricted to 382 children whose first BLL test value during 1996–1999 was between 20 and 40 µg/dL and for whom complete housing intervention data were available. We chose the minimum BLL of 20 µg/dL because Wisconsin mandates a lead hazard investigation of residences of children with this BLL.

Data Analysis

The major outcome variable for this study was the length of time needed to make homes lead-safe. Variables investigated that might have affected the outcome included gender, race/ethnicity, age at first BLL of 20 µg/dL or greater, and the value of the first BLL. Because the distribution of ages and times required to make homes lead-safe

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**Objectives.** We determined the length of time needed to make homes lead-safe in a population of children aged 0 to 6 years with blood lead levels (BLLs) of 20 micrograms per deciliter (µg/dL) or greater. Reducing this time would reduce children’s exposure to lead.

**Methods.** Data came from the Wisconsin Childhood Lead Poisoning Prevention Program’s comprehensive blood lead surveillance system. Analysis was restricted to children whose first BLL test value during 1996–1999 was between 20 and 40 µg/dL and for whom housing intervention data were available (n = 382). Results. The median length of time required to make a home lead-safe was 465 days. Only 18% of children lived in homes that were made lead-safe within 6 months; 45% lived in homes requiring more than 18 months to be lead-safe.

Conclusions. Efforts are needed to reduce the time it takes to make a home lead-safe. Although abatement orders always include time limits, improved compliance with the orders must be enforced. Greater emphasis should be placed on securing lead-safe or lead-free housing for families, thus reducing lead exposure. (Am J Public Health. 2007;97:267–270. doi:10.2105/AJPH.2005.067603)
was skewed, median values, as opposed to means, were reported.

To obtain a description of the variables used, we obtained study variable frequencies and counts of all children. Because of the small percentage of children in race categories other than African American, a dichotomized variable (African American/Other) was created for the analysis.

To evaluate factors that may have been associated with longer time periods for making homes lead-safe, we did a case–control study.

Case children were defined as children whose homes required more than 180 days to be considered lead-safe; control children were defined as children in homes that required 180 days or fewer to be lead-safe.

To examine the individual effects of gender, race/ethnicity, age, and first BLL test value on case or control status, we used simple logistic regression to calculate crude odds ratios and 95% confidence intervals. To evaluate the effect of several predictor variables, we used multivariate logistic regression to calculate adjusted odds ratios and confidence intervals. Variables that were significant in the simple model were maintained in the multivariate model.

RESULTS

Characteristics of Children

The majority (68%) of the children were African American, and 76% of all children had a first BLL test value between 20 and 29 μg/dL. The overall mean first BLL test value for all children was 26 μg/dL (SD = 5.4). Boys were slightly more likely to have a BLL of 30 μg/dL or greater than were girls (26% vs 22%, P = .05). The BLLs differed slightly by race/ethnicity with White children having a mean BLL of 25 μg/dL (SD = 4), African American children having a mean BLL of 26 μg/dL (SD = 5), Hispanic children having a mean BLL of 29 μg/dL (SD = 6), and Asian children having a mean BLL of 27 μg/dL (SD = 6).

The age of the children ranged from 6 months to 6 years. The median age for all children was 27 months. There was no difference in age ranges between boys and girls. However, there was a difference of ages at first BLL test among African American children and children of other races/ethnicities. The median age of African American children at the first BLL test was 24 months, compared with 17 months for White children, 18 months for Hispanic children, and 16 months for Asian children.

Length of Time Required for Homes to Be Considered Lead-Safe

From a child’s first BLL test value of 20 μg/dL or greater, the median length of time needed to make a home lead-safe was 465 days (approximately 1.3 years). The length of time ranged from a minimum of 7 days to a maximum of 1963 days. Over the 4-year period studied, the median time improved from 828 days in 1996 to 347 days in 1999 (Figure 1).

Table 1 shows the characteristics of the children with elevated BLLs by length of time needed to make the home lead-safe. Among all children included in the study, only 18% lived in homes that were made lead-safe within 6 months. Girls were more likely to live in homes that were rendered lead-safe within 6 months than were boys (21% vs 16%). White children were more likely to live in homes that were made lead-safe within 6 months than were African American children (25% vs 13%). Children whose BLLs were 35 μg/dL or greater were more likely to live in homes that were rendered lead-safe within 6 months than were children of other BLLs.

Table 1 shows that the percentage of homes made lead-safe within 6 months improved between 1996 and 1999. In 1996, lead-safety improvements were completed within 6 months in only 16% of homes, whereas in 1999, improvements were completed within 6 months in 31% of homes.

Overall, 46% of children lived in homes that required more than 18 months to be deemed lead-safe. However, the percentage of homes requiring more than 18 months for such improvements decreased dramatically from 1996 to 1999. In 1996, 61% of homes required longer than 18 months to be completed, whereas in 1999, only 24% of homes required more than 18 months for these improvements.

Table 2 displays the results of the logistic regression used to evaluate factors that may be associated with requiring more than 180 days to make a home lead-safe. African American race was significantly associated with case status.

DISCUSSION

Because children spend more than 80% of their time indoors, their homes are important targets for preventing elevated BLLs. In our study population, only 18% of homes were deemed lead-safe within 6 months, whereas 45% required longer than 18 months to be deemed lead-safe. Because prolonged exposure adds potential health risks to children, it is unacceptable to keep children in homes that require long lengths of time for repair. Over the time period studied, the percentage
of homes made lead-safe within 6 months improved from 16% to 31%, and the percentage of homes taking longer than 18 months decreased from 61% to 24%. We assumed, on the basis of our experiences in health departments, that the improvement in abatement times reflected the benefit of increased funding for efforts to reduce lead-based hazards in home settings. However, the resources available are still considerably lacking.

In 2001, the Wisconsin Department of Health and Family Services began requiring all local health departments that receive state funds for lead poisoning prevention to conduct investigations on the homes of children who have BLLs of 20 µg/dL or greater. This action has dramatically improved the number of homes investigated and the length of time to investigation. For example, in 2000, when investigations were not mandatory, only 42% of homes were investigated within 14 days of the health department’s receiving the BLL report; in 2004, more than 90% of these cases were investigated within 14 days.

Our study showed that African American children were twice as likely to live in homes that required more than 180 days to be deemed lead-safe. The majority of African American children in Wisconsin live in urban, lower-income communities. Although we did not ask about socioeconomic status, race may be an indicator for families with lower income, who tend to reside in rental housing units. Jacobs et al. reported that rental units had a higher prevalence of lead-based paint hazards than owner units and that among low-income households, 35% contained lead-based paint hazards, compared with 19% of upper-income families.

Despite efforts for immediate inspection and strong remediation orders with short timelines, ensuring compliance remains problematic. Although rapid inspection and compliance orders will always be needed, primary prevention is the more efficient alternative. When sufficient housing is upgraded to “lead-safe” or “lead-free” and can be readily identified by renters with young children, we should begin to see fewer poisoned children.

One example of a regulation that may have a positive effect on reducing childhood lead poisoning is Wisconsin Act 113, enacted in 1999. Among other provisions, Act 113 mandates that a lead-free or lead-safe property registry be created. The registry encourages housing owners to bring their property into compliance with state standards, providing immunity from liability if a child is lead-poisoned while occupying a property with a lead-free/lead-safe certificate.

Community efforts targeted at educating families must be maintained. Families residing in homes with lead paint need to be aware of the hazards associated with ingestion of the paint, the common locations of the hazards (such as windows and cabinets), and proper cleaning techniques. Residents also should be provided contact information for state or local health departments or the US Department of Housing and Urban Development if landlords or property owners refuse to make needed repairs.

Although progress has been made in reducing the time needed to make homes lead-safe in Wisconsin, 24% of homes in 1999 still required longer than 6 months for such improvements. Stronger efforts should be made to reduce substantial delays in compliance with abatement orders.

### TABLE 1—Characteristics of Children With Elevated Blood Lead Levels: Wisconsin, 1996–1999

<table>
<thead>
<tr>
<th>Length of Time for Home to Be Made Lead-Safe, mo</th>
<th>Total (n = 382)</th>
<th>0-6, no (%)</th>
<th>7-12, no (%)</th>
<th>13-18, no (%)</th>
<th>≥19, no (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boy</td>
<td>206</td>
<td>33 (16)</td>
<td>44 (21)</td>
<td>26 (13)</td>
<td>103 (50)</td>
</tr>
<tr>
<td>Girl</td>
<td>176</td>
<td>37 (21)</td>
<td>42 (24)</td>
<td>26 (15)</td>
<td>71 (40)</td>
</tr>
<tr>
<td>Race/ethnicity</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>32</td>
<td>8 (25)</td>
<td>9 (28)</td>
<td>5 (16)</td>
<td>10 (31)</td>
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<tr>
<td>African American</td>
<td>259</td>
<td>33 (13)</td>
<td>58 (22)</td>
<td>37 (14)</td>
<td>131 (51)</td>
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<tr>
<td>Hispanic</td>
<td>14</td>
<td>6 (43)</td>
<td>2 (14)</td>
<td>2 (14)</td>
<td>4 (29)</td>
</tr>
<tr>
<td>Asian</td>
<td>14</td>
<td>5 (36)</td>
<td>2 (14)</td>
<td>3 (21)</td>
<td>4 (29)</td>
</tr>
<tr>
<td>First BLL test, µg/dL</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20-24</td>
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<td>95 (52)</td>
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<td>25-29</td>
<td>107</td>
<td>19 (18)</td>
<td>29 (27)</td>
<td>13 (12)</td>
<td>46 (43)</td>
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<tr>
<td>30-34</td>
<td>56</td>
<td>9 (16)</td>
<td>20 (36)</td>
<td>6 (11)</td>
<td>21 (38)</td>
</tr>
<tr>
<td>35-40</td>
<td>36</td>
<td>10 (28)</td>
<td>9 (25)</td>
<td>5 (14)</td>
<td>12 (33)</td>
</tr>
<tr>
<td>Age at first BLL test, mo</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-12</td>
<td>65</td>
<td>12 (29)</td>
<td>14 (22)</td>
<td>9 (14)</td>
<td>23 (35)</td>
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<td>13-24</td>
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<td>80</td>
<td>10 (13)</td>
<td>22 (28)</td>
<td>8 (10)</td>
<td>40 (50)</td>
</tr>
<tr>
<td>≥37</td>
<td>87</td>
<td>16 (18)</td>
<td>18 (21)</td>
<td>14 (16)</td>
<td>39 (45)</td>
</tr>
<tr>
<td>Year of initial BLL test</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1996</td>
<td>127</td>
<td>20 (16)</td>
<td>23 (18)</td>
<td>6 (5)</td>
<td>78 (61)</td>
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<td>1997</td>
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<td>19 (13)</td>
<td>40 (27)</td>
<td>24 (16)</td>
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<tr>
<td>1998</td>
<td>59</td>
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<td>11 (19)</td>
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<tr>
<td>1999</td>
<td>49</td>
<td>15 (31)</td>
<td>12 (24)</td>
<td>10 (20)</td>
<td>12 (24)</td>
</tr>
</tbody>
</table>

Note. BLL = blood lead level.

*Percentages may not add to 100% because of missing responses.

About the Authors
Kristina M. Zierold is with the Department of Family and Community Medicine, Wake Forest University School of Medicine, Winston-Salem, NC. Jeff Havlena and Henry Anderson are with the Bureau of Environmental Health, Wisconsin Division of Public Health, Madison, WI.

Requests for reprints should be sent to Dr. Kristina Zierold, Department of Family and Community Medicine, Wake Forest University School of Medicine, Medical Center Boulevard, Winston-Salem, NC 27157 (e-mail: kzierold@wfubmc.edu).

This article was accepted November 28, 2006.

Contributors
K.M. Zierold conducted the analyses and led the writing of the article. J. Havlena and H.A. Anderson assisted...
## TABLE 2—Factors Associated With Requiring Longer Than 180 Days to Make Home Lead-Safe: Wisconsin, 1996–1999

<table>
<thead>
<tr>
<th>Factor</th>
<th>Crude OR (95% CI)</th>
<th>Adjusted OR (95% CI)</th>
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</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boy</td>
<td>1.40 (0.83, 2.35)</td>
<td>NA</td>
</tr>
<tr>
<td>Girl</td>
<td>Referent</td>
<td>Referent</td>
</tr>
<tr>
<td><strong>Race</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>African American</td>
<td>2.95* (1.73, 5.01)</td>
<td>2.71* (1.56, 4.71)</td>
</tr>
<tr>
<td>White/Other</td>
<td>Referent</td>
<td>Referent</td>
</tr>
<tr>
<td><strong>First BLL test, µg/dL</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35–40</td>
<td>0.55 (0.24, 1.26)</td>
<td>NA</td>
</tr>
<tr>
<td>30–34</td>
<td>1.11 (0.49, 2.49)</td>
<td>NA</td>
</tr>
<tr>
<td>25–29</td>
<td>0.98 (0.53, 1.84)</td>
<td>NA</td>
</tr>
<tr>
<td>20–24</td>
<td>Referent</td>
<td>NA</td>
</tr>
<tr>
<td><strong>Age at first test, mo</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥25</td>
<td>2.24* (1.14, 4.42)</td>
<td>1.70 (0.82, 3.54)</td>
</tr>
<tr>
<td>13–24</td>
<td>2.07* (1.04, 4.10)</td>
<td>1.61 (0.78, 3.35)</td>
</tr>
<tr>
<td>0–12</td>
<td>Referent</td>
<td>Referent</td>
</tr>
<tr>
<td><strong>Test year</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1999</td>
<td>0.42* (0.20, 0.92)</td>
<td>0.41* (0.19, 0.93)</td>
</tr>
<tr>
<td>1998</td>
<td>0.50 (0.24, 1.06)</td>
<td>0.60 (0.27, 1.31)</td>
</tr>
<tr>
<td>1997</td>
<td>1.26 (0.64, 2.48)</td>
<td>1.28 (0.64, 2.57)</td>
</tr>
<tr>
<td>1996</td>
<td>Referent</td>
<td>Referent</td>
</tr>
</tbody>
</table>

Note. OR = odds ratio; CI = confidence interval; NA = not applicable; BLL = blood lead level.

*Not used in multivariate analysis because not significant in univariate analysis.

**Acknowledgments**

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**Human Participant Protection**

No protocol approval was needed for this study.

**References**

Child labor is an important global issue associated with poverty, inadequate educational opportunities, gender inequality, and a range of health risks.\(^5\) Child labor is defined by the relevant international conventions (UNICEF's Convention on the Rights of the Child,\(^2\) International Labor Organization [ILO] Convention 138,\(^3\) and especially, 182\(^7\)) not by the activities performed by the child, but by the consequences of such activities (exceptions are the so-called unconditional worst forms of child labor such as prostitution and bondage, as noted in ILO Convention 182). For instance, work affecting a child's health and schooling should, according to these conventions, be eliminated.\(^5\) Identifying the health effects of child labor is essential because it enables policymakers to decide which types of child labor to target for eradication.

The ILO estimates that there are approximately 250 million child laborers worldwide, with at least 120 million of them working under circumstances that have denied them a childhood and in conditions that jeopardize their health and even their lives. Most working children are ages 11 to 14 years old, but as many as 60 million are between the ages of 5 and 11.\(^6\) Although the exact numbers are not known, available statistics indicate that approximately 96% of child workers reside in developing countries in Africa, Asia, and Latin America; there are also pockets of child labor in many industrialized countries.\(^5,7,8\) In spite of a reported decline in child labor during the period 1995 to 2000,\(^9\) child labor remains a major concern.

Most child laborers begin working at a very young age, are malnourished, and work long hours in hazardous occupations; frequently they do not attend school. They receive very low wages or are unpaid, and their income or help is usually essential for family survival. They are mainly employed in the informal sector, with agriculture accounting for more children workers than any other sector. It is estimated that, in developing countries, at least 90% of economically active children in rural areas are employed in agriculture.\(^10\) Recent ILO statistics from 20 developing countries categorized the proportion of economically active children aged 5 to 14 years as employed in agriculture, animal husbandry, and related work at 74% (73.3% of boys and 78.8% of girls).\(^1\)

used to evaluate children’s health status are of limited value for those who are age 10 years and older.

We provide evidence, garnered from a cross section of countries, on the relation between child labor and children’s health. To our knowledge, this study represents the first use of cross-country data to examine the issue. The benefit of cross-country data is that they allow us to synthesize indicators, creating a set of indicators unavailable in micro- or individual-country data. The drawback to using different data sources is that the statistics may not be comparable. To avoid problems of comparability, we limited ourselves to data that were standardized by the institutions that collected or compiled them. We analyzed the health effects of child labor on children by correlating existing health indicators and the prevalence of child labor in a large group of developing countries (Algeria, Angola, Bangladesh, Belize, Benin, Bolivia, Botswana, Brazil, Burkina Faso, Burundi, Cambodia, Cameroon, Chad, Chile, China, Congo, Colombia, Cote d’Ivoire, Costa Rica, Democratic Republic of Congo, Dominican Republic, Egypt, Ecuador, El Salvador, Eritrea, Gabon, Gambia, Ghana, Guatemala, Guinea, Guinea Bissau, Haiti, Honduras, India, Indonesia, Iran, Iraq, Jamaica, Jordan, Kenya, Laos, Liberia, Libya, Lesotho, Madagascar, Malaysia, Malawi, Mali, Mexico, Mongolia, Mozambique, Morocco, Myanmar, Namibia, Nepal, Nicaragua, Niger, Nigeria, Oman, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Rwanda, Senegal, Sierra Leone, Solomon’s Islands, Sri Lanka, Sudan, Swaziland, Syrian Arab Republic, Uganda, Uruguay, Tanzania, Venezuela, Vietnam, Thailand, Togo, Yemen, Zambia, Zimbabwe).

METHODS

Data and Indicator Sources

We derived our estimates on the prevalence of child labor among children aged 10 to 14 years from only 1 data set: the World Bank’s World Development Indicators.27 This source limits its estimates of working children to the “economically active population,” which means that children who are in non economic activities or are employed in hidden forms of work such as domestic service, prostitution, and armed conflict are not included.

Health indicators, such as health status, and health determinant indicators, which give information about the health of a community or population relative to some criteria or in comparison with other communities or populations, were obtained from the World Development Indicators, the Global Burden of Disease Study,28 and the life tables for 191 countries (our study included only the 83 developing countries).29

The following rates and percentages were obtained from the World Bank database: male and female adult mortality rates, fertility rates, the prevalence of undernourishment (percentage of population), the prevalence of HIV/AIDS among adults (percentage of population), and national poverty levels (percentage of population below the national poverty line, as determined using the World Bank’s country poverty assessments).

The World Bank’s data set came from multtopic welfare surveys, such as the Living Standard Measurement Study (LSMS), which measure and analyze poverty. Dozens of countries have implemented multtopic surveys, and many of them have conducted the same survey repeatedly, allowing for relevant comparisons across time. Multtopic surveys can also be used to measure the effect of public policies and programs on poverty. The LSMS—one of the best known and most useful of these surveys—has a questionnaire designed to study multiple aspects of household welfare and behavior; it also incorporates extensive quality-control features. The main objective of LSMS surveys is to collect household data that can be used to assess household welfare, understand household behavior, and evaluate the effect of various government policies on the quality living conditions of the population. Accordingly, LSMS surveys collect information on employment, household income and expenditures; asset ownership, such as housing or land; health; education; fertility; nutrition; migration; and access to services and social programs. To minimize errors and delays in data processing, LSMS surveys are implemented with distinct procedures that resolve most inconsistencies in the raw data before the data reach the central statistical office.

Data on HIV/AIDS infections, non-HIV infections, and malaria among children aged 5 to 14 years, associated with 4 major risk factors (malnutrition, poor water and lack of sanitation and hygiene, unsafe sex, and dangerous occupation), came from the Global Burden of Disease Study. These indicators are expressed as disability-adjusted life years calculated as the sum of years of life lost because of disability and years of life lived with disability. Mortality rates among children, both boys and girls, aged 10 to 14 years were obtained from these life tables.

The data, all from the year 2000, were collected from 83 countries in 6 geographic regions, as defined by the Global Burden of Disease Study (sub-Saharan Africa, Latin America and the Caribbean, Asia and Pacific Islands, China, India, and North Africa/ Middle East).

Data Analysis

The data on child labor (expressed as a percentage of children aged 10 to 14 years who were workers) and health indicators were analyzed by multiple regression to ascertain the effect of child labor on the various health indicators. All data were aggregated at the national level. The strength of the association between the percentage of children who were workers and HIV/AIDS infections, non-HIV infections, and malaria as expressed by disability-adjusted life years were also correlated using SPSS version 10 for Windows (SPSS Inc, Chicago, Ill).

The following were designated as dependent variables: the mortality rate among boys aged 10 to 14 years, the mortality rate among girls aged 10 to 14 years, and the percentage of the population aged 10 to 14 years undernourished.

Mortality rate among children aged 10 to 14 years is an important health indicator, commonly related to accidents. We chose mortality rate among children as a dependent variable because we could test independent variables against it to determine which independent variables most influence mortality in this age range. For each of the first 2 dependent variables, 2 separate regression models were developed, 1 using only the adult mortality rate for women and the other using only the adult male mortality rate. This
avoided possible collinearity between these 2 independent variables, a problem that could have occurred had we used a combined version of the adult mortality rate. We chose prevalence of malnutrition in the population as a dependent variable because it reflects the health environment of households and we wished to determine which variables were significantly related to it.

The independent (or predictor) variables used to predict the dependent variables were the following, in various combinations: adult mortality rate for men, adult mortality rate for women, percentage of the population below the poverty line, percentage of adults infected with HIV/AIDS, percentage of the population undernourished, percentage of children aged 10 to 14 years who were workers (child labor prevalence).

RESULTS

Figures 1 and 2 show the associations between the predictor variables and the dependent variables; Table 1 presents the multiple regression results. Figures 1 and 2 show that child labor appeared to be negatively correlated with the health status of the population, supporting the hypothesis that child labor affects child health.

This association could be caused by other factors affecting the population’s health status that were also correlated with the percentage of children engaged in paid labor. Therefore, we included control variables such as the percentage of the population below the poverty line and the adult mortality rate in the regression. The results of the regression confirmed that several variables played a determining role in the mortality rates of children aged 10 to 14 years and that 2 of these variables also affected the level of undernourishment. The prevalence of child labor was a significant predictor of undernourishment in a population and of the mortality rate for children aged 10 to 14 years (boys and girls), confirming that child labor affects children’s health.

We also looked at the association between childhood morbidity, as measured by disability-adjusted life years, and the prevalence of child labor in the 6 regions we studied (Figure 3). In each of the regions with a high prevalence of child labor, there was a high correlation between child labor and childhood morbidity associated with HIV/AIDS, non-HIV infectious diseases, and malaria.

DISCUSSION

Child labor remains one of the most provocative and controversial challenges facing the world at the beginning of the 21st century. Furthermore, child labor’s close links to poverty, lack of education, poor health, and gender inequalities highlight the need for broad-based social and economic progress.

By extrapolating data from the Global Burden of Disease Study, Graitcer and Lerer estimated mortality, morbidity, and disability associated with child labor.15 Despite the limits of the Global Burden of Disease Study—for example, the health statistics were constrained by the age stratification used, and the injury data were not provided by occupation—Graitcer and Lerer were able to estimate work-related injury and mortality. They concluded that in all regions the occupational mortality rate among children matched the adult occupational mortality rate, indicating that children may be working in conditions that are as hazardous as, or even more hazardous than, those of adults. Burn injury estimates from the Global Burden of Disease Study show that work-related burns constituted more than one third of all burn injuries...
sustained among children aged 5 to 14 years. It is worth noting that this statistic did not take into account burns sustained during housework, the most common of which occur while cooking over an open fire.

Graitcer and Lerer did not find any health problems in working Egyptian children, but they argued that a child’s exposure to poor working conditions and health hazards may result in health consequences much later in life. In reports on child labor in Morocco, Yemen, and Guatemala, the researchers of the Understanding Children’s Work project found few or no ill health effects resulting from work and suggested that this might be because the healthiest children are selected for work or because health consequences may not become apparent until a later stage in a child’s life. They also showed that it is not work per se that is damaging to a child’s health, but rather certain kinds of work.

Studies with an ecological design have proven valuable in descriptive and etiological epidemiology, as well as in economics, social planning, and policy evaluation. Our study is the first to analyze the health effects of child labor with cross-sectional data, showing that some health indicators are affected by child labor.

In Table 1, the independent variables account for approximately 77% of the mortality rates for children, both boys and girls, aged 10 to 14 years. This significance (P<.001) suggests that the model is both valid and statistically significant. Child labor, poverty, and adult mortality rates explain, at a significant level, the variance in adolescent mortality among boys and girls aged 10 to 14 years. The percentage of the population that is undernourished does not explain adolescent mortality rates for either boys or girls. For each 1 of the first 2 dependent variables (adolescent mortality rates for boys and girls aged 10 to 14 years), we developed 2 regression models, one taking into account only the adult mortality rate for women and the other the combined adult mortality rate for men and women. We did this to avoid any collinearity between these 2 independent variables.

The percentage of the population living below the poverty line was designated an independent variable because of its relevance to policy decisions on education, health, decentralization of resource management, and preventive measures. As predictor variables, child labor and poverty both were significantly correlated with malnutrition (as measured by the percentage of population that was undernourished), whereas the percentage of HIV/AIDS among adults was not significantly related to malnutrition.

Mortality rates for different age groups are important indicators of health status in a country. In the absence of incidence and prevalence rates for disease (morbidity data), they serve to identify vulnerable populations. They are also among the indicators most frequently used to compare levels of socioeconomic development across countries. The finding that child labor prevalence is significantly correlated with adolescent mortality, a population’s nutrition level, and the presence of infectious disease among children suggests that countries with high child labor prevalence have low health status.

Work can limit a child’s opportunities to obtain an education, especially for girls, whose educational attainment is a recognized determinant of child survival and health. Work can expose children to physical and

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**TABLE 1—Multiple Regression Results (Unstandardized Coefficients) for Mortality, Undernourishment, and Labor: Children Aged 10–14 Years, 2000**

<table>
<thead>
<tr>
<th></th>
<th>Boys</th>
<th>Girls</th>
<th>Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child labor prevalence</td>
<td>0.016*</td>
<td>0.016*</td>
<td>0.003*</td>
</tr>
<tr>
<td>Percentage of population below poverty lines</td>
<td>0.012*</td>
<td>0.015*</td>
<td>0.003*</td>
</tr>
<tr>
<td>Adult mortality rate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>0.023*</td>
<td>0.033*</td>
<td></td>
</tr>
<tr>
<td>Women</td>
<td>0.017*</td>
<td>0.019*</td>
<td></td>
</tr>
<tr>
<td>Percentage of population undernourished</td>
<td>-0.004</td>
<td>-0.006</td>
<td></td>
</tr>
<tr>
<td>Percentage of HIV/AIDS among adults</td>
<td>NA</td>
<td>NA</td>
<td>0.01*</td>
</tr>
</tbody>
</table>

*P < .05.

Note. NA = not applicable.
social environments conducive to high-risk sexual behavior. Because child labor is significantly correlated with infectious diseases among children, including HIV/AIDS, interventions that reduce child labor rates could have a direct health benefit.

We have identified a set of health indicators affected by child labor, and our data support the hypothesis that child labor affects children’s health, particularly as measured by adolescent mortality rates. Given the nature of the available data, it is difficult to carry out a proper causality analysis. The methodological weakness of an ecological study is that estimates of effect at the ecological level cannot be extrapolated to individuals. The ecological design did not permit us to obtain direct estimates of the effect of child labor in exposed versus unexposed populations. Therefore, we could not be certain, for instance, that the children experiencing greater morbidity and mortality in a given population were actually child laborers. Other drawbacks to the ecological method are that the method relies on existing data sources, which are often flawed and may involve confounding variables for which control may be difficult. Problems with the ecological approach, however, are minimized when measurement, analysis, and interpretation are all at the group level and the data sources are reliable. The ecological design lends itself to the study of structural or sociological effects on human behavior and concomitant disease or injury. The principal characteristic of the ecological design—namely, that it examines differences between groups—makes it well suited to evaluating social and health policies, such as sanctions for labor practices.

Although our findings indicate that child labor may be affecting the health of children, more data are needed to develop a better understanding of the short- and long-term health problems associated with child labor. Most important, longitudinal studies are required to understand the short- and long-term health effects of child labor on the individual child.

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This article was accepted February 25, 2006.

Contributors
P. Roggero originated the study and supervised all aspects of its implementation. V. Mangiaterra assisted with the study and supervised research input. F. Bustreo contributed ideas and reviewed drafts of the article. F. Rosati synthesized analyses and interpreted findings. All authors reviewed the drafts of the article.

Acknowledgments
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Human Participant Protection
No protocol approval was needed for this study.

References
Changing the Child Labor Laws for Agriculture:
Impact on Injury

Barbara Marlenga, PhD, Richard L. Berg, MS, James G. Linneman, BA, Robert J. Brison, MD, and William Pickett, PhD

Child labor laws were designed to protect the most vulnerable workers from unsafe and unhealthy work and work environments. In the United States, federal child labor laws limit the hours and times of day that children younger than 16 years may work and set minimum age standards for various types of work. They also identify, under the Hazardous Occupations Orders, hazardous jobs that cannot be performed by children younger than 18 years in nonagricultural occupations and younger than 16 years in agricultural occupations. However, children who work on their parents’ farms are explicitly exempted from these federal child labor laws.

Agriculture is the most hazardous industry in the United States for young workers. Nearly half of all work-related fatalities among children occur in agriculture with a risk for fatal injury that is 3 to 4 times that of young workers in other occupational settings. Furthermore, 76% of fatally injured agricultural workers younger than 16 years were working in a family business that was exempt from the child labor laws.

Existing approaches to the prevention of farm injuries among children have emphasized education and training with little consideration of public policy approaches. However, public health professionals and child safety advocates recommend policy-oriented approaches as more efficacious alternatives for prevention.

The National Research Council and the Institute of Medicine jointly recommended 2 policy changes related to children and agriculture in their 1998 report on the health and safety implications of US child labor: (1) establishment of a minimum age of 18 years for all hazardous work regardless of whether the setting is an agricultural or nonagricultural occupation, and (2) compulsory compliance with the Hazardous Occupations Orders “whether the minor is employed by a stranger or by a parent or other person standing in for the parent.” Before initiating these changes in policy, those involved in and affected by these changes should be aware of their potential efficacy.

The goal of this study was to evaluate the National Research Council and the Institute of Medicine’s joint policy recommendations with respect to their potential efficacy for injury prevention. Our objectives were to review existing cases of traumatic farm injury to children and (1) describe the characteristics of the injured children according to worker status, (2) identify farm jobs prohibited and not prohibited by the Hazardous Occupations Orders that are most often associated with injuries, (3) estimate the proportion of work-related injuries that could potentially be prevented if the family farm exemption was removed from the Hazardous Occupations Orders (because the child would be restricted from doing the hazardous job), and (4) estimate the proportion of work-related injuries that could be prevented if the age standard for the Hazardous Occupations Orders was raised from 16 to 18 years (because the child would be restricted from doing the hazardous job).

The Hazardous Occupations Orders are authorized by the Fair Labor Standards Act (FLSA) of 1938 and are contained in Subpart E-1 of Regulations, 29 CFR Part 570. The FLSA was amended in 1966 to address young people working in agriculture. The final regulations became effective in 1970 and have been virtually unchanged since that time. A listing of the hazardous agricultural activities that were identified as prohibited for minors younger than 16 years are available as a supplement to the online version of this article at http://www.ajph.org.

Objective. The child labor laws are intended to protect young workers from the most dangerous jobs. However, children who work on their parents’ farms are exempt from these laws. We evaluated the potential for preventing the occurrence of farm injuries among children by changing the US Federal Child Labor Laws, Hazardous Occupations Orders for Agriculture.

Methods. A retrospective case series of 1193 farm injuries among children from the United States and Canada was assembled. The Hazardous Occupations Orders were systematically applied to each case. Injury preventability was estimated.

Results. A total of 286 (24%) cases of injury involved immediate family members engaged in farm work. Among these children, 33% of those aged younger than 16 years and 36% of those aged 16 or 17 years were performing work prohibited under the Hazardous Occupations Orders.

Conclusions. Removing the family farm exemption from the Hazardous Occupations Orders and raising the age restriction for performing hazardous agricultural work from 16 to 18 years would be efficacious in preventing the most serious injuries experienced by young family farm workers. Potential reductions in injury would meet Healthy People 2010 goals for reducing traumatic injury in the agricultural sector. (Am J Public Health. 2007;97:276–282. doi:10.2105/AJPH.2005.078923)
METHODS

Our study was a primary review of 4 retrospective case series of farm injuries among children. The latter were assembled to represent fatal injuries, hospitalized injuries, and 2 forms of restricted-activity injuries (injuries that resulted in at least 4 hours of restricted activity or required medical treatment).

Farm injuries among children were generically defined as injuries to children younger than 18 years that occurred at a farm worksite or during activities related to the operation of a farm (excluding injuries in the farm residence). Examination of both work-related and non–work-related injury cases and cases involving a broad range of ages enabled us to estimate the proportion of all childhood farm injuries that may be prevented by changing the Hazardous Occupations Orders, as well as the proportion of work-related injuries that may be preventable.

Data Sources

In the United States, there is no comprehensive national database of pediatric agricultural fatalities. Fatality data were obtained with methods developed by the Canadian Agricultural Injury Surveillance Program. This program contains a comprehensive, population-based fatal-injury data set from a neighboring country with farming practices and child labor laws that are analogous to those observed in much of the United States. We developed an enhanced database that contained every known case of an agriculture-related fatal childhood injury in Canada between 1992 and 2001 (n=226). The Canadian fatality case series data were supplemented with 17 US occupational fatality case reports from the National Institute for Occupational Safety and Health’s Fatal Assessment and Control Evaluation program for the years 1992 through 2000, for a total of 243 fatality cases.

In the United States, there is also no comprehensive national database of hospitalized pediatric agricultural injuries. A national registry of hospitalized farm injury cases similar to the database of fatalities has been developed in Canada. We used the Canadian Agricultural Injury Surveillance Program case identification approach to identify injured children treated at 5 regional pediatric hospitals and 2 general hospitals in Canada. These hospitals were from the provinces of Alberta and Ontario. A study period of 1990 through 2001 was used for the hospitalized injury portion of this study (n=361).

Data files from the 1998 Childhood Agricultural Injury Survey (n=330) and 2000 Childhood Agricultural Injury Survey on Minority-Operated Farms (n=259) were obtained electronically from the National Institute for Occupational Safety and Health, for a total of 589 restricted activity injury cases. Injuries identified within these surveys represent a spectrum of farm injuries among children that resulted in at least 4 hours of restricted activity with 10.4% (n=61) requiring hospitalization, 78.3% (n=461) requiring treatment in the emergency department or by an outpatient provider, and 11.4% (n=67) not requiring medical treatment. Data for both surveys were collected by telephone interview from random samples of US farm operators. Analogous data were not available in Canada.

Instrument

A standardized data abstraction instrument was developed in consultation with a child labor expert from the US Department of Labor. A study glossary was developed in concert with the instrument detailing the exact specifications and circumstances under which each Hazardous Occupations Orders–prohibited job category would apply if the exemption were lifted and the minimum age raised. The ability of the investigators to apply the instrument in a valid and reliable manner was assessed through iterative testing with actual cases. Data elements covered within the instrument included case demographics, detailed descriptions of the injury event, and applicability of the Hazardous Occupations Orders–prohibited job categories.

Given the specificity of the Hazardous Occupations Orders, several assumptions guided our coding of prohibited work. For Hazardous Order 1 (operating a tractor of >20 horsepower), we considered all tractors operated by children to be greater than 20 horsepower unless the horsepower was specified or the youth was operating a “lawn tractor.” For Hazardous Order 5 (felling, bucking, skidding, loading or unloading timber with butt diameter of >6 inches), we considered all work with timber to involve a butt diameter of more than 6 inches. For Hazardous Order 6 (working from a ladder or scaffold at a height of >20 feet), we considered work from the top of a silo and work on a barn roof to be working at a height of more than 20 feet, unless a lower height was specified. For Hazardous Order 9 (handling or applying toxic agricultural chemicals), we considered all work with chemicals to be hazardous.

Data Abstraction, Coding, and Analysis

With a standard protocol, 2 investigators independently abstracted and coded all cases involving children performing farm work at the time of injury. The protocol was developed through a series of validation exercises. In each exercise, 10 randomly selected cases were reviewed and interrater agreement was assessed. All disagreements were resolved through discussion with the study team, including consultation with the child labor expert for specific interpretation of the Hazardous Occupations Orders–prohibited job categories, and the protocol was updated. Agreement reached 90% in the third exercise, and the final case review proceeded. Any subsequent disagreements were resolved by consensus. The data analyses are descriptive, and standard summary statistics are presented.

RESULTS

The characteristics of the full case series of 1193 injured children as they relate to the Hazardous Occupations Orders are presented in Figure 1. The majority of injured children were younger than 16 years (n=1029; 86%) and were not working at the time of their injury (n=836; 70%). A total of 286 (24%) cases involved family members engaged in farm work. Very few of the injured children were designated as non-family hired workers on the farm (n=37; 3%).

Applicability of Hazardous Occupations Orders

Approximately one third (33% for those aged younger than 16 years, 36% for those aged 16–17 years) of the children working on a family farm were engaged in jobs prohibited by the Hazardous Occupations Orders if
the exemption were lifted and the minimum age raised. This percentage varied by data source, with children who were fatally injured being the most likely to have been performing prohibited jobs (Figure 2). Hazardous Order 1, operating a tractor with more than 20 horsepower, and Hazardous Order 2, operating or assisting to operate farm machinery, were the leading prohibited job categories for both age groups (Table 1).

**Potential for Preventing Injuries**

If the Hazardous Occupations Orders were implemented and enforced on family farms, 33% (71/213) of work injuries to children aged younger than 16 years could hypothetically have been prevented (Table 1). Overall, with both changes to the Hazardous Occupations Orders, 34% (97/286) of the work injuries could potentially have been preventable.

**Work Injuries Not Covered by the Hazardous Occupations Orders**

The Hazardous Occupations Orders do not prohibit the majority of jobs that lead to work-related injury to those younger than 18 years (189/286; 66%). Leading categories of work not covered by the Hazardous Occupations Orders (Table 2) include the following: (1) working with animals in situations not covered by Hazardous Order 6 (40%), (2) farm work with other machinery not covered in Hazardous Occupations Orders 2 and 3 (25%), and (3) farm maintenance in situations not covered by Hazardous Order 6 (13%).

The leading specific jobs associated with injury were as follows: (1) farm work with all-terrain vehicles (12%), (2) feeding large animals (10%), (3) farm work on horseback (9%), and (4) working with other farm machinery (9%). The severity of these 189 work injuries varied, with 8% (n = 15) fatal, 31% (n = 59) requiring hospitalization, 52% (n = 99) requiring treatment in the emergency department or by an outpatient provider, and 8% (n = 16) not requiring medical treatment.

**DISCUSSION**

Our study demonstrates that removal of the family farm exemption from the Hazardous Occupations Orders has the potential to eliminate one third of the occupational injuries experienced by children younger than 16 years who are working on their parents' farms. Removal of the family farm exemption in combination with a change in the age restriction for hazardous work could lead to similar reductions among children aged 16 and 17 years. These policy changes were recommended by the National Research Council and Institute of Medicine in their 1998 joint report on child labor in the United States but have never been implemented by Congress through an amendment to the FLSA. If implemented and enforced, these changes could also lead to reductions in injury rates that meet or exceed national health objectives recommended in the Healthy People 2010 initiative being led by the US Department of Health and Human Services.

Children working in agriculture continue to have the highest rate of fatal work injuries compared with children in other work environments, with the preponderance of these fatal injuries occurring on farms that are family owned and operated. Protection from physical harm is a fundamental human right for children, and it is well recognized that children require higher standards of protection than adults. These facts are not recognized in existing occupational health and safety legislation aimed at family farms, which is perplexing given the magnitude of the pediatric farm injury problem. Given
these observations and in light of our research findings, there is a clear need for at least minimum safety standards to protect children from harm on family farms.

The Hazardous Occupations Orders should be considered the minimum safety requirement for all working youths, because the Orders do in fact cover many of the most serious traumatic injury circumstances that affect children working on farms (Figure 2) and are thus likely to be efficacious. However, removing the family farm exemption from the Hazardous Occupations Orders and raising the age standard will be insufficient to ensure that the farm work performed by children is safe. Our study findings build upon the National Institute for Occupational Safety and Health recommendations for changes to the Hazardous Occupations Orders and provide additional objective evidence that can assist in the revision of the content of the Hazardous Occupations Orders to make them more relevant to contemporary farm environments and practices.

With respect to children at work, the changes should include (1) identification of high-risk activities that impose risks for blunt animal trauma, and (2) replacement of out-of-date lists of farm machinery with ones that reflect modern agricultural practice. There is an obvious need to update the Hazardous Occupations Orders, and there is an additional need for further evaluation of their content and implementation.

The adoption of changes in the Hazardous Occupations Orders will clearly require a paradigm shift within farm society and among the health and safety professionals who serve the agricultural population. Existing injury prevention initiatives aimed at farmers have traditionally favored voluntary over regulatory approaches to prevention. However, we believe that a shift toward policy-oriented approaches is inevitable and will be guided by the known lack of efficacy of educational approaches to injury prevention, the inadequacy of voluntary engineering controls, the magnitude of the pediatric farm injury problem, and the political will of national public health and medical organizations.

Beyond the Hazardous Occupations Orders, our study results suggest a need for other measures that address the physical safety of children on farms. The study findings clearly put the burden of occupational injuries to children on farms into a broader context. Assuming that the Hazardous Occupations Orders are efficacious, implementation and enforcement of these policies would still have no impact on the majority of farm injuries experienced by children who were present in the farm worksite but were not themselves engaged in farm work. New occupational policies and other preventive initiatives are required to address these injury patterns, which are heavily concentrated in the very young. These common and often lethal injury events are not addressed in any existing regulations.

**Generalizability**

An important concern surrounding our analysis was whether patterns of farm injuries among children observed primarily in Canada could be generalized to the United States. National, record-level data describing pediatric farm fatalities exist for the United States but are not available to researchers operating outside the federal government, because of confidentiality restrictions. Hospital medical records are also not available for similar reasons. Hence, our study relied heavily upon Canadian injury records, and an obvious concern is the generalizability of Canadian injury patterns to the United States context.

In the United States, leading causes of farm injury to children include tractor-related injuries, farm machinery (including power take-off) injury, livestock injury, falls from structures, chemical burns, and poisonings. Leading causes of traumatic injury in the present case series were very similar, which provides some assurance as to the generalizability of our findings. Second, although regional differences exist, the leading types of crops and livestock produced on US and Canadian farms are similar, suggesting more similarities than differences in agricultural practices between the countries. Finally, similar to the situation in the United States, the Hazardous Occupations Orders, children who live on Canadian farms are exempt from most provincial occupational health and safety legislation that would prohibit their participation in hazardous work.
TABLE 1—Hazardous Occupations Orders (HO) Categories of Prohibited Jobs Involved in Cases of Fatality, Hospitalized Injury, and Restricted-Activity Injury, by Age, Among Family Members Aged Younger Than 18 Years Injured While Working on a Family Farm: 1990–2001

<table>
<thead>
<tr>
<th>Hazardous Order Number and Job Category</th>
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<th>Restricted-Activity Injuries</th>
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<td></td>
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<td></td>
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<tr>
<td><strong>Aged &lt; 16 Years</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. cases of injury</td>
<td>28</td>
<td>75</td>
<td>110</td>
<td>213</td>
</tr>
<tr>
<td>HO1: Tractor</td>
<td>9</td>
<td>16</td>
<td>12</td>
<td>37 (17.4)</td>
</tr>
<tr>
<td>HO2: Farm machinery</td>
<td>4</td>
<td>13</td>
<td>3</td>
<td>20 (9.4)</td>
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<tr>
<td>HO3: Other machinery</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1 (0.5)</td>
</tr>
<tr>
<td>HO4: Animals</td>
<td>0</td>
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<td>2</td>
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<td>HO9: Chemicals</td>
<td>0</td>
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| working in 1 or more hazardous job categories
|                                        |            |                        |                               |           |
| **Aged 16–17 Years**                  |            |                        |                               |           |
| No. cases of injury                    | 9          | 16                     | 48                            | 73        |
| HO1: Tractor                          | 4          | 5                      | 5                             | 14 (19.2) |
| HO2: Farm machinery                   | 1          | 5                      | 5                             | 11 (15.1) |
| HO6: Working from heights             | 0          | 0                      | 3                             | 3 (4.1)   |
| HO8: Working in storage units         | 1          | 0                      | 0                             | 1 (1.4)   |
| HO9: Chemicals                        | 0          | 1                      | 0                             | 1 (1.4)   |
| No. cases (%) involving children      | 5 (55.6)   | 9 (56.3)               | 12 (25.0)                     | 26 (35.6) |
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**Conclusions**

This novel evaluation addressed a leading public health problem on North American farms—the occurrence of injuries to populations of working children. Through this analysis we demonstrated that the Hazardous Occupations Orders, if implemented and enforced, have the potential to prevent one third of work-related injuries sustained by children working on family farms. Within the agricultural sector, this would exceed the population health goals espoused in the Healthy People 2010 initiative.

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Policy-oriented approaches to farm injury prevention among children have historically met with opposition from agricultural organizations, mainly for financial (costs to the farm enterprise) and cultural (e.g., traditional work practices) reasons. Agriculture is exempt from much existing occupational health and safety legislation for these reasons. Although it is recognized that changes to the Hazardous Occupations Orders may lead to new labor practices and safety requirements for farm operations, and some of these will have financial implications, public health practice obligations and, specifically, the need for protection of children on farms should supersede such economic and cultural arguments.

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**Strengths and Limitations**

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About the Authors
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This article was accepted March 11, 2006.

Contributors
B. Marlenga, R.J. Brison, and W. Pickett contributed to the conception and design of this study and the acquisition of data. B. Marlenga and W. Pickett led the writing. R.L. Berg and J.G. Linneman completed the analyses. All authors reviewed the article, contributed to critical revisions, and provided assistance in all other aspects of the study.

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Human Participant Protection
This project was approved by the institutional review boards of both Marshfield Clinic Research Foundation and Queen’s University.

References
6. Hartling L, Brison RJ, Crumley ET, Klassen TP,


Using Participant Event Monitoring in a Cohort Study of Unintentional Injuries Among Children and Adolescents

| J. R. Wilkins III, DrPH, BCE, J. Mac Crawford, PhD, Lorann Stallones, PhD, Kathleen M. Koechlin, PhD, Lei Shen, PhD, John Hayes, PhD, and Thomas L. Bean, EdD |

Unintentional injuries are a significant childhood health problem in the United States, for example, in 2001 such injuries accounted for almost 45% of all deaths in the population aged 1 to 19 years. Unintentional injury is the leading cause of death in the 1- to 34-year age group and has been for some time. Of the 30 million nonfatal injuries treated in US hospital emergency departments in 2001, 35% involved individuals aged younger than 20 years.

A significant methodological problem in injury epidemiology is collecting accurate data on events causing tissue damage as well as the tissue damage itself. Other factors that complicate this process include the varieties of injury-producing events (e.g., slips, trips, falls), the multidimensionality of injury severity, and the question of what constitutes a reportable event. In studies of unintentional injuries, the reporting threshold has commonly been defined in terms of the nature of medical attention or the degree of interference with normal activities. Combined with the relative rarity of high-severity injuries, the ascertainment problem hampers accurate estimation of injury rates and identification of important risk indicators.

It has been suggested that the reporting threshold be lowered, when appropriate, to include minor injuries, which would increase the number of injury events available for study, and that such data be collected on a weekly or even daily basis, which would shorten the recall period and thereby reduce underreporting and misclassification. Some have argued that minor injuries may serve as proxies for more severe injuries.

We conducted a study to develop multivariable risk prediction models of work-related injuries among young people aged 9 to 18 years who were exposed to agricultural hazards. We report on the quality of data obtained from youths who completed daily diaries during a 13-week reporting period.

Objectives. We conducted a 3-year cohort study of 407 youths aged 9 to 18 years to develop multivariable risk prediction models of agriculture-related injuries.

Methods. Data were obtained via participant event monitoring, with youths self-reporting injuries and exposures in daily diaries over a 13-week period. We evaluated data quality by comparing injury self-reports with other injury data.

Results. Semilogarithmic plots of rates of all unintentional injuries combined (US data from 2000) as well as of agriculture-related injuries (US and Canadian data from 19 previous studies) graphed as a function of injury severity exhibited linearity, as did plots based on the present results. Severity-specific unintentional injury rates were 1.4- to 4.3-times higher than national rates, suggesting that our methodology can significantly reduce injury underreporting. In addition, at each severity level, estimated agriculture-related injury rates were 5.8- to 9.3-times higher than rates from previous national, regional, and state-based studies.

Conclusions. Our approach to participant event monitoring can be implemented with youths aged 9 to 18 years and will yield reliable daily data on unintentional injuries. (Am J Public Health. 2007;97:283–290. doi:10.2105/AJPH.2005.077172)

METHODS

Identifying and Recruiting Youths

We targeted young people aged 9 to 18 years residing in the 20-county central Ohio area during 1999 through 2001 who lived or worked on farms or performed agriculture-related chores as part of 4-H (the youth development program of the US Department of Agriculture’s Cooperative Extension System). Youths and their “parent partners” (their primary caregivers who usually made the agriculture-related chore assignments) were recruited via letters and follow-up telephone calls. This effort proceeded serially, 1 county at a time, and relied on each county’s 4-H infrastructure to identify eligible youths.

Data Collection Procedures

We obtained data from 3 primary sources: (1) prebaseline self-administered questionnaires completed by young people and their parent partners; (2) baseline measurements of known and suspected injury risk factors, including neurobehavioral and anthropometric characteristics of the participating youths (not discussed further but available from the authors); and (3) semistructured diaries in which youths reported “accidents” and injury hazard exposures on a daily basis over a 13-week period. Self-administered questionnaires were designed to obtain data on family demographic and farm or household characteristics, risk attitudes and behaviors, and parenting behaviors in addition to several other youth-related factors (e.g., injury and agricultural work histories, athletic ability, and visual acuity). Most items on the questionnaires were derived from previously used and validated instruments.

Self-administered questionnaires were mailed to participating households before testing to obtain baseline measurements, with the expressed expectation that the questionnaires be completed by the day of testing. Study staff reviewed the returned questionnaires during the testing session and re-examined them later to detect problems not discerned at the testing site, i.e. item nonresponse or illogical or nonsensical responses. Appropriate corrections were made, or, if necessary, a telephone call was made to the child or caregiver to resolve problems. Self-administered questionnaires were coded for data entry at the testing site; this coding was also rechecked.

Daily record books (DRBs) were designed to gather injury and injury hazard exposure...
data from participating youths on a daily basis. Each DRB contained 7 diaries, 1 for each day of the week. Youths were instructed to complete the daily diary section of the DRB each evening before going to bed and then at the end of each week give each completed DRB to their parent partner to review for accuracy and completeness before mailing it to the project office. Most questions were closed-ended, the exceptions being exposure-related items requiring duration reporting and injury-related items pertaining to bystanders and activity and location at the time of injury.

We considered traditional reporting thresholds too restrictive given the project’s objectives, so the operational definition of a reportable event we used was a modification of the Peterson et al.11 definition of a minor portable event: any event with a specific time of onset that leaves a mark for at least 1 hour or that results in pain for at least 15 minutes, namely, any “accident” that caused pain, bleeding, skin redness, or bruising. Because participants were young, we used the more familiar terms “accident” for the event and “accidental” for intent.

Injury events reported in the DRBs were coded according to the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM),16 and the Murphy et al. Farm and Agricultural Injury Code (FAIC) system.17 As a surrogate measure of severity, all injury episodes were assigned 1 of the following treatment dispositions: no treatment; minor treatment or first aid; treatment at a hospital, clinic, or doctor’s office followed by release; or treatment at a hospital, clinic, or doctor’s office followed by hospitalization.

In instances in which medical attention was sought for an injury, we requested access to the youth’s medical records to validate the youth’s description of the injury. We compared injury descriptions obtained from medical personnel with those provided by youths to determine levels of agreement.

Quality Control Procedures

Given the data collection modality, data quality was a major concern. Consequently, we implemented a multifaceted system of quality control procedures. The quality control efforts described subsequently focused on youths’ interactions with the microcomputer system called Dr. GOOP (goal and object-oriented programming; designed by J. Hayes); injury reporting; and DRB follow-up.

Dr. GOOP is an interactive microcomputer system that allows automated telephone data collection. Data are collected using custom software with Intel voice boards (Intel, Santa Clara, Calif) having an analog telephone interface. Youths were asked to make a 1-minute toll-free telephone call to this “talking computer” on the final day of each project week. If a call was not made on schedule, Dr. GOOP called the household the following day. Youths were asked whether or not they were filling out their DRBs on a daily basis, whether or not their parent partner reviewed their DRBs for “accuracy and completeness,” and whether or not they had forgotten to report any “accidents.” The primary functions of Dr. GOOP were to keep participants engaged in the project and to contribute to quality control efforts.

As mentioned in the previous section, we assessed injury reporting concordance by obtaining medical records for injuries reported to have required medical attention. Using the medical record as the gold standard, we measured concordance with respect to type and anatomical site of injury, laterality, and day and date of injury.

We evaluated each DRB for accuracy and completeness within 10 days of receipt. Discernible errors that could not be resolved were usually rectified through a follow-up telephone call to the participant. When such calls were made, youths were again reminded about the correct way to complete DRBs.

Statistical Analysis

Descriptive statistics (frequency counts, percentages, means, and standard deviations) were calculated for injury events. We evaluated the comparability of the injury data we obtained with injury data collected via other methods by statistically and graphically contrasting the severity-specific injury rates estimable from our data with corresponding age-, race-, and severity-specific rates of all unintentional injuries available through the Web-Based Injury Statistics Query and Reporting System (WISQARS)15 and with corresponding age-, race-, and severity-specific rates of agriculture-related injuries among youths reported from relevant US and Canadian studies conducted over the past 20 years.18–37 For these previously reported agriculture-related rates, we fit a linear mixed-effects model with random effects to account for variation among studies.

RESULTS

Recruitment and Retention

During calendar years 1999 through 2001, 3152 households were contacted (55% of the age-eligible residents were girls). Among the 1926 eligible youth–parent dyads identified, 471 consented to participate, yielding an overall response rate of 24.5%. Recruitment effort outcomes (e.g., agreement or refusal to participate, ineligibility) did not vary according to (youth’s) age or gender.

Of the 471 initial responders, 64 contributed no time at risk of injury, because they dropped out early, failed to provide written consent, or failed to complete or return the required prebaseline questionnaires. Comparisons of these 64 youths not providing usable data with the 407 youths who provided such data showed that they were more likely to be boys and that they were slightly older. However, there were no differences between the 2 groups with respect to lifetime history of medically attended injuries or farm residence at the time of baseline testing.

The 169 boys (41.5% of the total) and 238 girls (58.5%) taking part were similar in their age distributions (boys, mean age=13.1 years, SD=2.3; girls, mean age=12.8 years, SD=2.4). Overall, participating youths completed and returned 4098 DRBs (i.e., 28 686 days of injury and activity data). Approximately 56% of boys and girls completed and returned all 13 DRBs. Although the mean number of contributed “youth-weeks” was approximately equal among boys (10.2) and girls (10.0), some variation was observed according to age. The youngest boys were the most responsive, completing and returning 11.0 DRBs on average. The quality of both injury and activity data tended to improve over the 13-week follow-up period, with girls and older youths in general making the fewest errors in their DRBs.12,38
Frequency, Severity, and Nature of Injuries

The 407 participants providing usable data reported 2788 (unintentional) injury-producing events (Table 1). Approximately two thirds of injuries required no treatment (n=1888; 67.7%), whereas 27.9% (n=778) required “minor” treatment (i.e., “first-aid” administered by youths or family members at home or by nurses or teachers at school (e.g., cold compress)).

Coding according to the FAIC system\(^1^\) showed that approximately 50% of the injury events were agriculture related. Nonagricultural injury events accounted for about 40% of self-reported events, with approximately 10% considered unclassifiable. Most agriculture-related events occurred while youths were involved in farm production activities (n=775; 27.8% of all injuries, 55.4% of all agriculture-related injuries). Approximately 13% of all injuries occurred in or around the “farm home,” which, it should be emphasized, is a place of residence as well as a part of an agricultural setting where work occurs.

Treatment received varied little according to FAIC category. Girls, as mentioned, made up 58.5% of the sample, but they reported 70.9% of all injuries; they were less likely than boys to report agriculture-related injuries. In general, injury rates increased with age; agriculture-related injury rates were highest among 15- to 18-year-old youths (by a factor of 2 for boys and 1.6 for girls relative to the other age groups).

ICD-9-CM diagnosis codes were assigned to the 3352 injuries produced by the 2788 injury events (2396 events caused 1 injury, and 392 events caused 2 or more). In more than 80% of cases (Table 2), tissue damage was described as superficial (37.6%), as a contusion with intact skin surface (25.4%), or as an open wound (19.0%). In general, youths’ age at the time of the event varied little according to ICD-9-CM code or gender, although boys reporting superficial injuries (ICD codes 910–919), fractures (codes 800–829), and unspecified injuries (codes 958 and 959) were significantly older on average (P<.05) than were girls reporting the same injuries.

Log-Transformed Incidence Rates

In Figure 1a, data from WISQARS (rates of all unintentional injuries) were plotted as small open circles (at injury severity levels 2–4); the small open circle plotted at severity level 1 was the minor injury rate reported by Peterson et al. (for 61 second-grade children).\(^1^1^\) Severity-specific rates estimated from our PEM-derived data were also plotted in Figure 1a (dashed linear trend line). Not only are the 2 trend lines approximately parallel, but our PEM-derived rates are 1.4- to 4.3-times higher than national rates (see nonoverlapping confidence intervals for severity levels 1 and 2 in Table 3).

The small numbers of reported injuries at severity levels 3 and 4 can be interpreted by assuming that the Poisson distribution applies. One severity level 3 injury was observed, the likelihood of which would be only 15% if the true rate were the same as that from WISQARS. No fatal injuries were observed.

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**TABLE 1—Distribution of Injury-Producing Events by Farm and Agricultural Injury Code and Treatment Received:** Central Ohio 4-H Youths, 1999–2001

<table>
<thead>
<tr>
<th>Farm and Agricultural Injury Code</th>
<th>No Treatment</th>
<th>Minor Treatment*</th>
<th>MA, Released</th>
<th>MA, Hospitalized</th>
<th>Treatment Not Reported</th>
<th>Any Type of Treatment</th>
</tr>
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<td></td>
<td>Boys, No. (%)</td>
<td>Girls, No. (%)</td>
<td>Boys, No. (%)</td>
<td>Girls, No. (%)</td>
<td>Boys, No. (%)</td>
<td>Girls, No. (%)</td>
</tr>
<tr>
<td>Farm production work</td>
<td>214 (34.7)</td>
<td>326 (42.7)</td>
<td>57 (28.5)</td>
<td>146 (25.3)</td>
<td>5 (25.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Farm tractors, machines, tools,</td>
<td>3 (0.5)</td>
<td>1 (0.1)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>equipment, not being used for</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>farm production</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-work site</td>
<td>9 (1.6)</td>
<td>21 (1.6)</td>
<td>3 (1.5)</td>
<td>8 (1.4)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>On-farm outside services</td>
<td>1 (0.2)</td>
<td>0 (0.0)</td>
<td>1 (0.5)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Farm home</td>
<td>60 (10.6)</td>
<td>176 (13.3)</td>
<td>29 (14.5)</td>
<td>91 (15.7)</td>
<td>3 (15.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Farm leisure</td>
<td>12 (2.1)</td>
<td>22 (1.7)</td>
<td>0 (0.0)</td>
<td>9 (1.6)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Agriculture-related, not elsewhere</td>
<td>17 (3.0)</td>
<td>100 (7.6)</td>
<td>9 (4.5)</td>
<td>31 (5.4)</td>
<td>1 (5.0)</td>
<td>1 (10.0)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not agriculture related</td>
<td>191 (33.7)</td>
<td>535 (40.5)</td>
<td>82 (41.0)</td>
<td>242 (41.9)</td>
<td>9 (45.0)</td>
<td>5 (50.0)</td>
</tr>
<tr>
<td>Unknown/not classifiable</td>
<td>60 (10.6)</td>
<td>140 (10.6)</td>
<td>19 (9.5)</td>
<td>51 (8.8)</td>
<td>2 (10.0)</td>
<td>3 (30.0)</td>
</tr>
<tr>
<td>Gender total</td>
<td>567 (100.0)</td>
<td>1321 (100.0)</td>
<td>200 (100.0)</td>
<td>578 (100.0)</td>
<td>20 (100.0)</td>
<td>1 (100.0)</td>
</tr>
<tr>
<td>Overall total (n=2788)</td>
<td>1888 (67.7)</td>
<td>778 (27.9)</td>
<td>30 (1.1)</td>
<td>1 (0.4)</td>
<td>91 (3.3)</td>
<td>29 (10.5)</td>
</tr>
</tbody>
</table>

Note. MA = medically attended (treatment at a hospital, clinic, or doctor’s office). No injury-producing events were reported in the following 5 Farm and Agricultural Injury Code categories: agricultural services; forestry; fishing, hunting, trapping; rural traffic farm hazards; and interruption unrelated to work. As a result of rounding, not all columns sum to 100%.

*Minor treatment was defined as “first-aid” administered by youths or family members at home or by nurses or teachers at school (e.g., cold compress).
Injury rates for the studies assessed were 1.84, 0.14, and 0.006 per 100 for severity levels 2, 3, and 4, respectively. Our estimate for severity 2 injuries was higher than all of those observed in the other studies and was 7.8-times higher than the combined estimate from those studies, a statistically significant difference. One severity level 3 injury was observed in this study, and was 7.8-times higher than the combined estimate from the other studies (0.140 per 100), suggesting an elevated rate in the present study.

Youths’ Interactions With Dr. GOOP

Overall, the results of youths’ interactions with Dr. GOOP suggested that, as intended, this system was successful in keeping participants engaged in the data collection process. In more than 73% of cases, youths initiated contact with Dr. GOOP. Otherwise, Dr. GOOP called and the youth answered or Dr. GOOP called, someone in the household answered the phone, and the youth called Dr. GOOP shortly thereafter.

An increasing trend was seen from year 1 to year 3 in the percentages of youths reporting that they were completing their DRBs each day (83.4%, 89.0%, and 90.6%, respectively). Furthermore, a decreasing trend was seen among youths reporting they had forgotten any accidents in a given week. In year 1, 12.1% of youths who answered the question about whether or not they had forgotten any accidents reported they had done so. In year 2 this percentage dropped to 6.5%, and in year 3 only 4.9% of youths reported that they had forgotten to report any accidents. More than 80%
Severity/treatment dispositions were classified as no treatment (1); minor treatment or first aid (2); treatment at a hospital, clinic, or doctor’s office followed by release (3); and treatment at a hospital, clinic, or doctor’s office followed by hospitalization (4).

FIGURE 1—Log-transformed injury incidence rates from the present study, the US population of 9- to 18-year-olds as a whole, and 19 national and regional studies: all unintentional injuries combined (a) and agriculture-related injuries (b).

Note. Severity/treatment dispositions were classified as no treatment (1); minor treatment or first aid (2); treatment at a hospital, clinic, or doctor’s office followed by release (3); and treatment at a hospital, clinic, or doctor’s office followed by hospitalization (4).

of the time (over all 3 years), youths reported that their parent partners had checked their DRBs for accuracy and completeness.

Injury Reporting Concordance

The overall concordance between youths’ self-reports and medical records was 67.2% (43 of 64 cases). The highest concordance rate was for the anatomical site of the injury (88.2%; 15 of 17 cases); the lowest was for laterality (52.9%; 9 of 17 cases). The poor laterality concordance may have been a result of the anatomical diagram in the DRB (the diagram’s left was probably interpreted as right, and vice versa). Concordance estimates for injury type and date were 66.7% (10 of 15 cases) and 60.0% (9 of 15 cases), respectively.

Follow-Up

Approximately 45% of the 407 participants required 1 or more DRB follow-up telephone call (n=181). A total of 547 calls were made (54.5% concerned injuries, and 45.5% concerned activities). Young people who did and did not require follow-up calls were similar with respect to age and gender. Fewer than 10 follow-up calls for self-administered questionnaires were necessary.

DISCUSSION

The results shown in Figure 1 and the outcomes of our quality control subanalyses indicate that our approach to PEM can be successfully implemented to collect reliable daily data on unintentional injuries from 9- to 18-year-olds over a 13-week reporting period. Furthermore, our PEM methodology appeared to significantly reduce injury underreporting. As can be seen in Table 3, rates estimated from our data were 1.4- to 4.3-times higher than were national rates for all unintentional injuries combined and 5.8- to 9.3-times higher than were aggregated rates for agriculture-related injuries found in previous studies.

Although not all injury events were reported by all participants, we agree with Peterson et al. that PEM-derived data “seem to provide a much better estimate of injury frequency than could be obtained in any other fashion.” However, the observed rate differences might be explained by factors other than underreporting in the comparison populations. For example, although our 4-H youth participants reported exposures similar to those of other youths living or working on farms, the higher rates exhibited by these young people might reflect real elevated risks of both unintentional and agriculture-related injuries. It is unlikely that the differences are explained by overreporting of injury events among our participants.

Characteristics of childhood injuries such as multiple, intermittent, and heterogeneous exposures make PEM an attractive data collection methodology. In addition to a significant increase in the number of injury events available for analysis, the time elapsed between injury event and injury event reporting is minimized. Because accuracy of recall of past experiences decreases over time, self-reporting of injury-producing events and injuries themselves has been viewed as problematic. Nevertheless, accurate self-reporting methods for dietary intake have been developed because obtaining such data through direct observations would be prohibitively expensive.

Many experts believe, as an example, that valid data on young people’s behaviors can be obtained from parental observations without
the need for trained external observers. Consequently, our approach to designing daily data collection forms was guided by the methods advocated by Peterson et al. and incorporated a pair of approaches shown to have good reliability and validity in nutritional studies: the checklist approach and the diary approach. 

As noted earlier, data on interactions with Dr. GOOP indicated that most youths self-reported on most days, suggesting a relatively small adverse effect of recall bias in comparison with other studies.

Although there are contrary views, the potential utility of data on minor injuries should not be underestimated. Factors explaining the occurrence of minor injuries are to some extent correlated with the factors that explain the occurrence of serious injuries (i.e., minor injuries may serve as reasonable proxies for serious injuries). Morrongiello et al. reported a significant correlation between minor and serious injuries, although in their study, mothers reported on the injury experiences of their 2- and 3-year-old children. Furthermore, minor injuries merit study because they can be disruptive to a household’s routine and labor intensive, with repeated contact attempts necessary. With PEM, youths were allowed some flexibility in terms of when they could fill out their DRBs.

Given the nature of our data collection methodology, it must be acknowledged that there were several potential sources of error. In the DRB alone, youths were expected to respond to approximately 60 activity items each day, along with 12 items for each injury event. Although every precaution was taken to standardize baseline testing through intensive training, we recognize that there may have been variability between examiners in protocol implementation given that multiple staff members were responsible for testing.

Other disadvantages include the large inputs of time and labor required to check the DRBs for accuracy and completeness. Because approximately 29,000 days of activity data were collected, staff reviewed, recorded errors on, coded, and entered data from approximately 29,000 single-page forms. Approximately 3,000 injuries (with 12 response items per injury) were coded and entered into a database, and telephone calls were made to youths whose errors could not be unambiguously corrected. We recognize that our PEM approach, as implemented here, may not be widely feasible because of its relatively high costs.

Finally, the potential lack of generalizability of our approach is an issue given the relatively low response rate and the nonrandom nature of our sample. We did find that responders and nonresponders were virtually identical with respect to age and gender. Furthermore, the decision to recruit 4-H youths was based on certain characteristics of the 4-H infrastructure.

First, a large number of Ohio children and adolescents with potential exposures to agricultural hazards participate in the state’s 4-H Youth Development program. More than 200,000 young people ranging in age from 5 to 19 years are involved in different activities sponsored by 4-H. Of these youths, approximately 33,000 live on farms. Second, 4-H participants meet regularly in small, organized groups, permitting regular contact with investigators.

Third, each 4-H club has at least one adult volunteer who is committed to youth development and strategically positioned to facilitate recruitment of young people and their primary caregivers. Fourth, a traditional
component of youth participation in 4-H is investment of time and effort in “projects” (e.g., raising an animal to show at a county fair) that often require record keeping over a 3- to 12-month period. Finally, as reflected in the comments of the 4-H advisors who participated in a planning focus group, there is a strong expectation that all projects be completed.

The American Academy of Pediatrics recently published recommendations for the prevention of agricultural injuries among children and adolescents, citing the following sobering statistics: each year in the United States there are 104 deaths, 22,000 emergency department visits, and 78,000 injuries not treated in emergency departments in this population.8 These troubling facts underscore the need for better injury and exposure data collection methodologies. Although we focused on the problem of childhood agriculture-related injuries in our study, we believe that the lessons learned can be used to guide future research efforts designed to prevent all types of unintentional childhood injuries.

Acknowledgments
This research was supported by the National Institute for Occupational Safety and Health (grant ROI #CRR15860). We thank Barbara Morrongiello, David Schwebel, and Huyun Xiang for their thoughtful comments on earlier versions of this article. We also acknowledge the invaluable assistance of the late Lizette Peterson-Homer in the early conceptualization of the study. This article is dedicated to her memory.

Human Participant Protection
All protocols pertinent to human participants, including the informed consent process, were approved by the institutional review board of Ohio State University.

References
31. Stueland DL, Lee BC, Nordstrom DL, Layde PM,


Associations Between Childhood Intelligence and Hospital Admissions for Unintentional Injuries in Adulthood: The Aberdeen Children of the 1950s Cohort Study

Debbie A. Lawlor, PhD, Heather Clark, MSc, and David A. Leon, PhD

Unintentional injuries among adults are an important public health problem resulting in substantial morbidity, disability, and premature mortality. Injury risk has been shown to be related to educational attainment and socioeconomic position, but the extent to which this association reflects cognitive capabilities is unknown. Over the past few years, there has been increasing interest in the association between childhood cognitive ability and later health, with studies indicating that childhood intelligence is inversely related to all-cause mortality and other adverse health outcomes.

Little is known about the association between cognitive ability early in life and later injury. To our knowledge, only 1 study has assessed this relationship. In the Australian Veterans Health Study, there was a strong inverse linear association between intelligence assessed in early adulthood and deaths resulting from motor vehicle accidents. Associations with other forms of injury or with non-fatal injuries were not assessed. For our study, we examined the association of childhood intelligence measured at 3 different ages (7, 9, and 11 years) with hospital admissions for unintentional injuries.

**METHODS**

We used data from the Aberdeen Children of the 1950s cohort study. The cohort, described in detail elsewhere, comprised participants in the Aberdeen Child Development Survey, which collected data on the parental and childhood characteristics of 14,938 children enrolled in primary schools in Aberdeen, Scotland, in 1962. Comprehensive information on the 12,150 of these children born in Aberdeen, including the course of their mother’s pregnancy and their physical characteristics at birth, was abstracted from the Aberdeen Maternity Neonatal Databank. These 12,150 individuals were born between 1950 and 1956 and were members of the Aberdeen Children of the 1950s cohort.

In 1999, we began tracing study members through Scotland’s General Register Office; 97% were successfully traced. Traced participants were linked to the Scottish Morbidity Register, which provides information including diagnoses coded according to the International Classification of Diseases, Ninth and Tenth Revisions (ICD-9 and ICD-10), for all admissions to hospitals in Scotland. Because these data are complete only from January 1, 1981, onward, we began our follow-up period on that date. Participants have also been linked to the National Health Service Central Register, which provides detailed information on deaths and migration out of Scotland. We used ICD codes to define types of unintentional injuries (a table of the specific codes used to define types of unintentional injuries is available from the authors).

Throughout the 1950s in Scotland, tests of intelligence were routinely administered to children at ages 7, 9, and 11 years, and results for members of the Aberdeen Children of the 1950s cohort were linked to their study data. The tests used were the Moray House Picture Intelligence Test (number 1 or 2) at age 7 years, the Schonell and Adams Essential Intelligence Tests (form A or B) at age 9 years, and a battery of Moray House Tests—2 ability tests (verbal reasoning 1 and 2) and 2 attainment tests (arithmetic and English)—at age 11 years. Children took all of these intelligence tests within 6 months of their 7th, 9th, and 11th birthdays, respectively. Tests were age standardized using means of 100 and standard deviations of 15 for Scotland as a whole.

Socioeconomic status early in life has been shown to be related to childhood intelligence as well as occurrence of unintentional injuries and may confound any association between childhood intelligence and unintentional injuries. As a result, we adjusted for a range...
of indicators of socioeconomic status and other potential confounders from early in life—paternal occupational social class, maternal age at delivery, birthweight, and gestational age—in our analyses. Data on birthweight, gestational age, maternal height (to the nearest inch), paternal occupational social class at the time of the participant’s birth, gravidity, and maternal age at delivery (in 5-year age categories) were abstracted from the Aberdeen Maternal and Neonatal Database.

During the 1950s and 1960s in Scotland, all children underwent a medical examination at the time of their entry into primary school and had their height and weight measured as part of this assessment. Data from this physical examination were abstracted from the school medical examinations for all participants. We further adjusted for educational attainment to determine the extent to which it mediated any association between childhood intelligence and adult injury.

Between 2000 and 2002 a questionnaire survey was mailed to 11,282 surviving cohort members; 7183 (63.7%) responded. Respondents were more likely to be women, to have been members of more affluent families in childhood, and to have had higher intelligence test scores as children. We derived data on educational attainment from these questionnaire responses. Although these data were collected after most of the injury events assessed here had occurred, most of the participants had completed their formal education before their mid-20s and, therefore, before the occurrence of any outcome events.

We used Cox proportional hazards regression models, with participants’ age as the time axis, to analyze our data. As mentioned, the follow-up period began on January 1, 1981, when complete Scottish Morbidity Register data on hospital admissions became available. Participants were omitted from the analyses if they had died (n = 116; 10 of these cases involved unintentional injuries), emigrated to anywhere outside Scotland (n = 927), or had a record of a hospital admission for trauma during the period before January 1, 1981, when case ascertainment was incomplete as the register of hospital admissions was being established (n = 4). After these exclusions, 11,103 (91%) of the original cohort members remained in the analyses.

Contributions to risk were censored at the earliest of the following: (1) first episode of the outcome of interest (if individuals had repeated hospital admissions for the main analyses, they were censored at the first event); (2) emigration date (including emigration to England and Wales, where it was not possible to link information to hospital admissions data); (3) death (there were no deaths resulting from unintentional injuries during the follow-up period); or (4) December 31, 2003, the end of follow-up. We assessed proportionality assumptions by inspecting cumulative incident plots; there was no evidence of any violation. Because the follow-up period began in 1981, our analyses assessed hospital admissions for unintentional injuries that occurred when cohort members were between the ages of 25 and 54 years.

To compare effect magnitudes between intelligence scores at each of the 3 different ages, and to be consistent with other studies on the association of intelligence with health-related outcomes, we divided each of the intelligence measures by its standard deviation and estimated hazard ratios for unintentional injury per standard deviation of intelligence score at each age. Birthweight was standardized according to gestational age and gender. Thus, the hazard ratio for birthweight was represented by a 1-standard-deviation increase in birthweight standardized for differences in birthweight owing to differences in gestational age and gender; as such, it represented in utero growth.

There were small amounts of missing data for childhood intelligence scores, gestational age, father’s occupational social class at child’s birth, and childhood height and weight (Table 1). By contrast, a substantial percentage of data on educational attainment (42%) were missing because information on education was obtained from the questionnaire survey conducted in 2000 and was therefore affected by nonresponse (Table 1).

We used multiple multivariate imputation, including all other covariates, the log of survival time, and the censoring indicator, to impute a distribution of missing values for variables without complete data. We used switching regression in Stata version 9.2 (StataCorp LP, College Station, Tex), as described by Royston. We carried out 20 cycles of regression switching and generated 10 imputation data sets. There was no evidence of statistical heterogeneity between the data sets generated. We also conducted all analyses on the subsample with complete data (n = 5572; 50.2%); the results from these complete data subset analyses were essentially the same as those presented here but were less precisely estimated.

Within the cohort as a whole, there were 9422 families; 5048 (41.5%) of the participants had at least 1 other sibling in the cohort. The usual method of computing standard errors in Cox regression analyses assumes that all study participants are independent (e.g., the intelligence in one individual will not be related to the intelligence of another individual other than by chance). It is likely that within families, this assumption does not hold because siblings’ intelligence will be related to each other through genetic and family environment factors. For this reason, we used robust standard errors (which take into account nonindependence of siblings) to estimate 95% CIs and P values in this study. Stata was used in conducting all analyses.

RESULTS

Table 1 shows the characteristics of the cohort. At the start of the follow-up period (1981), 11,103 members of the cohort were alive and believed to be residing in Scotland. Over the follow-up period, they contributed a total of 231,152 person-years of risk for injury. Among these individuals, 1043 had at least 1 hospital admission categorized as resulting from an unintentional injury, a rate of 45.3 injuries per 10,000 person-years (95% CI = 42.6, 48.1). Consistent with previous studies of injury-related mortality, men in the cohort (69.4 per 10,000 person-years; 95% CI = 64.7, 74.4) were more likely than women in the cohort (45.3 per 10,000 person-years; 95% CI = 42.6, 48.1) to have had at least 1 hospital admission classified as resulting from an unintentional injury.

There were no gender differences in the effects of intelligence or other covariates on injury risk (all interaction Ps > .5). Table 2 shows gender-adjusted associations of childhood intelligence and other early-life characteristics with hospital admissions categorized as resulting from unintentional injuries. Childhood intelligence test scores at the ages of 7, 9, and 11 years were inversely associated
TABLE 1—Baseline Characteristics of Participants in the Aberdeen Children of the 1950s Cohort: Aberdeen, Scotland

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Sample (n=12150), No. (%) or Mean (SD)</th>
<th>Missing Data, No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Girl</td>
<td>5868 (48.3)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>IQ score</td>
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<td></td>
</tr>
<tr>
<td>Age 7 y</td>
<td>107.1 (16.4)</td>
<td>471 (3.9)</td>
</tr>
<tr>
<td>Age 9 y</td>
<td>111.3 (17.0)</td>
<td>764 (6.3)</td>
</tr>
<tr>
<td>Age 11 y</td>
<td>104.1 (13.4)</td>
<td>882 (7.3)</td>
</tr>
<tr>
<td>Father's occupational social class at time of birth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I/II (highest)</td>
<td>1163 (9.6)</td>
<td></td>
</tr>
<tr>
<td>III nonmanual</td>
<td>1335 (11.0)</td>
<td></td>
</tr>
<tr>
<td>III manual</td>
<td>5319 (43.8)</td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td>1689 (13.9)</td>
<td></td>
</tr>
<tr>
<td>V (lowest)</td>
<td>1963 (16.2)</td>
<td></td>
</tr>
<tr>
<td>Mother's number of pregnancies</td>
<td></td>
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</tr>
<tr>
<td>1</td>
<td>3991 (32.8)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>3505 (28.9)</td>
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</tr>
<tr>
<td>3</td>
<td>2202 (18.1)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>1208 (9.9)</td>
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</tr>
<tr>
<td>≥5</td>
<td>1243 (10.2)</td>
<td></td>
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<td>Mother's height, in</td>
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<td>≤60a</td>
<td>3101 (25.5)</td>
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<tr>
<td>61</td>
<td>1911 (15.7)</td>
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</tr>
<tr>
<td>62</td>
<td>2169 (17.9)</td>
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<td>63</td>
<td>1777 (14.6)</td>
<td></td>
</tr>
<tr>
<td>64</td>
<td>1489 (12.3)</td>
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</tr>
<tr>
<td>≥65</td>
<td>1703 (14.0)</td>
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<tr>
<td>Mother's age at delivery, y</td>
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</tr>
<tr>
<td>15–19</td>
<td>567 (4.6)</td>
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<td>20–24</td>
<td>3798 (31.3)</td>
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<td>30–34</td>
<td>2546 (21.0)</td>
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<td>35–39</td>
<td>1108 (9.1)</td>
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</tr>
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<td>≥40</td>
<td>354 (2.9)</td>
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<tr>
<td>Born outside marriage</td>
<td></td>
<td>0 (0)</td>
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<tr>
<td>Gestational age, wk</td>
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<td>1262 (10.0)</td>
</tr>
<tr>
<td>&lt;37</td>
<td>760 (7.0)</td>
<td></td>
</tr>
<tr>
<td>37–40</td>
<td>7805 (61.7)</td>
<td></td>
</tr>
<tr>
<td>&gt;40</td>
<td>2323 (19.3)</td>
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<tr>
<td>Birthweight, lb</td>
<td>7.27 (1.13)</td>
<td>22 (0.2)</td>
</tr>
<tr>
<td>Height at primary school entry, in</td>
<td>42.8 (4.1)</td>
<td>431 (3.5)</td>
</tr>
<tr>
<td>Weight at primary school entry, lb</td>
<td>42.0 (6.4)</td>
<td>511 (4.2)</td>
</tr>
<tr>
<td>Educational attainment</td>
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<td>5067 (41.7)</td>
</tr>
<tr>
<td>No formal qualifications</td>
<td>1624 (22.9)</td>
<td></td>
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<tr>
<td>School leaving certificate</td>
<td>173 (2.4)</td>
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<tr>
<td>Certificate of secondary education</td>
<td>165 (2.3)</td>
<td></td>
</tr>
<tr>
<td>Ordinary-level qualifications</td>
<td>1684 (23.8)</td>
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<tr>
<td>Advanced-level qualifications</td>
<td>926 (13.1)</td>
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</tr>
<tr>
<td>Higher national certificate</td>
<td>1138 (16.1)</td>
<td></td>
</tr>
<tr>
<td>University degree</td>
<td>1374 (19.4)</td>
<td></td>
</tr>
</tbody>
</table>

*a 152 cm or less.

Table 1 continued...
# TABLE 2—Gender-Adjusted Associations (With 95% Confidence Intervals [CIs]) of Childhood Intelligence and Other Early Life Characteristics With at Least 1 Unintentional Injury Hospital Admission in Adulthood: Aberdeen Children of the 1950s Cohort, Aberdeen, Scotland

<table>
<thead>
<tr>
<th>Variable</th>
<th>No. of Accidents</th>
<th>Gender-Adjusted Hazard Ratio (95% CI)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>IQ score</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Age 7 y (per SD)</td>
<td>1043</td>
<td>0.75 (0.70, 0.80)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Age 9 y (per SD)</td>
<td>1043</td>
<td>0.76 (0.72, 0.81)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Age 11 y (per SD)</td>
<td>1043</td>
<td>0.72 (0.68, 0.77)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Father's occupational social class at time of birth</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I/II (highest)</td>
<td>65</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>III nonmanual</td>
<td>87</td>
<td>1.08 (0.78, 1.50)</td>
<td></td>
</tr>
<tr>
<td>III manual</td>
<td>458</td>
<td>1.45 (1.11, 1.89)</td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td>212</td>
<td>2.06 (1.54, 2.75)</td>
<td></td>
</tr>
<tr>
<td>V (lowest)</td>
<td>221</td>
<td>1.83 (1.36, 2.46)</td>
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</tr>
<tr>
<td>Mother's number of pregnancies</td>
<td></td>
<td></td>
<td>&lt;.001</td>
</tr>
<tr>
<td>1</td>
<td>301</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>300</td>
<td>1.15 (0.98, 1.35)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>191</td>
<td>1.17 (0.98, 1.40)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>109</td>
<td>1.21 (0.97, 1.51)</td>
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</tr>
<tr>
<td>≥ 5</td>
<td>142</td>
<td>1.50 (1.22, 1.84)</td>
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<tr>
<td>Mother's age at delivery, y</td>
<td></td>
<td></td>
<td>.40</td>
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<tr>
<td>15–19</td>
<td>55</td>
<td>1.17 (0.89, 1.53)</td>
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</tr>
<tr>
<td>20–34</td>
<td>857</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>≥ 35</td>
<td>131</td>
<td>1.09 (0.90, 1.31)</td>
<td></td>
</tr>
<tr>
<td>Born outside marriage</td>
<td></td>
<td></td>
<td>.30</td>
</tr>
<tr>
<td>No</td>
<td>991</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>52</td>
<td>1.16 (0.88, 1.54)</td>
<td></td>
</tr>
<tr>
<td>Mother's height, in</td>
<td></td>
<td></td>
<td>.02</td>
</tr>
<tr>
<td>≤ 60*</td>
<td>290</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>61</td>
<td>174</td>
<td>0.96 (0.80, 1.17)</td>
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</tr>
<tr>
<td>62</td>
<td>177</td>
<td>0.87 (0.72, 1.05)</td>
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<tr>
<td>63</td>
<td>159</td>
<td>0.96 (0.79, 1.17)</td>
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</tr>
<tr>
<td>64</td>
<td>123</td>
<td>0.89 (0.72, 1.11)</td>
<td></td>
</tr>
<tr>
<td>≥ 65</td>
<td>120</td>
<td>0.76 (0.62, 0.94)</td>
<td></td>
</tr>
<tr>
<td>Birthweight (per z score)</td>
<td>1043</td>
<td>0.95 (0.88, 1.02)</td>
<td>.10</td>
</tr>
<tr>
<td>Height at school entry (per z score)</td>
<td>1043</td>
<td>0.86 (0.81, 0.92)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Weight at school entry (per z score)</td>
<td>1043</td>
<td>0.92 (0.84, 1.01)</td>
<td>.08</td>
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<tr>
<td>Educational attainment</td>
<td></td>
<td></td>
<td>&lt;.001</td>
</tr>
<tr>
<td>None</td>
<td>399</td>
<td>1.00</td>
<td></td>
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<tr>
<td>School leaving certificate</td>
<td>26</td>
<td>0.67 (0.41, 1.12)</td>
<td></td>
</tr>
<tr>
<td>Certificate of secondary education</td>
<td>24</td>
<td>0.90 (0.55, 1.47)</td>
<td></td>
</tr>
<tr>
<td>Ordinary-level qualifications</td>
<td>251</td>
<td>0.76 (0.64, 0.91)</td>
<td></td>
</tr>
<tr>
<td>Advanced-level qualifications</td>
<td>82</td>
<td>0.46 (0.35, 0.58)</td>
<td></td>
</tr>
<tr>
<td>Higher national certificate</td>
<td>162</td>
<td>0.71 (0.57, 0.87)</td>
<td></td>
</tr>
<tr>
<td>University degree</td>
<td>99</td>
<td>0.43 (0.33, 0.57)</td>
<td></td>
</tr>
</tbody>
</table>

Note: Analyses were conducted with 10 multiple imputation data sets, which allows all 11 103 participants to contribute to the analyses. For the intelligence measures, hazard ratios refer to each 1-standard-deviation increase in score. The hazard ratio for birthweight was that for a 1-standard-deviation increase standardized for differences in birthweight owing to differences in gestational age and gender.

*152 cm or less.

Discussion

To our knowledge, this is the first study to examine the relationship between childhood intelligence and risk of nonfatal injury in adulthood. We found inverse linear associations...
between childhood intelligence and all types of unintentional injuries as well as with specific types of injuries. Childhood intelligence was associated with repeated hospital admissions for injury in adulthood, and similar associations were found for admissions of less than 3 days and those of 3 days or more, suggesting that childhood intelligence is associated with both minor injuries requiring short-stay admissions and more serious injuries requiring longer-length admissions.

Whereas inverse linear associations remained after adjustment for a range of potential confounding and mediating factors, educational attainment resulted in marked attenuation toward the null in the overall association, suggesting that educational attainment may be an important mediator of the relationship between childhood intelligence and risk of injury in adulthood. Attenuation with adjustment for education appeared to be most marked among individuals with childhood intelligence test scores above 100, suggesting that educational attainment may have less impact on the association between childhood intelligence and adult injury among individuals with lower childhood intelligence scores.

TABLE 3—Multivariate Associations of Childhood Intelligence at the Age of 7 Years With at Least 1 Unintentional Injury Hospital Admission in Cohort Overall and Stratified by Intelligence Score: Aberdeen Children of the 1950s Cohort, Aberdeen, Scotland

<table>
<thead>
<tr>
<th></th>
<th>Hazard Ratio (95% Confidence Interval)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Model 1</td>
</tr>
<tr>
<td>All participants</td>
<td>0.75 (0.70, 0.80)</td>
</tr>
<tr>
<td>Participants with IQ score &lt; 100</td>
<td>0.72 (0.62, 0.83)</td>
</tr>
<tr>
<td>Participants with IQ score ≥ 100</td>
<td>0.81 (0.71, 0.92)</td>
</tr>
</tbody>
</table>

Note. Analyses were conducted with 10 multiple imputation data sets, which allowed all 11,103 participants to contribute to the analyses.

*For at least 1 hospital admission categorized as an unintentional injury per each increase of 1-standard-deviation in intelligence score at the age of 7 years.

*Adjusted for gender only.

*Same as model 1 plus indicators of socioeconomic position: father’s occupational social class at time of birth, mother’s previous number of pregnancies, born outside marriage, and mother’s age and height.

*Same as model 2 plus birthweight.

*Same as model 3 plus childhood height and weight.

*Adjusted for educational attainment only.

*Same as model 4 plus educational attainment.
However, it should be noted that we had no a priori hypotheses in terms of whether educational attainment has different effects depending on level of childhood intelligence, and therefore our post hoc results should be treated with caution until they are replicated in other studies.

**Study Limitations**

A weakness of our study is that reliable information on hospital admissions was available only from 1981 onward. Thus, we were able to examine associations of childhood intelligence with injuries occurring between the ages of 25 and 54 years only, and our findings may have been affected by survival bias if childhood intelligence is related to deaths stemming from injuries occurring in childhood. However, in the original cohort, only 116 (1%) deaths occurred before 1981, so as a result of unintentional injuries; therefore, survival bias is unlikely to have affected our results.

Although there were substantial amounts of missing data on educational attainment, we attempted to minimize selection bias via multiple imputation. In this strategy, data are assumed to be missing at random, which means that whether an individual has a missing value for a particular variable does not depend on the value of that variable after adjustment for other observed variables. In our present study, data were not missing completely at random because individuals with missing data (largely as a result of questionnaire nonresponse) were more likely to be of low socioeconomic status, to be men, and to have had lower psychometric intelligence in childhood.

However, the missing at random assumption would be met if there was no association between one’s actual educational attainment and the likelihood of not having data for educational attainment (i.e., not responding to the questionnaire asking about education) after adjustment for other variables (such as socioeconomic status, childhood intelligence, and gender) that we have for all or most of the study participants. Although it is never possible to determine that this is the case from the data available in a given study, we cannot think of any reason why it would not be so in the present study. Results of analyses restricted to the subset of individuals with complete data were similar to the results presented here based on 10 multiple imputation data sets. The similar association in the complete data subset supports the idea that data were missing in a random pattern.

The only assessment of adult characteristics available in this cohort occurred after hospital admissions for injuries, and given that injuries may affect people’s socioeconomic position and behaviors, it would have been inappropriate for us to adjust for these characteristics. Thus, we were unable to adjust for indicators of adult socioeconomic position or adult behaviors and lifestyle that might, in addition to education, be mediators of the association between childhood psychometric intelligence and adult injuries.

We used ICD codes routinely applied to hospital admission discharge summaries, but there may have been inaccuracies in these diagnostic codes. For example, there is often concern that some suicides or attempted suicides are coded as unintentional injuries. This is a problem that affects all research in which routine data sources are used, including those related to death certificates.

In general, broad disease categories (in this case, unintentional injuries) are less prone to misclassification than subcategories. As such, we would emphasize as our primary results the associations we found with injuries overall. However, the analyses focusing on injury subtypes did not suggest that any specific subtype drove the inverse association we found with injuries overall. Specifically, there was no evidence that poisonings, which would be the subtype most likely to include suicide attempts, particularly drove this association.

**Possible Mechanisms and Study Implications**

Several (not mutually exclusive) mechanisms might explain the association between childhood psychometric intelligence and adult injury. First, children with lower intelligence are likely to be at greater risk of nonfatal injuries in childhood. Childhood head injury is associated with increased risk of further injury in adulthood; however, we were unable to assess this possible pathway because information on hospital admissions for injuries during childhood was not available. Second, lower childhood intelligence may be related to a reduced ability to process and use information that could provide protection against environmental risks.

Finally, lower intelligence in childhood is related to lower educational attainment. Educational attainment may influence one’s ability to process information and assess risks, one’s occupation and physical environment, and the type of society and culture in which one lives. For example, one’s level of risk is affected by factors such as the environment in which one lives and works and pressure from peers to engage in risk-taking behaviors. The attenuating effect of education on the intelligence—jury association suggests that this may represent an important pathway, but interventional studies would be required to determine whether general educational interventions reduce injury risk.

In addition, prospective cohort studies with detailed measurements of education, cognition, socioeconomic position, and behaviors from across the life course, including throughout childhood, adolescence, and early and later adulthood, would be useful for determining the most important pathways between childhood intelligence and adult injury. If information on preinjury occupation and other socioeconomic characteristics had been available for the present cohort, we would have been able to explore these pathways further.

Two recent systematic reviews of early learning and school readiness interventions, one of which focused on randomized trials only, concluded that these programs had important effects on reading, arithmetic ability, and general intelligence that extended to adolescents of secondary-school age. Thus, such programs may provide a means through which childhood intelligence can be enhanced. If associations between childhood intelligence and later adult morbidity and mortality—including the associations with adult injuries described here—are causal, then these interventions may have an impact on these later adult mortality and morbidity outcomes. Long-term follow-up of intervention studies would be required to make such an assessment.

Our findings show that childhood intelligence is associated with hospital admissions for injuries in adulthood. This association may in part explain the relationship between
childhood intelligence and adult mortality uncovered in earlier studies, and childhood intelligence may represent a modifiable factor that can contribute to reducing adult injury risks.

Acknowledgments
The Aberdeen Children of the 1950s Study was funded as a component project of the Medical Research Council (grant G0828205). A project on cognition and adult health in the cohort was supported by the Chief Scientist Office, Scottish Executive Health Department (grant CZG/2/203), which also funded Heather Clark. Debbie A. Lawlor was funded by a United Kingdom Department of Health Career Scientist Award (award PHCSA). We are very grateful to Raymond Illesley for providing us with the data from the Aberdeen Child Development Survey and for his advice about the study. Graeme Ford played a crucial role in identifying individual cohort members and in helping us initiate the process of revitalizing the cohort. Sally Macintyre, Doris Campbell, George Davey Smith, Marion Hall, Bianca De Stavola, Susan Morton, David Batty, David Godden, Diana Kuh, Glyn Lewis, and Viveca Othberg collaborated with us in revitalizing the cohort. Margaret Beveridge assisted with study management. We also thank staff at the Information and Statistics Division (Edinburgh), the General Register Office (Scotland), and the National Health Service Central Register (Southport) for their substantial contributions, and John Lemon, who undertook the linkage to the Aberdeen Maternity and Neonatal Databank. Finally, we thank the study participants who responded to a mailed questionnaire 40 years after the original survey was completed.

Human Participation Protection
The revitalization of the Aberdeen Children of the 1950s Study cohort was approved by the Scottish multicenter research ethics committee and local research ethics committees, along with the Scottish Privacy Advisory Committee. Participants responding to the questionnaire provided informed consent to be involved in the study.

References

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Racial and Ethnic Differentials in Overweight and Obesity Among 3-Year-Old Children

Rachel Tolbert Kimbro, PhD, Jeanne Brooks-Gunn, PhD, and Sara McLanahan, PhD

Although levels of overweight and obesity among adults in the United States have reached epidemic proportions, concern about overweight among children has only recently garnered the attention of public health researchers. Since 1971, the prevalence of overweight among US children has increased by more than 100% (it stood at 10.4% in 2000), and this prevalence is expected to continue to increase. Similar to the situation with adults, rates of overweight among children vary according to race/ethnicity, with Hispanic children more likely to be overweight than children in other racial/ethnic groups. In addition, overweight may be more prevalent among children of lower socioeconomic status; 1 study showed that 35% of low-income Hispanic children aged 2 to 5 years were above the 85th percentile, as compared with 24% of White children and 27% of Black children.

Overweight is a significant health problem among children, given that children who are overweight are more likely than those who are not to develop type 2 diabetes and other conditions placing them at risk of later cardiovascular disease. Furthermore, overweight children are more likely to become overweight adults. Most research has focused on children aged 5 years or older, but recent work shows that overweight problems in children may start much earlier. In this study, we used data from a national sample of mostly disadvantaged children to examine the determinants of racial and ethnic differences in rates of overweight and obesity at the age of 3 years.

Reasons for racial and ethnic differences in childhood overweight and obesity are unknown. We do know that, as a result of factors such as culturally determined food intake patterns, less avoidance of fat-containing foods, and greater consumption of whole milk, Hispanic children may ingest more fat than do White children. In addition, Hispanic and Black mothers frequently do not identify their overweight children as being overweight, indicating that culture may play a part in how mothers perceive their children’s health status.

We were unable to find studies in which factors beyond basic sociodemographic characteristics and nutritional intake were controlled, and these factors alone do not explain racial/ethnic differences in overweight prevalence rates among children. In our study, we controlled for children’s and mothers’ characteristics as well as food and nutrition variables and children’s opportunities for exercise.

METHODS

Data Sources

Data were derived from waves 1, 2, and 3 of the Fragile Families and Child Wellbeing Survey as well as the In-Home Longitudinal Study of Pre-School Aged Children, an in-depth survey administered to a subsample of Fragile Families respondents when children were at age 3 years. About 79% of the wave 3 respondents agreed to participate in the In-Home survey; there were no significant race/ethnicity differences between those who did and did not complete the survey.

The Fragile Families Study was a national survey that followed a birth cohort of new, mostly unwed parents and their children, with follow-up surveys at 1 year, 3 years, and 5 years and another scheduled at 8 years. Wave I interviews, conducted between 1998 and 2000, gathered data on 3712 births among unmarried parents and 1188 births among married parents in 20 large US cities. The survey oversampled unmarried mothers and thus included a large sample of minority and immigrant women. The data gathered included information on the resources and relationships of new parents and their effects on children, and they were intended to illuminate the “fragile” nature of these young, often poor, families. Mothers’ first interviews took place within 48 hours of their delivery, while they were still in the hospital; fathers were interviewed either in the hospital or elsewhere a short time later.

We used data derived from the wave I survey and the follow-up interviews conducted at 1 year (1999–2001) and 3 years (2001–2003). In addition to the sociodemographic and attitudinal information provided by both mothers and fathers in the wave 3 survey, the In-Home survey included...
Variables

Children were weighed and measured at approximately age 3 (mean age=36.0 months), and their body mass indexes (BMIs; calculated as mass in kilograms divided by height in meters squared) were calculated and compared with gender-specific BMI-for-age percentile data issued by the Centers for Disease Control and Prevention (CDC). The CDC classifies children who are at or above the 85th percentile for their age or gender group as “at risk of overweight” or “overweight.” However, rather than use these designations, we followed the recommendations of the American Obesity Association and used “overweight” and “obese” to describe children’s weight status. We believe that these terms more accurately reflect the severity of the childhood obesity problem. We classified children between the 85th and 95th percentiles (for their age or gender group) as “overweight” and children above the 95th percentile as “obese.”

Children were measured and weighed during the In-Home study, and all interviewers were trained in using the CDC height and weight measurement guidelines. Heavy clothing and shoes were removed, and electronic scales that took weight measurements in 0.1-kg increments were used. In the 2 pilot study cities (n=197), Oakland, Calif, and Austin, Tex, mothers were weighed and then weighed again holding their child; the difference was recorded as the child’s weight. In the other 18 cities (n=1779), children were weighed with their mother only if they would not cooperate in being weighed separately (n=124). We followed CDC guidelines to convert weight, height, and age (in months) to percentiles. We classified children as non-Hispanic White, non-Hispanic Black, or Hispanic according to their mother’s self-reported ethnicity.

We controlled for child background characteristics including gender, age (in months, interview responses, information on parent and child activities, and observations of both parent–child interactions and the home environment. In our study, we used data from the 2271 non-Hispanic White (20%), non-Hispanic Black (55%), and Hispanic (25%) mothers and children who completed the In-Home survey.


<table>
<thead>
<tr>
<th>Total (N=1976), %</th>
<th>White (n=1081), %</th>
<th>Black (n=406), %</th>
<th>Hispanic (n=489), %</th>
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<td>68†</td>
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<td>Overweight</td>
<td>17</td>
<td>18</td>
<td>15***</td>
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<td>Obese</td>
<td>18</td>
<td>14†</td>
<td>17†</td>
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<tr>
<td>Obese and overweight, overall total</td>
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<td>At least some college</td>
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<td>55†</td>
<td>30***</td>
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<td><strong>Age, y</strong></td>
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<td>25–35</td>
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<td>51*</td>
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<tr>
<td>&gt;35</td>
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<td>22†</td>
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<tr>
<td>Father not in home</td>
<td>50</td>
<td>31*</td>
<td>62†</td>
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<td>27</td>
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<td>15†</td>
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<td>23</td>
<td>17†</td>
<td>23*</td>
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<td>Immigrant</td>
<td>11</td>
<td>4†</td>
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<td>Breast-fed child for 6 mo or longer</td>
<td>18</td>
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<td><strong>Weight status</strong></td>
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<td>33</td>
<td>47†</td>
<td>30</td>
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<tr>
<td>Overweight (85th-95th percentile)</td>
<td>26</td>
<td>25</td>
<td>24**</td>
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<td>Obese (&gt;95th percentile)</td>
<td>41</td>
<td>28†</td>
<td>46**</td>
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<td><strong>High stress level</strong></td>
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<tr>
<td>High stress level</td>
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<td>16</td>
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<td><strong>Smoked during pregnancy</strong></td>
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<td>Smoked during pregnancy</td>
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<td>30†</td>
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<td><strong>Food and nutrition factors</strong></td>
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<td>Mother does not shop at grocery stores</td>
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<td>4</td>
<td>3**</td>
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<tr>
<td>Mother takes bus or taxi or walks to food store</td>
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<td>9†</td>
<td>37***</td>
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<tr>
<td>Food insecurity</td>
<td>18</td>
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<td>19</td>
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<tr>
<td>Child takes bottle to bed</td>
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<td>6†</td>
<td>4†</td>
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<td>WIC participation at age 1 y</td>
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<td><strong>No. of hours of television child watches per day</strong></td>
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<td>16**</td>
</tr>
<tr>
<td>2–4</td>
<td>59</td>
<td>64</td>
<td>57</td>
</tr>
<tr>
<td>≥5</td>
<td>22</td>
<td>11†</td>
<td>27†</td>
</tr>
</tbody>
</table>

Continued
were used: normal (2500 to 4500 g), low
children’s weight status when they were
birthweight is correlated with weight status
centered around the mean), and birth order

tion between breast-feeding duration and
months (some studies have shown an associa-
tion). We assessed whether or not the
behavior. We assessed whether or not the
smoking during her pregnancy, and her
enced a high level of parental stress, whether
owed to obesity), whether she experi-
tions of breast-feeding are associated with
weight status.29,30

We also included indicators for whether or
not mothers were overweight or obese, which
was assessed during the In-Home survey
(when the children were at age 3 years), ac-
cording to their BMIs and using CDC guide-
lines.31 Mothers who were missing weight in-
formation (n = 139; 6%) were dropped from
the sample. Whether or not BMI data were
missing may have been related to mothers’
information (n=139; 6%) were dropped from
the sample. Whether or not BMI data were
missing may have been related to mothers’
weight status, but we were not able to test
this possibility directly. A logistic model pre-
dicting whether BMI information was missing
(data not shown) revealed only 1 significant
predictor: immigrant mothers had higher
ods of missing weight information.

Mothers who were pregnant at the time
of the in-home interview were also dropped
from the sample (n = 156; 7%). Research
has shown that mothers’ and children’s
weight status is linked, probably both
through general household nutrition
choices22 and through genetics.32,33

Mothers’ BMIs were calculated from self-
reported height and weight and thus should
be interpreted cautiously. We were inter-
ested in determining the effects of the other
covariates with and without mothers’
weight status in the model, so we included
this covariate in the final step.

We were interested as well in how mothers
obtain everyday food for the household. We
included an indicator variable for whether
the mother had to take a bus or taxi or walk
to the supermarket, hypothesizing that moth-
ers who had to do so would be more likely
to shop less often and to purchase foods that
would last a while (i.e., processed foods rather
than fresh fruits and vegetables) and that
these shopping practices might increase the
odds of overweight among their children.

We also included an indicator variable for
whether mothers shopped for groceries most
often at a place other than a supermarket (i.e.,
a convenience store or specialty shop). Super-
markets, which are not always available in
poor urban areas, provide the most reason-
ably priced and best-quality food, and shop-
ning at convenience stores might contribute
to child overweight.34,35

We constructed a measure of household
food insecurity based on 18 items that pro-
vided information on nutrition and hunger in
the household. Households were coded as
“food insecure” if mothers responded yes to 3
or more of the items.36 We also included an
item for whether the child took a bottle to
bed at the age of 3 years, a practice known to
increase the risk of childhood weight prob-
lems.37 Finally, our set of variables included
an indicator for participation in the Special
Supplemental Nutrition Program for Women,
Infants, and Children (WIC) in the child’s first
year of life to assess the impact (which re-
mains unclear38) of such participation on
children’s weight status.

In addition, we included variables captur-
ing the child’s opportunities for exercise.
Along with employing a set of categories de-
signed to measure extent of daily television
watching (0–1 hour per day, 2–4 hours per
day, more than 5 hours per day), we assessed
how often children went to public places
such as parks or zoos (0 times per week,
1–2 times per week, 3 or more times per
week). We included these measures for televi-
sion watching and public outings because
they provide an indication of how sedentary
a child may be and are sometimes correlated
with overweight.16,39 Also, we included a set
of categories indicating the most regular
child-care situations in which children were
involved (at-home care by mother or father,

<table>
<thead>
<tr>
<th>TABLE 1—Continued</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of public outings for child per week</td>
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<tr>
<td>1–2</td>
</tr>
<tr>
<td>≥3</td>
</tr>
</tbody>
</table>

Day care situation

At-home care by parent* | 42 | 42** | 38† | 48 |
In-home day care provider | 29 | 34 | 26** | 32 |
Center-based day care provider | 30 | 24 | 36† | 20 |

Note: WIC = Special Supplemental Nutrition Program for Women, Infants, and Children.
*Reference category.
**P < .01; †P < .001 (from either χ² tests or t tests as appropriate, for differences between Whites and Hispanics and between Blacks and Hispanics).
### TABLE 2—Odds Ratios From Logistic Regression Analyses Predicting Overweight or Obese Status Within Pooled Sample: Fragile Families and Child Wellbeing Survey, 1999–2003

<table>
<thead>
<tr>
<th></th>
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<td>0.56(†)</td>
<td>0.58(†)</td>
<td>0.57(†)</td>
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<td>0.54(†)</td>
<td>0.58(***)</td>
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<td>1.03</td>
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<td>Normal(^a)</td>
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<td>0.65(**)</td>
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<td>2.27(†)</td>
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<td>Education</td>
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<td></td>
</tr>
<tr>
<td>Less than high school(^a)</td>
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<td>...</td>
<td>...</td>
</tr>
<tr>
<td>High school</td>
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<td>1.01</td>
<td>1.00</td>
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<tr>
<td>At least some college</td>
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<td>1.00</td>
<td>1.03</td>
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<tr>
<td>Age, y</td>
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<td></td>
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<tr>
<td>25–35(^a)</td>
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<tr>
<td>&lt; 25</td>
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<td>0.94</td>
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</tr>
<tr>
<td>&gt; 35</td>
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<td>1.09</td>
<td>1.07</td>
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<tr>
<td>Relationship status with father</td>
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<td></td>
<td></td>
</tr>
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<td>Father not in home(^a)</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Married to father</td>
<td>0.88</td>
<td>0.87</td>
<td>0.87</td>
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</tr>
<tr>
<td>Cohabiting with father</td>
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<td>0.88</td>
<td>0.88</td>
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</tr>
<tr>
<td>Immigrant</td>
<td>0.88</td>
<td>0.77</td>
<td>0.80</td>
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<tr>
<td>Breast-fed child for 6 mo or longer</td>
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<td>0.97</td>
<td>1.00</td>
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<td>1.08</td>
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<tr>
<td>Smoked during pregnancy</td>
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<td>0.99</td>
<td>1.00</td>
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<tr>
<td>Food and nutrition factors</td>
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<tr>
<td>Does not shop at grocery stores</td>
<td>1.47(\ast)</td>
<td>1.41</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Takes bus or taxi or walks to food store</td>
<td>1.13</td>
<td>1.14</td>
<td></td>
<td></td>
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<tr>
<td>Food insecurity</td>
<td>0.88</td>
<td>0.86</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child takes bottle to bed</td>
<td>2.01(†)</td>
<td>2.10(†)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WIC participation at age 1 y</td>
<td>0.92</td>
<td>0.88</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of hours of television child watches per day</td>
<td></td>
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<tr>
<td>0–1(^a)</td>
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<td>2–4</td>
<td>1.17</td>
<td>1.14</td>
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<tr>
<td>≥5</td>
<td>0.94</td>
<td>0.91</td>
<td></td>
<td></td>
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<tr>
<td>No. of public outings for child per week</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>0(^a)</td>
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<td>1–2</td>
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<tr>
<td>≥3</td>
<td>1.09</td>
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<tr>
<td>Child care situation</td>
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<td>At-home care by parent(^a)</td>
<td>...</td>
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<td>...</td>
<td>...</td>
</tr>
<tr>
<td>In-home day care provider</td>
<td>0.93</td>
<td>0.91</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Center-based day care provider</td>
<td>1.00</td>
<td>1.00</td>
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Continued...
TABLE 2—Continued

<table>
<thead>
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<th>Weight status</th>
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<tbody>
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<tr>
<td>Overweight (85th–95th percentile)</td>
<td>1.21</td>
</tr>
<tr>
<td>Obese (&gt;95th percentile)</td>
<td>1.76†</td>
</tr>
</tbody>
</table>

χ² (df) 35.54† (2) 59.22† (17) 83.30† (28) 106.92† (30)

Note: WIC = Special Supplemental Nutrition Program for Women, Infants, and Children. Children with a body mass index at or above the 85th percentile were classified as overweight; children at or above the 95th percentile were classified as obese.

*Reference category.

P < .10; **P < .05; ***P < .01; †P < .001.

mothers in our sample; Black mothers were most likely to be obese (46%), followed by Hispanic mothers (40%). Hispanic mothers reported the most parental stress.

In terms of food and nutrition factors, regular shopping at stores other than supermarkets was relatively rare, with only 4% of White mothers, 3% of Black mothers, and 6% of Hispanic mothers having done so.

Thirty-seven percent of Black mothers had to walk or take a bus or taxi to their food store of choice, in comparison with 28% of Hispanic mothers and only 9% of White mothers. There was a high prevalence of food insecurity in the sample, with 12% of White mothers, 19% of Black mothers, and 21% of Hispanic mothers responding yes to 3 or more insecurity items. Interestingly, there were large ethnic disparities in whether children took a bottle to bed; 14% of Hispanic children did so, as compared with only 6% of White children and 4% of Black children. Participation in WIC at the age of 1 year was high among Blacks (80%) and Hispanics (78%).

Levels of television watching in the sample were high, with 59% of children overall watching between 2 and 4 hours of television daily and another 22% watching 5 or more hours. White children were less likely to watch 5 or more hours per day than were Hispanic children, whereas Black children were more likely to do so. Public outings were common in the sample, with 62% of children having at least 1 outing per week. However, Black children had fewer outings per week than did either White or Hispanic children. In terms of child care, 59% of the children were cared for in an in-home day care setting; Black children were more likely than were Hispanic children to be in day care.

Table 2 shows the results of the first analysis involving the pooled sample, in which the dependent variable was whether children were overweight or obese. Hispanic children who were aged 3 years were nearly twice as likely as White and Black children of the same age to be overweight. We also examined whether there were nativity differences in child overweight prevalence rates in the Hispanic subsample (data not shown) and found none. The White–Hispanic difference was not attenuated by the addition of the child’s and mother’s characteristics and the mother’s health and health behavior variables. It is interesting that we found no gender differences in overweight given that some studies have indicated that girls have a slightly higher prevalence of overweight than boys; however, it is possible that these gender differences do not become apparent until later in childhood. In comparison with children in the normal birthweight category, children in the low birthweight category had lower odds of overweight or obesity at age 3 years, whereas children in the high birthweight category had more than twice the odds of overweight or obesity.

In model 3, we added the variables for food and nutrition and children’s opportunities for exercise. Children whose mothers did not regularly shop at a grocery store were at increased odds of being overweight or obese (P < .10). In addition, taking a bottle to bed nearly doubled the odds of overweight and obesity at age 3 years. None of the children’s exercise variables significantly predicted overweight or obesity.

In the final model, we added mother’s weight status to determine whether household nutrition and genetics decreased the effects of the other model variables. As expected, children with obese mothers had nearly twice the odds of being overweight or obese than did children with normal-weight mothers. However, having an overweight but not obese mother did not significantly affect overweight or obesity odds. The addition of mother’s weight status decreased the White–Hispanic difference slightly, although Blacks and Whites were still about half as likely as Hispanics to be overweight or obese. Adding mother’s weight status eliminated the significance of the shopping variable but had only a minimal impact on the other covariates.

We divided children into categories of those with obese mothers and those with nonobese mothers to assess whether the determinants of child overweight and obesity differed according to mothers’ weight status (Table 3). Interestingly, the Black–Hispanic differential was larger for children of obese mothers than for children of nonobese mothers. Another interesting difference between the 2 subsamples is that low birthweight status did not affect the odds of overweight or obesity among children of nonobese mothers, whereas high birthweight status increased the odds nearly 2.5 times. Also, having been breast-fed for at least 6 months significantly decreased the odds of overweight or obesity among children of obese mothers but did not significantly affect outcomes among children of nonobese mothers.

Table 4 shows unadjusted and adjusted percentages of overweight and obese children according to mothers’ weight status and race/ethnicity. We controlled adjusted figures for children’s and mothers’ background characteristics, health and health behaviors, food and nutrition, and exercise characteristics. Mothers’ weight status had a significant impact on children’s likelihood of being overweight or obese; 42% of White children with obese mothers were themselves overweight or obese, as compared with 36% of Black children and 56% of Hispanic children (corresponding percentages for children with normal-weight mothers were 26%, 25%, and 40%). Clearly, maternal weight status is a key determinant (through household nutrition,
TABLE 3—Odds Ratios From Logistic Regression Analyses Predicting Overweight or Obese Status Among Children With Obese and Nonobese Mothers: Fragile Families and Child Wellbeing Survey, 1999–2003

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<tr>
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<th>Children With Obese Mothers</th>
<th>Children With Nonobese Mothers</th>
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<tbody>
<tr>
<td></td>
<td>Model 1 (n = 810)</td>
<td>Model 2 (n = 807)</td>
</tr>
<tr>
<td></td>
<td>Model 3 (n = 1161)</td>
<td>Model 4 (n = 1161)</td>
</tr>
<tr>
<td>Race/ethnicity</td>
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<tr>
<td>Hispanic</td>
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<td>...</td>
</tr>
<tr>
<td>Black</td>
<td>0.46†</td>
<td>0.48†</td>
</tr>
<tr>
<td>White</td>
<td>0.59**</td>
<td>0.56**</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child’s characteristics</td>
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<td></td>
</tr>
<tr>
<td>Boy</td>
<td>1.04</td>
<td>1.06</td>
</tr>
<tr>
<td>Age, mo (centered at mean)</td>
<td>1.01</td>
<td>1.01</td>
</tr>
<tr>
<td>Birthweight</td>
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<tr>
<td>Normal</td>
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</tr>
<tr>
<td>Low</td>
<td>0.44**</td>
<td>0.41***</td>
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<tr>
<td>High</td>
<td>1.78**</td>
<td>1.90**</td>
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<tr>
<td>High school</td>
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<td>1.25</td>
</tr>
<tr>
<td>At least some college</td>
<td>1.09</td>
<td>1.10</td>
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<td>Age, y</td>
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<td>1.00</td>
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<td>&gt;35</td>
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<td>Father not in home</td>
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</tr>
<tr>
<td>Married to father</td>
<td>0.88</td>
<td>0.80</td>
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<td>Cohabiting with father</td>
<td>0.97</td>
<td>0.91</td>
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<tr>
<td>Immigrant</td>
<td>0.86</td>
<td>0.77</td>
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<tr>
<td>Health status and health behaviors</td>
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<td>0.60**</td>
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<tr>
<td>High stress level</td>
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<tr>
<td>Smoked during pregnancy</td>
<td>1.04</td>
<td>1.07</td>
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<tr>
<td>Food and nutrition factors</td>
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<tr>
<td>Mother does not shop at grocery stores</td>
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<td>1.28</td>
</tr>
<tr>
<td>Mother takes bus/taxi or walks to food store</td>
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<tr>
<td>Food insecurity</td>
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<td>0.88</td>
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<tr>
<td>Child takes bottle to bed</td>
<td>2.94***</td>
<td>1.83**</td>
</tr>
<tr>
<td>WIC participation at age 1 y</td>
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<td>0.95</td>
</tr>
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<td>No. of hours of television child watches per day</td>
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<tr>
<td>0-1</td>
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<tr>
<td>24</td>
<td>1.27</td>
<td>1.07</td>
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<tr>
<td>≥5</td>
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<td>0.78</td>
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<tr>
<td>No. of public outings for child per week</td>
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<td>0</td>
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<td>...</td>
</tr>
<tr>
<td>1-2</td>
<td>1.29</td>
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</table>

We found that Hispanic children aged 3 years were nearly twice as likely as White children to be overweight or obese. They also had twice the odds of overweight or obesity than did Black children despite similar family socioeconomic profiles. These results are striking and suggest that childhood overweight problems begin earlier than previously thought. In addition, the racial and ethnic differences observed decreased only slightly when we included children’s and mothers’ characteristics, mothers’ health status and health behaviors, and children’s opportunities for exercise in the models, indicating that other, unmeasured factors must have accounted for these differences.

The reason we did not see more evidence of socioeconomic effects on children’s overweight in the pooled models (Table 2) is probably because Fragile Families children tended to be more disadvantaged than the general population of children. Results also showed that 3-year-olds whose birthweights were high, who took a bottle to bed, and whose mothers did not have ready access to a grocery store were at increased odds of overweight. Once we controlled for maternal weight, however, access to a grocery store was no longer a significant predictor of overweight or obesity at the age of 3 years.

There were clear gradients according to maternal weight status in children’s odds of both overweight and obesity. The largest differentials occurred among obese children, with the odds of obesity doubling in all 3 racial/ethnic groups among children of obese mothers in comparison with children of normal-weight mothers. Interestingly, breastfeeding seemed to have a protective effect among children of obese mothers but not among children of nonobese mothers. This finding may indicate that physicians should especially encourage obese mothers to breastfeed their babies.

Our study went beyond others investigating overweight in childhood by assessing children at the age of 3 years and examining children’s and mothers’ characteristics, as well as genetic factors.
as household characteristics, as possible factors affecting rates of childhood overweight. For example, although there was a high level of daily television watching in the sample, we did not see any consistently significant effects of television watching on children’s odds of overweight or obesity. In addition, visiting a public place such as a park at least once a week had no effect on childhood overweight. We also saw no significant effects of type of child care on children’s odds of overweight or obesity.

In this study, White–Hispanic and Black–Hispanic differences in overweight prevalence rates were not explained by socioeconomic, health and household, or parenting characteristics. There is some evidence that Hispanic mothers, particularly those who are at lower levels of acculturation, may be more likely than would women in other groups to hold the common cultural belief that chubby children are healthier.17, 41 This value could lead these mothers to provide more food and encourage their children to eat more, resulting in greater rates of overweight in this community.

It has also been shown that Hispanic mothers are more likely than are White or Black mothers to worry when their children say they are not hungry and to continue to pressure their children to eat.42

Given our findings that Hispanic children were nearly twice as likely as either White or Black children to be overweight or obese by the age of 3 years and that a variety of the characteristics assessed here (e.g., mothers’ characteristics and household characteristics) did not account for racial/ethnic differences in overweight, future studies of overweight among Hispanic children should take the cultural factors just described into account. In addition, given the heterogeneous nature of the Hispanic population in the United States, interventions designed to prevent childhood obesity in the Hispanic community should be culture specific. ■

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**Contributors**
R.T. Kimbro and J. Brooks-Gunn originated the study. R.T. Kimbro analyzed the data and wrote the article. J. Brooks-Gunn and S. McLanahan supervised the analyses and contributed to editing drafts of the article.

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**Human Participant Protection**
This study was approved by the institutional review boards of Princeton University, Columbia University, and each of the 75 hospitals involved in the recruit- ment of participants. Informed consent was obtained from all participants.

**References**
Time Spent Outdoors at Midday and Children’s Body Mass Index

Elizabeth Milne, PhD, MPH, Julie A. Simpson, PhD, Robyn Johnston, PGrad Dip (Hlth Prom), Billie Giles-Corti, PhD, MApp Sc, Dallas R. English, PhD, MS

Childhood obesity is an independent risk factor for adult obesity and the associated health problems of type 2 diabetes, hypertension, and cardiovascular disease. In many developed countries, there has been a large increase in the prevalence of childhood overweight and obesity in recent years. The prevalence of obesity has increased two- to threefold over 25 years in the United States, and by the same amount over 10 years in the United Kingdom. In Australia, the prevalence of childhood overweight doubled, and that of obesity trebled between 1985 and 1995; 20% to 25% of children are currently being classified as overweight or obese. Furthermore, data from the last 35 years indicate that the increase in obesity among children is accelerating. It is not yet clear whether the increase is primarily because of higher energy intake, reduced physical activity, or both. However, encouraging both a healthy diet and more physical activity is recognized as a key strategy to curb these disturbing trends.

Most interventions aimed at preventing or treating childhood overweight and obesity have been designed to improve children’s eating habits and increase their physical activity levels. Children have been particularly encouraged to walk or ride bicycles to school and to spend less of their leisure time engaged in sedentary activities. However, there is limited evidence that these interventions have been effective.

Over the past 25 years, there have also been a growing number of sun protection interventions designed to reduce children’s exposure to sun in an effort to reduce the incidence of skin cancer in adult life. Many of these interventions have focused on reducing the time children spend outdoors in the middle of the day when solar ultraviolet radiation is most intense, typically between 10 AM and 3 PM. Children have been encouraged to stay indoors and engage in a range of alternative indoor activities during these hours.

Messages promoted in interventions (“Stay indoors and keep out of the sun”) are aimed at reducing exposure to the sun and may be perceived as being at odds with messages aimed at increasing physical activity (“Go outside and be active”). For example, studies consistently report that the time children spend outdoors is highly correlated with their level of physical activity. It is, therefore, plausible that adhering to the sun safety message could inadvertently have a detrimental affect on children’s body mass index (BMI).

Results from our study—the Kidskin sun protection intervention trial, conducted in Perth, Western Australia, between 1995 and 2001—have been published. In those articles, we reported that children who received the intervention spent less time outdoors in the middle of the day after both 2 years and 4 years of the intervention. We also reported that 2 years into the study, the total time spent outdoors was similar in the 3 study groups. For this analysis, we examined whether, after 6 years, the Kidskin intervention had an effect on the total time children spent outdoors—and thus, on their opportunity to engage in physical activity—or on their weight relative to height.

METHODS

Analysis

The design and baseline results of the Kidskin intervention study have been previously described. Briefly, the study involved a cohort of children who commenced school in 1995 at the age of 5 or 6 years (hereafter age 6). The design was a nonrandomized trial in which schools were the units of intervention. There were 3 groups: a control group of 14 schools, a moderate-intervention group of 11 schools, and a high-intervention group of 8 schools. Children in the control schools received the standard Western Australian health education curriculum. Children in the moderate- and high-intervention schools received a specially designed sun protection curriculum that was administered over 4 consecutive
years, beginning with children aged 6 years (1995–1998). Children were encouraged to reduce sun exposure by staying indoors during the middle of the day, when solar ultraviolet radiation is highest, and to protect themselves when outdoors by using shade, clothing, hats, and sunscreen. The program was designed to be taught across the curriculum and integrated into a range of subjects, including physical education. Children in the high-intervention group were sent program materials over the summer vacation, when sun exposure is likely to be highest, and were also offered low-cost sun protective swimwear.

Outcomes used to evaluate the program included number of nevi (as a biological marker of melanoma risk), measured suntan, and reported time spent outdoors. Information on time spent outdoors was collected from questionnaires completed by parents when children were at baseline (age 6) and at ages 8, 10, and 12 years (age 8, age 10, and age 12, respectively). Parents were asked for the average age time each day that the children were outdoors between 8 and 11 AM, 11 AM to 2 PM, and 2 to 5 PM. Data were recorded separately for the beach, public outdoor swimming pools, and at home and around the neighborhood (including backyard swimming pools). The total time spent outdoors was calculated by adding the responses for these 3 time periods.

In order to adjust for children's body surface area in the analysis of nevi at ages 6, 10, and 12, each child's height was measured to the nearest millimeter with a stadiometer, and weight was measured with a set of digital bathroom scales accurate to 200 g, according to standardized protocols. Trained observers were blinded to the aim of the current analysis. BMI (weight in kilograms divided by height in meters squared) at ages 6, 10, and 12 was subsequently calculated.

**Body Size**

BMI was transformed into age- and gender-specific z scores by the least mean squares method and by using 2000 growth chart data from the Centers for Disease Control and Prevention. The children were also classified as normal weight, overweight, or obese on the basis of their age, gender, and BMI. The age- and gender-specific BMI cutoff points for the 3 body size categories (normal weight, overweight, obese) were developed for the International Obesity Taskforce from large, nationally representative cross-sectional datasets from Brazil, Great Britain, Hong Kong, the Netherlands, Singapore, and the United States. The z score (BMI-for-age) and body size category were derived for each child using add-ons to Stata 8.2 (Stata Corp, College Station, Tex).

In the primary analysis, the z score data collected at baseline (at age 6), at age 10, and at age 12 were modeled simultaneously by constructing linear models (growth curves) for z scores by time since baseline. We assessed the intervention by comparing a model in which each study group had its own slope for z score over time, with a model of a common slope, by fitting an interaction between study group and time. Because they were considered a priori to be potential confounders of the associations under study, gender, ethnicity (southern European vs Great Britain and northern European), and parental educational level (tertiary vs other) were included in all models. Random intercepts and slopes and covariances between these terms were fitted at the school and child level. Random effects were only retained if the likelihood ratio test had a P value<.05. The final model had a random intercept, slope, and covariance at the child level, and a random slope at the school level.

Two secondary analyses were performed, in which the outcome measure was z score at either age 10 or 12. The data were analyzed using linear mixed effects modeling that incorporated a random effect for school and adjustment for the fixed effects: study group, total time outdoors at baseline, gender, ethnicity, parental educational level (defined previously), and tendency to sunburn (tendency to painfully and severely sunburn vs tendency to mildly or not sunburn). In all analyses, total time spent outdoors was log transformed after the addition of 1 to account for zero values.

**RESULTS**

**Response and Retention**

At the beginning of the Kidskin intervention study, consent was obtained from 1776 (70%) of those invited to participate. All analyses were restricted to the 1623 children of European ethnicity, which was determined from information provided by parents in the 1995 (baseline) questionnaire. A total of 1615 children of European ethnicity had height and weight recorded at age 6. At age 10, a total of 1448 (retention rate of 90%) children were measured, and at age 12, 1116 (69%) children were measured.

Valid z scores (BMI-for-age) were available for analysis for 1598 children who were age 6, 1446 children at age 10, and 1115 children at age 12. Total time spent outdoors was available for analysis for 1488 children who were age 6, 1275 children at age 10, and 1000 children at age 12.

The respective distributions of BMI, gender, ethnicity, and total time spent outdoors at baseline were similar when we compared children with and without follow-up data at age 12 (mean BMI [SD]: 15.9 [1.6] vs 16.1 [1.7] kg/m²; percentage boys: 50.2 vs 57.4; median total time spent outdoors [interquartile range]: 161.3 [112.5, 219.4] vs 157.5 [106.1, 225.0] minutes/day). The percentage of children who had a tertiary-educated parent was slightly higher among those with follow-up data than among those without: 32.5% versus 27.8%. However, parental education was not closely associated with the prevalence of childhood overweight or obesity (data not shown).
Body Size

At age 6, 10.3% and 2.8% of the children were overweight and obese, respectively (Table 1). These proportions increased markedly by age 10 to 16.3% and 5.7%, respectively; the changes between age 10 and age 12 were smaller. At baseline, children in the high-intervention group had higher z scores and were more likely to be obese than were children in the moderate-intervention and control groups (Table 1). These differences were also apparent in the primary analysis, in which the adjusted mean z score at baseline was 0.21 (95% confidence interval [CI]=0.10, 0.32) greater in the high-intervention group than in the control group. No differences in the adjusted mean z score at baseline between the moderate-intervention group and control group were observed (Figure 1). Both the moderate-intervention and control groups had a minimal (nonsignificant) increase in z score over time (change in z score per 1-year increase in age was 0.016 [95% CI=–0.007, 0.025], respectively); whereas there was a decrease in z score over time for the high-intervention group (change in z score per 1-year increase in age was −0.017 [95% CI=−0.039, 0.005]; Figure 1; overall P=.067).

Table 2 shows the adjusted mean difference in z scores at age 10 and 12 among the study groups. There were no significant differences between the control and intervention groups.

Total Time Spent Outdoors

Overall, children spent between 2 and 3 hours outside every day between 8 AM and 5 PM. The distribution of total time spent outdoors by age and study group is presented in Table 1. As indicated in the “Methods” section, the results for this outcome cannot be compared between years; the appropriate comparison is among the groups in each year. At age 8, the median total time spent outdoors in each of the groups was similar (P=.735, data not shown). There was no association between study group and total time outdoors at either age 10 or age 12 (Table 2).

When group was ignored in the analysis, no association was observed between total time spent outdoors and BMI (data not shown).

The results in Table 2 for children at age 10 were unchanged when restricted to children for whom we also had data on BMI and time spent outdoors at age (data not shown).

DISCUSSION

The Kidskin sun protection intervention program reduced the amount of time children spent outdoors in the middle of the day during the summer9,13 and was not associated with an increase in BMI. This is reassuring, because it suggests that the program did not lead to a reduction in physical activity—at least relative to dietary energy intake. This interpretation is supported by our previous9 and current findings that the Kidskin intervention was not associated with a reduction in the total time spent outdoors, which indicates that children who received the Kidskin intervention rescheduled their time outdoors to earlier in the day, later in the day, or both. This is clearly a desirable outcome and reflects some of the objectives of the Kidskin intervention program.

Each year, specific program objectives focused on students developing the problem solving, decisionmaking, planning, and goal-setting skills to reduce summer sun exposure, while continuing to engage in their usual leisure activities. The inclusion of home- and classroom-based activities may have increased family support of rescheduling activities to reduce sun exposure. The maintenance of physical activity levels was also supported by the cross-curricular nature of the program.

Each year, the curriculum included activities that integrated sun protection and shade games into physical education lessons. Therefore, although maintaining time outdoors was not a specific objective of the Kidskin program, maintaining physical activity

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TABLE 1—Distribution of Body Size and Total Time Spent Outdoors, by Age at 6 Years, 10 Years, and 12 Years: The Kidskin Study, Australia, 1995–2001

<table>
<thead>
<tr>
<th>Sample size</th>
<th>Body Size</th>
<th>6 Years (Baseline)</th>
<th>10 Years</th>
<th>12 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>N = 1598</td>
<td>Mean BMI, kg/m² (SD)</td>
<td>16.0 (1.6)</td>
<td>18.2 (3.1)</td>
<td>19.4 (3.6)</td>
</tr>
<tr>
<td></td>
<td>Mean z score, BMI-for-age (SD)</td>
<td>0.25 (0.92)</td>
<td>0.29 (0.96)</td>
<td>0.22 (1.01)</td>
</tr>
<tr>
<td></td>
<td>All children</td>
<td>0.25 (0.92)</td>
<td>0.29 (0.96)</td>
<td>0.22 (1.01)</td>
</tr>
<tr>
<td></td>
<td>High-intervention group</td>
<td>0.42 (0.93)</td>
<td>0.35 (0.93)</td>
<td>0.21 (0.98)</td>
</tr>
<tr>
<td></td>
<td>Moderate-intervention group</td>
<td>0.20 (0.87)</td>
<td>0.27 (0.97)</td>
<td>0.25 (1.00)</td>
</tr>
<tr>
<td></td>
<td>Control group</td>
<td>0.19 (0.94)</td>
<td>0.28 (0.98)</td>
<td>0.20 (1.04)</td>
</tr>
<tr>
<td>Percentage overweight</td>
<td>10.3</td>
<td>16.3</td>
<td>17.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>All children</td>
<td>12.6</td>
<td>18.3</td>
<td>15.8</td>
</tr>
<tr>
<td></td>
<td>High-intervention group</td>
<td>8.8</td>
<td>17.5</td>
<td>19.8</td>
</tr>
<tr>
<td></td>
<td>Moderate-intervention group</td>
<td>10.1</td>
<td>14.5</td>
<td>16.2</td>
</tr>
<tr>
<td>Percentage obese</td>
<td>2.8</td>
<td>5.7</td>
<td>5.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>All children</td>
<td>5.3</td>
<td>6.1</td>
<td>5.0</td>
</tr>
<tr>
<td></td>
<td>High-intervention group</td>
<td>1.5</td>
<td>4.2</td>
<td>4.0</td>
</tr>
<tr>
<td></td>
<td>Control group</td>
<td>2.3</td>
<td>6.5</td>
<td>6.4</td>
</tr>
<tr>
<td>Total time spent outdoors</td>
<td>10 Years</td>
<td>12 Years</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sample size</td>
<td>n = 1488</td>
<td>n = 1275</td>
<td>n = 1000</td>
<td></td>
</tr>
<tr>
<td>Median minute per day (interquartile range)</td>
<td>160.7 (112.5, 221.3)</td>
<td>177.9 (65.1, 189.6)</td>
<td>105.5 (53.7, 192.4)</td>
<td></td>
</tr>
<tr>
<td>All children</td>
<td>160.2 (111.4, 215.1)</td>
<td>104.9 (62.1, 173.6)</td>
<td>100.0 (52.9, 180.2)</td>
<td></td>
</tr>
<tr>
<td>High-intervention group</td>
<td>154.8 (102.6, 213.8)</td>
<td>121.2 (61.0, 180.3)</td>
<td>97.1 (51.4, 173.6)</td>
<td></td>
</tr>
<tr>
<td>Moderate-intervention group</td>
<td>167.1 (112.5, 228.2)</td>
<td>129.3 (72.9, 207.5)</td>
<td>117.6 (55.5, 208.6)</td>
<td></td>
</tr>
</tbody>
</table>

Note. BMI = body mass index.
Note. Scores were derived from the linear growth curves, with gender, ethnicity, and parental education set to their baseline distribution.

**FIGURE 1—Predicted z scores over time, by level of intervention.**

**TABLE 2—Adjusted Differences in z Scores (BMI-for-Age) and Relative Differences in Total Time Spent Outdoors at Age 10 and 12 Years: The Kidskin Study, Australia, 1995–2001**

<table>
<thead>
<tr>
<th></th>
<th>10 Years (95% CI)</th>
<th>12 Years (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adjusted absolute difference, z score (BMI-for-age)*</td>
<td>n = 1423</td>
<td>n = 1100</td>
</tr>
<tr>
<td>Control group</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Moderate-intervention group</td>
<td>0.01 (-0.12, 0.14)</td>
<td>0.05 (-0.09, 0.20)</td>
</tr>
<tr>
<td>High-intervention group</td>
<td>-0.08 (-0.22, 0.06)</td>
<td>-0.11 (-0.27, 0.05)</td>
</tr>
<tr>
<td>Adjusted relative difference, total time spent outdoors*</td>
<td>n = 1177</td>
<td>n = 921</td>
</tr>
<tr>
<td>Control group</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Moderate-intervention group</td>
<td>1.0 (0.87, 1.15)</td>
<td>0.94 (0.81, 1.09)</td>
</tr>
<tr>
<td>High-intervention group</td>
<td>0.90 (0.78, 1.05)</td>
<td>0.98 (0.83, 1.15)</td>
</tr>
</tbody>
</table>

*Adjusted for gender, ethnicity, parental educational level, and z score at baseline.

Note. BMI = body mass index; CI = confidence interval. The number of children available for analysis in Tables 1 and 2 differs because of missing data in the confounders.

was addressed by the objectives and design of the intervention.

The proportion of children in the Kidskin intervention cohort who were overweight or obese increased during the course of the study, particularly between ages 6 and 10 years. Another longitudinal study of Australian children found an increase in the prevalence of childhood overweight from 15% among children between age 5 and 10 years at baseline in 1997, to 19.7% 3 years later; the prevalence of obesity increased from 4.3% to 4.8% during the same period. That study involved children in a relatively broad age range, and BMI was assessed at only 2 time points; therefore, it is not possible to examine the increase at specific ages. Furthermore, the actual proportions of children in the 2 studies who were overweight or obese are not directly comparable, because children in the Kidskin intervention study were aged 5 or 6 years at baseline, compared with 5 to 10 years in the study by Hesketh et al.

The Kidskin study has some strengths and limitations. It was a large intervention trial, which had a 4-year intervention period and 2 additional years of follow-up to gauge long-term effects. We collected objective data on sun exposure, nevi, and BMI in a cohort of more than 1000 children who were followed from ages 6 to 12 years. BMI was measured at 3 time points by trained observers and was treated as a continuous variable in the analyses. The study’s large size means that we can be confident about the null findings, and as is apparent from the confidence intervals in Table 2, the results are consistent with (at most) very small adverse effects on BMI.

The retention rates in this study were high: more than 90% after 4 years and 69% after 6 years. Our results are unlikely to be biased because of loss to follow-up, because the results for BMI at age 10 remained the same, whether or not children followed up to age 12 were included in the analysis. Furthermore, loss to follow-up was not related to BMI at baseline or with any associated variable.

Limitations include lack of randomization and baseline differences among the groups. We did not directly assess physical activity among children in the Kidskin study, because that was outside the scope of the study. Nonetheless, time spent outdoors has consistently been correlated with physical activity. Time spent outdoors could be considered an indirect measure of physical activity, because it is clearly related to the opportunity to undertake physical activities such as walking, running, cycling, and swimming, which are not as easily or frequently done indoors.

Studies of the relation between physical activity and childhood overweight and obesity have used a variety of indirect measures of physical activity, including time spent playing sports or watching television, or time spent in activities that elicit sweating and breathlessness. Although findings have been inconsistent, more studies have reported an association than not. The reason for the lack of association between total time spent outdoors and BMI in the Kidskin study is not clear, although it may be attributed to our imprecise
measurement of time spent outdoors. In addition, we did not have data on children's nutrient intake and so were unable to adjust for this in our analysis.

To our knowledge, no other published skin cancer prevention intervention has reported the effect of the program on children's adiposity. However, it is useful to know that it is possible to reduce the time children spend outdoors when ultraviolet radiation is at its highest without producing an unfavorable affect on children's weight relative to height. Children in the Kidskin intervention study increased their time outdoors at other times of the day, which may, at least partly, explain the absence of any effect on BMI.

A growing number of health issues are becoming the focus of health promotion efforts. Health promoters need to be aware of—and account for—the aims of other programs operating contemporaneously within a given target population.

**References**


**Human Participant Protection**

This study was approved by the human research ethics committees at the University of Western Australia and Curtin University of Technology. Written consent was obtained from the children in the study and their parents.

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This article was accepted June 1, 2006.

**Contributors**

E. Milne, D. English, and B. Giles-Corti originated the study and supervised all aspects of its implementation. R. Johnston designed the Kidskin intervention program. J. Simpson undertook the statistical analysis. E. Milne led the writing. All authors helped to conceptualize ideas, interpret findings, and review drafts.

**Acknowledgments**

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The authors acknowledge Donna Cross, who contributed to the design and conduct of the study.
Prevalence Estimates of Overweight and Obesity in Cree Preschool Children in Northern Quebec According to International and US Reference Criteria

Noreen D. Willows, PhD, Melissa S. Johnson, MSc, and Geoff D.C. Ball, PhD, RD

The prevalence of pediatric overweight and obesity in Canada has increased dramatically since the early 1980s, creating a public health concern.1 (Note. The terms overweight and obese are used to denote increased body mass index [BMI]. These terms are used by the International Obesity Task Force [IOTF] to identify increased BMI, but the Centers for Disease Control and Prevention [CDC] uses the terms at-risk of overweight and overweight. We appreciate the different terms used in these references; however, the terms overweight and obese are used in this manuscript for simplicity.) In Canada, childhood growth is not monitored with a national surveillance system, so prevalence estimates have been derived from local,2 regional,3 and national surveys.4 Overweight and obesity prevalence data from Canadian children (aged approximately 6 to 12 years) and adolescents (aged approximately 13 to 17 years) have been well described,4–7 but recent reports have also included preschool boys and girls (aged approximately 2 to 5 years).

Data from preschool children collected during the Canadian National Longitudinal Survey of Children and Youth in the mid- to late 1990s indicated that many preschool children were overweight or obese.8 Among children aged 2 to 3 years, approximately 18% were overweight (but not obese) and approximately 27% were obese. Among children aged 4 to 5 years, approximately 17% were overweight (but not obese) and approximately 23% were obese.8 However, because heights and weights were parent-reported, the true prevalence level of obesity may have been underestimated owing to biased reporting.9

Recent studies that used measured height and weight data showed that about 30% of children aged 2 to 6 years (n=1370) in 2 regions of Ontario were either overweight or obese,10 and among children aged 3 to 5 years in Newfoundland and Labrador (n=4161), 16.8% of boys and 18.5% of girls were overweight while 7.8% of boys and 8.2% of girls were obese.3 Results from the Canadian Community Health Survey, which were based on measured heights and weights obtained in 2004, indicated that 13% of children aged 2 to 5 years were overweight and 6% were obese.11

In North America, Aboriginal peoples are the descendants of the original inhabitants of that continent. In Canada, the term “Aboriginal peoples” is inclusive of First Nations, Inuit, and Métis. In the United States, “American Indian” and “Native American” are the terms used to describe First Nations people.12 Community-based surveys have indicated that First Nations children in Canada and American Indian children in the United States may be at particular risk for obesity.13 In the Canadian Community Health Survey, 41% of Aboriginal children aged 2 to 17 years were overweight (21%) or obese (20%), which is a greater prevalence than that seen for other ethnic groups.11 There is evidence from a few small community-based studies that overweight is prevalent in preschool First Nations children. In a published report based on measured heights and weights, 34.6% of First Nations boys (n=78) and 45.2% of First Nations girls (n=62) aged 2 to 5 years living in the remote Ontario community of Sandy Lake were overweight or obese.14 In another study that used measured data, high BMI was common among First Nations children aged 4 to 19 years (n=719) living in the Island Lake Tribal Council in Manitoba. In that study, 85% of girls aged younger than 8 years were overweight (25%) or obese (60%) and 80% of boys were overweight (28%) or obese (52%).15 The issue of excess body weight in young children is very relevant in First Nations communities given their potentially increased risk for type 2 diabetes.15–17

Given the public health concern of overweight and obesity in young children, there has been a call for early surveillance of childhood obesity in Canada and for longitudinal research to understand the pattern of excess weight gain.18 There are, however, several issues
concerning the definition and measurement of overweight and obesity that must be considered when surveillance and tracking are undertaken. For example, the term obesity refers to an excessive amount of adipose tissue in relation to lean body mass whereas overweight refers to excess weight in relation to height. Although the term overweight may imply a lesser degree of excess fat than is associated with obesity, no criteria exist to make this distinction.

From a classification perspective, prevalence estimates of overweight and obesity will vary as a function of the reference population used to group children into relative weight categories.20-21 However, in a position paper developed by the Dietitians of Canada, Canadian Paediatric Society, College of Family Physicians of Canada, and Community Health Nurses Association of Canada,22 it was recommended that the IOTF reference23 be used when making population-based comparisons of BMI-based weight categories whereas the CDC growth charts for the United States24 should be used in clinical and community settings for individual assessments of children. These recommendations were made on the basis of expert opinion, because empirical data were lacking.25

The IOTF reference used age- and gender-specific BMI cutoffs created with data from 6 international surveys of children, and statistical procedures were used to align BMI cutoffs in childhood that corresponded to adult cutoffs for overweight (BMI≥25 kg/m²) and obesity (BMI≥30 kg/m²). In the IOTF classification system, children are designated as neither overweight nor obese, overweight, or obese. The CDC growth charts, in contrast, were derived from US data exclusively and use age- and gender-specific BMI cutoffs to categorize children along the BMI continuum as underweight (BMI<5th percentile), normal weight (BMI≥5th percentile and <85th percentile), at risk of overweight (BMI≥85th percentile and <95th percentile), or overweight (BMI≥95th percentile). Given that the IOTF and CDC references were developed from unique data sets and used different statistical methods and theoretical approaches, each method generates dissimilar estimates of overweight and obesity.22 Furthermore, because different terms are used by the IOTF and CDC to describe children in different BMI weight categories, it is often difficult to make comparisons among studies.

Few American Indian children were included in the development of the CDC reference, and none were included in the IOTF reference. Despite the inadequate representation of American Indian children, the CDC reference is used to classify them into weight categories.23 It is noteworthy that no Canadian data (neither Aboriginal nor non-Aboriginal) were included in the development of the IOTF and CDC standards. Unfortunately, the current lack of nationally representative measured height and weight data from Canadian children precludes the development of Canadian growth charts, so the use of methods and standards developed by other countries is required to monitor childhood overweight and obesity in Canada. The Indian and Inuit Health Committee of the Canadian Paediatric Society supports the use of CDC growth charts to monitor child growth, while recognizing that First Nations and Inuit children may have growth patterns that differ from the reference population of children who were used to derive the CDC charts.26

Presently, there is limited information regarding the magnitude of overweight and obesity in preschool-aged First Nations children in Canada. There is no information of the comparability of prevalence estimates obtained with the IOTF and CDC references in young children of First Nations descent and it is unknown whether these 2 methods provide comparable longitudinal tracking of relative weight categories in First Nations children. Therefore, our objectives were 2-fold: (1) to determine the prevalence of overweight and obesity in preschool First Nations boys and girls aged 5 years living in northern Quebec with both the IOTF and CDC references, and (2) to examine the longitudinal tracking of weight categories between ages 2 and 5 years with the IOTF and CDC references in First Nations boys and girls who had heights and weights measured at both ages.

METHODS

Study Sample

The James Bay Cree of northern Quebec, who number approximately 14 000 persons, were traditionally a nomadic people. The population underwent a rapid lifestyle transition, most notably in the 1970s, with the construction of massive hydroelectric projects. Although traditional hunting and fishing subsistence activities are still important, the Cree now live predominantly in 9 rural and remote communities along the coast and inland from James Bay between the 49th and 55th parallels in the sub-Arctic region of the province of Quebec. Because of a relatively recent shift to a sedentary lifestyle and away from traditional foods, obesity and type 2 diabetes mellitus have become highly prevalent in Cree adults,27 and the prevalence of overweight among school-aged children is high.28

Data Collection

In Cree communities, a routine medical examination occurs when a child aged approximately 5 years begins school. In July 2002, measured heights and weights taken at the time of this examination were retrospectively obtained from the medical charts of children born from January 1994 to July 1997. All charts were reviewed twice to ensure accuracy of data collection. Community health nurses were instructed to measure body weight to the nearest 0.1 kg (using a medical balance scale) and height to the nearest 0.1 cm (using a stadiometer). Children were measured while wearing light clothing, and shoes were removed. In total, 1252 children were born from January 1994 to July 1997 and would have had a 5th birthday by July 2002; however, 99 were excluded from the study because they had endured a serious illness or trauma, or were deceased. Of the remaining 1153 children, 1044 had measurements taken when aged between 55 and 65 months (aged approximately 5 years). In Cree communities, anthropometric measures are also taken at well-baby clinics when a child is aged 18 to 24 months; the timing of this clinic visit depends in part on physician availability. For the longitudinal aspect of this study, we included only those children who attended the clinic when aged 2 years because the IOTF reference is not applicable for younger children. Of the 1044 children, 562 were measured when aged 2 years.

The Cree Board of Health and Social Services of James Bay (Quebec) and the Human Research Ethics Board of the Faculty of Agriculture, Forestry and Home Economics at the University of Alberta approved this investigation. Members of the Research Committee of
the Cree Health Board were given the opportunity to read and comment on our findings.

**Statistical Analyses**

BMI (calculated as weight in kilograms divided by height in meters squared) and BMI percentiles from the CDC reference were calculated for each child using Epi Info, version 3.3 (CDC, Atlanta, Ga). To accommodate descriptive comparisons among weight categories between the 2 classification systems, the same terms were applied to results derived from both the IOTF and CDC references. The terms overweight and obese described children who measured higher than the equivalent BMI cutoffs of the IOTF reference, or age- and gender-specific BMI between the 85th percentile and lower than the 95th percentile, and BMI 95th percentile or higher of the CDC reference, respectively. The term normal weight was used to describe children who were not overweight or obese.

There was no evidence of underweight as no child possessed a BMI lower than the 5th percentile on CDC growth charts.

Descriptive statistics for all continuous variables were presented as the mean ±SD. Group comparisons were performed with the independent sample t test. The \( \kappa \) statistic was used to estimate the agreement in weight classification between the CDC and IOTF references. A positive predictive value was calculated to determine the proportion of overweight or obese children aged 5 years who were in those categories when aged 2 years. A negative predictive value was calculated to determine the proportion of normal-weight children aged 5 years who had normal weight at 2 years. A \( P \) value less than .05 was considered significant and SPSS version 13.0 (SPSS Inc, Chicago, Ill) was used for all statistical analyses.

**RESULTS**

Anthropometric data for boys and girls aged 5 years and the proportions of children in each of the relative weight categories are provided in Table 1. Boys were slightly taller than girls (\( P < .05 \)), but no other differences in anthropometry were observed. Based on the IOTF reference, 52.9% of children were either overweight (31.6%) or obese (21.3%), whereas based on the CDC criterion, 64.9% were either overweight (27.5%) or obese (37.4%). The proportion of boys classified as obese using the CDC reference was twice as great as the proportion classified as obese using the IOTF reference (40.5% vs 20.9%, respectively). The difference observed in girls was smaller in magnitude, but the trend was consistent, with more girls classified as obese using the CDC reference than using the IOTF reference (34.2% vs 21.6%, respectively).

Overall, the CDC and IOTF references classified 71.9% of children the same way and the \( \kappa \) value was 0.58 indicating moderate agreement in classification (Table 2). All children classified as having normal weight by the CDC reference were classified the same way by the IOTF reference; however, 43.6% of children classified as overweight by the CDC reference were classified as having normal weight by the IOTF reference, and 43.0% of children classified as obese by the CDC reference were considered overweight by the IOTF reference. When weight categories were made dichotomous (“normal” and “overweight or obese”) by combining the overweight and obese categories, 88.0% of children were classified the same way and the \( \kappa \) value was 0.76, indicating good agreement between the 2 references.

For the subgroup with longitudinal data available at both 2 and 5 years of age (Table 3), all anthropometric indicators (in both boys and girls) increased between 2 and 5 years of age, except for absolute BMI, which decreased (all \( P < .05 \)). In boys, the proportion of individuals classified as obese by the IOTF reference decreased slightly (21.8% to 18.8%) from 2 to 5 years of age, but increased with the CDC reference (31.7% to 40.6%). Positive changes were noted in the overweight category for both the IOTF (25.8% to 31.0%) and CDC (22.5% to 25.5%) references between 2 and 5 years of age. This resulted in a notable reduction in the normal-weight category in boys as classified by the CDC reference (45.8% to 33.9%). In girls, the proportion of individuals in the obese category decreased slightly between 2 and 5 years of age for both the IOTF (24.4% to 21.0%) and CDC (35.4% to 33.0%) references. The reduction in obesity was mostly compensated for by an increase in the overweight group for the CDC reference (24.4% to 28.5%), but corresponded to an increase in the normal-weight group for the IOTF reference (41.6% to 46.0%).

Unique patterns of change in weight categories from ages 2 to 5 years were noted between the IOTF and CDC references when data from boys and girls were combined (Tables 4 and 5). According to the IOTF reference, 4.9% of children who were classified as normal weight at 2 years of age were classified as obese at 5 years of age (Table 4). By
**TABLE 2**—Comparison of Agreement for Categorizing Weight Categories for Cree Children Aged 5 Years (N = 1044) Between the Centers for Disease Control and Prevention (CDC) and the International Obesity Task Force (IOTF) Reference Criteria: Northern Quebec, Canada, 2002

<table>
<thead>
<tr>
<th></th>
<th>IOTF</th>
<th>CDC</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Normal Weight (n = 492)</td>
<td>Overweight (n = 330)</td>
<td>Obese (n = 222)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IOTF</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal weight</td>
<td>367 (100.0)</td>
<td>... a</td>
<td>... a</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overweight</td>
<td>125</td>
<td>162 (56.4)</td>
<td>... a</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Obese</td>
<td>... a</td>
<td>168</td>
<td>222 (56.9)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note.** Numbers in parentheses represent the percentage of agreement in weight classification between the IOTF reference and the CDC reference.

aNot applicable.

**TABLE 3**—Anthropometric Data and Proportions of Cree Children (at 2 and 5 Years of Age) in Relative Weight Categories Based on the International Obesity Task Force (IOTF) and Centers for Disease Control and Prevention (CDC) References: Northern Quebec, Canada, 2002

<table>
<thead>
<tr>
<th></th>
<th>2 Years</th>
<th>5 Years</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Boys</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No.</td>
<td>271</td>
<td>271</td>
<td></td>
</tr>
<tr>
<td>Age, mo, mean ±SD</td>
<td>24.8 ±0.9</td>
<td>60.4 ±0.9</td>
<td>-2.2</td>
</tr>
<tr>
<td>Height, cm, mean ±SD</td>
<td>90.1 ±3.1</td>
<td>112.4 ±6.6</td>
<td>-11.9</td>
</tr>
<tr>
<td>Weight, kg, mean ±SD</td>
<td>15.1 ±2.0</td>
<td>22.9 ±4.2</td>
<td>+5.2</td>
</tr>
<tr>
<td>BMI, kg/m², mean ±SD</td>
<td>18.6 ±2.0</td>
<td>18.0 ±2.7</td>
<td>+3.0</td>
</tr>
<tr>
<td>BMI percentile on CDC growth charts, mean ±SD</td>
<td>79.8 ±22.2</td>
<td>83.6 ±21.0</td>
<td>+8.9</td>
</tr>
<tr>
<td>Normal weight (IOTF), %</td>
<td>52.4</td>
<td>50.2</td>
<td></td>
</tr>
<tr>
<td>Normal weight (CDC), %</td>
<td>45.8</td>
<td>33.9</td>
<td>-11.9</td>
</tr>
<tr>
<td>Overweight (IOTF), %</td>
<td>25.8</td>
<td>31.0</td>
<td>+5.2</td>
</tr>
<tr>
<td>Overweight (CDC), %</td>
<td>22.5</td>
<td>25.5</td>
<td>+3.0</td>
</tr>
<tr>
<td>Obese (IOTF), %</td>
<td>21.8</td>
<td>18.8</td>
<td>-3.0</td>
</tr>
<tr>
<td>Obese (CDC), %</td>
<td>31.7</td>
<td>40.6</td>
<td>+8.9</td>
</tr>
</tbody>
</table>

|               |         |         |          |
| **Girls**     |         |         |          |
| No.           | 291     | 291     |          |
| Age, mo, mean ±SD | 24.8 ±0.9 | 60.4 ±0.9 | -2.2     |
| Height, cm, mean ±SD | 89.1 ±3.0 | 112.2 ±4.2 | -11.9    |
| Weight, kg, mean ±SD | 14.8 ±1.9 | 22.4 ±3.7 | +5.2     |
| BMI, kg/m², mean ±SD | 18.6 ±1.9 | 17.8 ±2.3 | +3.0     |
| BMI percentile on CDC growth charts, mean ±SD | 81.4 ±21.6 | 83.2 ±18.6 | +4.4     |
| Normal weight (IOTF), % | 41.6 | 46.0 |          |
| Normal weight (CDC), % | 40.2 | 38.5 | -1.7     |
| Overweight (IOTF), % | 34.0 | 33.0 | -1.0     |
| Overweight (CDC), % | 24.4 | 28.5 | +4.1     |
| Obese (IOTF), % | 24.4 | 21.0 | -3.4     |
| Obese (CDC), % | 35.4 | 33.0 | -2.4     |

**Note.** BMI = body mass index.

*P < .01

**DISCUSSION**

Using anthropometric measurements of Cree preschool children in northern Quebec, Canada, we compared prevalence estimates of overweight and obesity according to 2 different growth references and tracked patterns of BMI-based weight categories during the preschool period. We found that prevalence estimates for overweight and obesity in children were high, regardless of the reference used to classify children. However, the CDC reference provided higher estimates of obesity compared with the IOTF reference, although differences in the prevalence of overweight were smaller in magnitude. In addition, we found that the categorization of children into different relative weight groups according to the IOTF and CDC criteria differed between boys and girls. The IOTF and CDC references also revealed unique patterns of change in relative weight categories as children progressed from 2 to 5 years of age, which provided evidence for disparate patterns of tracking of relative weight categories with BMI.

Consistent with other reports that compared estimates of overweight and obesity in preschool children with the CDC and IOTF references, our study revealed that the IOTF reference provided a more conservative estimate of obesity in relation to the CDC.
reference. In the present study, Cree boys aged 2 to 5 years were 1.58-times more likely to be classified as obese by the CDC method than by the IOTF method (40.5% vs 20.9%) while girls were 1.94-times more likely to be classified as obese by the CDC method than by the IOTF method (6.2% vs 2.5%). In children from Newfoundland and Labrador aged 3 to 5 years, Canning et al.20 found that boys aged 2 to 5 years were 2.48-times more likely to be classified as obese by the CDC method than by the IOTF method (19.4% vs 7.8%), whereas girls were 2.01-times more likely to be classified as obese (16.5% vs 8.2%), respectively. On the basis of these observations, caution must be taken when comparing absolute levels of obesity in preschool children with the different methods.

There has been limited study of the tracking of relative weight categories in young children. In our analyses, absolute BMI in both boys and girls decreased between 2 and 5 years of age while the CDC BMI percentiles increased. This finding may appear counterintuitive, but if studies are planned to examine changes in growth, the use of different references may correspond to differences in the ability to detect changes over time. As a means of addressing the limitations inherent in the relative BMI categorizations, it would be prudent to express any changes over time in both categorical (normal weight, overweight, or obese) and absolute terms and not rely on a single indicator.29 This information would be useful given that an increase or decrease in absolute BMI could take place but not correspond to a change in weight category if individuals do not cross BMI threshold cutoffs.

Our study has several strengths. We determined prevalence estimates from a large sample of young children representative of the Cree communities in northern Quebec, and BMI was calculated from measured rather than reported heights and weights. The study was both a cross-sectional and a longitudinal examination of overweight and obesity in preschool-aged First Nations boys and girls (to date, an understudied population of children). The limitations of the study relate to the accuracy of the data that were collected. Although a standard protocol for measuring children existed, not all community nurses may have adhered to it. Furthermore, numerous staff used a variety of stadiometers and weight scales to perform measurements. However, we do not anticipate that these limitations resulted in large or systematic errors in data collection. Our data underscore the high prevalence of overweight and obesity in Canadian preschool children and show that the magnitude of the problem may be substantial among First

### TABLE 4—Tracking of Relative Weight Categories in Cree Children Between 2 and 5 Years of Age (N = 562) Classified According to the International Obesity Task Force Reference Criteria: Northern Quebec, Canada, 2002

<table>
<thead>
<tr>
<th></th>
<th>2 Years</th>
<th>5 Years</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Normal weight (n = 270)</td>
<td>Overweight (n = 180)</td>
<td>Obese (n = 112)</td>
<td></td>
</tr>
<tr>
<td>2 Years</td>
<td>Normal weight (n = 263)</td>
<td>188 (71.5)</td>
<td>62</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Overweight (n = 169)</td>
<td>69</td>
<td>71 (42.0)</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>Obese (n = 130)</td>
<td>13</td>
<td>47</td>
<td>70 (53.8)</td>
</tr>
</tbody>
</table>

Note. Numbers in parentheses represent the percentage of agreement in weight classification at 5 years of age with that at 2 years of age.

### TABLE 5—Tracking of Relative Weight Categories in Cree Children Between 2 and 5 Years of Age (N = 562) Classified According to the Centers for Disease Control and Prevention Reference Criteria: Northern Quebec, Canada, 2002

<table>
<thead>
<tr>
<th></th>
<th>2 Years</th>
<th>5 Years</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Normal weight (n = 204)</td>
<td>Overweight (n = 152)</td>
<td>Obese (n = 206)</td>
<td></td>
</tr>
<tr>
<td>2 Years</td>
<td>Normal weight (n = 241)</td>
<td>144 (59.8)</td>
<td>61</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>Overweight (n = 132)</td>
<td>46</td>
<td>50 (37.9)</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>Obese (n = 189)</td>
<td>14</td>
<td>41</td>
<td>134 (70.9)</td>
</tr>
</tbody>
</table>

Note. Numbers in parentheses represent the percentage of agreement in weight classification at 5 years of age with that at 2 years of age.
Nations boys and girls. The high levels of overweight and obesity we found reinforce the case for increased efforts at preventing and decreasing childhood obesity. There is also a clear need to identify the factors that contribute to the onset and persistence of childhood overweight and obesity in Cree and other First Nations children, including the need to understand linkages between changes in growth and changes in food intake and physical activity. We echo recent sentiments made by others in the need for collecting measured height and weight data among representative samples of Canadians as a means of accurately determining the prevalence of overweight and obesity. The lack of Canadian data are particularly relevant to Aboriginal children, given the large and growing population of Aboriginal peoples in Canada, reported high rates of overweight and obesity in Aboriginal children in both Canada and the United States, and evidence for potentially unique growth patterns in aboriginal children. Health practitioners working with First Nations and American Indian children should be careful when assessing childhood obesity and be cognizant of the fact that comparisons of BMI with reference standards may lead to inappropriate risk assessments.

Human Participant Protection
The Cree Board of Health and Social Services of James Bay (Quebec) and the human research ethics board of the Faculty of Agriculture, Forestry and Home Economics at the University of Alberta approved this investigation.

References
Otitis media (OM) affects nearly all preschool children, and onset in the first few months of life predicts later chronic and recurrent OM. Data from the Indian Health Service (IHS) and the National Center for Health Statistics revealed that, during the 1990s, OM-associated outpatient visit and hospitalization rates among American Indian and Alaska Native children aged younger than 5 years were 2.3- to 2.9-times higher, respectively, than among US children in the same age group. Also in the 1990s, Northern Plains American Indians, including residents of the Bemidji Area IHS in Minnesota, had the second highest rates of IHS outpatient visits and hospitalizations for OM.

Although OM rates are higher among American Indians/Alaska Natives than among other groups, little is known about specific factors that could affect their OM risk. Potentially modifiable risk factors for early OM identified in other populations include upper respiratory infections (URIs), early colonization with OM pathogens, day care attendance or sibling day care attendance, short breast-feeding duration, prone sleeping, and heavy maternal smoking. Family history is also an important risk factor. One that may be attributed to shared environmental or genetic factors. A substantial heritable component has been demonstrated in twin studies, and evidence for links between chronic and recurrent OM and regions on chromosomes 10q and 19q was recently demonstrated in a study of Black and White children, Paradise et al. showed that race was no longer predictive of time with middle ear effusion after control for socioeconomic status. The aim of the Little Ears Study, described here, was to investigate OM epidemiology in American Indian children from birth to age 2 years, including OM incidence in the first 6 months of life (hereafter, “early OM”), as well as relationships between early OM onset and sociodemographic characteristics, OM risk factors, and maternal knowledge and attitudes.

**Methods.** Pregnant women from Minnesota American Indian reservations and an urban clinic were enrolled in our study between 1998 and 2001. Follow-up was performed on enrollees’ infants until the children were 2 years old. Research nurses collected data by ear examination, from interviews and questionnaires given to enrolled mothers, and OM episodes that were abstracted from medical records.

**Results.** Sixty-three percent of infants had experienced an OM episode before 6 months of age. Logistic regression analyses showed that maternal OM history, infant history of upper respiratory infection, and compliance with study visits were significantly related to early OM incidence. Although high percentages of infants were exposed to cigarette smoke and other children and were formula fed, these factors were not related to OM incidence. Mothers’ prenatal awareness of OM risk factors associated with environmental tobacco smoke exposure and formula feeding did not predict their postpartum behaviors.

**Conclusions.** We found that infant history of upper respiratory infection and maternal OM history are risk factors for early OM incidence in American Indian infants. Mothers’ prepartum knowledge and attitudes regarding OM did not predict their postpartum avoidance of risk behaviors. (Am J Public Health. 2007;97:317–322. doi:10.2105/AJPH.2004.052837)
Statistical Analysis
We summarized distributions using frequency tables for categorical variables and means and standard deviations for quantitative variables. We used chi-squared and t-tests to evaluate relationships between early OM onset and sociodemographic variables, OM risk factors, and maternal attitudes and knowledge. Characteristics of study dropouts were also explored. Variables with a significant or marginally significant relationship with early OM (at P<.1) were included in logistic regression models along with terms for 2-way interactions. Interaction terms that were not significant were removed from the regression models in order of decreasing significance until only main effects and significant interactions remained.

RESULTS

Enrollment
Of those contacted, 408 eligible women agreed to take part in the study (about 20% of contacts) and gave birth to 408 infants (including 4 fetal deaths and 4 sets of twins). Fifteen women also enrolled during a subsequent pregnancy, but we included only the first pregnancy or a single twin in our analyses. One infant was ineligible because of cleft palate, and one twin died during the neonatal period, leaving 406 infants. Data from 383 prepartum interviews and 373 self-completed questionnaires were collected; 344 infants underwent ear examinations, and 2-week risk factor data were available for 330 (96%) of these infants.

Women’s average age at delivery was 24.1 years (SD=5.6). Most of the women were Ojibwe (Table 1), the most populous Minnesota tribe (Ojibwe is the sixth most commonly reported tribal affiliation in the United States28). Known OM risk factors were common in the sample (Table 2), and women who smoked reported an average of 7.2 cigarettes per day (SD=4.6). Those who completed only the prepartum interview were similar in terms of age, marital status, and employment status to those who completed both the prepartum and 2-week interviews but were more likely to be urban residents (54% vs 24%; P<.01) and smokers (57% vs 43%; P=.06).

<table>
<thead>
<tr>
<th>Infants, No. (%)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>174 (53)</td>
</tr>
<tr>
<td>Female</td>
<td>157 (47)</td>
</tr>
<tr>
<td>Race</td>
<td></td>
</tr>
<tr>
<td>American Indian*</td>
<td>328 (99)</td>
</tr>
<tr>
<td>More than 1 race</td>
<td>82 (25)</td>
</tr>
<tr>
<td>WIC participant</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>321 (97)</td>
</tr>
<tr>
<td>No</td>
<td>10 (3)</td>
</tr>
<tr>
<td>Breast-feeding</td>
<td></td>
</tr>
<tr>
<td>Birth</td>
<td>193 (58)</td>
</tr>
<tr>
<td>2 weeks</td>
<td>126 (38)</td>
</tr>
<tr>
<td>Regular exposure to childrenb</td>
<td></td>
</tr>
<tr>
<td>Any exposure</td>
<td>287 (87)</td>
</tr>
<tr>
<td>Exposure to more than 2 children</td>
<td>181 (55)</td>
</tr>
<tr>
<td>Living arrangements</td>
<td></td>
</tr>
<tr>
<td>2 or more adults</td>
<td>299 (91)</td>
</tr>
<tr>
<td>More than 2 other children</td>
<td>87 (26)</td>
</tr>
<tr>
<td>Sleeping arrangements</td>
<td></td>
</tr>
<tr>
<td>1 or more adults in same room</td>
<td>318 (99)</td>
</tr>
<tr>
<td>1 or more children in same room</td>
<td>98 (31)</td>
</tr>
<tr>
<td>Smoke exposure</td>
<td></td>
</tr>
<tr>
<td>Smoker in householdc</td>
<td>266 (80)</td>
</tr>
<tr>
<td>Mother smokes</td>
<td>174 (53)</td>
</tr>
<tr>
<td>Otitis media history</td>
<td></td>
</tr>
<tr>
<td>Mother</td>
<td>97 (30)</td>
</tr>
<tr>
<td>Fatherd</td>
<td>33 (11)</td>
</tr>
<tr>
<td>Full or half siblinge</td>
<td>122 (57)</td>
</tr>
</tbody>
</table>

Note. WIC = Special Supplemental Nutrition Program for Women, Infants, and Children.
*3 infants had 1 White and 1 American Indian parent; mother described child’s race as White.
bHome, day care, regular visitors, or regular visits to other homes.
cParent or other adult smoker in the home.
d39% answered “don’t know.”
eIf history was known.

variables in the univariate analyses. However, after stratification according to study visit compliance, infant history of URI was significantly related to OM among infants with noncompliant mothers but not among infants with compliant mothers (P<.01 and .99, respectively). The interaction between compliance and URI history was significant (P=.01). Including this interaction term in the logistic regression model resulted in nearly identical study compliance odds ratios (ORs) of 5.47 and 5.45 in the presence and absence of a history of URI, respectively (Table 4). This finding illustrates that URI history conferred no additional OM

TABLE 3—Percentage of Early Otitis Media (OM) in Infants, by Maternal and Infant Sociodemographic Characteristics and Risk Variables: Little Ears Study, Minnesota, 1997–2003

<table>
<thead>
<tr>
<th>No. of Infants (% With Early OM)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Maternal characteristics/beliefs</td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td>.99</td>
</tr>
<tr>
<td>More than high school</td>
<td>62 (63)</td>
</tr>
<tr>
<td>High school or less</td>
<td>143 (63)</td>
</tr>
<tr>
<td>Employment status</td>
<td>.93</td>
</tr>
<tr>
<td>Work, school, or both</td>
<td>93 (62)</td>
</tr>
<tr>
<td>Neither</td>
<td>112 (63)</td>
</tr>
<tr>
<td>Maternal status</td>
<td>.72</td>
</tr>
<tr>
<td>Married/living with partner</td>
<td>127 (62)</td>
</tr>
<tr>
<td>Other</td>
<td>78 (64)</td>
</tr>
<tr>
<td>Age at delivery, y</td>
<td>.71</td>
</tr>
<tr>
<td>&lt;19</td>
<td>35 (60)</td>
</tr>
<tr>
<td>≥19</td>
<td>180 (63)</td>
</tr>
<tr>
<td>Alcohol use in early pregnancy</td>
<td>.38</td>
</tr>
<tr>
<td>Yes</td>
<td>110 (65)</td>
</tr>
<tr>
<td>No</td>
<td>93 (60)</td>
</tr>
<tr>
<td>OM nothing to worry about</td>
<td>.01</td>
</tr>
<tr>
<td>True</td>
<td>10 (40)</td>
</tr>
<tr>
<td>False/don’t know</td>
<td>195 (65)</td>
</tr>
<tr>
<td>OM gets better by itself</td>
<td>.01</td>
</tr>
<tr>
<td>True</td>
<td>11 (41)</td>
</tr>
<tr>
<td>False/don’t know</td>
<td>194 (65)</td>
</tr>
<tr>
<td>I can take steps to prevent OM</td>
<td>.54</td>
</tr>
<tr>
<td>Disagree/don’t know</td>
<td>21 (68)</td>
</tr>
<tr>
<td>Agree</td>
<td>184 (62)</td>
</tr>
</tbody>
</table>

Infant characteristics

<table>
<thead>
<tr>
<th>Odds Ratio (95% Confidence Interval)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Maternal OM history</td>
<td>1.77 (1.02, 3.08)</td>
</tr>
<tr>
<td>Compliance with number of study visits and URI before first OM*</td>
<td>5.47 (2.66, 11.26)</td>
</tr>
<tr>
<td>Compliance with number of study visits and no URI before first OM*</td>
<td>5.45 (2.62, 11.36)</td>
</tr>
<tr>
<td>Noncompliance with number of study visits and URI before first OM*</td>
<td>4.32 (1.62, 11.56)</td>
</tr>
</tbody>
</table>

Note. URI = upper respiratory infection.
aReference category: noncompliance with number of study visits and no URI before first OM.

TABLE 4—Results of Logistic Regression Analyses Assessing Early Otitis Media (OM) Onset: Little Ears Study, Minnesota, 1997–2003

<table>
<thead>
<tr>
<th>Odds Ratio (95% Confidence Interval)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Maternal OM history</td>
<td>1.77 (1.02, 3.08)</td>
</tr>
<tr>
<td>Compliance with number of study visits and URI before first OM*</td>
<td>5.47 (2.66, 11.26)</td>
</tr>
<tr>
<td>Compliance with number of study visits and no URI before first OM*</td>
<td>5.45 (2.62, 11.36)</td>
</tr>
<tr>
<td>Noncompliance with number of study visits and URI before first OM*</td>
<td>4.32 (1.62, 11.56)</td>
</tr>
</tbody>
</table>

Note. URI = upper respiratory infection.
*aReference category: noncompliance with number of study visits and no URI before first OM.
risk among infants whose mothers had complied with the study visit criteria. The odds ratio for occurrence of a URI before occurrence of first OM among infants whose mothers did not complete the required number of visits was 4.32. The only other significant risk factor in the model was maternal history of chronic or recurrent OM (OR = 1.77).

**Relationships Between Attitudes and Behaviors**

Prepartum interview responses showed that more than 90% of women knew the signs and symptoms of OM, and 73% believed that “smoking cigarettes around children increases their chances of getting ear infections.” However, only 15% and 24% of women associated formula feeding and day care, respectively, with increased OM risk, and 46% believed that ear infections were a normal part of life for children. Only 7% agreed that OM was nothing to worry about; these women and their infants attended fewer study visits than did women who did not have this belief (P = .04). Although 90% of women agreed that there were steps one could take to prevent OM, this attitude did not affect breast-feeding or smoking behaviors as reported at the 2-week interview (P = .86 and 0.98, respectively). Similarly, 80% agreed that cigarette smoke exposure increased an infant’s chances of experiencing OM episodes, but this belief did not influence smoking behaviors according to 2-week-interview responses (P = .27).

**DISCUSSION**

Our data illustrate that OM incidence in infants at or before the age of 6 months was higher in the Little Ears cohort than in a predominantly White cohort followed in the Minnesota Twin Cities area in the mid-1990s (63% vs 48%). Diagnostic criteria for OM and mean number of study or clinic visits by the age of 6 months were similar in Little Ears and an earlier cohort (7 and 6 visits, respectively).

We investigated compliance with study visits because of the obvious dependence of OM diagnoses on completion of ear examinations. Women and infants who complied with the study visit criteria completed more clinic visits as well, increasing the likelihood of OM being diagnosed. The difference in OM rates between infants whose mothers were compliant and those whose mothers were noncompliant suggests that OM may actually have been underdiagnosed in the study population. Study visit compliance was not a risk factor for OM but was related to likelihood of OM detection. Infants whose mothers were noncompliant may have been as likely as infants whose mothers were compliant to experience an OM episode but less likely to have it detected because they underwent fewer examinations.

Regular ear examinations would allow detection of asymptomatic episodes of OM, which occur frequently in the first year of life. Prospective studies involving more frequent examinations have reported higher OM rates than have studies involving fewer examinations. A study reported that rates of acute OM were higher among American Indian children living within 5 miles (8 km) of an IHS health facility than among those living farther away, suggesting that access to care increases OM ascertainment. Maternal OM history was significantly related to early OM in this study and in an earlier study. This relationship suggests a possible role for genetic factors in early OM or greater awareness of OM leading to increased care seeking and more frequent diagnoses (i.e., detection bias). A study conducted on an Apache reservation reported a significantly greater-than-expected concordance of tympanic membrane scarring in first-degree relative pairs, a finding consistent with a genetic hypothesis.

We did not find that compliance with study visits was related to maternal OM history. However, infant OM would be diagnosed more frequently if mothers with a history were more likely to seek medical care for a symptomatic child. Reported maternal OM history was not validated against medical records, but women were queried about their own history of chronic and recurrent OM. In a study of college students, agreement values between self-report and medical record data were 0.53 for number of physician visits related to ear problems and 0.78 for tympanostomy tube placement.

Previous studies have shown that URIs increase OM risk. The interaction between URI and study visit compliance observed here suggests that OM was diagnosed independent of previous URIs among infants with more clinic visits. OM episodes not associated with previous URIs may have been milder and therefore not brought to the attention of physicians by noncompliant mothers. Mild episodes would have been more likely to be detected in compliant families who used health services more frequently. Viral respiratory infections promote the development of OM by releasing inflammatory mediators, increasing nasopharyngeal colonization, and suppressing immune defenses; exposure to other children increases the likelihood of colonization and infection with the viruses associated with OM.

Although often observed and potentially modifiable OM risk factors such as short breast-feeding duration and exposure to cigarette smoke were common in this study, they did not influence early OM incidence. The reason that there was not a significant relationship between OM and smoke exposure may have been the relatively small number of cigarettes per day smoked by study mothers or the lack of a truly unexposed group, given that infant exposure to environmental tobacco smoke was common.

Some studies have shown that longer breast-feeding durations and exclusive breast-feeding decrease OM risk, but others have shown that short breast-feeding duration has no effect on OM in early life. Early OM rates were similar among infants with and without these 2 risk factors, so inadequate power is an unlikely explanation for the lack of association between these factors and early OM. However, if infants of women who smoked and did not breast-feed had fewer clinic visits, OM may have been underascertained, resulting in a lack of association between these risk factors and early OM. Women’s levels of knowledge about modifiable OM risk factors varied. Their prenatal belief that steps could be taken to prevent infant OM did not predict their postnatal breast-feeding and smoking behaviors. Lawlor et al. suggested that members of disadvantaged groups consider smoking to be an acceptable risk because they are more concerned about addressing immediate dangers (poor housing conditions, environmental and occupational hazards) they view as more proximate threats.
than smoking.\textsuperscript{28} Discrepancies between knowledge about healthy behaviors and actual healthy behaviors has long been acknowledged by health educators and has given rise to the concept that knowledge alone is not sufficient for behavior change. Strategies intended to change health behaviors must incorporate intrapersonal, interpersonal, institutional, community, and policy factors.\textsuperscript{29}

Data collected prospectively in 2 Minnesota studies involving similar methods revealed higher OM rates in Little Ears than in a sample derived from a health maintenance organization.\textsuperscript{7} The present findings are also consistent with higher rates of OM-associated outpatient visits and hospitalizations reported among American Indian/Alaska Native children than among other US children.\textsuperscript{29}

The majority of OM studies involving American Indian samples has been conducted in Navajo and Apache communities. To our knowledge, this is the first study of OM in a predominantly Ojibwe sample, and our findings may not be generalizable to other tribes.

In addition, women who took part in the Little Ears Study may not have been representative of all eligible women at the study sites. Nevertheless, results from Little Ears are similar to data reported by the Minnesota Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) and the Bemidji Area IHS on Minnesota rates of breast-feeding and smoking during pregnancy.\textsuperscript{30,31} Breast-feeding initiation rates among mothers served by WIC in Minnesota were 60% to 68% between 1998 and 2001, as compared with 58% among participants in Little Ears.\textsuperscript{32} In the Bemidji IHS service area, 41% of women smoked during pregnancy during 1996 through 1998, in comparison with 45% in the Little Ears Study.\textsuperscript{31}

Participants lost to follow-up were more likely to be smokers and to be urban residents. Because OM rates did not vary according to level of environmental tobacco smoke exposure, the overrepresentation of smokers in the group lost to follow-up should not have affected rates of early OM.

In conclusion, OM onset occurred before 6 months of age in nearly two thirds of infants in the Little Ears cohort, but OM may actually have been underdiagnosed in this study, particularly among infants whose mothers did not comply with study visit criteria. URI was the only potentially modifiable risk factor identified. The significant relationship observed between maternal OM history and infant OM may have been due to genetic predisposition or to increased likelihood of detection resulting from maternal awareness of OM and its symptoms.

Although smoke exposure and short duration of breast-feeding were not related to early OM in this study, they have been reported as OM risk factors in other epidemiological studies. Women’s prenatal knowledge and attitudes regarding OM risk were not concordant with their postnatal behaviors. Interventions designed to reduce OM risk factors should focus on barriers to change as well as community, cultural, and policy influences (e.g., health insurance coverage providing regular access to preventive and health care visits).

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**About the Authors**

Kathleen A. Daly is with the Department of Otolaryngology and the Otis Media Research Center, School of Medicine, University of Minnesota, Minneapolis. At the time of this study, Phyllis L. Prie was with the Division of Epidemiology, School of Public Health, University of Minnesota, Minneapolis. Kristine L. Rhodes is with the Division of Epidemiology, School of Public Health, University of Minnesota, Minneapolis. At the time of this study, Lisa L. Hunter was with the Department of Otolaryngology and the Otitis Media Research Center, School of Medicine, University of Minnesota, Minneapolis. Cynthia S. Davoy is with the Division of Biostatistics, School of Public Health, University of Minnesota, Minneapolis.

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**Contributors**

K.A. Daly originated and supervised the study, participated in developing the algorithm to diagnose otitis media, and wrote the article. P.L. Prie trained research nurses in interview techniques, designed many of the questions, and reviewed and commented on the article. K.L. Rhodes coordinated the study and reviewed and commented on the article. L.L. Hunter trained the research nurses in tympanometry and hearing screenings, oversaw the interpretation of these tests, and participated in developing the algorithm to diagnose otitis media. C.S. Davoy performed the analysis, participated in developing the algorithm to diagnose otitis media, and reviewed and commented on the article.

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This study was supported by research grant from the National Institute on Deafness and Other Communication Disorders, National Institutes of Health (grant R01 DC029653), and the Lions SM Multiple District Hearing Foundation.

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**Human Participant Protection**

This study was approved by the institutional review boards of the University of Minnesota and the Indian Health Service. A certificate of confidentiality was also obtained from the National Institutes of Health to protect the confidentiality of sensitive data collected as part of the study. Women or their legal guardians provided written informed consent.

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**References**


Caring For Our Children: National Health and Safety Performance Standards for Out-of-Home Child Care

Caring For Our Children is the most comprehensive source of information available on the development and evaluation of health and safety aspects of day care and child care centers. The guidelines address the health and safety needs of children ranging from infants to 12-year-olds. This field-reviewed book provides performance requirements for child care providers and parents, as well as for regulatory agencies seeking national guidelines to upgrade state and local child care licensing.

The second edition is extensively revised based on the consensus of ten technical panels each focused on a particular subject. The book includes eight chapters of 658 standards and a ninth chapter of 48 recommendations for licensing and community agencies and organizations.

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The Effect of Poverty and Caregiver Education on Perceived Need and Access to Health Services Among Children With Special Health Care Needs

Shirley L. Porterfield, PhD, and Timothy D. McBride, PhD

Nearly 1 in 5 families in the United States have a child with special health care needs.1 Children with special health care needs, both physical and mental, are significantly more likely to live with poor families compared with children in general.2–5 Although poverty is a risk factor for poor health among children, low parental education adds to this risk.6–10 Lack of education is highly associated with low family income, and many families may not realize that children who “take their time” to gain particular skills have a disability or a delay that may be helped by a medical or therapeutic intervention. A survey of adults who accompanied special needs children during appointments with specialist physicians found that only half these caretakers (82.5% were parents) were able to provide even a lay description of their child’s diagnosis.11 Information, including available intervention strategies, was the greatest expressed need in a recent survey of parents of children with disabilities.12 This suggests that support services should be tailored to meet the needs of intended recipients—both children and their caregivers.13

Although children with special health care needs are as likely as other children to have health insurance coverage,14,15 previous research has found lower use of specialty care among children whose parents were low income or less educated.6–10 We hypothesized that information about special needs plays a key role in seeking specialty care—i.e., if parents do not think that their child needs a particular health care service, they will not seek access to that service. Therefore, even though a child with special health care needs may have insurance coverage for specialty care, service use will only occur if the parent seeks treatment.

We examined the association between several variables—family poverty, caregiver level, health insurance coverage, perceived need for specialized health care—and the use of 3 types of specialty health care services—specialist physicians, developmental therapies, and prescription medications among children with special health care needs (N=38,866).

Objectives. We examined the association between several variables and the use of specialist physician services, developmental therapies, and prescription medications among children with special health care needs (N=38,866).

Methods. We used a bivariate probit model to estimate whether a given child needed specialized services and whether that child accessed those services; we controlled for activity limitations and severity of special needs. Variables included family income, mother’s (or other caregiver’s) educational level, health insurance coverage, and perceived need for specialized services. We used data from the 2001 National Survey of Children with Special Health Care Needs.

Results. Lower-income and less-educated parents were less likely than higher-income and more-educated parents to say their special needs children needed specialized health services. The probability of accessing specialized health services—when needed—increased with both higher family income and insurance coverage.

Conclusions. Children with special health care needs have less access to health services because their parents do not recognize the need for those services. An intervention in the form of information at the family level may be an appropriate policy response. (Am J Public Health. 2007;97:323–329. doi:10.2105/AJPH.2004.055921)
influence on levels of information; (3) native language, because parents who speak English as a second language may have difficulty gaining information and using the health care system; (4) child’s age, because health care needs change as children age; and (5) health insurance, because it affects access to health services.

**METHODS**

The 2001 National Survey of Children with Special Health Care Needs (NSCSHCN) was primarily funded by the Maternal and Child Health Bureau and was conducted by the National Center for Health Statistics. The survey was designed to provide state and national estimates of both prevalence and health services use of children aged 0 to 17 years with special health care needs. In the survey, children with special health care needs were defined as those who had “a chronic physical, developmental, behavioral, or emotional condition and who also required health and related services of a type or amount beyond that required by children generally.” Subjects were screened into the survey through a random digit-dialing sampling procedure that was stratified by state. There were 38,866 special needs interviews, 96% of which were completed by a parent of the child in question. The large sample size allowed for the identification of rural and urban residence in 34 states.

**Dependent Variables**

We examined the perceived need for and access to specialist physician services, therapy services, and prescription medications. The NSCSHCN asked the following questions: “During the past 12 months, was there any time when CHILD needed care from a specialty doctor?” If the answer was yes, the follow-up question was, “Did CHILD receive all the care from a specialty doctor that he/she needed?” If the answer was no, the next question was, “Why did CHILD not get the care from a specialty doctor he/she needed?” The first 2 questions in this sequence were used to determine the values of the dependent variables in the estimated models.

**Independent Variables**

**Health status.** The NSCSHCN did not ask parents to identify their child by diagnosis; therefore, for the purposes of our study, children were divided into groups on the basis of a severity-of-special-needs scale. Parents were asked, “Overall how would you rank the severity of CHILD’s condition(s) or problem(s)? Please pick a number between zero and ten where zero is the mildest and ten is the most severe.” Similar to previous research, we collapsed this scale into 4 categories: very low, low, medium, and high severity of the special needs condition.

**Demographics.** Parents’ levels of information about their children’s condition and needs were not directly available. We used 2 variables—family income and caregiver’s educational level—as proxy measures for information. Family income, which has been shown to have an effect on access to health services and perceived need, was included as an independent variable when we estimated both dependent variables. We divided family income into 3 categories: incomes below the federal poverty level (calculated by dividing respondent’s household income by the Department of Health and Human Services’ guidelines for poverty by household size), incomes between 100% and 200% of the federal poverty level, and incomes above 200% of the federal poverty level. We controlled for the educational level of the mother (or the respondent if the mother’s information was not available), which was categorized as having less than a high-school education, having completed a high-school education, or having at least some post-high-school education or training.

Several control variables were included. Race and ethnicity were examined separately, with categories for White, Black, other (including multiracial), and Hispanic. Because respondents were not asked their marital status, children were categorized as having only 1 adult in the household or having 2 or more adults in the household. Categorical variables indicated whether there was more than 1 child with special health care needs in the household.

Whether the interview was conducted in a language other than English and whether the residence was in a metropolitan statistical area.

To capture the change in health care needs as children age, we created an age spline with kinks in the spline that corresponded roughly to the ages at which public interventions change. The first segment of the spline included children aged 0 to 2 years—i.e., those who conceivably might be eligible for and participating in a public birth-to-3 program, such as those funded through Title V (Maternal and Child Health). The second segment included children aged 3 to 5 years, which are the preschool years during which children become the responsibility of their local school district under the Individuals with Disabilities Education Act. The third segment included children aged 6 through 13 years (traditional elementary-school years), and the fourth segment included children aged 14 through 17 years (high-school years).

**Health insurance.** We asked questions about health insurance coverage during the past 12 months. Nonexclusive categorical variables indicated whether the child was uninsured at all during the past year and what types of insurance the child had during the months of coverage. Insurance categories included private coverage, Medicare, the State Children’s Health Insurance Program (SCHIP), Title V coverage, and other public insurance (Medicare, military, and Indian Health Service).

**Analyses**

When modeling the use of health care services, a widely used technique is a 2-stage model: a dummy variable is the dependent variable in the first equation, which indicates whether or not the person accessed health services, and a continuous variable in the second equation measures the amount of health services accessed (measured through total cost of services). In this study, however, we did not have a continuous measure of service use among those who accessed services. Therefore, we used a 2-stage model with dummy variables as the dependent variables for both equations (1 = needed/accessed services, 0 = did not). Nevertheless, the disturbance (error) terms were correlated between the equations. The bivariate probit model handles this type of estimation, where each
TABLE 1—Sample Characteristics From 2001 National Survey of Children With Special Health Care Needs, Weighted Percentage of Sample

<table>
<thead>
<tr>
<th>Dependent variables</th>
<th>Mean</th>
<th>No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specialist physician services, %</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Needed</td>
<td>51.0</td>
<td>38 755</td>
</tr>
<tr>
<td>Received</td>
<td>92.4</td>
<td></td>
</tr>
<tr>
<td>Therapy services, %</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Needed</td>
<td>23.5</td>
<td>38 780</td>
</tr>
<tr>
<td>Received</td>
<td>88.2</td>
<td></td>
</tr>
<tr>
<td>Prescription medications, %</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Needed</td>
<td>87.9</td>
<td>38 796</td>
</tr>
<tr>
<td>Received</td>
<td>98.2</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Independent variables</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Income relative to federal poverty level, %</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; federal poverty level</td>
<td>15.0</td>
<td>35 229</td>
</tr>
<tr>
<td>100%–200% of federal poverty level</td>
<td>22.0</td>
<td></td>
</tr>
<tr>
<td>&gt;200% of federal poverty level</td>
<td>63.0</td>
<td></td>
</tr>
<tr>
<td>Severity of functional limitations, %</td>
<td></td>
<td>38 655</td>
</tr>
<tr>
<td>Very low</td>
<td>17.0</td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>37.9</td>
<td></td>
</tr>
<tr>
<td>Medium</td>
<td>31.7</td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>13.4</td>
<td></td>
</tr>
<tr>
<td>Education of mother or caregiver, %</td>
<td></td>
<td>38 866</td>
</tr>
<tr>
<td>&lt; high school</td>
<td>14.4</td>
<td></td>
</tr>
<tr>
<td>High-school diploma</td>
<td>29.1</td>
<td></td>
</tr>
<tr>
<td>Some post–high-school education/training</td>
<td>52.7</td>
<td></td>
</tr>
<tr>
<td>Age of child, y</td>
<td>9.9</td>
<td>38 839</td>
</tr>
<tr>
<td>0-2</td>
<td>6.4</td>
<td></td>
</tr>
<tr>
<td>3-5</td>
<td>13.0</td>
<td></td>
</tr>
<tr>
<td>6-13</td>
<td>54.1</td>
<td></td>
</tr>
<tr>
<td>14-17</td>
<td>26.6</td>
<td></td>
</tr>
<tr>
<td>Insurance, %</td>
<td></td>
<td>38 866</td>
</tr>
<tr>
<td>Private</td>
<td>72.2</td>
<td></td>
</tr>
<tr>
<td>Medicaid</td>
<td>25.8</td>
<td></td>
</tr>
<tr>
<td>SCHIP</td>
<td>6.3</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>7.8</td>
<td></td>
</tr>
<tr>
<td>Uninsured at least 1 month during past year</td>
<td>11.0</td>
<td></td>
</tr>
<tr>
<td>Has Title V coverage, %</td>
<td>3.0</td>
<td>38 866</td>
</tr>
<tr>
<td>Interview conducted in language other than English, %</td>
<td>3.5</td>
<td>38 866</td>
</tr>
<tr>
<td>Family composition, %</td>
<td></td>
<td>38 866</td>
</tr>
<tr>
<td>Total adults</td>
<td>2.1</td>
<td></td>
</tr>
<tr>
<td>Total children with special needs, %</td>
<td>1.4</td>
<td></td>
</tr>
<tr>
<td>Total children without special needs, %</td>
<td>0.9</td>
<td></td>
</tr>
<tr>
<td>Race/ethnicity, %</td>
<td></td>
<td>38 866</td>
</tr>
<tr>
<td>White</td>
<td>74.7</td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>14.9</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>6.5</td>
<td></td>
</tr>
<tr>
<td>Hispanic</td>
<td>11.5</td>
<td></td>
</tr>
</tbody>
</table>

Note. SCHIP = State Children’s Health Insurance Program. Totals may add to more than 100% because respondents may report multiple responses to questions.

*Percentage of those that needed specialist services.

...equation is a probit estimation equation with the error terms distributed with the normal distribution. Maximum likelihood estimation is used for the 2 equations. To estimate the bivariate probit model, different variables must be included in the different equations; therefore, some variables are indicated as “not included” in the tables.

The estimation of the second stage of the model—whether or not the child accessed the needed service—was modeled as conditional on the child’s need for service. Therefore, the model corrects for any selection bias that might be present, because those who indicated they needed services would access the services.55

RESULTS

Study Population

Characteristics of the sample are shown in Table 1. The most common special health care need identified was prescription medications (87.9%). More than half the families reported that their child needed specialist physician services (51%), and 23.5% reported that their child needed therapy services.

Most children were described as having low to medium special health care needs (37.9% and 31.7%, respectively), and only 13.4% were described as having high needs. A little more than one third of the parents of children included in the sample had annual incomes below 200% of the federal poverty level (37%), which was similar to the proportion of mothers whose formal education had not extended beyond high school (43.5%). More than 70% of the children in the sample had been insured through a private policy sometime during the past year, and 11% had been uninsured for at least 1 month during the past year.

Information and Access to Specialty Health Care Services

The results of the multivariate analysis that was estimated with a bivariate probit model were somewhat difficult to interpret because of their nonlinearity; thus, they were converted into probabilities for more direct interpretation (full regression results are available from the authors). Table 2 shows the probability that a base case, or typical child with special
TABLE 2—Results of Bivariate Probit Models of the Effect of Individual Characteristics on Probabilities of Service Need and Use, by Service Type: National Survey of Children With Special Health Care Needs, 2001

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Specialist Physician Services&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Therapy Services&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Prescription Medications&lt;sup&gt;c&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base case, mean</td>
<td>0.536</td>
<td>0.925</td>
<td>0.202</td>
</tr>
<tr>
<td>Income relative to federal poverty level</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; federal poverty level</td>
<td>0.465 ***</td>
<td>0.875 ***</td>
<td>0.231 *</td>
</tr>
<tr>
<td>100–200% of federal poverty level</td>
<td>0.508 ***</td>
<td>0.899 ***</td>
<td>0.208 *</td>
</tr>
<tr>
<td>&gt;200% of federal poverty level&lt;sup&gt;d&lt;/sup&gt;</td>
<td>0.562</td>
<td>0.940</td>
<td>0.198</td>
</tr>
<tr>
<td>Severity of functional limitations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very low&lt;sup&gt;d&lt;/sup&gt;</td>
<td>0.433</td>
<td>0.965</td>
<td>0.137</td>
</tr>
<tr>
<td>Low</td>
<td>0.500 ***</td>
<td>0.932 ***</td>
<td>0.184 ***</td>
</tr>
<tr>
<td>Medium</td>
<td>0.591 ***</td>
<td>0.906 ***</td>
<td>0.242 ***</td>
</tr>
<tr>
<td>High</td>
<td>0.669 ***</td>
<td>0.894 ***</td>
<td>0.294 ***</td>
</tr>
<tr>
<td>Child has activity limitations</td>
<td>0.653 ***</td>
<td>...&lt;sup&gt;e&lt;/sup&gt;</td>
<td>0.413 ***</td>
</tr>
<tr>
<td>Education of mother/caregiver</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; high school</td>
<td>0.439 ***</td>
<td>0.912</td>
<td>0.197</td>
</tr>
<tr>
<td>High-school diploma</td>
<td>0.486 ***</td>
<td>0.931</td>
<td>0.202</td>
</tr>
<tr>
<td>Some post-high-school education/training&lt;sup&gt;d&lt;/sup&gt;</td>
<td>0.566</td>
<td>0.924</td>
<td>0.203</td>
</tr>
<tr>
<td>Age of child, y spline&lt;sup&gt;f&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0.719 ***</td>
<td>0.953</td>
<td>0.233 **</td>
</tr>
<tr>
<td>4</td>
<td>0.559 ***</td>
<td>0.939</td>
<td>0.318 ***</td>
</tr>
<tr>
<td>9</td>
<td>0.509 ***</td>
<td>0.928 *</td>
<td>0.230 ***</td>
</tr>
<tr>
<td>15</td>
<td>0.538 ***</td>
<td>0.910 **</td>
<td>0.142</td>
</tr>
<tr>
<td>Insurance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private</td>
<td>...&lt;sup&gt;e&lt;/sup&gt;</td>
<td>0.932 ***</td>
<td>...&lt;sup&gt;e&lt;/sup&gt;</td>
</tr>
<tr>
<td>Medicaid</td>
<td>...&lt;sup&gt;e&lt;/sup&gt;</td>
<td>0.944 ***</td>
<td>...&lt;sup&gt;e&lt;/sup&gt;</td>
</tr>
<tr>
<td>SCHIP</td>
<td>...&lt;sup&gt;e&lt;/sup&gt;</td>
<td>0.941 **</td>
<td>...&lt;sup&gt;e&lt;/sup&gt;</td>
</tr>
<tr>
<td>Other</td>
<td>...&lt;sup&gt;e&lt;/sup&gt;</td>
<td>0.911 *</td>
<td>...&lt;sup&gt;e&lt;/sup&gt;</td>
</tr>
<tr>
<td>Uninsured at least 1 month during past year</td>
<td>...&lt;sup&gt;e&lt;/sup&gt;</td>
<td>0.866 ***</td>
<td>...&lt;sup&gt;e&lt;/sup&gt;</td>
</tr>
<tr>
<td>Has Title V coverage</td>
<td>0.659</td>
<td>0.964 ***</td>
<td>0.460 ***</td>
</tr>
<tr>
<td>Non-English interview</td>
<td>0.654 ***</td>
<td>0.908</td>
<td>0.213</td>
</tr>
<tr>
<td>Household composition</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single parent</td>
<td>0.540</td>
<td>0.902 ***</td>
<td>0.194 *</td>
</tr>
<tr>
<td>More than 1 adult&lt;sup&gt;d&lt;/sup&gt;</td>
<td>0.535</td>
<td>0.929</td>
<td>0.204</td>
</tr>
<tr>
<td>&gt; 1 child with special needs</td>
<td>0.528</td>
<td>0.914 **</td>
<td>0.216 ***</td>
</tr>
<tr>
<td>Race/ethnicity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White, non-Hispanic&lt;sup&gt;d&lt;/sup&gt;</td>
<td>0.547</td>
<td>...&lt;sup&gt;e&lt;/sup&gt;</td>
<td>0.204</td>
</tr>
<tr>
<td>Black, non-Hispanic</td>
<td>0.415 ***</td>
<td>...&lt;sup&gt;e&lt;/sup&gt;</td>
<td>0.183 ***</td>
</tr>
<tr>
<td>Other, non-Hispanic</td>
<td>0.513 ***</td>
<td>...&lt;sup&gt;e&lt;/sup&gt;</td>
<td>0.206</td>
</tr>
<tr>
<td>Hispanic</td>
<td>0.508 ***</td>
<td>...&lt;sup&gt;e&lt;/sup&gt;</td>
<td>0.208</td>
</tr>
<tr>
<td>Metropolitan status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lives in a MSA</td>
<td>0.545 ***</td>
<td>0.924</td>
<td>0.199 *</td>
</tr>
<tr>
<td>Lives in non-MSA&lt;sup&gt;d&lt;/sup&gt;</td>
<td>0.513</td>
<td>0.928</td>
<td>0.208</td>
</tr>
</tbody>
</table>

Note. SCHIP = State Children’s Health Insurance Program; MSA = metropolitan statistical area. Probabilities were computed with all variables at their mean, except for the variable shown; probabilities were determined from regression results (not shown but available from the authors).

<sup>a</sup>r = 0.2678** (equation error terms are correlated).
<sup>b</sup>r = 0.4800*** (equation error terms are correlated).
<sup>c</sup>r = –0.8281 (not significant).
<sup>d</sup>Reference group.
<sup>e</sup>Not included in model.
<sup>f</sup>The age spline is computed as an interaction term between the age category indicated and the continuous variable age of the child.

*P < .10; **P < .05; ***P < .01.
health care needs, would both need services and then access services if the child needed the services. A typical child was defined as a child with the mean characteristics of all children in the data set; therefore, to compute the probabilities in Table 2, we used the mean of the variables in the regression models.

Table 2 shows, for example, that the statistical probability was .536 that a base case child would need specialist physician services and was similar to the percentage who were identified during screening as having accessed more health care than their peers. However, a child with these characteristics would be very likely to get the services if their parents identified the child as needing the services, because the probability was .925 that this base case child would get specialist physician services. Similarly, the parents of the base case child would be very likely to indicate that the child needed prescription medications ($P_{=.986}$) and to get medications if the parents indicated a need ($P_{=.993}$). However, the parents of the base case child would be much less likely to indicate a need for therapy services ($P_{=.202}$) and less likely to obtain these services even if the parents indicated that therapy was needed ($P_{=.730}$). The finding that fewer than three quarters of children with special health care needs who needed therapy services actually obtained these services suggests a potential problem of access to care.

The power of the multivariate procedures is to isolate the effects of individual child characteristics on the probability of needing and accessing services while holding all other characteristics equal. Table 2 shows the probability of needing and getting services for a base case child with all the characteristics set equal to the base characteristics, except for the characteristic isolated and shown in the table. For instance, parents whose family income was below the federal poverty level would be less likely to indicate that their child needed specialist physician services ($P_{=.465}$) and also less likely to get the needed services ($P_{=.875}$) compared with a base case child ($P_{=.536}$ and .925, respectively).

We tested whether access to information affects parents’ ability to know whether their child needs services and possibly their ability to access needed services, with both the education and the income variables. We found support for the hypothesis that education influences awareness of need for services, but education had less impact on access to services. For example, mothers who did not complete high school were about 13 percentage points less likely to indicate that their child needed specialist physician services ($P_{=.439}$) compared with mothers who had college degrees ($P_{=.566}$). The less-educated mothers also were about 5 percentage points less likely to report a need for prescription medications. There were mixed results with respect to the impact of mother’s education on actual use of services, with children of less-educated mothers more likely to access specialist physician services and therapy services.

Consistent with our hypothesis about the role of family income, Table 2 shows that a child whose family was poor was significantly less likely to use specialist physician services and prescription medications compared with a child whose family income was above 200% of the federal poverty level. However, lower-income parents also were less likely to report that their child needed specialized health services.

Parents of children with activity limitations were significantly more likely to report that their children needed specialist physician services and therapy services, although the actual use of specialist physician services was significantly lower among these children, and use of therapy services was significantly higher. As expected, access to health insurance played a key role in gaining access to health services, although our analysis suggests that type of health insurance makes little difference, particularly for use of therapy services (Table 2).

**Why Children Did Not Receive Services**

Parents of children who did not access all services needed were asked why services were not accessed. The 2 most common responses were that the services “cost too much” or that there was a “health plan problem” (Table 3). However, the patterns of responses differed quite a bit across the services. For example, although 60.5% of respondents reported that prescription medications cost too much and 29% reported a health plan problem, the responses were reversed for therapy services, with 19.1% reporting the services costs too much and 22.6% reporting a health plan problem.

Therefore, adequate coverage for therapy services was a significant barrier to accessing care for children with special health care needs. In addition to cost and health plan problems, “lack of resources at school” was often cited as a reason for not accessing all necessary therapy services.

**DISCUSSION**

Our study documents the impact of information (measured by proxy through poverty status and mother’s education) on the perceived need for and access to 3 specialized health services for children with special health care needs. Access appears to be driven by the income and educational status of the parents and the severity and nature of the special needs. Both income and education affect access indirectly, because less-educated and lower-income parents have a lower perceived need for specialized health care services. Lower-income parents were more likely than higher-income parents to report that their child with special health care needs had severe functional limitations, but they were less likely than higher-income parents to say that their children needed specialized health care services. Some of these findings may be the result of parents who believed services were not affordable, because “high cost” was the reason most often reported for not accessing services (Table 3). However, the empirical results presented here point to another explanation: because income levels of parents affected their perceived need for specialized health care services—which should be there regardless of income—lower-income parents may lack the information or the resources to navigate the difficult terrain of accessing health care for their children. We saw a similar pattern when comparing families by mother’s education. The probability of accessing specialized health care services increased with family income.

Many parents who did not access services cited the cost of services as the reason. It is not surprising that respondents cited out-of-pocket costs of services as a barrier, because in 2004, 97% of families with private insurance coverage were responsible for office visit copays or coinsurance, and nearly 80% of families in preferred provider organizations
who saw in-network providers were responsible for annual deductibles that averaged $287.26. A separate 2003 survey reported that 42% (up from 28% in 2001) of working-age Americans with chronic illnesses spent more than 5% of their income on out-of-pocket medical costs (excluding health insurance premiums), despite being covered by private health insurance.

Insurance increases the probability of accessing health services, although insurance type did not appear to matter in our analysis. With the exception of therapy services, nearly everyone who reported a service need did indeed access the needed service. Interestingly, public insurance and private insurance appeared equally effective at providing access to specialist physician services and prescription medications, but they were equally ineffective at providing access to therapy services. However, we also found that parents of children with special health care needs were less likely to access health services if they had been uninsured for at least 1 month during the past year, which suggests that a broader policy response may be appropriate. Title V programs are available to only a small proportion of this population, but these programs appear to be particularly effective at providing access to specialized care.

Our results clearly point to the importance of targeted outreach to low-income and less-educated parents who have children with special health care needs. We found these children were less likely to access health services because their parents did not recognize the need for those services or did not know what services were available. Intervention in the form of information at the family level may be an appropriate policy response, particularly among harder-to-reach subpopulations, such as those with lower incomes or lower literacy.

The way parents obtain access to therapy services needs to be revised. Anecdotal evidence suggests that insurance plans often limit or restrict access to therapy services, although no systematic research appears to have been done in this area. Our results show that parents cited health plan problems more often than costs of care as a barrier to accessing therapy services. Although anecdotal evidence suggests that children with special health care needs benefit greatly from therapy services, the research evidence is mixed. Among school-aged children, therapy services are often accessed through the public schools (as mandated under the Individuals with Disabilities Education Act), yet many of the parents in our study reported that their child’s school-based therapy was “inadequate.”

Although children with special health care needs are disproportionately covered by Medicaid, the role of SCHIP in providing access to health care services for these children is being examined. In a 3-state study, 16% to 25% of new enrollees in SCHIP were children with special health care needs, and fewer than half of these children were covered by any insurance before SCHIP enrollment. Because of recent state proposals to cut SCHIP plans, it is imperative to know what impact the type of public health insurance has on the population of children with special health care needs.


<table>
<thead>
<tr>
<th>Service</th>
<th>Reasons Why Not Accessed</th>
<th>Frequency of Response, Mean (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specialist physician services</td>
<td>Costs too much</td>
<td>27.60</td>
</tr>
<tr>
<td></td>
<td>Health plan problem</td>
<td>24.80</td>
</tr>
<tr>
<td></td>
<td>Not available in area or transportation a problem</td>
<td>9.70</td>
</tr>
<tr>
<td></td>
<td>Inconvenient times</td>
<td>7.70</td>
</tr>
<tr>
<td></td>
<td>Doctor did not know how to treat</td>
<td>10.50</td>
</tr>
<tr>
<td></td>
<td>Some other reason</td>
<td>17.20</td>
</tr>
<tr>
<td></td>
<td>No insurance</td>
<td>2.70</td>
</tr>
<tr>
<td></td>
<td>Child refused to go</td>
<td>4.10</td>
</tr>
<tr>
<td></td>
<td>Difficulty getting appointment</td>
<td>3.90</td>
</tr>
<tr>
<td></td>
<td>Dissatisfaction with provider</td>
<td>2.20</td>
</tr>
<tr>
<td></td>
<td>Treatment is ongoing</td>
<td>4.00</td>
</tr>
<tr>
<td>Prescription medications</td>
<td>Costs too much</td>
<td>60.50</td>
</tr>
<tr>
<td></td>
<td>Health plan problem</td>
<td>29.00</td>
</tr>
<tr>
<td></td>
<td>Not available in area or transportation a problem</td>
<td>2.50</td>
</tr>
<tr>
<td></td>
<td>Doctor did not know how to treat</td>
<td>2.20</td>
</tr>
<tr>
<td></td>
<td>Some other reason</td>
<td>11.80</td>
</tr>
<tr>
<td></td>
<td>No insurance</td>
<td>5.30</td>
</tr>
<tr>
<td>Did not access all needed therapy services</td>
<td>Costs too much</td>
<td>19.10</td>
</tr>
<tr>
<td></td>
<td>Health plan problem</td>
<td>22.60</td>
</tr>
<tr>
<td></td>
<td>Not available in area or transportation a problem</td>
<td>12.00</td>
</tr>
<tr>
<td></td>
<td>Not convenient times</td>
<td>7.50</td>
</tr>
<tr>
<td></td>
<td>Doctor did not know how to treat</td>
<td>3.80</td>
</tr>
<tr>
<td></td>
<td>Some other reason</td>
<td>19.10</td>
</tr>
<tr>
<td></td>
<td>No insurance</td>
<td>2.20</td>
</tr>
<tr>
<td></td>
<td>Difficulty getting appointment</td>
<td>2.40</td>
</tr>
<tr>
<td></td>
<td>Treatment is ongoing</td>
<td>8.30</td>
</tr>
<tr>
<td></td>
<td>Lack of resources at school</td>
<td>14.90</td>
</tr>
</tbody>
</table>

Note: Totals may add to more than 100% because of rounding or because respondents report multiple responses to questions.

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Contributors
S.L. Porterfield originated the study and completed most of the analysis and the writing of the article. T.D. McBride assisted with both the analysis and the writing. Both authors interpreted findings, drew conclusions, and reviewed drafts of the article.
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Human Participant Protection
No protocol approval was needed for this study.

References
Spina bifida and anencephaly are the most commonly occurring neural tube defects and affect approximately 2500 births per year in the United States, though rates have been steadily declining for decades.1–3 Most cases (70%) of spina bifida and anencephaly, as well as other birth defects, can be prevented by consumption of at least 400 micrograms (µg) of folic acid by women of childbearing age prior to conception and during pregnancy.1 Since the implementation in 1996 of folic acid supplementation of enriched grain products, the prevalence of neural tube defects has declined by as much as 26%.4,5

Although it is logical to assume that individuals with spina bifida are candidates to use assistive technologies, comprehensive reviews of their actual use and effect on performance have been relatively sparse. No data are available indicating the prevalence of use for different types of assistive technology by people with spina bifida. In addition, few rigorous evaluations of the public health benefits and rehabilitation outcomes from use of assistive technology by people with spina bifida have been conducted. Based on our review of the literature and clinical experience, we expect that individuals with spina bifida utilize assistive technology to enable or enhance mobility, manipulative skills, personal care independence, and cognitive performance.

Mobility and Community Participation

From our review, we observed that, as children with spina bifida age, they transition from walking to wheeling or a combination of mobility techniques depending on context.6 Those with higher-level lesions might be expected to ambulate initially, but many cease walking after reaching age 3 to 4 years and shift to use of wheeled mobility.7,8 Transition to wheeled mobility increases the risk of wear and tear on upper limbs because of the stress and strain of wheelchair self-propulsion.9 This may be further complicated by device vibration from the terrain, though the risk of upper-extremity damage can be mitigated and economy of energy enhanced through skills training.7,10,11

To actively participate in the community, individuals with spina bifida extend their mobility through driving and use of public transportation, but community mobility can be problematic for wheelchair and other adaptive mobility device users.12 Andrén and Grimby13 found that adults aged 24–43 years with spina bifida in Sweden experienced difficulty with mobility outdoors and when using public transportation because of interactions between personal assistive technology and inaccessible environments.

Mobility is of primary importance for participation in the community, but limitations in hand function and manipulation skills may also be problematic for individuals with spina bifida. When individuals have difficulty performing personal care, such as clean intermittent catheterization (use of a flexible catheter to drain the bladder), managing external collection devices, and digital stimulation for bowel programs (initiation of a bowel movement by insertion of the index finger into the anus to empty one’s rectum), additional accommodations (including use of personal assistants or help from others) may be required. This results in reduced independence in activities of daily living, and the need for specialized personal care routines.13

Difficulty with fine-motor skills, such as handwriting, requires assessment and adaptation, and provides an opportunity for utilization of assistive technology. Manipulation difficulties may be further complicated by cognitive deficits that are characterized by short attention span, learning disabilities, intellectual delay, distractibility, and overall delay in adaptive skill development. Recent studies have confirmed a 50% prevalence rate of specific or general cognitive deficits among individuals with spina bifida and hydrocephalus, and associated enrollment in special education.14,15 Simeonsson et al16 noted that challenges with tactile perception,
auditory concentration, visual perceptual organization, and visual–motor integration are seen in a disproportionate number of children with spina bifida. In addition, a growing number of young adults with spina bifida are facing challenges with respect to education, vocation, housing, and relationships.14

Assistive technology has often been recommended to enhance performance and advance independence outcomes in daily living, community participation, education, and employment, primarily with reference to mobility and bladder or bowel care. The selection of mobility aids such as wheelchairs, walking aids (e.g., crutches), or lower-limb braces (e.g., ankle–foot orthosis) is primarily determined by lesion level. Bartonek and Saraste17 evaluated a series of patients with spina bifida and contrasted those who achieved expected ambulatory function outcomes with those who did not. They found that although lesion level predicted the type of mobility aid, it did not predict the successful use of that aid. Rather, a wide range of other factors seemed to influence successful use of mobility devices.

Self-Care and Cognitive Support

With regard to bladder and bowel care, clean intermittent catheterization and timed bowel programs are the most frequent solutions with varying degrees of successful day-to-day management.20 Less successful implementation of bowel and bladder routines leads to increased risk for secondary complications and adverse psychosocial complications.8,19,20

Assistive technology to support cognitive functioning has also been used for children with spina bifida. These technologies include electronic time prompts and alarm avoidance to improve performance of wheelchair push-ups,21 memory aids to assist in health maintenance routines,22 word-prediction software to improve the rate and accuracy of text entry on computers,23 and hand-held electronic predictive spelling aids.24 Although these interventions appear promising, long-term efficacy for any device has not been established.

Barriers to Assistive Technology Use

In a survey of individuals aged 16 to 25 years with motor disabilities (including spina bifida) regarding barriers encountered with use of assistive technology, researchers in Sweden found that respondents most frequently complained about lack of access to computers and software at school and home, to technical aids for leisure time, and to mobility devices.25 Although half of the participants were satisfied with the level of technical assistance they received, half reported they received too little technical support, information, and training to effectively use assistive technology independently. This resulted in a continued need for personal assistance from parents or aides. The subjects also reported that as they transitioned into adult life, they felt increasingly isolated and lonely and perceived a social discrimination that resulted in their exclusion from community participation.

It is important to understand the impact of assistive technology on health and function. However, measuring outcomes of assistive-technology use is complex. Complex interactions between physical, functional, psychosocial, and quality-of-life variables all contribute to either technology use or abandonment.26

The positive benefits of enhanced function afforded by assistive technology may not outweigh dissatisfaction with its appearance, difficulties with maintenance, cost, and other factors.

Critical Transitions

The transition from childhood to young adulthood is a demanding developmental stage. During this time, individuals encounter significant challenges as they move from high school to postsecondary education or employment. There is also the necessary transition from the pediatric to the adult health care system. During this transition, young adults with disabilities will encounter changing roles and expectations. In addition, their repertoire of skills, competencies, and needs are often not well matched to the requirements of the adult world.27

Shultz and Liptak28 proposed that characteristics such as high self-esteem, positive social orientation, warm and cohesive family life, friendship networks, and previous success in coping with stressful experiences are helpful for this transition. Adolescents with spina bifida may have fewer opportunities to develop these characteristics within the context of their complex health, physical, cognitive, and social challenges. Low engagement in typical activities of adolescence such as decisionmaking, friendship activities, and household responsibilities are likely to impede successful transition to adulthood, particularly in terms of self-management and employment.29

Adolescents and young adults with disabilities who rely on assistive technology are often transitioned toward unclear or tentative postsecondary education, employment, and independent living outcomes.30 In the kindergarten through-12th-grade educational and pediatric medical environments, adolescents may have access to a broad range of support for assistive technology and other activities. In the postschool and adult medical environments, assistive technology and related services are less well integrated and less available. In addition, assistive technology support needs may increase even though funding for services tends to diminish.

Advocacy and networking skills are often required to successfully access services, and these may not be well developed in young adults with disabilities. For example, young adults may need to build relationships with vendors who sell assistive technology and other experts to receive the support they need for their assistive technology. A recurrent cycle of technology evaluation, selection, acquisition, training, use, and modification may lead to frustration because of changing needs, device failure, or new options and features of technology that necessitate retraining. Although expectations about the value of assistive technology vary across adolescents with various types of disability, most hope for greater access to assistive technology and, with it, a higher level of social acceptance in the community.30

The purpose of this research was to examine a historical database for information about adolescents and young adults with spina bifida to gain a better understanding of their use of assistive technology and level of community participation. The results of this descriptive study will define goals for more in-depth future research into the use of and satisfaction with assistive technology among adolescents and young adults with spina bifida and the relationships between assistive technology, quality of life, and secondary conditions that emerge while these individuals function and age.
METHODS

Data were obtained from a cross-sectional sample drawn from an existing longitudinal database maintained at Children’s Hospital and Regional Medical Center, Seattle, Washington. The Patient Data Management System is a cumulative database that contains serial examination information on all children seen at Children’s Hospital and Regional Medical Center with spina bifida beginning in 1960. Data were collected on multiple aspects of their health care: primary and secondary conditions, developmental milestones, surgical procedures and hospitalizations, utilization of mobility devices and other assistive technology, related physical and occupational therapy services, intellectual and educational assessment, and other variables. The institutional review board of Children’s Hospital and Regional Medical Center approved all procedures for this study.

We selected individuals from the database aged between 13 years and younger than 28 years as of December 1, 2003, with a diagnosis of myelomeningocele (n = 348). A cross-sectional data set was created using the most recent record for each individual for each type of assessment (i.e., demographic, physical therapy, occupational therapy, etc.). Descriptive statistics were generated for nonmissing data to determine the prevalence of assistive technology use and to describe the biological, demographic, and functional characteristics of the study sample. To examine personal care independence, we created a composite variable by calculating the sum of each person’s reported ability to do 8 self-care items independently: dress completely, prepare meals, make a sandwich, perform hygiene, use the toilet, do own laundry, wash hands without help, and bathe alone (each coded 1 = pass, 0 = fail). This total score was divided into low (0–2), medium (3–5), and high (6–8) personal care independence.

Characteristics were examined for 2 groups to account for potential differences that might exist between adolescents (aged 13–17 years) and young adults (aged 18 years and older).

RESULTS

The study sample was nearly evenly divided between males and females (Table 1) and ages ranged from 13 to 27 years (mean age = 18 ± 2.46 years). Sacral lesions were most common (37%) among adolescents, whereas mid and low lumbar-level lesions were most common (37%) among young adults. Overall, 68% had a shunt in place, of whom 93% had received the shunt before they were aged 6 months.

At the time of their most recent assessment, 93% of the adolescents lived with 1 or both natural parents, whereas the same was true for only 75% of the young adults. All individuals aged younger than 18 years were in some type of education program (Table 1). Forty-three percent of the adolescents attended regular education classes within 2 grades of their age; 80% of the young adults were employed.
expected level, 27% were in special education, 9% were in regular education with more than 2 years delay, and 21% were in regular education placements with a resource room, where students were offered the opportunity for additional educational services outside the regular classroom. Of the young adults, 35% were still attending special education and 17% were in regular education classes within 2 grades of expectation. Only 50% of the young adults had completed high school and only 14% had completed college degrees or vocational or technical training. (Some students may have reported that they had graduated from high school when they were still receiving special technical training. (Some students may have reported that they had graduated from high school when they were still receiving special educational services.) Among the young adults, 71% reported no current employment.

More than half of the individuals (57%) used manual or electric wheelchairs (Table 2). In addition, 35% used braces and 23% used some form of walking aid to assist with ambulation (Table 2). Ninety percent of individuals reported some kind of stool management program (digital stimulation, timed program, enema, suppository). Furthermore, 97% reported a program for bladder management (clean intermittent catheterization, diapers, incontinence pants, external collector). These characteristics were similar for both age groups.

Personal care independence was similar for both age groups. The majority of individuals reported moderate to high independence when it came to self-care activities such as eating, washing, and dressing without help (Table 3).

Thirty percent of the adolescents reported independent ambulation without aids or braces outside the home; this was true for only 16% of the young adults (Table 3). A greater percentage (36%) of young adults was wheelchair independent compared with the younger group (25%). More than half (53%) of the young adults used independent transportation (either automobile or public transit), compared with only 33% of the adolescents.

Despite apparently satisfactory mobility with or without aids, 72% reported no participation in structured activities and 63% reported no participation in unstructured activities (Table 3).

Limited information was available regarding the developmental status of the individuals in the database. For approximately half of the sample, verbal IQ (mean $= 87.28 \pm 18.02$) and performance IQ (mean $= 82.79 \pm 17.48$) scores were available. Although the means scores were not in the range of developmental disability, they fell below the 16th percentile compared with the scores of age-matched peers in the general population (e.g., mean IQ score $= 100 \pm 15$ for Wechsler instruments).

### DISCUSSION

Spina bifida is a relatively uncommon condition and the resulting disability is variable depending on lesion level, shunt history, cognitive resources, secondary conditions, and psychosocial and environmental variables. Few databases exist that allow detailed examination of such a large sample of individuals over time. In this study, we used a cross-sectional sample to describe the biological, demographic, and functional characteristics of adolescents and young adults with myelomeningocele. This unique opportunity provides the background data necessary to conduct further research on assistive technology, secondary conditions, and other areas important to people with spina bifida.

The results of this study also provide a method for comparing experiences of adolescents and young adults with spina bifida to those of peers with other kinds of disabilities as well as with developing peers without disabilities. For example, the employment rate for individuals of working age in the database is approximately the same as that reported by the National Council on Disability on the basis of census data for adults with disabilities. However, the unemployment rate is mediated to some degree by the 14% who are attending some type of postsecondary education or training. Given that most people with disabilities are able and would prefer to work with appropriate supports, including assistive technology, and that employment confers significant advantage in terms of health status, perceived quality of life, and economic well-being, this high rate of unemployment is of concern.

### Limitations

In general, information about assistive technology in the database was limited to mobility devices and personal care programs, which reflected the medical model under which these data were collected. A broader range of data with respect to the barriers individuals encounter in their communities, the assets they bring to bear on these barriers, and the compensatory strategies they employ are not currently available. Furthermore, the extent of the role played by assistive technology in the level of independence observed among individuals in this data set with regard...
to hygiene, eating, dressing, and community participation is unclear. Information regarding assistive technology use in school or work environments is also not captured in these data.

Analysis of these data was limited by time (age) differences between the most recent assistive technology and medical technology assessments and demographic updates (i.e., education, employment, living status, and so on). Changes may have occurred in an individual’s use of assistive technology and the database information may not be current with respect to independent living, employment, or community participation status for some participants. On the basis of age and date of last assessment, we estimate that time differences would only affect 10% of the study sample and would not have a significant impact on our conclusions.

Recent Assistive Technology Developments

There are a number of relatively recent developments in assistive technology that may be presumed to potentially benefit adolescents and young adults with spina bifida. In the area of assisted mobility, a range of lighter-weight, manually propelled wheelchairs are now more commonly available. Power-assisted manual wheelchairs and battery-powered scooters may also provide greater options for future community mobility needs. Although community transit access continues to be problematic, greater availability and use of paratransit services and wheelchair-accessible city bus systems may afford broader access to community activities and supports.

For students with learning disabilities, a variety of compensatory software programs are now available. For example, students with writing difficulties can now use speech-recognition software for text entry. Alternatively, they may use word-prediction software, with correction for words begun with phonetic spelling, to increase the speed and accuracy of writing. Students with reading disabilities can use a variety of software applications to convert text to speech. Memory and other executive-function deficits may be aided with personal digital assistants, text pagers, cell phones with calendar or text page capacity, watches with alarms or calendars, and other tools.32 No research is available on the prevalence of use of assistive technology to address learning difficulties among youth with spina bifida, and there is no research to support the efficacy of these interventions for this group, so this would be fertile ground for future research. Currently, assistive technology is not available to effectively compensate for those students with overall diminished intellectual resources.

Public Health Implications

The biggest public health priority related to spina bifida is prevention of the disease by use of dietary supplements of folic acid by women of childbearing age. It is estimated that 70% of cases are preventable with this intervention.1 In addition, reduction in the incidence and severity of secondary conditions and the promotion of health and well-being among individuals with spina bifida is also an important area of focus for public health practitioners.33 These public health priorities contribute to the broader goals of increasing the independence, productivity, social participation, and quality of life for people with spina bifida.

A recent survey of adults with disabilities in Washington State showed that moderate-to-severe secondary conditions were 2 to 3 times more likely in adults with disability than in adults in general.34 The most commonly reported secondary conditions included pain, obesity, fatigue, difficulty getting out into the community, falls and injuries, sleep problems, muscle spasms, and bowel and bladder problems. These findings are consistent with the secondary conditions expected and found among those who have spina bifida.30 Furthermore, though research
has shown that adolescents with physical disability, including those with spina bifida, may be less likely than nondisabled counterparts to smoke, drink, or use drugs, they are much more likely to have unhealthy eating patterns and to engage in sedentary leisure activities that diminish opportunities to maintain fitness.35

Although the incidence of spina bifida is on the decline, the number of individuals affected with a childhood disability is on the rise. Individuals with spina bifida could benefit from programs and approaches proposed for use with others who have developmental disability. Ayyangar36 contended that although conditions resulting in childhood disability are varied, using a general health framework approach to their care and management is most advantageous. A broad focus on anticipatory guidance, growth, development, medical care, psychological and vocational counseling, and resource planning is recommended to address particular challenges. Promoting healthy eating habits, encouraging exercise and socialization behaviors, and strengthening bonds between children with disability, family, and community are essential to minimize disability-related problems in adulthood.

There is variable success with independence and full community participation among those with spina bifida, which may relate to the complexity of the disorder and associated disability management methods, including uses of assistive technology. Although using assistive technology can result in significantly enhanced independence, employment, and life satisfaction, the technology must be carefully matched with the individual to achieve successful outcomes.37

Conclusions

A significant number of adolescents and young adults with spina bifida rely on assistive technology and special care routines to maintain their health. They use assistive technology for mobility, but little is known about secondary complications such as musculoskeletal overuse syndromes and other challenges associated with wheelchair and walking-aid use. However, the use of assistive technology to address learning disabilities and other barriers to societal inclusion is not so evident. This underutilization may be delaying or restricting successful transitions to independent living and full participation within the community. Additional research to determine the extent to which assistive technology is used, the impact of assistive technology on daily living and quality of life, and the ways in which assistive technology contributes to secondary conditions in individuals with spina bifida is warranted. From these additional data, recommendations could be made to increase consideration of assistive technology across a broader range of domains.

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K.L. Johnson originated the study and led the writing of the article. B. Dudgeon and W. Walker contributed to the interpretation of the data and the writing of the article. C. Kuehn led the data analysis and collaborated in writing the article.

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Human Participant Protection
Approval to conduct this study was given by the institutional review board of Children’s Hospital and Regional Medical Center, Seattle, Wash, and was obtained prior to the analysis of this data set.

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Johnson et al. | Peer Reviewed | Research and Practice | 335
Adolescent Participation in Preventive Health Behaviors, Physical Activity, and Nutrition: Differences Across Immigrant Generations for Asians and Latinos Compared With Whites

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In the year 2000, 1 in 5 children in the United States was an immigrant or a child of immigrants, yet the health and health behaviors of this large and growing population remain understudied. Research on immigrant adolescents suggests that rates of risk behaviors such as substance use increase across generations, but other health-related behaviors have received less attention. Differences across racial/ethnic groups have been noted overall for prevalence of adolescent behaviors such as bicycle helmet and seat belt use, physical activity, and eating a healthy diet. A large percentage of the Asian and Latino populations are first- or second-generation immigrants, yet no studies have compared multiple generations of these groups with Whites to understand whether behavioral disparities may be emerging across generations.

Acculturation is the multidimensional and multidirectional process whereby immigrants and their descendents adopt the behaviors, beliefs, and values of the host culture while adapting those belonging to their culture of origin. Generation status does not directly measure acculturation, but is an important and easily identifiable measure representing length of exposure to the host culture. Generation status has been associated with variations in health care access and utilization, education outcomes, and health-risk behaviors.

For Latino adolescents, substance use and sexual activity have been shown to increase with generation. One small study that explored preventive health behaviors suggested that foreign-born Latino adolescents use seat belts more often than do US-born Latino adolescents. For some Latinos, the language spoken at home and the proportion of foreign-born neighbors mediate obesity-related behaviors such as dietary behavior, physical activity, and smoking, and these differences are related to the increased obesity seen in US-born Latino adolescents. For Asian youths, the association of behavioral trends with generation status remains largely unexplored, although one study that measured acculturation linked increased English language use to smoking.

The phenomenon of health and health behaviors worsening from first to later generations has been termed “the healthy immigrant effect.” No study has explored whether this trend holds across ethnic groups for multiple health-related behaviors such as physical activity, preventive behaviors (bicycle helmet, seat belt, and sunscreen use), television viewing and video game playing (with less considered healthier), and dietary behaviors (higher fruit, vegetable, and milk consumption; lower soda consumption). For Latino adolescents, the phenomenon was generally worse, whereas Whites demonstrated generally worse preventive health behaviors than did Whites and, in the case of nutrition, a worsening across generations. Targeted interventions may be needed to address behavioral disparities.

Objectives. We investigated preventive health behaviors (bicycle helmet, seat belt, and sunscreen use), physical activity, television viewing or video game playing, and nutrition (fruit, vegetable, milk, and soda consumption) among Asian and Latino adolescents living in the United States; assessed trends across generations (first-, second-, and third-generation immigrants or later); and compared each generation with White adolescents.

Methods. We used data from 5801 adolescents aged 12 to 17 years in the representative 2001 California Health Interview Survey.

Results. In multivariate analysis, first-generation Asians measured worse than Whites for preventive health behaviors (lower participation), physical activity (less activity), and television viewing or video game playing (more hours), but improved across generations. For these same behaviors, Latinos were similar or worse than Whites, and generally showed no improvement across generations. First-generation Asians and Latinos had healthier diets than Whites (higher fruit and vegetable consumption, lower soda consumption). However, Asian adults’ fruit and vegetable consumption decreased and their soda consumption increased, so that by the third generation Latinos’ nutrition was poorer than Whites’.

Conclusions. For the health behaviors we examined, Asian adolescents’ health behaviors either improved with each generation or remained better than that of Whites. Latino adolescents demonstrated generally worse preventive health behaviors than did Whites and, in the case of nutrition, a worsening across generations. Targeted interventions may be needed to address behavioral disparities.

Therefore, we analyzed data from a representative study of California adolescents that included a large sample of Asians and Latinos. We examined the health-related behaviors of California adolescents in 4 ways. We assessed behaviors for Asians and Latinos and compared each group as a whole first with White adolescents and secondly with each other. Next, we compared each generation with Whites. Finally, we analyzed data for within-group racial/ethnic trends across first, second, and third or higher generations for Asians and Latinos. Characterizing the health-related behaviors of immigrant populations and how these behaviors change with generation may identify subpopulations among which clinical or public health interventions may be particularly effective.

METHODS

Data Source and Participants

We used data from the adolescent portion of the 2001 California Health Interview Survey, conducted from November 2000 to September 2001. The California Health Interview Survey is a statewide telephone survey that collects information on health, health-related behaviors, and access to health care. It is representative of the state’s noninstitutionalized civilian population. Detailed methodological information appears elsewhere.

The California Health Interview Survey used a 2-stage, random-digit-dial design. In stage 1, a random sample was taken from a list of all California telephone numbers, which were then screened to determine if they were residential households. In stage 2, 1 adult per household was randomly selected for interview. Adults who were the parent/guardian of an adolescent (aged 12–17 years) gave consent to interview 1 randomly selected youth. Adolescents provided assent. A computer-assisted telephone interview was conducted in 6 languages (Cantonese, English, Khmer, Korean, Mandarin, Spanish, and Vietnamese); 12% of adults and 9% of adolescents were interviewed in a language other than English.

Data were collected on 55,428 adults and 5801 adolescents. The household screener completion rate was 59.2%, and the overall response rate was 37.7%. This is comparable to other random-digit-dial surveys.

The adolescent interview completion rate was 63.5% among screened households. Response rates did not differ by gender or number of adolescents in the household, but parents were slightly more likely to grant permission for older (aged 15–17 years) than for younger adolescents. Poststratification and other nonresponse adjustments corrected for selective nonresponse on the basis of demographic and geographic factors.

Outcome Variables

Adolescents were asked questions on preventive health behaviors including: “How often do you wear a helmet when riding a bicycle?”; “How often do you use a seat belt when riding or driving in a car?”; and “How often do you use strong sunscreen—a sunscreen with sun-protection factor of 15 or greater—when you go outside on a very sunny day for more than 1 hour?” The median was used to dichotomize these variables. Bicycle helmet use was calculated only for respondents who rode bicycles, and was coded as 1 = always or usually wears a helmet versus 0 = sometimes or never. Seat belt use was coded as 1 = always uses a seat belt and 0 = usually, sometimes, or never. Sunscreen use had 3 responses, and was coded as 1 = always and 0 = sometimes or never.

Adolescents were asked about physical activity: “In the past 7 days, did you do any physical activity for at least 20 minutes that made you sweat and breathe hard, such as basketball, soccer, running, swimming laps, fast bicycling, fast dancing, or similar aerobic activities?” They were also asked: “Again, thinking about the past 7 days, did you do any physical activity for at least half an hour that did not make you sweat or breathe hard? This could be things like walking for at least 30 minutes, slow bicycling or skating, or doing chores like cleaning the house or mopping floors.” Responses for both questions ranged from 0 to 7 days. The percentage meeting 2004 Centers for Disease Control and Prevention adolescent recommendations for minimal activity was calculated with the following standards: vigorous activity for at least 20 minutes or moderate activity for at least 30 minutes over at least 3 of the past 7 days. This definition appeared on the Centers for Disease Control and Prevention’s public education Web site before adoption of new recommendations in 2005, and was recommended in the 2000 federal report to the President on physical activity.

Adolescents were asked, “Thinking about your free time on Monday through Friday, on a typical day, about how many hours do you usually watch TV or play video games (such as PlayStation)?” The question was repeated for Saturday and Sunday. The average daily number of hours spent on these activities was calculated as a weighted average of weekday and weekend responses.

Mean daily dietary intake was calculated from: “How many servings of fruit, such as an apple or banana, did you have yesterday?”; “How many servings of vegetables, such as corn, green beans, lettuce, or other vegetables, did you have yesterday?”; “How many glasses of milk did you drink yesterday?”; and “How many glasses of cans of soda, such as Coke or 7-Up, did you have yesterday?”

Independent Variables

Adolescents were defined as first generation if they were born outside the United States, second generation if US-born with 1 or more foreign-born parents, and third generation or later if the adolescent and both parents were born in the United States. Adolescents were asked to describe themselves as Latino/Hispanic or not, and then as 1 or more of the following: American Indian or Alaska Native; Asian; Black or African American; Native Hawaiian or other Pacific Islander; White; or other. Respondents choosing multiple groups were asked which group they most identified with. Respondents who again chose multiple groups were categorized as “other or multiple races.” Age and gender were self-reported. The parent or guardian reported his or her own level of education (less than high school, high school, some college, college graduate, and greater), household income, and number of household members (from which percentage of federal poverty level was calculated), and residence zip code (population density by zip code was used to determine rural vs urban residence).

Data Analysis

Descriptive statistics were computed by race/ethnicity and generation within Asian
and Latino groups. These included means for nutrition and television or video game outcomes (which were continuous) and percentages for other outcomes (which were dichotomous).

A first set of multivariate regressions predicted outcomes from a model of racial/ethnic and generation indicators (within Asian and Latino groups). Whites were the reference group. The models made 3 sets of comparisons: (1) each racial/ethnic group (i.e., Asians, Latinos) versus Whites, and versus each other (pooling across generation for each); (2) each Asian and Latino generation versus Whites overall; and (3) a test of within-group racial/ethnic generation trend among Asians and Latinos. These regressions were linear for continuous outcomes and logistic for dichotomous outcomes.

A second set of multivariate models predicted the same outcomes when adjusted for the following covariates: adolescent age and gender, parent education level, rural versus urban residence, and percentage of federal poverty income level. These models are referred to as the adjusted models. Using recycled predictions, we present covariate-adjusted means from linear regressions and covariate-adjusted percentages from logistic regressions by race/ethnicity and generation.

Final analyses were weighted, and SAS version 9.1 (SAS Institute Inc, Cary, NC) survey procedures that account for the California Health Interview Survey’s complex sample design were used. No variable was missing for more than 2% of cases. Because missing responses were rare, we used mean imputation for continuous variables, median imputation for ordered categories, and modal imputation for unordered categories.

Data for all racial/ethnic groups are presented in Table 1 and indicated in the “Total” lines in Tables 2 and 3, but regression results are presented only for Asians and Latinos.

### RESULTS

#### General Characteristics

The sample of 5801 participants was weighted to reflect the composition of California’s adolescents aged 12 to 17 years (Table 1). The racial/ethnic distribution included White (44%), Latino (36%), and Asian (8%) adolescents. Most Asians and Latinos were first (36% and 28%, respectively) or second (52% and 56%, respectively) generation.

#### Preventive Behaviors

Overall, Asians were less likely than Whites to use bicycle helmets ($P=.05$), seat belts ($P=.002$), and sunscreen ($P=.002$) (Table 2). For all 3 preventive behaviors, participation for first-generation Asians was lower than for Whites ($P=.004$ for bicycle helmet, $P<.001$ for seat belt and sunscreen), but were not significantly different from Whites in later generations. These patterns remain true for all 3 behaviors after adjustment for socioeconomic characteristics despite the loss of the overall generation trend for sunscreen use.

Latinos were less likely than were Whites to use bicycle helmets ($P<.001$) and sunscreen ($P<.001$), but as likely to use seat belts. Latino bicycle helmet use for all 3 generations remained lower than use among Whites even after adjustment ($P<.001$ for each generation). Adjusted analyses found that first-generation Latinos (but not later generations) were more frequently users of seat belts than were Whites, and similar to Whites in sunscreen use. Latinos showed no intragroup generational trends for any of the outcomes.

In comparisons between Asians and Latinos, Asians were more frequent bicycle helmet ($P<.001$) and sunscreen users ($P=.01$) before adjustment. Overall, Latinos were more frequent seat belt users. However, in generational comparisons between the groups, although first-generation Latinos were more frequent users than were first-generation Asians ($P<.001$, data not shown), third-generation Latinos and Asians were similar in usage frequency.

#### Physical Activity and Television Viewing or Video Game Playing

Overall, fewer Asians than Whites met physical activity guidelines, but there was an unadjusted trend toward increased participation ($P=.04$) across generations. Although first-generation Asians were significantly less active than Whites ($P<.001$), second- and third-generation Asians were not significantly different from Whites. The generation trend toward increased physical activity was not significant in the adjusted models. Fewer Latinos met the activity recommendations than Whites in general ($P<.001$) and for first and second generation.
generations in particular (P=.003 and P=.004, respectively), but they were similar at third generation. After adjustment, the difference between Latinos and Whites was not significant overall or at each of the generations. There were no intragroup generational trends. Asians reported more hours of television viewing and video game playing than Whites (P=.002) (Table 3). In adjusted models, first- and second-generation Asians reported more hours than Whites (P=.05 and P=.001, respectively), but at third generation they were similar. Latinos reported more hours overall (P<.001) and at each generation (P<.001 for all) than Whites before adjustment, but after adjustment only third-generation Latinos remained higher than Whites (P=.02). There were no intragroup generational trends for either Asians or Latinos. After adjustment, Asians’ television viewing or video game playing was significantly higher than Latinos’ (P=.04).

Nutrition

Compared with Whites, Asians consumed more servings of vegetables daily (P<.001), fewer servings of soda (P<.001), and similar amounts of fruit (Table 3). There were no intragroup generational trends for these outcomes. Adjusted fruit consumption in first-generation Asians was slightly higher than for Whites, but was not significantly different in second or third generations. Vegetable consumption was higher at each generation and soda consumption was lower in both unadjusted and adjusted models and always using a seatbelt (adjusted model).

Overall, Latino youth were similar to Whites for fruit and soda consumption, and reported less vegetable and milk consumption. Fruit, vegetable, and soda consumption all showed intragroup generational trends (P<.001) in the direction of worsening nutrition. First-generation Latinos consumed more fruit (P<.001) and similar amounts of vegetables compared with Whites, but by the third generation consumed fewer fruits and vegetables (P<.001 for both). First- and second-generation Latino youth were similar to Whites for soda consumption, but third-generation Latinos consumed about 25% more soda than Whites (P=.01). After adjustment, first-generation Latinos were no longer significantly different from Whites in milk consumption; first and second generations consumed less soda than Whites of similar socioeconomic status, but third generation consumed more. The generation trends remained significant.

Comparisons between Asians and Latinos showed no differences in fruit consumption. Asians consumed vegetables more (P<.001), and Latinos consumed soda more (P<.001). Overall, Latinos consumed more milk than Asians, but in generational comparisons between the groups (data not shown), third-generation Asians consumed more milk (P<.001).

As a sensitivity test, we examined whether our overall comparisons by race/ethnicity would have differed if the reference group had been restricted to the 88% of Whites classified as third generation or higher. Because we found no evidence of generation differences among Whites at P<.05 except for 3 dietary behaviors (fruit, vegetable, and soda consumption), we restricted our sensitivity tests to these 3 outcomes; the significance of reported results did not change at the 5% threshold for any of them.

DISCUSSION

Our study illustrates distinctive patterns of health-related behaviors across immigrant generations for Asian and Latino adolescents in California, even after control for socioeconomic status. Generally, Asians showed maintenance or improvement of the health behaviors examined in this article across...
Whites, Latino youth exhibit an emerging trend from better to poorer nutrition than soda consumption. Given the generational of worsening nutrition for fruit, vegetable, and with Whites in bicycle helmet and sunscreen tions toward improving disparities compared to Whites. When present, disparities for Asians appeared in the first generation but not in later generations, whereas for Latinos disparities either appeared in later generations or persisted across generations. These results suggest that the association of behavior with the length of exposure to the United States mainstream culture as measured by generation status may differ by immigrant population.

Latinos showed no trends across generations toward improving disparities compared with Whites in bicycle helmet and sunscreen use, and they showed trends in the direction of worsening nutrition for fruit, vegetable, and soda consumption. Given the generational trend from better to poorer nutrition than Whites, Latino youth exhibit an emerging disparity in these health behaviors across generations. These results are consistent with other studies that suggested that acculturation has a negative effect on measured health-risk health behaviors in this population.11–13 The exception in this study was in meeting Centers for Disease Control and Prevention physical activity recommendations, for which, similar to findings in previous studies,14 minimal variation in levels of physical activity were noted across generations.

The generational trend noted for Latino youth in nutrition is particularly concerning because it may contribute to the high rates of obesity in this community.29 Interventions targeting Latino youth who are new immigrants may help to reinforce healthful nutritional habits.

Unlike previous research suggesting that Asian adolescents’ health-related behaviors might worsen across generations,15–19 our study found that their behaviors improved. In our study, elimination of the disparities seen in first-generation Asian adolescents was noted for bicycle helmet, seat belt, and sunscreen use; percentage meeting Centers for Disease Control and Prevention physical activity recommendations; and hours of television viewing or video game playing. Asians also showed either improvement or maintenance of better nutrition compared with Whites. The improvement in health-promoting behaviors across generations may be because this is the first large and representative sample to study generational trends for Asian adolescents, or the particular behaviors that were assessed. It is possible that other behaviors such as substance use or sexual activity might show different patterns. Our findings may be limited by the small sample size for third-generation Asians, decreasing our ability to note differences between this group and Whites. Because the generational trends included all Asians, we can be assured by the presence of trends for most preventive behaviors and absence of trends for most dietary behaviors that the patterns noted here would likely hold if we did have more statistical power.
Little research has examined why one immigrant population might meet or surpass the majority population in health-related behaviors (e.g., Asians’ preventive behaviors), while another loses its relative behavioral health advantage (e.g., Latinos’ dietary behaviors). Evidence on other topics is informative. Research that utilized the theory of segmental assimilation identified potential factors leading to wide variation across racial/ethnic groups in educational aspiration and attainment of second-generation children. These factors include characteristics of the immigrant group such as average education and job skill levels, the proportion who were documented immigrants or refugees, and the proportion living in 2-parent households. Barriers to achievement included perceived racism and the more rapid acculturation of teens than their parents. Community characteristics thought to contribute differences in behaviors. For example, within subgroups could contribute to generational differences in behaviors. The data on other topics is informative. Research that utilized the theory of segmental assimilation identified potential factors leading to wide variation across racial/ethnic groups in educational aspiration and attainment of second-generation children. These factors include characteristics of the immigrant group such as average education and job skill levels, the proportion who were documented immigrants or refugees, and the proportion living in 2-parent households. Barriers to achievement included perceived racism and the more rapid acculturation of teens than their parents. Community characteristics thought to improve outcomes in this study included high levels of social capital. Research is needed to determine whether factors that influence educational attainment also influence preventive health behaviors and explain differences among racial/ethnic groups.

All youths spent more time watching television and playing video games per day than the 2-hour maximum recommended by the American Academy of Pediatrics. There is not, however, a clear consensus on what are reasonable cutoffs for the amount of time spent with these activities, and more research is needed to determine the nature of any associations with risks for obesity and other health problems. Sunscreen use was infrequent. Risk for skin cancers is higher for lighter-skinned populations, but the American Academy of Dermatology and the American Academy of Pediatrics recommend daily use of sunscreen with a sun-protection factor of 15 or greater for all racial/ethnic groups.

Our findings suggest that, across generations, Latinos show persistent disparities for preventive behaviors and increasing disparities for dietary behaviors, but that for Asians many disparities decrease. Further investigation is required to understand why these differing trends occur, and how interventions may best reinforce positive health behaviors that immigrants bring from their home countries.

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M. L. Allen took primary responsibility for study, analysis, and writing. M. N. Elliott assisted with conceptualization, provided statistical expertise, and assisted with writing. L. S. Morales assisted with conceptualization, study design, and revision. A. L. Diamant assisted with conceptualization, study design, and writing. K. Hambarsoomian assisted with the study and completed analyses. M. A. Schuster oversaw the study and worked closely with Allen in conceptualizing the study, developing analyses, and writing the article.

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**Human Participant Protection**

This project was reviewed by the institutional review board of the University of California, Los Angeles, and deemed exempt from review.

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Residential Segregation and Injection Drug Use Prevalence Among Black Adults in US Metropolitan Areas

Hannah L. F. Cooper, ScD, Samuel R. Friedman, PhD, Barbara Tempalski, PhD, and Risa Friedman, MPH

As recognized by the National Institutes of Health, identifying the determinants of injection drug use among Black adults is important for public health, given the substantial and persistent overrepresentation of Black Americans among people diagnosed with injection-related health problems, including HIV/AIDS and fatal illicit drug overdoses. Structural factors, including racial residential segregation, have been hypothesized to be potent determinants of drug use patterns among Black individuals, and, in fact, some have suggested that such factors play a more important role in determining drug use among Blacks than among Whites. Few studies, however, have pursued related lines of inquiry. This omission is striking when placed within the broader context of public health, a discipline that has increasingly emphasized the structural determinants of health and health-related behaviors.

The microlevel focus of research on drug use patterns among Blacks is, however, consonant with the larger body of research into the etiology of licit and illicit drug use and dependence in the general population, a body of research that has tended to locate the causes of drug use and abuse within the individual, family, and peer group. This microlevel orientation is also evident in drug-related interventions: the 2 principal methods of addressing active drug use and addiction, drug treatment programs and, particularly for Black Americans, the criminal justice system, primarily target individuals.

Our analysis investigates the relations of 2 dimensions of racial residential segregation, namely, residential isolation and concentration, to the subsequent prevalence of injection drug use among Black adults residing within 93 large US metropolitan statistical areas (MSAs). Residential segregation has been found to adversely affect the physical and mental health status of Black populations across the life course. Although no research has yet investigated the association of segregation with injection drug use prevalence among Black adults, available studies allow us to trace a pathway linking these 2 phenomena.

Black residents of segregated communities are at elevated risk of depression, anxiety, and general psychological distress. These mental health outcomes, in turn, create vulnerability to both engaging in injection drug use and sniffing or snorting injectable drugs such as heroin and cocaine.

Research regarding the relation of structural factors to drug use in the general population also testifies to the relevance of structural determinants: rates of unemployment, poverty, arrest, and neighborhood disorder have been found to be associated with patterns of injection drug use and heroin and cocaine use in various geographically defined communities. Because segregation concentrates and amplifies material deprivation in Black communities, this research collectively suggests that segregation may contribute to the prevalence of injection drug use in Black urban populations.

Our examination of the relation of each of 2 segregation dimensions to injection drug use prevalence among Black adults reflects emerging recognition in public health that residential segregation is a multidimensional construct. Until recently, public health research on segregation and health has almost exclusively conceptualized residential segregation as a unidimensional phenomenon consisting of unevenness (defined as the extent to which the racial composition of an MSA deviates from that of its constituent neighborhoods) and operationalized using the dissimilarity index. However, Massey and Denton's 1988 factor analysis of 20 segregation measures found that segregation is instead a highly complex phenomenon consisting of multiple dimensions, including but not limited to unevenness, isolation, and concentration, each signaling a particular spatial configuration.

This complexity has historical roots: although the overarching origins of racial residential segregation lie largely in efforts to re-store and maintain White supremacy in the wake of emancipation, its multidimensional...
nature is in part a product of variations across geographic areas in the specific methods employed to perpetuate this supremacy.\textsuperscript{56,63–65} Acevedo-Garcia and others\textsuperscript{39,60–62} have thus recommended expanding inquiries into segregation and health beyond the current focus on unevenness to include these additional dimensions. The index of dissimilarity has itself been questioned because of concerns about its conceptual links to health and interpretability.\textsuperscript{39,60,62,66} The following paragraphs review the definitions of the 2 segregation dimensions studied here, namely residential isolation and concentration, and trace their possible relation to injection drug use.

\textit{Isolation} refers to the extent of potential intraracial contact for a group in its residential area and thus, reflects a combination of the percentage of the overall population constituted by that group in an MSA and its distribution across the MSA's neighborhoods.\textsuperscript{57,58} Some have hypothesized that isolation is the segregation dimension that holds the most relevance for health, and higher Black isolation has been associated with poorer self-reported health and higher mortality and homicide rates among African Americans.\textsuperscript{39,59,67}

MSAs with high levels of Black isolation were often produced through White violence and legal actions, including zoning laws and restrictive covenants, designed to exclude Black individuals and families from historically majority-White neighborhoods.\textsuperscript{56,68–71} Ongoing discrimination by the real estate and banking industries against Black individuals seeking to buy or lease homes outside majority-Black neighborhoods has perpetuated Black residential isolation.\textsuperscript{56,72}

Drawing on past research that indicates that isolated Black areas can suffer disproportionately high rates of unemployment, poverty, and violence,\textsuperscript{73,74} each of which has been linked to injection drug use or other of injectable drugs,\textsuperscript{50–55,73,76} we posited that MSAs with elevated Black isolation would have a relatively high prevalence of injection drug use among Black adults.

\textit{Concentration} refers to the “relative amount of physical space occupied by a minority group in the urban environment.”\textsuperscript{57,289} As Black migration to cities increased between 1870 and 1970,\textsuperscript{56,65} Whites’ refusal to permit Blacks to live outside strictly delineated areas created highly concentrated Black neighborhoods as existing housing units were divided and subdivided to create new homes for the burgeoning Black population.\textsuperscript{56,69}

Midcentury urban renewal programs that relocated large numbers of Black households from “renewed” areas to majority-Black neighborhoods compounded this concentration.\textsuperscript{56,65} As has been suggested previously,\textsuperscript{24,77} we posited that the overcrowded conditions that can characterize concentrated Black areas would contribute to the prevalence of injection drug use, in part by creating intensely stressful living conditions.

Further, the urban renewal programs that produced some concentrated Black communities might have disrupted social networks and institutions, both in the renewed community and the new host community, for a prolonged period.\textsuperscript{78} Such disruptions have been linked to increased injection drug use and injectable drug use.\textsuperscript{77,79–81}

\section*{METHODS}

We tested the hypotheses that isolation and concentration would be positively related to Black injection drug use prevalence in a sample of 93 large US MSAs with the use of a lagged cross-sectional design, a design commonly used in comparative research in which predictor variables precede the outcome variable in time,\textsuperscript{82–84} thus allowing the statistical model to mirror the conceptual model's temporal sequence.

Defined by the US Census Bureau, MSAs are adjacent counties that include at least 1 central city home to 50,000 or more people that collectively form a single cohesive socio-economic unit.\textsuperscript{85,86} To be included in our sample, MSAs had to have been home to at least 500,000 residents in 1993. Ninety-six MSAs met this criterion. Three MSAs, however, lacked sufficient data on injection drug use among Black adults and were dropped from the sample. The boundaries of 50 MSAs changed between 1990 and 1998\textsuperscript{87}, all measures were operationalized using 1998 boundaries.

\section*{Measures}

\textbf{Segregation.} Massey and colleagues\textsuperscript{58} have identified the isolation and relative concentration indexes as valid measures of their respective constructs. The isolation index captures, for the average member of racial/ethnic group X in an MSA, the percentage of individuals sharing his or her residential census tract who are also in group X (Table 1).\textsuperscript{56,88,89}

The relative concentration index compares the surface area of census tracts occupied by 1 racial/ethnic group in an MSA to that occupied by another (Table 1).\textsuperscript{57} As Massey and Denton\textsuperscript{90} note, this area-based measure also reflects tract population density: because tract boundaries are partially determined by population size, tracts with a smaller surface area are usually more concentrated than larger tracts. Where MSA boundaries remained constant between 1990 and 1998, index values were obtained from the 1990 Census. Otherwise, we calculated values using 1990 US Census Summary Tape File 1 data.

\textbf{Injection drug use prevalence among Black adults.} It is difficult to estimate injection drug use prevalence in geographic areas because injection drug use is both illegal and heavily stigmatized.\textsuperscript{91–94} Our calculation method estimated the 1998 prevalence of injection drug use among Black adults in each of the 93 MSAs in a 4-stage process: (1) estimating the proportion of injection drug users in each MSA who are Black, (2) calculating the number of injection drug users, regardless of race, in each MSA, (3) calculating the prevalence of injection drug use among Black adults with project data produced in stages 1 and 2 combined with US Census data on the number of Black and White adults in each MSA in 1998, and (4) validating our injection drug use prevalence estimates. Project stages 1 and 2 have been described in detail elsewhere.\textsuperscript{14,95}

In stage 1, we calculated the proportion of injection drug users who were Black in 1998 in each of 3 databases that documented injection drug users’ encounters with the health care system and then averaged these database-specific percentages to create a single estimate for each MSA.\textsuperscript{14} The 3 databases analyzed were the Substance Abuse and Mental Health Administration’s (drug) Treatment Episode Data Set (TEDS) and the Centers for Disease Control and Prevention’s HIV Counseling and Testing Database (CTS) and AIDS Public Information Database (APID) (Table 2).
<p>| TABLE 1—Construct Definitions, Operational Definitions, and Formulas for Calculating 2 Dimensions of Racial Residential Segregation in Metropolitan Statistical Areas (MSAs) |</p>
<table>
<thead>
<tr>
<th>Construct and Construct Definition</th>
<th>Measure and Operational Definition</th>
<th>Measure Formula, Range, and Interpretation</th>
</tr>
</thead>
</table>
| Isolation: Extent of potential contact among members of a single racial/ethnic group within their residential area. | Isolation index: For the average member of racial/ethnic group X in a MSA, the percentage of individuals sharing his or her residential census tract who are also in group X. | Formula: $\sum_{i=1}^{N} \left[ \frac{x_i}{X} \right] \left[ \frac{x_i}{t_i} \right]
$

where

$x_i$ = no. of members of group X in census tract $i$

$X$ = no. of members of group X in the MSA

$t_i$ = total population of census tract $i$

Range: proportion of population in group X − 1.0

Interpretation: A value of 1.0 indicates total isolation.

Concentration: “The relative amount of physical space occupied by a minority group in the urban [and suburban] environment”57,90 | Relative concentration index: Ratio of urban and suburban space occupied by 1 racial/ethnic group relative to that occupied by another in a MSA. | $\left\{ \frac{\left[ \sum_{i=1}^{n_1} (x_i a_i / X) \right]}{\left[ \sum_{i=1}^{n_2} (y_i a_i / Y) \right]} - 1 \right\}$

where

Census tracts are ordered from smallest to largest in surface area and

$a_i$ = area of census tract $i$

$n_1$ = rank of tract where cumulative total population of tracts equals total minority population of MSA, summed from smallest tract up

$n_2$ = rank of tract where cumulative population of tracts equals majority population total from largest tract down

$T_1$ = total population of tracts from 1 to $n_1$

$T_2$ = total population of tracts from $n_2$ to $n$

$y_i$ = no. of members of group Y in census tract $i$

$Y$ = no. of members of group Y in MSA

$X$, $x_i$, and $t_i$ as defined above

Range: no lower bound to 1.0

Interpretation: A value of 1.0 indicates that X’s concentration exceeds Y’s concentration to greatest extent possible.

Source: Massey D and Denton N.57,16

Because the proportion of injection drug users who were Black in APID reflected racial patterns of both HIV seroprevalence and injection drug use, APID-based estimates were adjusted for the HIV seroprevalence among Black injection drug users in the MSA. We analyzed CTS, APID, and TEDS data because each database captures a slightly different segment of the underlying injecting population in each MSA. Collectively, they should represent the racial demographics of this underlying population better than any single database could alone.14

In stage 2, to calculate the number of injection drug users in each MSA, we first adjusted the 1998 National Household Survey on Drug Abuse estimate of the number of past-year injection drug users nationwide to account for underreporting of injection drug use and undercoverage of injection drug users.95–97 The adjusted nationwide figure was then apportioned to each of the 93 MSAs studied with the use of data on national and MSA-specific patterns of utilization of injection drug use-related services and past MSA-specific injection drug use estimates.95

In stage 3, we calculated the number of Black injection drug users in each MSA by multiplying the proportion of injection drug users in the MSA who were Black (from stage 1) by the estimated number of past-year injection drug users in that MSA (from stage 2). We then calculated race-specific injection drug use prevalence estimates by dividing the number of Black injection drug users in each MSA by the total number of Black adults aged 19 through 65 years in that MSA in 1998, obtained from the US Census.
In stage 4, we investigated our estimates’ validity by correlating them with 2 theoretically related variables, the prevalence of heroin and cocaine overdose fatalities (calculated using the Centers for Disease Control and Prevention’s Multiple Cause of Death database) and of injection-related AIDS among Black adults (calculated using the APID).

Because the prevalences of injection drug use, overdose mortality, and AIDS among Black adults were each highly correlated with the region of the country in which the MSA was located and the MSA population size and racial composition, we used partial correlation methods to validate our prevalence estimates that controlled for these factors. Recognizing possible circularities inherent in analyzing the relation between injection drug use prevalence (calculated with APID data) and the prevalence of injection drug use-related AIDS, we examined the relation between the prevalence of injection-related AIDS and injection drug use prevalence calculated both with and without APID data.

**Potential confounders.** Past literature suggests that MSA population size, racial/ethnic composition (percentage Black and percentage White), and geographic region might confound the relation between segregation and Black injection drug use prevalence. These variables were calculated using 1990 Census data.

**Analysis**

Multiple linear regression methods were used to test our hypotheses. We conducted extensive exploratory data analysis and regression diagnostics to ensure that the data met our model’s assumptions, and to gain a comprehensive understanding of key variables’ distributions and interrelations. Because the distributions of Black injection drug use prevalence and population size were skewed, they were transformed with a natural logarithmic function. Observations that had undue influence in the multiple regression analysis, assessed with the DFFITS (difference in fit, standardized) test, were reweighted. An examination of variance inflation factors in the multiple regression model indicated that the 2 segregation measures were not collinear and thus could be simultaneously included in the model. The percentage of MSA residents who were Black was, however, collinear with the isolation index (variation inflation factor = 3.5) in this model, a relation rooted in the index’s incorporation of MSA racial composition (Table 1). The variable denoting the percentage of residents who were Black was therefore dropped from the main analysis to increase the point estimates’ precision.

To investigate the extent to which the observed relation between isolation and Black injection drug use prevalence was an artifact of MSA racial composition, we ran a second regression model that incorporated the percentage Black and compared the magnitude of the relation to injection drug use prevalence across the 2 regression models.

**RESULTS**

Our injection drug use prevalence estimates indicate that in half the MSAs studied, there were 1983 injection drug users or more per 100,000 Black adults (Table 3). Injection drug use prevalence among Black adults ranged considerably (interquartile range = 1422 to 2759 per 100,000). The validation analysis indicated that these injection drug use prevalence estimates were positively and significantly associated with the prevalences of overdose deaths ($R = 0.31; P = .003$) and injection-related AIDS among Black adults ($R = 0.49; P < .001$); the latter correlation persisted when injection drug use prevalence estimates were recalculated without APID data ($R = 0.47; P < .0001$).

The median adult population size in the 93 MSAs studied was approximately 721,000, and the median percentage of the total MSA population who self-identified as Black was 9% (Table 3). As in other research on US MSAs, values were high on both segregation measures. In 47 of the 93 MSAs studied, the isolation index indicated that the average Black adult or child lived in a census tract in which at least 48% of the tract population...

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**TABLE 2—Description of Databases Analyzed to Calculate the Prevalence of Injection Drug Use Among Black Adults in 93 Large US Metropolitan Statistical Areas, 1998**

<table>
<thead>
<tr>
<th>Database Characteristics</th>
<th>Treatment Episode Data Set (TEDS)</th>
<th>HIV Counseling and Testing Service</th>
<th>AIDS Public Information Database</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>SAMHSA database recording admissions to public and private drug treatment facilities licensed by the state.</td>
<td>CDC database documenting HIV test incidents at 11,640 HIV counseling and testing sites. Participating sites include family planning and STD clinics, hospitals and private medical centers, drug treatment programs, correctional facilities, and freestanding counseling and testing clinics.</td>
<td>CDC database describing newly diagnosed cases of AIDS.</td>
</tr>
<tr>
<td>Coverage</td>
<td>SAMHSA estimates that the 1997 TEDS database described 87% of all admissions to facilities participating in TEDS and 67% of admissions to all treatment programs nationwide.</td>
<td>No coverage estimates are available.</td>
<td>85% of all AIDS cases are eventually reported in most areas.</td>
</tr>
</tbody>
</table>

Note. CDC = Centers for Disease Control and Prevention; SAMHSA = Substance Abuse and Mental Health Services Administration.
was Black (Table 3; note that this is lower than published values of the isolation index for 1990 calculated using 1990, rather than 1998, MSA boundaries56). In 50% of the MSAs sampled, the relative concentration index was 0.72 or greater, exceeding the 0.60 cutoff point Massey and colleagues58 used to identify high levels of segregation in this dimension.

Bivariate regression analyses indicated that the isolation index was not associated with the natural logarithm of injection drug use prevalence among Black adults (Table 4). However, once we controlled for MSA sociodemographic characteristics and region, particularly the West, where isolation was low and Black injection drug use prevalence high, a positive relation between the isolation index and the natural logarithm of injection drug use prevalence among Black adults emerged (Table 4).

By exponentiating the regression equation, we find that an increase of 0.50 in the isolation index was associated with a 23% increase in the (unlogged) injection drug use prevalence among Black adults. Adding percentage Black to the model only slightly altered the magnitude of the relation between isolation and the natural logarithm of injection drug use prevalence, from b=0.41 to b=0.43, suggesting that the relation between isolation and injection drug use prevalence was not an artifact of MSA racial composition. There was no relation between the relative concentration index and the logarithm of Black injection drug use prevalence in bivariate or multivariate analyses. The model accounted for 31% of the outcome’s variation in these MSAs.

**DISCUSSION**

MSAs with higher levels of Black residential isolation in 1990 had a higher prevalence of injection drug use among Black adults in 1998 than other MSAs did. It is noteworthy, however, that concentration was not associated with injection drug use prevalence. These divergent relations testify to the distinct association each segregation dimension has with particular health outcomes and, more specifically, lend support to the proposition that residential isolation may be the segregation dimension that holds particular significance for health.39,59–62

There are multiple pathways through which Black residential isolation could be linked to injection drug use prevalence among Black adults in MSAs. Unlike concentrated Black census tracts, which are primarily characterized by elevated poverty rates, isolated Black tracts tend to be associated with multiple indicators of social and material disadvantage, including poverty, unemployment, and violence.67,73,74 Each of these characteristics, alone or in combination, could create vulnerability to injection drug use.

Exposure to community violence creates a risk of illicit drug use (including heroin and cocaine use), perhaps because witnesses or victims of violence use drugs to manage subsequent depression, fear, and anxiety.76 Likewise, poverty may promote the transition to (and continuation of) injecting among active drug users because injection drug use is a more efficient drug administration method than sniffing or snorting.79 Moreover, evidence suggests that injectable drugs are more overtly available in disadvantaged neighborhoods than they are elsewhere.80
Another interpretation of our findings is also possible. Isolated Black census tracts may protect against injection drug use by creating a place where Black residents encounter on a daily basis organizations fostering a positive Black identity; endure little White-initiated interpersonal discrimination; and seek and offer solace and racial solidarity in the face of racial inequality and discrimination. The absence of these protections may create vulnerability to injection drug use among Black individuals living outside isolated Black census tracts.104–111 though this risk may be offset by the greater access these individuals tend to have to socioeconomic resources and a reduced exposure to violence.24

Further research is needed to elucidate the pathways through which elevated isolation is associated with injection drug use prevalence and to determine, as we could not in this ecological study of MSAs, whether the relation is evident only among Black residents of isolated Black tracts, Black individuals residing outside such tracts, or both.

Two additional avenues of research are also possible. First, a positive relation between residential isolation and injection drug use prevalence may exist in other racial/ethnic groups. Puerto Ricans, who appear to have the highest prevalence of cocaine use of all Latino groups,112 are also the sole racial/ethnic group experiencing a level of isolation that approaches that of Black Americans.56

Research is needed to determine whether isolation promotes injection drug use among Puerto Ricans, and perhaps other racial/ethnic groups.

Our findings also suggest an additional line of inquiry: studying the extent to which Black isolation shapes the distribution of injection drug use-related health problems across Black urban populations by elevating the prevalence of injection drug use. This inquiry is particularly pressing given the high prevalence of overdose deaths and injection drug use-related AIDS borne by Black Americans.2–11 Collectively, the results of this research could help injection drug users and their allies identify communities in need of drug-related health services, including drug treatment and syringe exchange programs.

Our findings must be understood in the light of their limitations, which lie principally in the study’s ecological and cross-sectional design and measurement of injection drug use prevalence among Black adults. Because our unit of analysis was the MSA, we could not investigate the role of neighborhood- or individual-level factors, such as socioeconomic status, gender, and age, as confounders or modifiers of the relation between MSA-level residential isolation (or concentration) and Black injection drug use prevalence.27,29 Multilevel research into these possibilities should address these limitations. Additionally, although we used a lagged cross-sectional design in which predictors predated the outcome, the possibility of autocorrelation precludes assessing the causal direction of our findings.

Our service-based method of calculating injection drug use prevalence leaves room for an alternative interpretation of our findings: although it is possible that residential isolation produces a higher prevalence of injection drug use, it is also possible that isolation results in a higher prevalence of health problems among injection drug users and thus, greater use of drug-related services. Possibly countering this bias, however, is the fact that isolated Black areas of segregated MSAs tend to be medically underserved,113 and CTS and TEDS capture individuals accessing routine or nonemergency health services.

We place our findings in the context of past research regarding racial inequality, discrimination, and health. Our analysis suggests that injection drug use should be added to the growing list of the adverse health behaviors and outcomes among Black Americans that may be generated by racial inequality and discrimination.144,145

Further and more specifically, this analysis also adds a new dimension to the body of research documenting the relation between inequitable and discriminatory racial relations and licit and illicit drug use and abuse. Investigators have concluded that Black adolescents and adults who report higher levels of interpersonal or everyday discrimination are more likely to report lifetime smoking, smoking more frequently, and engaging in problem drinking than other Black individuals.104–110 Likewise, Black adults reporting higher levels of internalized racism also report consuming more alcohol than other Black adults.19 Our findings extend this body of research by concluding that structural, in addition to intrapsychic and interpersonal, manifestations of racial inequality and discrimination may adversely shape injection drug use rates among Black adults.

If substantiated by additional research, our finding that a structural factor is related to Black injection drug use prevalence may also bear consequences for US domestic drug policy. As noted earlier, the criminal justice system, which locates cause within the individual and calls it culpability, plays a major role in the US government’s response to illicit drug use among Black Americans that dwarfs its role in addressing the drug use of White Americans.199–32 If, as our research suggests, the cause of injection drug use among Black adult urban residents lies partially in isolation, related prevention and intervention efforts may also benefit from altering social structures—and, more broadly, from eradicating racial inequality and discrimination in the United States—rather than from arresting and incarcerating large numbers of Black individuals.
Acknowledgments

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Human Participant Protection

The human subjects committee of the National Development and Research Institutes, Inc. approved all analyses.

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**Behind the Mask**

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United Nations (UN) officials have described Darfur as the worst humanitarian crisis in the world.1 Despite the January 2005 accord ending 23 years of North–South civil war, conflict continues in this impoverished western region of Sudan. The Darfur crisis escalated in early 2003 with rebel insurrections against the government of Sudan. Government forces and Arab militias have since conducted a campaign against local populations, displacing more than 200,000 refugees into Chad and 1.8 million people within the greater Darfur region.2 The death toll from disease and violence is unknown, with estimates ranging from 180,000 to 390,000.3,4 Widespread violations of human rights and international humanitarian law occurred, including incidents of rape, killing of civilians, and large-scale destruction of villages.5 The UN has cited occurrences of war crimes and crimes against humanity6 and other groups have warned of genocide.6

An estimated 3.6 million people—more than half of Darfur’s preconflict population—have been affected by the crisis.7 Although aid reaches the majority of this conflict-affected population, escalating violence has limited operations and decreased the proportion of UN-accessible populations from 90% in mid-2005 to 72% in early 2006.7 At the time of the study, banditry, harassment, and regional fighting limited humanitarian aid, particularly in South Darfur.8

To date, needs assessments in Darfur have predominantly focused on malnutrition and mortality rates.9-11 Mental health and women’s health burdens in this population remain largely unknown despite women heading 65% to 84% of internally displaced households in South Darfur.9 International Medical Corps conducted a rapid population-based needs assessment of internally displaced persons (IDPs) in Nyala, South Darfur, to help appropriate services for basic needs and women’s and mental health.

METHODS

Sampling

The greater Darfur region of western Sudan has an estimated population of 6.5 million2 and covers an area three fourths the size of Texas (approximately 196,000 mi2). It comprises 3 states: North, West, and South Darfur. Logistic and security constraints limited our study to Nyala, the largest of 9 districts in South Darfur State.

We surveyed 6 of 9 registered IDP camps in Nyala. At the time of the study, Nyala hosted nearly 40% of South Darfur’s registered IDP population (267,450 of 701,872), and included Kalma, the largest IDP camp in Darfur. The 6 camps were Kalma (142,125), Al Sheref (30,899), Otash (17,650), Billel (11,882), Mosei (11,099), and Deleg (8,881).7 Overall, the sample represented 83% of the total IDP population in Nyala (222,536 of 267,450), or 32% of the total IDP population in South Darfur (222,536 of 701,872). Three camps were excluded because of insecurity or inadequate number of IDPs for sampling (<2,000 people).

To determine an appropriate sample size for this study, we assumed a prevalence of major depression of 0.05, with a margin of error of ±0.01 at a 90% confidence level. The sample size required given these conditions was 1,293 households. We assumed a mean household size of 6 people9 and used systematic random sampling to survey 1,293 households in proportions relative to the population size of each camp (Table 1). We used a combination of maps based on satellite
TABLE 1—Demographic Characteristics of Internally Displaced Women (N = 1274) in Nyala Province: South Darfur, Sudan, January 2005

<table>
<thead>
<tr>
<th>Description</th>
<th>No. (%) or Mean ±SE (Range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camps surveyed (n = 1265)</td>
<td></td>
</tr>
<tr>
<td>Kalma</td>
<td>772 (61)</td>
</tr>
<tr>
<td>Al Sheref</td>
<td>120 (9)</td>
</tr>
<tr>
<td>Otash</td>
<td>116 (9)</td>
</tr>
<tr>
<td>Bilel</td>
<td>81 (6)</td>
</tr>
<tr>
<td>Mosei</td>
<td>78 (6)</td>
</tr>
<tr>
<td>Deleg</td>
<td>107 (8)</td>
</tr>
<tr>
<td>Months of displacement (n = 1233)</td>
<td>6.1 ±0.12 (0.1–28)</td>
</tr>
<tr>
<td>Months in present camp (n = 1237)</td>
<td>5.8 ±0.12 (0.01–25)</td>
</tr>
<tr>
<td>Mean household size in camp (n = 1269)</td>
<td>6.4 ±0.07 (1–30)</td>
</tr>
<tr>
<td>Area before displacement (n = 1270)</td>
<td></td>
</tr>
<tr>
<td>Urban</td>
<td>793 (62)</td>
</tr>
<tr>
<td>Rural</td>
<td>477 (38)</td>
</tr>
<tr>
<td>Age of respondent (n = 1252), y</td>
<td>34 ±0.29 (16–85)</td>
</tr>
<tr>
<td>Marital status (n = 1274)</td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>1010 (79)</td>
</tr>
<tr>
<td>Widowed</td>
<td>154 (12)</td>
</tr>
<tr>
<td>Divorced/Seperated</td>
<td>54 (4)</td>
</tr>
<tr>
<td>Husband Missing</td>
<td>49 (4)</td>
</tr>
<tr>
<td>Never married</td>
<td>7 (1)</td>
</tr>
<tr>
<td>Marital wife status (n = 1190)</td>
<td></td>
</tr>
<tr>
<td>First wife</td>
<td>827 (69)</td>
</tr>
<tr>
<td>Second wife</td>
<td>296 (25)</td>
</tr>
<tr>
<td>Third wife</td>
<td>55 (5)</td>
</tr>
<tr>
<td>Fourth wife</td>
<td>12 (1)</td>
</tr>
<tr>
<td>Ethnicity/tribe (n = 1233)</td>
<td></td>
</tr>
<tr>
<td>Fur</td>
<td>474 (38)</td>
</tr>
<tr>
<td>Zaghawa</td>
<td>228 (18)</td>
</tr>
<tr>
<td>Arab</td>
<td>119 (10)</td>
</tr>
<tr>
<td>Daju</td>
<td>107 (8)</td>
</tr>
<tr>
<td>Baygo</td>
<td>72 (6)</td>
</tr>
<tr>
<td>Massalit</td>
<td>55 (4)</td>
</tr>
<tr>
<td>Other*</td>
<td>122 (10)</td>
</tr>
<tr>
<td>Religion (n = 1274)</td>
<td></td>
</tr>
<tr>
<td>Muslim Sunni</td>
<td>1261 (99)</td>
</tr>
<tr>
<td>Christian</td>
<td>13 (1)</td>
</tr>
</tbody>
</table>

Note: Percentages may not add up to 100 because of rounding.

*Includes Tunjur (26); Dinka (22); Birgid (20); Habbania (19); Tama (13); Bederia (6); Gaam (5); Kineenwai, Logo, Tagoi (2 each); Debr, Falasha, Hamer, Hawzell, Nobin (1 each).

TABLE 1—Continued

<table>
<thead>
<tr>
<th>Occupation (n = 1270)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Farmer/Herder</td>
<td>654 (51.6)</td>
</tr>
<tr>
<td>Housewife</td>
<td>454 (36)</td>
</tr>
<tr>
<td>Unemployed</td>
<td>92 (7)</td>
</tr>
<tr>
<td>Service sector</td>
<td>28 (2.2)</td>
</tr>
<tr>
<td>Professional</td>
<td>19 (1.5)</td>
</tr>
<tr>
<td>Retired</td>
<td>13 (1)</td>
</tr>
<tr>
<td>Clerical</td>
<td>4 (0.3)</td>
</tr>
<tr>
<td>Factory</td>
<td>3 (0.2)</td>
</tr>
<tr>
<td>Student</td>
<td>3 (0.2)</td>
</tr>
</tbody>
</table>

Note: Percentages may not add up to 100 because of rounding.

*Includes Tunjur (26); Dinka (22); Birgid (20); Habbania (19); Tama (13); Bederia (6); Gaam (5); Kineenwai, Logo, Tagoi (2 each); Debr, Falasha, Hamer, Hawzell, Nobin (1 each).

...imaging and field surveying to determine the sampling frame within the camps.

Instrument

The questionnaire was written in English, translated into Sudanese Arabic, and back-translated into English by 3 native speakers. Three regional, human rights, and medical experts reviewed the questionnaire for content validity, and the survey was pilot-tested with 6 Sudanese IDPs in Sudan. Interviewers administered the survey in Arabic, the lingua franca among the majority of the tribes represented in the camps. The survey contained 102 questions on respondent demographics, basic needs, morbidity, mental and women’s health, and opinions regarding women’s rights and roles in society. We asked about events since the holiday of Eid al-Adha, 2003, which coincided with rebel insurrections in February 2003.

We assessed for the prevalence of major depressive disorder using the Patient Health Questionnaire, a well-validated, highly sensitive instrument for identifying individuals with current and past depression. Major depression was diagnosed if 5 or more of 9 depressive symptoms were present nearly every day during the previous 2 weeks. This corresponded with a cutoff score of 15, which has been found to be valid in predicting a clinical diagnosis of major depression. Questions regarding suicidal ideation and suicide attempts over the past year among household members were reported as yes or no responses. Women’s rights and roles in society were assessed by a response of agree or disagree. These rights were selected on the basis of health and human rights concerns identified in other studies. Mental health counseling was defined as “having someone to talk about your problems who will listen and give emotional support.”

Interviews

As part of the International Medical Corps field team, we recruited 16 data collectors who underwent 3 days of classroom teaching and role playing followed by several days of field observation. Government officials approved all data collectors and granted permission for the study without limitations. We also sought and received support from local sheikhs, who encouraged household members to respect the privacy of the interviews.

All interviews were conducted during a 1-week period in January 2005. A household was defined as people sleeping and eating under the same roof or in the same structure. A non-Arab, who was a woman, Sudanese data collector interviewed the household female (aged ≥15 years or emancipated minor) who could most accurately provide information about the experiences of the entire household. Interviews lasted approximately 30 minutes and were conducted in the most private setting possible. Questionnaires were reviewed for completeness after the interview by the interviewers and by team leaders daily.

Statistical Analysis

The data were analyzed with Stata version 8.0 statistical software (Stata Corp, College Station, Tex). To test differences in proportions, statistical significance was determined using the Pearson χ² statistic. For those cross-tabulations containing cells with expected frequencies of fewer than 5, statistical significance was determined with the Fisher exact test; a Yates corrected χ² was used for all others. Analysis of variance was used for statistical comparison of means. For all statistical determinations, significance levels were established at P<.05.
RESULTS

Respondent Characteristics

Of the 1293 households sampled, 1274 female heads of household participated in the study (98.5% response rate). Demographics of the respondents are presented in Table 1. Mean household size was 6.4 ±0.07 persons. The mean age was 34 ±0.29 years (range, 16–85 years). The majority of the women sampled were Muslim (99%), married (79%), farmers or pastoralists (52%), and from either the Fur or Zaghawa tribes (55%). The 1274 household respondents reported on the experiences of 8643 household members, including themselves. Households in this study were displaced from all 3 Darfur states. The mean duration of displacement from home was 6.1 ±0.12 months.

Basic Needs

Although there were gaps in coverage of basic needs, the majority of IDPs had some access to rations, shelter, and potable water. Overall, 78% of households (923 of 1187) reported receiving some rations, including any type of flour, oil, or beans (Table 2). Sixteen percent of all households (200 of 1254) had no shelter or had minimal cover (open-air lean-tos, mats, boxes). The mean number of blankets was 1.2 for an average household size of 6.4 persons.

Although the majority of water sources were protected, per person water consumption was low and boiling of water was not practiced. Ninety-nine percent of households (1246 of 1254) reported the use of water bladders or other protected sources of water. The average use of water was 7.6 liters per person per day for drinking, cooking, and hygiene. Nearly 80% of households reported insufficient fuel to cook meals or boil drinking water. Methods of obtaining fuel included collection by children (9%), and purchase of fuel (25%).

Morbidity

During the previous week, 12% of all household members (1042 of 8643) and 19% of children aged younger than 5 years (366 of 1864) had 1 or more symptoms of diarrhea or cough (Table 3). Forty-nine percent of household members with illness (570 of 1162) accessed medical care. Diarrhea was the most commonly reported illness among children aged younger than 5 years (18%), followed by symptoms of acute respiratory infection (4%). Only 35% of respondents (445 of 1273) knew how to mix oral rehydration solution, and fewer than 30% (354 of 1274) had access to the solution packets. Among women aged 15 to 49 years, 13% (242 of 1900) had received a tetanus vaccination while in the camp.

Women's Health

Overall, women in this study expressed limited sexual and reproductive rights.
TABLE 3—Morbidity and Mental Health Among Internally Displaced Women and Household Members (N = 8643) in Nyala Province: South Darfur, Sudan, January 2005

<table>
<thead>
<tr>
<th>Issue</th>
<th>No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Children aged ≤ 5 years who received measles vaccination in the camp (n = 1864)</td>
<td>1002 (54)</td>
</tr>
<tr>
<td>Women aged 15–49 years who received tetanus vaccination in the camp (n = 1900)</td>
<td>242 (13)</td>
</tr>
<tr>
<td>Household members with 1 or more symptoms*</td>
<td>1042 (12)</td>
</tr>
<tr>
<td>Children aged ≤ 5 years with 1 or more symptoms (n = 1864)*</td>
<td>366 (19)</td>
</tr>
<tr>
<td>Respondents with cough or shortness of breath (n = 1025)</td>
<td>205 (20)</td>
</tr>
<tr>
<td>Children ≤ 5 years old with cough or shortness of breath (n = 1864)</td>
<td>82 (4)</td>
</tr>
<tr>
<td>Household members with bloody or nonbloody diarrhea (n = 8200)</td>
<td>410 (5)</td>
</tr>
<tr>
<td>Children aged ≤ 5 years with bloody or nonbloody diarrhea (n = 1864)</td>
<td>340 (18)</td>
</tr>
<tr>
<td>Household members with symptoms who accessed medical care (n = 1162)*</td>
<td>570 (49)</td>
</tr>
<tr>
<td>Respondents with oral rehydration solution packets (n = 1274)</td>
<td>354 (28)</td>
</tr>
<tr>
<td>Respondents who knew how to mix oral rehydration solution (n = 1273)</td>
<td>445 (35)</td>
</tr>
<tr>
<td>Respondents reporting feeling down, depressed, and hopeless (n = 1244)</td>
<td>780 (63)</td>
</tr>
<tr>
<td>Respondents reporting feelings of sadness or constant crying (n = 1274)</td>
<td>280 (30)</td>
</tr>
<tr>
<td>Major depression (score of 15 or more) on the PHQ-9 (n = 1253)</td>
<td>390 (31)</td>
</tr>
<tr>
<td>Respondents reporting suicidal ideation in the past year (n = 1257)</td>
<td>66 (5)</td>
</tr>
<tr>
<td>Respondents reporting suicide attempt in the past year (n = 1260)</td>
<td>28 (2)</td>
</tr>
<tr>
<td>Respondents reporting household member with suicidal ideation (n = 1134)</td>
<td>26 (2)</td>
</tr>
<tr>
<td>Respondents reporting household member who committed suicide (n = 1124)</td>
<td>21 (2)</td>
</tr>
<tr>
<td>Type of counseling respondents with major depression deem beneficial (n = 390)*</td>
<td></td>
</tr>
<tr>
<td>International agencies</td>
<td>381 (98)</td>
</tr>
<tr>
<td>1-on-1 sessions</td>
<td>283 (72)</td>
</tr>
<tr>
<td>Group sessions</td>
<td>184 (47)</td>
</tr>
<tr>
<td>Religious counseling</td>
<td>127 (32)</td>
</tr>
<tr>
<td>Access to education/trade programs</td>
<td>65 (17)</td>
</tr>
<tr>
<td>Financial programs</td>
<td>49 (12)</td>
</tr>
<tr>
<td>Traditional healer</td>
<td>46 (12)</td>
</tr>
<tr>
<td>Local groups</td>
<td>35 (9)</td>
</tr>
<tr>
<td>Women’s support groups</td>
<td>33 (8)</td>
</tr>
<tr>
<td>Issues that would make it difficult to seek counseling (n = 358)*</td>
<td></td>
</tr>
<tr>
<td>Do not believe counseling is useful</td>
<td>121 (34)</td>
</tr>
<tr>
<td>Feeling ashamed</td>
<td>73 (20)</td>
</tr>
<tr>
<td>Nothing</td>
<td>67 (19)</td>
</tr>
<tr>
<td>Fear of community nonacceptance</td>
<td>46 (13)</td>
</tr>
<tr>
<td>Concerns about confidentiality</td>
<td>17 (5)</td>
</tr>
<tr>
<td>Fear of family nonacceptance</td>
<td>13 (4)</td>
</tr>
<tr>
<td>Interferes with household responsibilities</td>
<td>11 (3)</td>
</tr>
</tbody>
</table>

Note. PHQ-9 = Patient Health Questionnaire. Percentages may not add up to 100 because of rounding.

*Includes fever, productive or nonproductive cough, diarrhea with or without blood, shortness of breath, or total body rash during the previous week.

Eighty-four percent of women (1043 of 1240) reported a history of female circumcision. Fifty-one percent of women (458 of 900) felt a wife must agree to sexual intercourse regardless of her willingness to participate. Only 30% of women (374 of 1238) reported that husbands and wives shared decisions on the number and spacing of children. Ninety-six percent (1219 of 1266) used either the natural or rhythm method or no form of contraception. Of women desiring but not using birth control, 63% (209 of 331) reported that their husbands would not allow contraceptive use.

Women also reported high pregnancy rates and limited perinatal services. The mean number of pregnancies was 6 (±0.09; range 0–20), with first pregnancy at age 18 (±0.08) years (range 12–45). Although 58% of respondents (723 of 1236) reported that prenatal care was accessible for all pregnancies, the mean number of pregnancies receiving prenatal care was 1.4 (±0.06). Of the remaining 42% (513 of 1236), reasons for the lack of prenatal care included the unavailability of services (89%), financial difficulties (47%), and husbands not permitting wives to seek care (27%). In general, 67% of respondents (853 of 1269) reported that they needed permission from a family member to access health care most or all of the time. Seventy-nine percent (912 of 1147) had at least 1 delivery by a traditional birth attendant; 20% (227 of 1147) were assisted by trained midwives. Fifty-three percent (614 of 1147) reported at least 1 unattended delivery. Overall, 30% of respondents (380 of 1262) were breastfeeding at the time of the study, and half of these women reported difficulties breastfeeding.

Attitudes on Women’s Rights

Participants in the study expressed varying levels of support for women’s rights (Table 4). Support was highest for equal access to education and legal protections of women’s rights (84%–88%) and lowest for freedom of movement and expression (55%–68%). Seventy-seven percent of women (800 of 1040) felt that a good wife should obey her husband even if she disagrees, and 43% (444 of 1036) felt that a man has the right to beat a disobedient wife. Among married women, 61% (627 of 1027) felt pressured to enter marriage, and 20% (213 of 1069) were married without consenting.

Mental Health

Nearly one third of respondents (31%, 390 of 1253) met criteria for major depressive disorder (Table 3). Five percent of respondents reported suicidal ideation (66 of 1257), and 2% reported personal suicide attempts (28 of 1260) over the previous year. Two percent of households had a member that committed suicide during the past year (21 of 1124). Ninety-eight percent of women meeting...
TABLE 4—Marriage, Family, and Reproductive Health Characteristics and Women’s Rights Status of Internally Displaced Women (N = 1274) in Nyala Province: South Darfur, Sudan, January 2005

<table>
<thead>
<tr>
<th>No. (%) or Mean ±SE (Range)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Respondents who wanted to marry at the time of marriage (n = 1069)</td>
<td>856 (80)</td>
</tr>
<tr>
<td>Respondents who felt pressured by family to marry at the time of marriage (n = 1027)</td>
<td>627 (61)</td>
</tr>
<tr>
<td>Respondents who agreed that women should have the right to freely choose a husband and enter into marriage (n = 1092)</td>
<td>983 (90)</td>
</tr>
<tr>
<td>Family members who decide number and timing of children (n = 1238)</td>
<td></td>
</tr>
<tr>
<td>Respondent only</td>
<td>94 (8)</td>
</tr>
<tr>
<td>Mostly respondent</td>
<td>52 (4)</td>
</tr>
<tr>
<td>Equal participation with husband</td>
<td>374 (30)</td>
</tr>
<tr>
<td>Mostly husband</td>
<td>198 (16)</td>
</tr>
<tr>
<td>Husband only</td>
<td>225 (18)</td>
</tr>
<tr>
<td>Other, including God, no one, no need</td>
<td>295 (24)</td>
</tr>
<tr>
<td>Respondents who agreed women should have the same right as her husband to determine timing and spacing of their children (n = 932)</td>
<td>559 (60)</td>
</tr>
<tr>
<td>Respondents who agreed that the decision to use birth control should be a shared decision of a woman and her partner (n = 1054)</td>
<td>974 (92)</td>
</tr>
<tr>
<td>Respondents who did not agree that the decision to use birth control should be a shared decision of a woman and her partner (n = 1054)</td>
<td>80 (8)</td>
</tr>
<tr>
<td>Respondents who agreed that the decision to use birth control should be decided by the woman only (n = 932)</td>
<td>103 (11)</td>
</tr>
<tr>
<td>Respondents who did not agree that the decision to use birth control should be decided by the woman only (n = 932)</td>
<td>829 (89)</td>
</tr>
<tr>
<td>Type of birth control used (n = 1266)</td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>861 (68)</td>
</tr>
<tr>
<td>Natural/rhythm method</td>
<td>358 (28)</td>
</tr>
<tr>
<td>Birth control pills</td>
<td>27 (2)</td>
</tr>
<tr>
<td>Homeopathic/herbal</td>
<td>9 (0.7)</td>
</tr>
<tr>
<td>Injectable birth control</td>
<td>9 (0.7)</td>
</tr>
<tr>
<td>IUD</td>
<td>2 (0.2)</td>
</tr>
<tr>
<td>Type of birth control desired (n = 846)</td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>689 (81)</td>
</tr>
<tr>
<td>Natural/rhythm method</td>
<td>83 (10)</td>
</tr>
<tr>
<td>Injectable birth control</td>
<td>35 (4)</td>
</tr>
<tr>
<td>Birth control pills</td>
<td>26 (3)</td>
</tr>
<tr>
<td>IUD</td>
<td>5 (1)</td>
</tr>
<tr>
<td>Homeopathic/herbal</td>
<td>4 (0.5)</td>
</tr>
<tr>
<td>Did not know</td>
<td>4 (0.5)</td>
</tr>
<tr>
<td>Reasons for not using birth control despite wanting to use it (n = 331)</td>
<td></td>
</tr>
<tr>
<td>Husband will not allow</td>
<td>209 (63)</td>
</tr>
<tr>
<td>Not available</td>
<td>48 (15)</td>
</tr>
<tr>
<td>Financial</td>
<td>36 (11)</td>
</tr>
<tr>
<td>Ministry of Health policy</td>
<td>14 (4)</td>
</tr>
<tr>
<td>Medical reasons</td>
<td>12 (4)</td>
</tr>
<tr>
<td>Other</td>
<td>11 (3)</td>
</tr>
<tr>
<td>Respondents who were pregnant at the time of the study (n = 1253)</td>
<td>152 (12)</td>
</tr>
</tbody>
</table>

Continued

DISCUSSION

Basic Needs

Despite the predominant use of protected water sources (92%), the low per person usage of 7.6 liters per day falls far short of Sphere recommendations of 15 liters per day and raises concern about poor sanitation, hygiene, and communicable disease. Reasons for this finding may include the 50% decrease in rainfall this past year and insufficient water infrastructure. Supplying adequate quantities of water must be a high priority, even if it is of intermediate quality, to minimize water-related disease transmission.

Darfur’s climate exposes IDPs to drought and rainy seasons, dust storms, and extreme temperatures ranging from 40ºF at night to 110ºF during the day. The lack of covered shelter, blankets, and clothing poses an increased risk for acute respiratory illnesses, and the rains may increase potential for outbreaks of diarrheal diseases. During the rainy season (May–October), adequate protection from the elements is essential.

Although overall food distributions have increased and anthropometric surveys have shown significant improvements in malnutrition indices in Kalma and throughout Darfur, the findings confirm previous reports that IDPs are not receiving full sets of rations. The World Food Programme warns of food shortages secondary to drought, poor harvest, rising prices, and a large shortfall in funds. Most important, banditry and violence increasingly threaten humanitarian access to the estimated 3.5 million people requiring food aid. In this volatile environment, disruption of assistance could result in dramatic rises in malnutrition and morbidity.

Morbidity

Diarrhea was the most commonly reported condition, particularly for children, and reflects poor water and sanitation practices; it is a leading cause of morbidity and mortality among disaster-affected populations. The lack of oral rehydration solution and unfamiliarity with its preparation must be addressed.
TABLE 4—Continued

<table>
<thead>
<tr>
<th>Respondents’ total no. of pregnancies (n = 1236)</th>
<th>6 ±0.09 (0–20)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Live births (n = 1255)</td>
<td>5 ±0.08 (0–15)</td>
</tr>
<tr>
<td>Respondents’ opinion on the highest number of children a woman should have (n = 1225)</td>
<td>8 ±0.11 (0–25)</td>
</tr>
<tr>
<td>Pregnancies with prenatal care (n = 1132)</td>
<td>1.4 ±0.06 (0–9)</td>
</tr>
<tr>
<td>Prenatal care for all pregnancies (n = 1236)</td>
<td>723 (58)</td>
</tr>
<tr>
<td>Reasons for not receiving prenatal care (n = 513)</td>
<td></td>
</tr>
<tr>
<td>No services available</td>
<td>461 (89)</td>
</tr>
<tr>
<td>Financial</td>
<td>239 (47)</td>
</tr>
<tr>
<td>Not permitted by spouse</td>
<td>139 (27)</td>
</tr>
<tr>
<td>Restriction on movement</td>
<td>65 (13)</td>
</tr>
<tr>
<td>Not necessary</td>
<td>36 (7)</td>
</tr>
<tr>
<td>Work obligations</td>
<td>14 (3)</td>
</tr>
<tr>
<td>How often respondent must ask a family member to access health care services (n = 1269)</td>
<td></td>
</tr>
<tr>
<td>All of the time</td>
<td>765 (60)</td>
</tr>
<tr>
<td>Most of the time</td>
<td>88 (7)</td>
</tr>
<tr>
<td>Some of the time</td>
<td>213 (17)</td>
</tr>
<tr>
<td>Rarely</td>
<td>170 (13)</td>
</tr>
<tr>
<td>Never</td>
<td>33 (3)</td>
</tr>
<tr>
<td>Attended birth of children (n = 1147)</td>
<td></td>
</tr>
<tr>
<td>Traditional birth attendant</td>
<td>912 (79)</td>
</tr>
<tr>
<td>Unattended</td>
<td>614 (53)</td>
</tr>
<tr>
<td>Midwife</td>
<td>227 (20)</td>
</tr>
<tr>
<td>Family member</td>
<td>144 (13)</td>
</tr>
<tr>
<td>Doctor</td>
<td>46 (4)</td>
</tr>
<tr>
<td>Nurse</td>
<td>37 (3)</td>
</tr>
<tr>
<td>Village health worker</td>
<td>19 (2)</td>
</tr>
<tr>
<td>Respondents who were breastfeeding at the time of the study (n = 1262)</td>
<td></td>
</tr>
<tr>
<td>No problems</td>
<td>173 (49)</td>
</tr>
<tr>
<td>Milk not consistent</td>
<td>129 (36)</td>
</tr>
<tr>
<td>Milk never came in</td>
<td>24 (7)</td>
</tr>
<tr>
<td>Milk dried</td>
<td>20 (6)</td>
</tr>
<tr>
<td>Unable to breastfeed because of conflict</td>
<td>4 (1)</td>
</tr>
<tr>
<td>Decided not to breastfeed</td>
<td>3 (0.08)</td>
</tr>
<tr>
<td>Respondents reporting gynecologic symptoms (n = 1274)</td>
<td></td>
</tr>
<tr>
<td>Respondents with female circumcision (n = 1240)</td>
<td>1043 (84)</td>
</tr>
<tr>
<td>Respondents who agreed that a good wife obeys her husband even if she disagrees (n = 1040)</td>
<td>800 (77)</td>
</tr>
<tr>
<td>Respondents who agreed that a man has a right to beat his wife if she disobeys (n = 1036)</td>
<td>444 (43)</td>
</tr>
<tr>
<td>Respondents who agreed that it is a wife’s obligation to have sex with her husband even if she does not want to (n = 900)</td>
<td>458 (51)</td>
</tr>
<tr>
<td>Respondents who agreed that any woman has the right to refuse sex (n = 1027)</td>
<td>503 (49)</td>
</tr>
<tr>
<td>Respondents who agreed that more should be done to protect women and girls from having sex when they do not want to have sex (n = 935)</td>
<td>545 (58)</td>
</tr>
<tr>
<td>Respondents who agreed that women should have equal access to education (n = 1121)</td>
<td>991 (88)</td>
</tr>
<tr>
<td>Respondents who agreed that there should be specific provisions in the constitution to protect women’s rights (n = 1040)</td>
<td>873 (84)</td>
</tr>
<tr>
<td>Respondents who agreed that women should be able to associate with people of their choosing (n = 1086)</td>
<td>863 (79)</td>
</tr>
<tr>
<td>Respondents who agreed that women should have equal work opportunities (n = 1132)</td>
<td>866 (76)</td>
</tr>
</tbody>
</table>

Continued
food source that is important for conferral of immunity, nutrition, fertility regulation, and psychological well-being of mother and child. It is an essential preventive measure against diarrheal diseases.38

Women may be at risk of violence both within and outside of camps. There have been widespread reports of sexual violence in Darfur, particularly among women and girls foraging for wood beyond camp borders.39 The predominance of women and children gatherers found in this study underscores the risk for these individuals and the need for security and alternative fuel provisions. Domestic violence rates were not assessed in this study, but the finding of 43% of respondents agreeing that a husband may beat a disobedient wife reflects attitudes and experiences that may have serious health consequences for women.

The 84% prevalence of female circumcision was consistent with previous estimates of 89% in Sudan.40 Our finding does not include girls aged younger than 15 years who may have experienced circumcision (the custom may be practiced from infancy).41 Health consequences include hemorrhage, infection, urethral and sexual dysfunction, difficulties with childbirth, and psychological complications.42 A predominance of type III infibulation has been reported in Sudan,40 and surgical defibulation may be necessary for safe deliveries.42 The high prevalence of this traditional practice emphasizes the need for national policies, culturally sensitive educational programs, and appropriate health care, including obstetric and gynecologic services.

**Mental Health**

The prevalence of depression and suicide is a considerable mental health burden and challenge for humanitarian agencies in Sudan. The depression rate is comparable with other groups affected by complex emergencies.43 The respondent rates of suicidal ideation and attempts were lower than findings among other conflict-affected populations.44,45 The rates of attempts among women and household suicide prevalence, however, were still alarmingly high in comparison with general rates worldwide.44,45

Given elevated post-traumatic stress disorder rates and disability in other displaced populations,43 the prevalence of depression in this study may reflect only a portion of the mental health burden. The combined impact of gender disparities and sustained stressors, such as low socioeconomic status, are known critical determinants of poor mental health.43 Moreover, the effects of sexual violence, displacement, and livelihood disruption may contribute significantly to the mental health burden in this IDP population.45,46

In this context, few nongovernmental organizations offer formal mental health services to IDPs, and to our knowledge, preexisting services in the host population are nonexistent. Provisions for mental health historically have been limited and controversial in emergency settings.47 It is noteworthy that 98% (381 of 390) of women meeting criteria for major depressive disorder felt that some form of counseling facilitated by international agencies might be helpful. In focus groups among IDPs in Darfur, women have also said that the provision of basic needs, security, education, and health care, in addition to counseling and psychosocial support, might help improve psychosocial well-being.46 Although the optimal intervention in this population is unknown, World Health Organization recommendations include the integration of mental health services and local staff training into community-based health care programs.47 As mental health and psychosocial programs develop, ongoing assessments of mental health needs and the monitoring and evaluation of programs will be essential.

**Attitudes on Women’s Rights**

Although 84% of the women interviewed expressed the belief that there should be legal protection for the rights of women, many did not fully support women’s rights, including freedom of movement, work, and expression. These limitations may reflect cultural norms, but they may also reflect camp circumstances. The weak support for freedom of movement (55%), for example, may be influenced by insecurity and fears of violence around the camps. By contrast, the strong support for equal access to education (88%) may reflect increased exposure of IDPs to schools in the camps.

Historically, Sudan has one of the lowest net school enrollment rates for girls in the world.48 In Darfur, educational opportunities for girls have been limited for reasons including limited finances, a lack of schools, early marriage, and domestic responsibilities.49,50 With the loss of land and livestock, and the establishment of UN-sponsored schools in the camps, many girls are in school for the first time, with lower primary classes composed of at least 40% girls in South Darfur.50 Although gender parity has not yet been achieved and cultural and economic barriers remain, strong support for education of girls may reflect increasing sensitivities to the importance of education.48,49

As one of the strongest predictors of physical health status,51 education may affect women’s ability to make informed health-related decisions, access services, interact with health care personnel, and participate in treatment regimens.52 In addition, schooling helps provide normalcy and psychosocial stability for children in conflict settings.47 Maintaining support for educational programs will be crucial for women’s and community health as humanitarians face funding shortfalls.

**Limitations**

A lack of security limited the geographic scope and questionnaire content to basic needs,
mental health, and limited domains of women’s health. The findings of the study represent 222,536 IDPs residing in the 6 camps surveyed. The results cannot be generalized to all of Nyala, South Darfur, or other regions of Sudan. In addition, the study does not represent the host population or inaccessible areas of Nyala. Because humanitarian agencies have had full access to the camps included in our study, the findings on basic needs may be more favorable than for inaccessible IDP groups.

Cross-cultural differences may have influenced the mental health assessment, because the Patient Health Questionnaire was not validated for this population. The instrument has been used in another Arabic country and other conflict-affected populations. In addition, the findings are consistent with depression assessments that used different instruments in other displaced populations. Although the limitations preclude firm conclusions about the prevalence of major depression in this population, the findings grossly indicate a large mental health burden where minimal provisions exist.

The findings in this study reflect the large-scale humanitarian effort in South Darfur and the relief of a significant burden of this displaced population’s basic needs, including food, water, and shelter that is needed. Mental health needs remain largely unaddressed, however, and significant gaps in women’s health needs remain. The limited sexual and reproductive rights identified in this study may also negatively affect women’s health and by extension community health.

During the writing of this article, security continued to deteriorate and threaten humanitarian operations throughout Darfur. In early 2006, regional fighting displaced 70,000 people in South Darfur alone. Peace talks in Nigeria are in jeopardy, and the situation has been referred to the UN Security Council. In the face of mounting insecurity and violence, the health burdens identified in this study present a formidable challenge for humanitarian agencies in Nyala.

**Contributors**

G. Kim assisted with the study design, data collection and analysis, and article preparation. R. Torbay assisted with the study conception, analyses, and article preparation. L. Lawry originated the study and supervised all aspects of its implementation. Each author contributed substantially to the conception and design of the study, the analysis and interpretation of the data, and the drafting and revising of the article.

**Acknowledgments**

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**Human Participant Protection**

The Western Institutional Review Board, a for-profit organization in Olympia, Wash, offering independent institutional review board services, reviewed and approved this study. The ethics review board was guided by Title 45 of the US Code of Federal Regulations and complied with the Declaration of Helsinki. All data were kept anonymous. Verbal informed consent was obtained from all participants, who did not receive any material compensation.

**References**


23. ReliefWeb. In Sudan’s refugee camps, tensions rise...
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Edited by Bettina Beech, DrPH, MPH, and Maurine Goodman, MA, MPH

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Kim et al. | Peer Reviewed | Research and Practice | 361
The potential of religious organizations to mitigate the societal impact of HIV/AIDS is often invoked in both policy and general public discourse. Faith-based responses to the pandemic have found enthusiastic support at the highest political level, and funding agencies have been looking to channel their AIDS assistance through churches and other religious organizations. However, relatively little systematic and unbiased evidence exists to show how this potential has been realized in practice.

The literature on the role of religion and religious organizations in dealing with the HIV/AIDS crisis is scarce and primarily addresses the influence of religious beliefs and organizational structures on HIV/AIDS risks and prevention. The main thrust of this literature is that religion and religiosity may serve as a barrier to HIV/AIDS by promoting, and even enforcing, less risky behaviors. Much of the literature focuses on differences between more and less conservative denominations. Thus, Garner found that, because of doctrinal and organizational factors, Pentecostals in KwaZulu Natal, South Africa, were less likely to engage in extramarital sex than were members of other churches. Gregson et al. came to a similar conclusion with regard to adherents of “spirit-type” churches in rural Zimbabwe. Hill and Ali reported that in Brazil, evangelicals had less extramarital sex than did Catholics.

The institutional resources of religious organizations, it is argued, may also help national and community-level prevention efforts. It is acknowledged, however, that religious prevention messages, usually extolling premartial abstinence and marital fidelity, often clash with the secular emphasis on safer sex. Some religious leaders throughout Africa and in other parts of the world continue to portray HIV/AIDS as punishment for sexual sins, or to express opposition to condom use on the basis that condoms encourage promiscuity.

As the issues of treatment and care increasingly move to the forefront of the fight against the AIDS pandemic, it is imperative to examine how, if at all, religious organizations are involved with these issues. However, it is also important to stress the differences between the factors that constrain prevention-related and care-related activities. The former are frequently predicated on religious organizations’ official stance on marriage, family, extramarital sex, and condoms, and, therefore, are subject to heated ideological debate. In contrast, the latter are less ideologically laden and, therefore, less controversial, and are primarily contingent on religious organizations’ material resources, organizational structure, embeddedness within the community, and relationships with one another. Religious organizations have a long and celebrated tradition of health and social care provision, especially in resource-poor settings, and HIV/AIDS-related care and support should not be an exception. However, much of the information on the involvement of religious organizations in HIV/AIDS-related care and support comes from leaders and advocates of such organizations. This information is often selective and self-congratulatory and does not allow for an impartial assessment of the achievements and problems in the provision of HIV/AIDS-related assistance by religious organizations. The volume and frequency of HIV/AIDS-related assistance provided by religious organizations, as well as the relative distribution of that assistance between members and nonmembers of religious organizations, generally remain unknown.

We have addressed these knowledge gaps with quantitative and qualitative data from a study conducted in 2003 in southern Mozambique (population 19 million). Mozambique is an impoverished country in southeast Africa, where adult HIV prevalence was estimated at about 16% at the time of study. Although Mozambique has a sizeable Muslim minority, especially in the north, the study area is overwhelmingly Christian. Our analysis focused on Christian churches, leaving out both non-governmental organizations whose activities are guided by Christian faith and non-Christian religious organizations. We examined the exposure of rank-and-file members of religious organizations in dealing with the HIV/AIDS pandemic.
METHODS

The fieldwork was carried out in 2 areas in southern Mozambique—Maputo, Mozambique’s sprawling capital, with some 1.5 million residents, and the predominantly rural district of Chibuto (Gaza province), about 200 km north of Maputo. The 2 areas had similar estimated adult HIV prevalence levels of around 20% (i.e., somewhat higher than the national average). The study was congregation-based, meaning that only individuals attending religious activities of their respective congregations were included, and was limited to the denominations that were most prominent in the 2 sites: Roman Catholic, Presbyterian, and Pentecostal-type denominations—Zionist, Apostolic, and the Assemblies of God. In Maputo, the study also included the Islamic community, but in Chibuto, the Islamic community was still very small, so Muslims were not included. Because 1 of our goals was to make comparisons between the city and the countryside, we omitted the small subsample of city Muslims from the analyses.

The fieldwork consisted of a representative survey and semistructured, in-depth interviews. For the survey, congregations within each denomination were selected randomly in each of the 2 sites, for a total of 31 congregations. Respondents were selected randomly from groups attending religious services in those congregations on a given day and were interviewed at the congregation or another location of their choice. This sampling procedure assured a response rate of nearly 100%. Excluding the city Muslims, the survey sample included 677 respondents, of whom 52% were from Maputo, 29% from rural Chibuto, and 19% from the semirural town of Chibuto and its surroundings. Because women typically predominate among church attendees, we stratified the sample by gender (the age brackets for men and women were 15–60 years and 15–50 years, respectively). In the resulting sample, women constituted 53% of the survey respondents and men constituted 47%. The survey instrument contained a variety of items dealing with HIV/AIDS, including questions on assistance provided by the respondent’s congregation to AIDS patients and their families either within or outside the congregation. Although the survey instrument was devised to fully protect confidentiality of both the respondents and the recipients of congregation help, it is possible that some respondents, restrained by the stigma of HIV/AIDS and concerned with the image of their churches, understated the presence of HIV/AIDS and the provision of the corresponding assistance in their congregations. The qualitative data, however, suggest that the rate of underreporting was modest.

About 8% of the survey respondents—57 persons, 27 in Maputo and 30 in Chibuto—also participated in semistructured interviews following the survey. The subjects for those interviews were selected purposefully to represent a broad range of demographic characteristics (gender, age, and marital status) and religious involvement. The semistructured interviews were designed to complement and expand upon the survey, especially in the areas of personal perceptions of HIV/AIDS risks and knowledge about the role of respective religious congregations in HIV/AIDS prevention and care.

In analyzing the survey data, we examined 2 types of outcomes: (1) personal encounters with HIV/AIDS, approximated by knowledge of someone who had HIV/AIDS or had died from it, and (2) assistance provided by the congregation to HIV/AIDS patients or their families. For each outcome type, we distinguished between church members and nonmembers and made comparisons along 3 dimensions. First, we compared city (Maputo) congregations to rural and semirural (Chibuto) congregations; aside from obvious socioeconomic and cultural differences between the 2 sites, access to testing and treatment was generally better in the city than in the countryside. Second, we examined differences across types of denominations. Although denominational nuances in the sub-Saharan context may be complex and elusive, we focused on a relatively simple dichotomy that encompasses both ideological and organizational dimensions critical to the role of churches in HIV/AIDS prevention and care.

We considered 2 groups of denominations: the first group was made up of “mainline” churches (Roman Catholic and Presbyterian), and the second group included the remaining churches (Zionist, Apostolic, and Assemblies of God), which we labeled “healing” churches because of the centrality of divine healing to their doctrines and practices. Mainline churches are generally more flexible doctrinally and more open socially; healing churches tend to have more conservative and rigid teachings and to be inward-oriented.

This dichotomy has proven relevant to knowledge and views about HIV/AIDS prevention, and we now extend it to matters of care and support. Finally, we compared men’s and women’s perspectives on the outcomes of interest, because HIV/AIDS risks, views, and practices are constrained by gender ideology and vary by gender. In order to ensure that area-, denominational-, and gender-associated variations in the provision of HIV/AIDS care were not confounded by other factors, we fit a multivariate logistic regression. The model controls for age, education, marital status index (defined on the basis of household possessions), marital status, and church attendance. We first present and interpret the patterns of association found in the survey data, and then elaborate on these patterns drawing from the semistructured interviews. Although not quantifiable, the insights from the interviews provide valuable information about the content and mechanisms of church-based HIV/AIDS care and support.

RESULTS

Encounters With HIV/AIDS and Exposure to Church-Based Assistance

Table 1 summarizes our results by area of residence, type of denomination, and respondent gender (associations with a $\chi^2$ result statistically significant at the $P<.05$ level are noted as such). Despite high HIV prevalence in the region, more than 40% of the survey respondents noted as such).
respondents did not personally know anyone who was HIV positive or had AIDS. The differences between rural and city residents and between men and women were not statistically significant. However, members of mainline churches demonstrated significantly greater familiarity with HIV/AIDS cases compared with respondents affiliated with healing denominations. This association was not owing to higher incidence of known HIV/AIDS cases among mainline denominations. In all, only about 10% of respondents reported knowing at least 1 person with confirmed or suspected HIV/AIDS within their respective congregations, and this percentage was about the same across the areas of residence, types of denomination, and gender.

A very small percentage of respondents—only about 4%, on average—said that their churches had ever helped their fellow church members suffering from HIV/AIDS. Notably, the only significant difference was between men and women: the latter were more likely to report such activities in their congregations. By contrast, men were significantly more likely than women to report church assistance to HIV/AIDS patients outside the congregation. Overall, 17% of respondents said that their congregations had provided assistance to nonmembers affected by HIV/AIDS. In addition to the already noted gender differences, such assistance was much more commonly reported by members of city churches than by members of rural and semirural churches. Mainline church members were significantly more likely to report the involvement of their respective congregations in such activities than were members of healing churches.

The percentages in the last row of Table 1 refer to respondents who said that their congregations had offered HIV/AIDS care and support to any HIV/AIDS patients (church members and nonmembers) or their families. About one fifth of respondents reported the involvement of their congregation members, and the differences between Maputo and Chibuto, and between mainline and healing denominations, reflected the corresponding patterns detected in assistance provided to nonmembers. The gender differences, however, were not significant, largely because the opposite trends detected in assistance to church members and nonmembers nearly canceled each other out.

To ascertain the net effects of denomination type, location, and gender, we subjected these effects to a multivariate analysis. Table 2 presents the results of a logistic regression model that predicts the odds of reporting church-based provision of HIV/AIDS assistance to either members or nonmembers by location, type of denomination, and gender; the model controls for respondent’s age, education, marital and material status, and frequency of church attendance. The results confirmed the bivariate associations. In fact, the type of denomination and the congregation’s location were the only 2 predictors that significantly affected the outcome.

**Types of Care and Support Provided Through Religious Organizations**

Both the survey and semistructured interviews supplied information on the types of assistance offered through church channels. Table 3 groups the reported types of assistance ever provided (regardless of volume and frequency) into 2 broad categories: psychological support (prayer, advice, encouragement, etc.) and tangible support (help with money, food, transportation, and other tangible items, as well as personal physical care). Psychological support was reported by a slightly higher number of respondents than was tangible support for both church members and nonmembers. The gaps between urban and rural churches and between the 2 types of denominations remained large but, as in the overall comparisons (Table 1), were only statistically significant for assistance provided to nonmembers. Interestingly, when assistance was broken down by type, the gender differences were no longer statistically significant.

The data presented in the tables cannot show important details about the volume, frequency, nature, and mechanisms of assistance to patients with HIV/AIDS and their families. The qualitative data help shed some light on these nuances, and we summarized the most valuable insights from the in-depth interviews. They suggest that prayer and related forms of psychological support by far constituted the most frequent and sizeable form of assistance. Less frequently, church members, usually women, provided help with basic personal care and with house care—cooking, cleaning,
outside the congregation may be problematic, because of church rivalries. Religious leaders are particularly cautious while sanctioning such activities in rural areas, where church boundaries are clearly demarcated and well known; overstepping these boundaries, even for the purpose of caring for the sick, may be interpreted as unsolicited proselytizing.

**Interchurch Coordination of HIV/AIDS-Related Activities**

Denominational and organizational differences and competition notwithstanding, churches do coordinate some of their HIV/AIDS-related assistance. The activities of *Tshembeka* (“to be trustworthy” in Shangana, the main local language), a nongovernmental organization operating in Chibuto, illustrate both the potential and challenges inherent in the involvement of religious organizations in interfaith HIV/AIDS care and support. *Tshembeka* was established with a small grant from the United States Agency for International Development awarded to World Relief, an international nongovernmental organization promoting community-based social projects. *Tshembeka* is made up of a dozen churches whose volunteer activists identify patients with AIDS-like symptoms in their neighborhoods and visit them at home to encourage them to get tested for HIV and to offer moral support and counseling if the patients’ seropositivity was confirmed (HIV-negative individuals were also said to receive similar support).

According to *Tshembeka*’s coordinator, a local mainline church leader, the organization had virtually no financial resources beyond those necessary to provide basic training to volunteer activists, to obtain pamphlets, and to obtain a small quantity of disposable gloves. As a result, earlier attempts to offer more complex home-based care and nutrition supplements had been abandoned or drastically reduced, and dropout and turnover rates among activists were high. High transportation costs prevented *Tshembeka* activists from taking patients to specialized HIV/AIDS clinics located in the province’s 2 main cities. Transportation costs were also a major barrier to the expansion of *Tshembeka*’s activities beyond the limits of the town of Chibuto into more distant rural areas of the district. However, even in the town, only a small fraction of churches was involved; the rest chose to stay out of the project. Although no church leaders would directly admit that his congregation’s nonparticipation was a result of interchurch friction, our fieldwork showed that such friction does play an important role. Even for many leaders whose churches were involved in *Tshembeka*’s activities, the humanitarian and charitable aspects of these activities were intertwined with the quest to boost the prestige and, eventually, the membership of their congregations.

**DISCUSSION**

Our study shows that despite high HIV prevalence in the region, public encounters with individuals with HIV/AIDS remained infrequent, as did the involvement of religious organizations in the provision of HIV/AIDS-related care and support. The degree of involvement, however, varied between urban

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**TABLE 3—Types and Recipients (%) of Reported Church-Based HIV/AIDS Care and Support: Survey of Religious Congregations, Mozambique, 2003**

<table>
<thead>
<tr>
<th>Type of Denomination</th>
<th>Gender</th>
<th>Location of Congregation</th>
<th>No. respondents</th>
<th>Church ever provided tangible support to members with HIV/AIDS</th>
<th>Church ever provided psychological support to members with HIV/AIDS</th>
<th>Church ever provided psychological support to nonmembers with HIV/AIDS</th>
<th>Church ever provided psychological support to any HIV/AIDS victim/family</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>677</td>
<td>325</td>
<td>14.5</td>
<td>11.0</td>
<td>12.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chibuto</td>
<td>352</td>
<td>294</td>
<td>10.2</td>
<td>8.9</td>
<td>15.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Maputo</td>
<td>325</td>
<td>294</td>
<td>20.5</td>
<td>16.7</td>
<td>11.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mainline</td>
<td>317</td>
<td>15.8</td>
<td>15.0</td>
<td>12.0</td>
<td>10.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Men</td>
<td>360</td>
<td>13.3</td>
<td>10.6</td>
<td>10.0</td>
<td>6.9</td>
</tr>
</tbody>
</table>

*Associations significant at P < .05.*
and rural areas and between different types of denominations. Within churches, the type of involvement in HIV/AIDS care and support also varied by gender.

The assistance offered by religious organizations included both tangible and intangible components. The latter clearly predominated, whereas the former was usually reserved for extreme situations—terminal stages of AIDS-related illness or for funerals. Much of the church-provided assistance was small in scale and episodic; it was neither organized nor controlled by the church leadership. Congregation leadership was involved mainly in infrequent, larger-scale actions that required pooling of meager congregational resources. Whatever the level and scope of assistance, it often targeted people outside of congregations. Church leaders’ involvement in HIV/AIDS assistance to nonmembers of their churches could be perceived by outsiders as attempts to spread their influence beyond the ranks of their congregations. These perceptions, and the resulting tensions among church leaders and members, hinder interfaith congregational cooperation initiatives, such as Tshembeka, which are already crippled by a chronic shortage of financial resources.

Our analysis suggests, therefore, that the potential of religious organizations in the fight against HIV/AIDS in southern Mozambique (which we perceive to be as a typical sub-Saharan setting) exists, but this potential is underutilized. This underutilization stems, in part, from limited practical exposure to HIV/AIDS cases, in part from church financial constraints and from interchurch ideological tensions and organizational rivalries. As the health and social burden of HIV/AIDS mounts, it becomes increasingly critical to remove the barriers to greater utilization of religious organizations. Because the material and financial resources of most religious organizations in sub-Saharan Africa are unlikely to improve substantially, the efforts of policymakers should focus on the sociopsychological and organizational obstacles faced by these organizations.

Critical areas for the involvement of religious organizations in HIV/AIDS-related assistance could include encouraging both members and nonmembers to use voluntary counseling and testing services, providing support for access to antiretroviral therapy, and supporting antiretroviral therapy adherence. Because the success of voluntary counseling and testing and antiretroviral therapy is obstructed not only by individuals’ material and financial constraints but also by the stigma and similar social barriers, the emphasis of religious organizations on compassion and solidarity may prove an effective mobilization tool. At the same time, while seeking to enlist the help of religious organizations in providing this and other types of HIV/AIDS-related assistance, policymakers should take into account doctrinal and organizational differences among religious denominations, as well as their perpetual (and often bitter) ideological and organizational competition.

About the Authors
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Contributors
V. Agadjanian directed the data collection and led the analysis. S. Sen assisted in the literature review and analysis.

Acknowledgments
This work was supported by the National Institute of Child Health and Human Development (grant R03 HD043675). Data collection and processing were carried out by the Center of African Studies, Eduardo Mondlane University, Maputo, Mozambique.

Human Participant Protection
The study has been approved by the Arizona State University institutional review board.

References
The Impact of Cost on the Availability of Fruits and Vegetables in the Homes of Schoolchildren in Birmingham, Alabama

Jamy D. Ard, MD, Stephanie Fitzpatrick, BS, Renee A. Desmond, DVM, PhD, Bryce S. Sutton, PhD, Maria Pisu, PhD, David B. Allison, PhD, Frank Franklin, MD, PhD, Monica L. Baskin, PhD

Over the past 40 years, the national prevalence of obesity (body mass index [BMI] ≥30 kg/m²) has risen from 13% to 31%, and the prevalence of overweight (25 ≤ BMI < 30 kg/m²) has grown from 31% to 34%.1 Potential explanations for the increasing prevalence of obesity include, but are not limited to, increased intake of energy-dense foods and sugar-containing beverages, lower levels of physical activity, declining levels of strenuous activity at work, and the proximity of fast-food restaurants.2,3 The combination of increased access to low-cost convenience foods and decreased disposable income for food may lead to preferential displacement of fruits and vegetables. This is unfortunate, as increased consumption of fruits and vegetables, coupled with a reduced-calorie dietary intake, may reduce obesity4,5 as well as protect against other health conditions such as cancer, diabetes, and hypertension.6–8

Increasing fruit and vegetable consumption may be difficult, because consumer food choice is closely linked with food cost.9 Retail price increases between 1982 and 1997 were lower for sugar and sweets (52%) and fats and oils (47%) compared with that for fruits and vegetables (93%).10 As such, food items purchased from retailers in high-income communities are less energy dense than in lower-income communities (i.e., more fruits and vegetables and fewer high-fat foods purchased).11 This type of evidence is consistent with (but does not prove) the notion that the costs of healthy items, specifically fruits and vegetables, are a limiting factor in consumption and lead to preferential purchasing of lower-cost, more-energy-dense food items with less nutritious value.12

Research by Zenk et al. has recently focused on the relationship between fruit and vegetable consumption and retail food store location and characteristics.13 Their analysis found no direct association between per-capita income and fruit and vegetable consumption and between fruit and vegetable affordability and consumption for a sample of predominantly African American consumers in the Detroit metropolitan area. However, they used a self-reported ordinal ranking of “food affordability,” which may not be truly representative of actual food cost per serving or relative prices of fruits and vegetables.

As more discussion regarding the impact of fruit and vegetable costs has developed, lowering the cost of these items has become an intervention target of interest in combating obesity. Therefore, it may be important for investigators, public health practitioners, and policymakers to understand the true effect of fruit and vegetable pricing on consumption and, ultimately, body weight. Several studies have examined the relationship between weekly household expenditure on certain food groups including fruits and vegetables using economic theories of consumer behavior as applied by the linear expenditure system model.14–16 To date, we are unaware of any studies that demonstrate that lowering the cost per serving of fruits and vegetables leads to increased availability in the home. Defining this relationship and other significant moderating factors would be a first step in making the link between fruit and vegetable costs and obesity. Moreover, understanding how the costs of fruits and vegetables impact special populations that suffer from disproportionate rates of obesity, including low-income and African American populations, would be valuable.

In this study, we linked baseline food availability data from participants of the Hi5+ program with (but does not prove) the notion that the costs of healthy items, specifically fruits and vegetables, are a limiting factor in consumption and lead to preferential displacement of fruits and vegetables.
intervention in Birmingham, Ala, to national price indices to assess the relationship between the costs of the items and the self-reported in-home availability.

METHODS

Population

The Hi5+ intervention was a school-based intervention in the Birmingham, Ala, metropolitan area. The project was designed to identify the role and influences of the family on eating habits and subsequently intervene on these habits to increase fruit and vegetable intake. Thirty-three elementary schools in 3 districts participated in the Hi5+ intervention, providing a biracial, broad socioeconomic sample of 4th-grade students. The Hi5+ intervention sample was reflective of the racial/ethnic composition and income distribution of the Birmingham metropolitan statistical area. Families were randomly assigned to an enhanced family intervention group or a control group. Outcomes were assessed at baseline and after 1 and 2 years follow-up. Primary outcomes of the intervention have been previously published. Data from the baseline assessment were used for this analysis.

Fruit and Vegetable Availability

Fruit and vegetable availability was ascertained from parents of 4th graders participating in Hi5+ (n = 1355). Availability of 3 100% fruit juice items, 13 fruits, and 18 vegetables was determined through a questionnaire that asked whether any of the items were in the home in any form (fresh, frozen, canned, or dried) in the previous 2 weeks (coded as yes or no responses). This instrument has been used in several assessments of fruit and vegetable availability, and was validated by the parent or legal guardian who was the primary household shopper. For this analysis we excluded 3 items—other 100% fruit juice, fruit cocktail, and other beans—because they were either nonspecific and could not be identified or because a price per serving was not available for the item (fruit cocktail).

Independent Predictors Assessment

Measures, including the fruit and vegetable availability survey, were obtained from students and parents during the spring of the baseline school year and randomly ordered among the participating schools. Measured height and weight were obtained for children, and self-reported height and weight were obtained from parents. BMI was calculated by dividing weight in kilograms by height in meters squared. Parents provided information on household income and completed the fruit and vegetable availability questionnaire.

Cost Estimates

Cost per serving of the juice, fruit, and vegetable items in the survey was obtained from the US Department of Agriculture, Agricultural Research Service. Reed et al. used 1999 AC Neilsen Homsescan data from 7195 households across the United States to determine the average cost per serving of 57 fruit and vegetable items in various varieties and forms. The average cost per serving not only represents the most common varieties and forms of the fruit and vegetable items, but it also represents a variety of food outlets from which these items may have been purchased. Food outlet variety may be a function of neighborhood, and prices have been shown to significantly differ by the type of outlet (e.g., chain supermarket vs deli and bodega).

Statistical Analysis

Descriptive data are presented as mean ± standard deviation (SD). All comparisons for apparently normally distributed, continuous variables were conducted with the Student t test. Proportions of African Americans and Whites reporting fruit and vegetable availability for each item were compared using chi-square analysis of independence in 2 × 2 contingency tables. Differences in mean number of items present in the home were compared by race using the Student t test.

To determine the effect of cost per serving on fruit and vegetable availability, we created multivariate discrete choice models using the generalized estimating equation method implemented in PROC GENMOD in SAS version 9.0 (SAS Institute Inc, Cary, NC) using the logit-link function. The dependent variable was availability of the fruit or vegetable in the home (yes or no) and the independent predictors included race (0 = White, 1 = African American), income (assessed as an ordinal variable as 1 = $<10000, 2 = $10000–$19999, 3 = $20000–$29999, 4 = $30000–$39999, 5 = $40000–$49999, 6 = $50000–$59999, 7 = $60000–$69999, 8 = $70,000), child’s BMI (continuous variable), parent’s BMI (continuous variable), gender (0 = male, 1 = female), and item cost (US Department of Agriculture survey). Confounding of the predictors with cost was assessed by examining the P value of that covariate as well as the incremental change at each 10% increase in the cost variable. Missing income values (20%) were imputed using median income for the child’s school. The model adjusted for clustering within the respondent’s home (for those having more than 1 fruit or vegetable item present) by using the repeated statement method. The multivariate model included those predictors from the univariate models that were significant at P < .05.

RESULTS

The sample of participants represented an equal distribution of boys and girls, whose parents had a wide range of income (Table 1). A number of the children were at risk for overweight (BMI in the 85th–95th percentile for children of the same age group) or were overweight (BMI greater than the 95th percentile). There were no differences by race for the percentages of children that were in either category. More than 50% of the parents were considered either overweight or obese. African American parents had nearly double the prevalence of obesity compared with White parents (35% vs 18%, respectively; P < .0001).

On average, parents reported having approximately 17 juice, fruit, or vegetable items available in the previous 2 weeks (Table 2). There was no statistical difference between racial groups in total availability of these items in the home (P = .16). Figure 1 shows that most homes had potatoes (other than french fries or tater tots), green beans, lettuce, corn, and orange juice available, and relatively few homes reported having items such as grapefruit, pears, and squash. As depicted in Figure 1, there was an inverse relationship between the proportion of homes reporting a particular item as being available and the cost per serving.

Figure 2 displays some of the differences in fruit and vegetable availability by race. Higher proportions of Whites reported having items...
**TABLE 1**—Demographic and Clinical Characteristics of Study Sample: Hi5+ Intervention, Birmingham, Ala, 2001–2004  

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age of child, y</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>516 (38.1)</td>
</tr>
<tr>
<td>9</td>
<td>783 (57.8)</td>
</tr>
<tr>
<td>10</td>
<td>10 (4.1)</td>
</tr>
<tr>
<td>Gender of child</td>
<td></td>
</tr>
<tr>
<td>Boy</td>
<td>679 (50.1)</td>
</tr>
<tr>
<td>Girl</td>
<td>676 (49.9)</td>
</tr>
<tr>
<td>Race of child</td>
<td></td>
</tr>
<tr>
<td>African American</td>
<td>431 (31.8)</td>
</tr>
<tr>
<td>White</td>
<td>924 (68.2)</td>
</tr>
<tr>
<td>Child’s weight status</td>
<td></td>
</tr>
<tr>
<td>At risk for overweight</td>
<td>122 (9)</td>
</tr>
<tr>
<td>Overweight</td>
<td>149 (11)</td>
</tr>
<tr>
<td>Parent’s income</td>
<td></td>
</tr>
<tr>
<td>&lt;$10,000</td>
<td>81 (6)</td>
</tr>
<tr>
<td>$10,000–$19,999</td>
<td>115 (8.5)</td>
</tr>
<tr>
<td>$20,000–$29,999</td>
<td>131 (9.7)</td>
</tr>
<tr>
<td>$30,000–$39,999</td>
<td>125 (9.2)</td>
</tr>
<tr>
<td>$40,000–$49,999</td>
<td>136 (10)</td>
</tr>
<tr>
<td>$50,000–$59,999</td>
<td>126 (9.3)</td>
</tr>
<tr>
<td>$60,000–$69,999</td>
<td>106 (7.8)</td>
</tr>
<tr>
<td>≥$70,000</td>
<td>275 (20.3)</td>
</tr>
<tr>
<td>No answer given</td>
<td>260 (19.2)</td>
</tr>
<tr>
<td>Parental BMI categories</td>
<td></td>
</tr>
<tr>
<td>&lt;$25 kg/m²</td>
<td>623 (46)</td>
</tr>
<tr>
<td>25–29.9 kg/m²</td>
<td>420 (31)</td>
</tr>
<tr>
<td>≥30 kg/m²</td>
<td>312 (23)</td>
</tr>
</tbody>
</table>

**Note.** BMI = body mass index.


<table>
<thead>
<tr>
<th></th>
<th>White, Mean ±SD</th>
<th>African, Mean ±SD</th>
<th>Total, Mean ±SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Juice</td>
<td>1.8 ±0.9</td>
<td>1.9 ±0.9</td>
<td>1.8 ±0.9</td>
</tr>
<tr>
<td>Fruit</td>
<td>5.8 ±2.4</td>
<td>5.7 ±2.6</td>
<td>5.8 ±2.5</td>
</tr>
<tr>
<td>Vegetables</td>
<td>10.0 ±3.1</td>
<td>10.5 ±3.7</td>
<td>10.1 ±3.3</td>
</tr>
<tr>
<td>Total</td>
<td>17.6 ±5.1</td>
<td>18.1 ±6.1</td>
<td>17.7 ±5.5</td>
</tr>
</tbody>
</table>

**Note.** Cost per serving of items obtained from US Department of Agriculture, Agricultural Research Service.  
  aOther than French fries or later tots.  
  bSpinach, collards, turnips, and so on.  
  cBell pepper or green pepper.

![Figure 1](image_url)  
**FIGURE 1**—Unadjusted correlation between fruit and vegetable availability and cost per serving: Hi5+ intervention, Birmingham, Ala, 2001–2004

As greens (including collards, turnip greens, spinach, and so on), sweet potatoes, and okra. All of these differences in proportions were statistically significant. It should be noted that several of the items reported in higher proportions by African Americans (e.g., greens, okra) cost more than the median cost per serving of $0.18.

The results of multivariate modeling of cost per serving of the items and their availabilities are shown in Table 3. Increasing the cost per serving of an item significantly decreased the odds of having the item available in the home by 23% ($P<.001$) for each $0.10-unit increase in cost. A higher income, African American race, and having a female child significantly increased the probability of having a fruit or vegetable item available at home. The BMI of the child or parent were not significant predictors of fruit and vegetable availability in the home. We also found a significant interaction between race and cost ($P<.001$). Although cost negatively impacted fruit or vegetable choice in both races, African Americans were less affected by increased cost compared with Whites. We controlled for income and gender and found that for each unit increase in cost (in units of $0.10) the odds ratio for having that fruit or vegetable in the home was 0.72 (95% CI, 0.7, 0.75) for Whites compared with 0.89 (95% CI, 0.82, 0.96) for African Americans.

Review of the simple correlation suggests that 2 items (squash and oranges) in the higher cost range may be primarily driving the inverse relationship between cost and fruit and vegetable availability. For this reason, we conducted a sensitivity analysis, removing oranges and squash from the multivariate model. With these items removed, the odds of having the remaining fruit and vegetable items available decreased by 30% ($P<.001$) as cost increased.

<table>
<thead>
<tr>
<th>Factor</th>
<th>Model 1</th>
<th>Model 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of item per serving (in $0.10 units)</td>
<td>0.77 (0.75, 0.79)</td>
<td>...*</td>
</tr>
<tr>
<td>Cost of item per serving</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low cost (&lt; $0.20 per serving)</td>
<td>0.99 (0.94, 1.03)</td>
<td>0.67 (0.63, 0.71)</td>
</tr>
<tr>
<td>Medium cost ($0.20–$0.29 per serving)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High cost ($≥$0.30 per serving)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Race of child</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>African American</td>
<td>1.12 (1.02, 1.23)</td>
<td>1.12 (1.02, 1.23)</td>
</tr>
<tr>
<td>Gender of child</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boy</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Girl</td>
<td>1.08 (1.01, 1.17)</td>
<td>1.08 (1.01, 1.17)</td>
</tr>
<tr>
<td>Household income (scored 1–8)*</td>
<td>1.03 (1.01, 1.05)</td>
<td>1.03 (1.01, 1.05)</td>
</tr>
</tbody>
</table>

Note. CI = confidence interval; OR = odds ratio. Results are from a linear model utilizing the binomial link function. Model 1 included race, gender, income, and cost per serving in continuous units. Model 2 included race, gender, income, and cost per serving in categorical units.

*Indicates factor not used in model.

Figures and tables:
- FIGURE 2—Proportions of Whites and African Americans reporting fruit and vegetable items available: Hi5+ intervention, Birmingham, Ala, 2001–2004

DISCUSSION

The results of this study demonstrate that in a sample of African American and White families from a broad socioeconomic spectrum, fruit and vegetable availability in the home decreased as the cost per serving increased. Although most homes had the low- to moderate-cost ($0.29 per serving) items available, relatively few homes had higher-cost ($≥$0.30 per serving) items available. The significant inverse relationship between in-home availability and cost per serving is consistent with the hypothesis of Drewnowski et al. that the cost of fruits and vegetables is a barrier to at-home availability and, ultimately, consumption.

However, in this study, cost per serving primarily influenced at-home availability for the most expensive fruits and vegetables. For instance, squash was $0.36 per serving and was available in only 26% of the homes. Therefore, public health policies that lower the cost of fruits and vegetables currently priced less than $0.30 per serving may have little effect. More appropriate intervention targets may be fruit and vegetable items that have the highest cost per serving in a given market. On the other hand, if families do not purchase the more expensive fruits and vegetables because of taste preferences or other factors unrelated to cost, lowering the cost of these items may have little impact on availability in the home or consumption.

In this study, we did not seek to determine the consumer’s motivation for purchasing the fruit or vegetable items. We believe that it will be necessary to understand consumer motivation for purchasing fruits and vegetables if interventions will be developed with the goal of making fruits and vegetables more attractive by cost manipulation alone. These results do
support future testing of interventions that aim to make lower-priced fruits and vegetables more available in a variety of stores and in low-income and minority neighborhoods. Because there is a general lack of low-cost fruits and vegetables in some of these locales, it is our speculation that interventions with this approach may be more effective.

A higher income increased the odds of having an item in the home, but only modestly. This modest effect suggests that the impact of income on obesity may be mediated through other avenues aside from limiting availability of fruits and vegetables in the home. That is, as the category of income increased, the odds of reporting an item available at home increased by just 3%, indicating that those with higher incomes were not necessarily using the additional income to purchase a wider variety of fruits and vegetables largely different from those in lower income brackets. Those with higher incomes may, however, have larger quantities of fruits and vegetables in the home, but this was not ascertained in our survey. It is also possible that these individuals purchased items other than fruits and vegetables that were low in energy density and of higher nutritive quality.

Although the cost of fruits and vegetables reduced at-home availability, the impact of cost on fruit and vegetable availability in African American homes was less than that on availability in White homes. Compared with Whites, a significantly larger proportion of African Americans reported higher availability of items such as greens, sweet potatoes, okra, and other foods that are consistent with traditional African American dietary patterns. However, the cost per serving for greens and okra was higher than the median cost per serving for the group of food items surveyed. This implies that African Americans may purchase some fruit and vegetable items based on preference, cultural significance, family traditions, and taste, overriding potential cost concerns. Other studies have also suggested that fruit and vegetable availability in African American homes may be less influenced by economic factors. For example, Edmonds et al. demonstrated that median income was inversely associated with at-home fruit (r = -0.63; P < .05) and vegetable availability (r = -0.67; P < .05).

Even though being African American increased the odds of having several items available in the home, there was still a higher proportion (35% vs 18%) of obese African American adults compared with Whites. This suggests that lowering the cost and increasing the availability of fruits and vegetables (in isolation) may have little impact on obesity for African Americans. To better understand how at-home availability of fruits and vegetables impacts obesity in African Americans, investigators need more information regarding food preparation styles, consumption patterns of fruits and vegetables, and the role of fruits and vegetables in displacing high-energy-dense foods in African American populations. Although fruits and vegetables are low-energy-dense foods, preparation techniques common in African American households, such as deep-fat frying, adding high-fat meats for seasoning, and adding sugar, can result in significant changes in the energy density of the final food product. In addition, fruit and vegetable items may not displace consumption of fried foods or sugar-containing beverages. It is also important to consider the role of physical activity, as fruit and vegetable intake may not be associated with a physically active lifestyle in African Americans.

**Limitations**

This study may be limited because cost per serving may not be the best measure of cost—most foods are priced per pound or per ounce. However, cost per serving provides a reasonable way to compare different items that may weigh the same but have different yields of edible portions. In addition, cost per serving does not capture other cost factors such as perceived cost and indirect cost associated with food procurement, preparation, and storage (e.g., transportation costs, use of coupons and discounts, buying in bulk). These cost factors may have significant effects on fruit and vegetable availability, but are not measured in this study as potential confounders. The use of a national data source to estimate cost decreases the variability in cost that may be seen at the regional level. Because of the decreased variability, our results may actually underestimate the differences in price sensitivity by race, particularly if African Americans systematically shop at higher-priced, smaller stores that have less fruit and vegetable variety compared with the stores where Whites shop.

Also, we cannot make any real assertions regarding consumption. Even though the food was reported as available in the home, this does not mean that the child or parent in our sample was the one who actually consumed the food item. However, at-home availability is the first step to consumption. Finally, we cannot estimate the extent to which personal preferences override usual cost concerns when one purchases fruit and vegetable items. As mentioned previously, preferences may have particular implications for interventions and specific ethnic groups.

**Conclusions**

This study demonstrates that as the cost of fruits and vegetables increases, the availability of fruits and vegetables in the home decreases. This is most evident for fruit and vegetable items in the highest cost range. Despite this fact, African Americans were more likely than Whites to have fruit and vegetable items available. Cost may be a significant barrier to fruit and vegetable consumption, but the link between cost and consumption of fruits and vegetables remains to be established. There may be other factors such as taste, preference, and culture that may have a more significant impact on fruit and vegetable purchase and consumption. Across-the-board price reductions of fruits and vegetables may have less effect than anticipated.

Future studies should address consumers’ motivations and barriers to purchasing fruits and vegetables. For instance, despite the actual cost of fruits and vegetables as a barrier, there are other perceived costs such as shopping time (driving to and from the store and picking out the item) as well as preparing the food item (cleaning, cutting, boiling, etc.) that may be perceived as equally important barriers. Furthermore, researchers should examine the impact of preparation styles for low-energy-dense foods, which may be influenced by cultural traditions, as well as create interventions that provide education on preparing and purchasing fruits and vegetables.

**About the Authors**

Jamy D. Ard is with the Department of Nutrition Sciences, University of Alabama, Birmingham. At the time of writing, Stephanie Fitzpatrick and Monica L. Baskin were with the Department of Health Behaviors, University of Alabama.
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RSVP: 773-702-0460. No capes required.

MARCH 19
Research Centers of Excellence and their Strategic Role in Biodefense

OLAF SCHNEEWIND, MD, PhD
Chair, Committee on Microbiology; Professor, Department of Microbiology
The University of Chicago Pritzker School of Medicine

APRIL 11
Strategic Partnerships

CORTIZ TROTTER
Chief Emergency Officer
City of Chicago

MAY 11
Public Health Response During Complex Emergencies

SCOTT FILER
Senior Analyst, National Health Security
Homeland Security Analysis Group
Argonne National Laboratory

MASTER OF SCIENCE IN THREAT AND RESPONSE MANAGEMENT

The UNIVERSITY of CHICAGO
Graham School of General Studies
JOB OPPORTUNITIES

GEORGIA

Health Educator: Develop alcohol/drug education programs, serve as liaison with public health care agencies; develop operational policies; supervise professional staff in implementing health programs; conduct evaluations & diagnostic studies to assess the quality of programs; CADC certified; 40 hours/week; Atlanta area; will pay previous wage; MS in Psychology or related; B.S. + 5 years experience; Job Ref #18763; Send resumes to CETPA, Inc., 7740 Roswell Rd, Ste 700, Atlanta, GA 30350.EOE.

Department of Social and Behavioral Health

FACULTY POSITIONS (TENURE-TRACK)

Virginia Commonwealth University invites applications for full-time Associate/Full Professors in its new Department of Social and Behavioral Health. The department's mission is to bring a multidisciplinary faculty together to promote research and scholarship that addresses how social, behavioral and cultural factors affect individuals' health, populations' susceptibility to disease, and to learn about and intervene in the ability of individuals and communities to navigate formal and informal healthcare systems. This new department is one of five developing departments in an emergent school of public health. The Department's goal is to foster collaborative relationships with clinical researchers, campus-wide social and behavioral scientists, health services researchers, basic sciences and to facilitate research linkages to outreach partners and community-based organizations.

We seek applications from creative, innovative individuals who want to share in creating a department with an innovative vision of public health and a commitment to excellence in research and scholarship. Candidates should have a doctoral degree in public health or a social or behavioral science (sociology, anthropology, psychology) with a focus on health. The successful applicant will have current national-level, external grant funding, demonstrate sustained success as a principal investigator, and a strong record of peer-reviewed publications. Applicants with a research focus in the sociobehavioral aspects of health, such as psychosocial interventions to improve health decision making and health care communication, chronic disease risk reduction and behavior change (diet, physical activity, tobacco), symptom management or quality of life, consumer health informatics (including the development of new media approaches for communication), chronic disease prevention and control, and amelioration of health disparities, are of particular interest.

Virginia Commonwealth University is rich in exciting opportunities to develop multidisciplinary and cross-institutional collaborations including the NCI-designated Massey Cancer Center, and is well positioned to take advantage of emerging federal and regional funding initiatives and priorities. The successful candidate will be expected to bring and continue development of their research program and to teach graduate students. The position will provide opportunities for diverse research experiences in a highly supportive collegial environment with potential for growth. A competitive salary, excellent benefits and start-up package are included.

Interested candidates should submit a cover letter describing their research and teaching experience, a curriculum vitae, and a list of three referees to:

Laura A. Siminoff, Ph.D., Professor and Chair, Department of Social and Behavioral Health, School of Medicine, Virginia Commonwealth University, P. O. Box 980149, Richmond, VA 23298. Applicants are encouraged to send their applications electronically to pdwallace@vcu.edu. The position will remain open until filled, but applicants are encouraged to apply by March 15, 2007.

Virginia Commonwealth University is an equal opportunity/affirmative action employer. Women, minorities, and persons with disabilities are encouraged to apply.
Department of Social and Behavioral Health
FACULTY POSITION
(tenure-track/specialty: Psychometrics)

Virginia Commonwealth University has a unique opening for a mid-career to senior level faculty position whose specialty is psychometrics, measurement and instrument development in a new Department of Social and Behavioral Health. The Department’s mission is to bring a multidisciplinary faculty together to promote research and scholarship that addresses how social, behavioral and cultural factors affect individuals’ health, populations’ susceptibility to disease, and to learn about and intervene in the ability of individuals and communities to navigate formal and informal healthcare systems. This new department is one of five developing departments in an emergent school of public health.

We seek applications from creative, innovative individuals who want to share in creating a department with an innovative vision of public health and a commitment to excellence in research and scholarship. Applications are invited from researchers with experience and training in psychometrics, measurement and instrument development who are interested in applications to health behavior and delivery problems. Particular value is placed on the ability to work collaboratively with other researchers and mentor junior faculty regarding measurement and research methods. A generous start-up package is available to help sustain and move the successful candidate’s research to the next level.

Faculty appointment in the tenure track at the associate or full professor level is available. A competitive salary, excellent benefits and start-up package are included. The successful applicant will possess a doctoral degree in a quantitative social, behavioral or measurement science (e.g., psychometrics, psychology) or in biostatistics with experience in the analysis of behavioral data and training in measurement. The candidate should have a strong record of peer-reviewed publications and sustained success as a researcher.

Interested candidates should submit a cover letter describing their research and teaching experience, a curriculum vitae, and a list of three referees to: LAURA A. SIMINOFF, Ph.D., Professor and Chair, Department of Social and Behavioral Health, School of Medicine, Virginia Commonwealth University, P.O. Box 980149, Richmond, VA 23298.

Applicants are encouraged to send their applications electronically to: pdwallace@vcu.edu. The position will remain open until filled, but applicants are encouraged to apply by March 15, 2007.

Virginia Commonwealth University is an equal opportunity/affirmative action employer.

Women, minorities, and persons with disabilities are encouraged to apply.
DEPARTMENT OF HEALTH SCIENCES  
BOSTON UNIVERSITY

Assistant/Associate Professor of Health Sciences  
Sargent College of Health and Rehabilitation Sciences

The Department of Health Sciences at Boston University invites applications for a tenure track position in our Health Science Program. Applicants should have an earned doctoral degree in the health science field. Disciplines include, but are not restricted to, epidemiology, health policy and management, health economics, community health, health services research and health outcomes research. Applicants should have a strong scholarly record of research funding, or potential for funding from extramural sources, as well as a commitment to teaching and to further develop the undergraduate program in Health Science.

Review of applications will commence upon receipt, and will continue until the position is filled. Applicants should submit a letter of application, curriculum vitae, statement of research plans and names of three individuals who can provide letters of reference to: Dr. Eileen O’Keefe, Search Committee Chair, Department of Health Sciences, Boston University, 635 Commonwealth Avenue, 4th floor, Boston, MA 02215. ebokeefe@bu.edu

For more information, please visit www.bu.edu/sargent.

Boston University is an Equal Opportunity/Affirmative Action Employer

Director of the Master of Public Health Distance Learning Program

The Medical College of Wisconsin seeks a strong and dynamic leader with a distinguished record of teaching, research, and administration.

The successful candidate should have the following qualifications:

- Experience with public health graduate education
- PhD (Public Health), DrPH, or an MD or DO plus an MPH
- Experience in the practice of public health
- Experience in developing collaborative relationships within an organization.

The chosen candidate will work closely with the Director of the PhD Degree Program in Public and Community Health and the Director of the Master of Science in Epidemiology Degree Program to develop a synergy of educational experiences among the programs.

- Familiarity with distance learning technologies, curriculum design and evaluation.

Salary and other considerations will be competitive. For additional position details, please visit www.mcw.edu/mph. The Search Committee will begin screening candidates on January 1, 2007 and will continue to review applications until the position is filled.

Applicants should provide a curriculum vita, a statement of interest, and the names and contact information of three references. EOE. Please address all correspondence to:

Jane Morley Kotchen, MD MPH  
MEDICAL COLLEGE OF WISCONSIN  
Department of Population Health  
8701 Watertown Plank Road  
RO. Box 26509, Milwaukee, WI 53226-0509

GEISINGER

Infectious Disease Opportunity

Director of System Epidemiology – Infection Control

Geisinger Health System, a nationally recognized leader in quality initiatives, is seeking a BC/BE Infectious Disease Physician to provide medical leadership of an Infection Control Program in an expanding multi-hospital healthcare system. The ideal candidate will possess data analysis skills and have prior experience in an environment which emphasizes quality healthcare delivery; this position will include inpatient/ID responsibilities. An advanced degree (MPH) is desirable but not required dependent upon the applicant’s qualifications.

Geisinger Health System Includes:

- Geisinger Medical Center, Danville, PA, a 408-bed, Level I tertiary/quaternary care center that includes the Weis Center for Research, Janet Weis Children’s Hospital, and the Center for Health Research.
- Geisinger Wyoming Valley, Wilkes-Barre, PA, a 177-bed acute care community hospital nestled on the edge of the Pocono Mountains. It includes a freestanding heart hospital, a comprehensive cancer center and the Janet Weis Children’s Hospital pediatric wing.
- Geisinger South Wilkes-Barre, Wilkes-Barre, PA, a acute care community hospital that is licensed for 190 beds, with an additional 20 skilled nursing beds and a 10-bed Acute Care Psychiatric Unit. GISWB offers a wide range of services including an Emergency Department, a fully accredited Sleep Disorders Center, and a Heart Center featuring comprehensive diagnostic, cardiac catheterization laboratory, surgical and cardiac rehabilitation.
- Geisinger Community Practice, more than 40 single and multi-specialty physicians offices throughout northeast and central Pennsylvania.
- Teaching opportunities through our 75 medical and surgical specialties and 23 accredited residency and fellowship programs.
- Opportunities for clinical trials and outcomes research through Geisinger Center for Health Research and the Weis Center for Research.

Geisinger offers physicians:

- An MPH program in conjunction with The Johns Hopkins Bloomberg School of Public Health. The opportunity to pursue this training would be supported for the appropriate candidate.
- The opportunity to utilize a mature, fully-integrated electronic health record – connecting a comprehensive network of more than 40 community medical groups and an integrated network of over 650 Geisinger primary and specialty physicians.
- Paid medical malpractice insurance with tail coverage.
- Excellent benefits package including 4 weeks vacation and 3 weeks CME annually (with stipend).
- The benefits of Pennsylvania living — good schools and affordable homes in nice neighborhoods — just an afternoon’s drive from the Poconos, New York City, Philadelphia and Washington, DC.

At Geisinger, you’ll experience the support, camaraderie and professional challenges of a leading practice while discovering the charms of Pennsylvania living.

To discuss this opportunity, contact:

Kathy Kardisco, Recruiter  
Geisinger Department of Professional Staffing  
100 North Academy Avenue, Danville, PA 17822-2428  
Phone: 1-800-845-7112 • Fax: 1-800-622-2515  
e-mail: kkardisco@geisinger.edu

Geisinger is a drug-screening employer; EOE/M/F/D/V.

www.geisinger.org/docjobs
Dean College of Public Health  
CHINA MEDICAL UNIVERSITY—TAICHUNG, TAIWAN

We invite applications for a full-time tenure faculty position at the level of professor to serve as the Dean and to advance the Public Health Programs at China Medical University, Taichung, Taiwan

The position is available immediately and requires the candidate an advanced degree in the areas of Public Health, Epidemiology, Biostatistics, Environment Health, Preventive Medicine or Socio-economic Behavior Sciences, and experience in Administration. We are seeking an outstanding Scientist who will lead four undergraduate departments in Public Health, Health Services and Administration, Occupational Safety and Health, and Health Risk Management, and three graduate programs in Environmental Health, Health Services and Administration and Occupational Safety and Health. Applications will be reviewed until the position is filled.

Send a letter of interest, curriculum vita with list of publications and three letters of recommendation to: Fung-Chang Sung, Ph.D., Dean Search Committee, China Medical University, 91 Hsueh-Shih Road, Taichung 404, Taiwan

The University is an equal opportunity, affirmative action employer.

ROLLINS SCHOOL OF PUBLIC HEALTH OF EMORY UNIVERSITY

FACULTY IN GLOBAL ENVIRONMENTAL HEALTH  
Department of Environmental and Occupational Health and Hubert Department of Global Health

THE DEPARTMENT OF ENVIRONMENTAL AND OCCUPATIONAL HEALTH (http://www.sph.emory.edu/eoh) and the HUBERT DEPARTMENT OF GLOBAL HEALTH (http://www.sph.emory.edu/gh), ROLLINS SCHOOL OF PUBLIC HEALTH OF EMORY UNIVERSITY, Atlanta, Georgia, announce an international search for faculty with interests in Global Environmental Health. The two departments recently established a joint program in GLOBAL ENVIRONMENTAL HEALTH (http://www.sph.emory.edu/GLOBAL) that has been highly successful in attracting bright, committed students who undertake diverse research projects largely in developing countries. The present search seeks to recruit additional faculty members actively involved in global environmental health research. Potential focus areas include health effects of global climate change, chemical and waste hazards, indoor air pollution, natural disasters, land use change, biodiversity, and water and sanitation.

The position is open-rank and tenure-track. Interested individuals should send a letter of interest and curriculum vita to: Dr. Paige Tolbert, Chair, GEH Search Committee, q/o Robin Thompson, GCR Room 219, Department of Environmental and Occupational Health, Rollins School of Public Health, Emory University, 1518 Clifton Road, NE, Atlanta, GA 30322 USA, or by email to ptolber@sph.emory.edu. Review of applications will begin immediately and continue until the position is filled. Start date is negotiable. Salary and rank will be commensurate with experience. Applications will be considered confidential and references will not be contacted without the permission of applicants.

Emory is an Equal Opportunity/Affirmative Action Employer
Tulane University School of Public Health and Tropical Medicine

Department of Community Health Sciences

Faculty Position in Maternal and Child Health

The Department of Community Health Sciences is seeking one tenure-track faculty member with expertise in Maternal and Child Health.

The Department has sections in Maternal & Child Health, Health Education & Communication, and Nutrition, but more broadly sees its mission as developing community-based solutions to national public health problems. We are the academic home for the DHHS-funded Tulane Xavier National Center of Excellence in Women’s Health, a HRSA-funded Maternal and Child Public Health Leadership Training Program and a CDC-funded Prevention Research Center. We have very strong ties with nearby city and state public health agencies as well as community-based organizations, which provide many opportunities for research and involvement in rebuilding New Orleans post-Katrina. We view the health of women and children from a broad social perspective.

The primary responsibilities for this position will be mentoring and teaching graduate students in Maternal and Child Health, conducting MCH-relevant research, and working with local public health organizations on MCH issues. The rank of the position will depend on the experience of the successful applicant. The position requires an earned doctorate in a relevant field, experience as a funded investigator, publications in peer-reviewed journals, and graduate-level teaching experience.

Minority applicants and women are especially welcome.

Send curriculum vitae and letter stating goals for research and teaching to:

Ted Chen, PhD MPH
Department of Community Health Sciences
Tulane University School of Public Health & Tropical Medicine
1440 Canal Street, Suite 2300
TW-19
New Orleans, Louisiana 70112
(504) 988-5391
tchen@tulane.edu

Tulane University is an EEO/AA employer.
Please see: www.sph.tulane.edu/chs

The University of Tennessee

Director for the Institute of Public Health

The University of Tennessee invites applications/nominations for the position of Director (& Professor) of the Institute of Public Health, with a 12-month tenure-track position. The Founding Director of this university-wide institute will be expected to provide visionary leadership and administrative guidance in its development and fulfill of the university’s mission of teaching, research and outreach.

The successful candidate will have an earned doctorate or equivalent degree (i.e., MD, DrPH, PhD), excellent leadership and interpersonal skills, with experience in public health, CEPH accreditation, experience in generating external financial support, capability for building strong academic and research programs and for advancing diversity and working effectively in multicultural communities. It is desired they have experience linking the practice of public health with academia. This individual will take the leadership role in establishing a university-wide Institute of Public Health, building upon an existing fully accredited Master of Public Health program.

The University of Tennessee, Knoxville, is the state’s flagship research institution (Carnegie One) with over 26,000 students. As a land-grant university, it is committed to excellence in learning, scholarship, and engagement with society.

The University aims to advance the frontiers of human knowledge and enrich/elevate society; it welcomes people of all races, genders, creeds, cultures, sexual orientations, and values intellectual curiosity, pursuit of knowledge, and academic freedom and integrity.

Interested individuals should submit electronic applications, in Word format, that includes (1) a cover letter of interest addressing qualifications, (2) a comprehensive curriculum vitae, and (3) the names and contact information of four current references (including addresses, phone numbers and e-mail addresses). A review of applications will begin March 1, 2007. The position will remain open until a suitable candidate is identified and the position is filled.

Application materials should be sent electronically to Brenda Hart at bhart57@utk.edu.

Inquiries should be made to:
Dr. Jay Whelan, PhD, MPH
Chair, Search Committee
Professor and Head, Department of Nutrition
229 Jessie Harris Building, 1215 West Cumberland Avenue
The University of Tennessee, Knoxville, TN 37996-1920
PHONE: 865-974-6237, E-MAIL: jwhelan@utk.edu

The University is an EEO/AA/TitleVI/Title IX/Section 504/ADA/ADEA/ institution in the provision of its education and employment programs and services.
The Johns Hopkins Bloomberg School of Public Health invites applications for Assistant Professor in bioethics and public health. This tenure-track faculty member will have his or her academic appointment in any relevant department of the Johns Hopkins Bloomberg School of Public Health, including Health Policy and Management, International Health, Population Family and Reproductive Health, Epidemiology, Health Behavior and Society, and Environmental Health Sciences. This new faculty member also will be a core faculty member of the Johns Hopkins Berman Institute of Bioethics.

Applicants must hold a PhD, JD, MD, or equivalent. Applicants should:
1. have a solid background in bioethics;
2. have strong commitments to public/population health;
3. exhibit potential for a distinguished record of scholarship in the field of bioethics and public health;
4. show promise for excellence in teaching;
5. show promise for ability to secure external funding;
6. show potential for collaborative and interdisciplinary work. Scholars from a variety of disciplines, including medicine, nursing, the social sciences, public health, law, and economics are eligible to apply.

Applicants with strong training in empirical (quantitative and/or qualitative) social science research are particularly encouraged to apply. The successful applicant will be mentored to develop an increasingly independent portfolio of scholarship and funding in bioethics and public health. This new faculty member will join other bioethics/public health faculty teaching and advising in the PhD program in bioethics and public health.

The successful applicant will join thriving communities of scholars both within the Johns Hopkins Bloomberg School of Public Health and within the Berman Institute of Bioethics. The Johns Hopkins Bloomberg School of Public Health is the largest school of public health in the country with particular strengths in global health, health policy, and the qualitative and quantitative sciences. The Johns Hopkins Berman Institute of Bioethics includes scholars with backgrounds in public health, philosophy, medicine, nursing, social science, statistical science, and law, with active portfolios of scholarship, teaching, and service in bioethics. Faculty of the Berman Institute have appointments in four schools of the University—arts and sciences, medicine, public health, and nursing.

Minority and women candidates are particularly encouraged to apply. The Johns Hopkins University is an affirmative action/equal opportunity employer. 

Please submit a CV and letter of interest to:
DR. NANCY KASS
Phoebe R. Berman Professor of Bioethics and Public Health
Department of Health Policy and Management
Hampton House 344
624 N. Broadway
Baltimore, MD 21205
nkass@jhsph.edu
Washington University School of Medicine has a unique opening for a junior or mid-career level scientist for a tenure-track faculty position in the Division of Health Behavior Research, Department of Internal Medicine. Candidates with a research focus in the behavioral aspects of diabetes, such as risk reduction behavior change, diabetes management, quality of life, translation/dissemination, and/or health disparities are encouraged to apply.

The position offers the opportunity to collaborate with epidemiologists, clinicians, social and behavioral scientists and other faculty both at Washington University and Saint Louis University School of Public Health. The successful candidate will be expected to develop their own externally funded research and to participate in teaching. Candidates should have a doctoral degree in behavioral science, psychology, epidemiology, public health, or a related field and a commitment to excellence in research and scholarship.

The successful candidate has access to institutional resources to facilitate the integration of behavioral science into the broader research activities at Washington University. These include the Prevention and Control Core of the Diabetes Research and Training Center (DRTC) and the Diabetes Initiative National Program office funded by The Robert Wood Johnson Foundation. Washington University has been a DRTC for the past 29 years. The NPO provides oversight and technical assistance to two national diabetes self-management programs: Advancing Diabetes Self Management and Building Community Supports for Diabetes Care.

The Division of Health Behavior Research also fosters close collaborative relationships with researchers at Saint Louis University School of Public Health. The Washington University environment is rich in exciting opportunities to develop multidisciplinary collaborations. Interested candidates should send a cover letter, curriculum vitae, names of 3 references, and a summary of research interests to:

MARIO SCHOOTMAN, PH.D. at bbeato@im.wustl.edu.
Applications will be accepted until the position is filled.
We offer a competitive salary and benefits package.
For more information about the Division of Health Behavior Research, visit http://dhbr.im.wustl.edu/.

AA/EOE M/F/D/V
The Department of Epidemiology and Biostatistics at the Drexel University School of Public Health in Philadelphia invites applicants for the following tenure-track faculty positions.

**Assistant or Associate Professor in Epidemiology.**

Candidates must have a doctorate in Epidemiology and evidence of effective teaching ability. Infectious disease epidemiologists, especially those interested in collaborative research with state and city health departments, are encouraged to apply. However, applicants with research interests outside infectious disease epidemiology are also welcome. Department faculty currently work in the areas of psychiatric epidemiology, epidemiology of aging, cardiovascular disease epidemiology, epidemiology of neurodevelopmental disorders, pediatric epidemiology, and cancer epidemiology. The position involves scholarship through externally funded research and teaching and academic advising in the School’s established MPH and DrPH programs. There will also be opportunities to help shape future academic programs (e.g., PhD in Epidemiology) currently in the planning stages.

Applicants should send a curriculum vitae and cover letter that includes a description of research interests to:

Craig J. Newschaffer, Ph.D., Chair, Department of Epidemiology and Biostatistics
Drexel University School of Public Health, 1505 Race Street, MS 660, Philadelphia, PA 19102-1192

**Associate or Full Professor in Biostatistics.**

Candidates must have a doctoral degree in Biostatistics or Statistics, experience in academic settings, and a history of productive scholarship. Past involvement with data coordinating and/or biostatistics consulting centers is desirable. This position involves scholarship through collaborative and/or methodologic research and teaching and academic advising in the School’s established MPH and DrPH programs. There will also be opportunities to help shape future academic programs (e.g., MS in Biostatistics) currently in the planning stages. School faculty are engaged in a range of public health research activities and collaboration with College of Medicine researchers is also encouraged. The position also involves development of a biostatistics consulting/data coordinating function within the Department.

**Grant Writer**

The Department of Emergency Medicine at Beth Israel Deaconess Medical Center, an affiliate of Harvard Medical School, is seeking a grant writer to work with its diverse faculty to facilitate the research and grant process. The Department of Emergency Medicine has over thirty faculty members with ongoing research in multiple areas including sepsis, critical care, cardiology, women’s health, international, EMS/disaster, and medical education.

This position is responsible for working with the emergency medicine faculty on research projects and writing, preparing, and editing new and renewal grant proposals from federal, state, and private funding sources. Responsibilities include: identification of new funding sources, facilitation of work groups for the preparation of grant proposals, management of the pre-submission process, and assistance with the post-awarded monitoring process. Candidate must possess excellent research, writing, and analytical (including biostatistical) skills, strong organizational and team skills. Candidate must work effectively under deadlines. The ideal candidate should have a strong research background in healthcare or public health. A PhD, MPH, or terminal degree in a relevant field is required. Full benefits, salary, and academic appointment at Harvard Medical School commensurate with experience. EOE

**AMERICAN UNIVERSITY OF ARMENIA (AUA)**

(Affiliate of the University of California)

**Dean, College of Health Sciences (Public Health)**

AUA is a privately endowed independent American institution of higher education in Armenia.

**RESPONSIBILITIES:** Provide academic leadership in all aspects of the College, including strategic planning, curriculum, program growth and development, hiring and evaluation of faculty, spurring regional and international recruitment of MPH students, fiscal management, outcome assessment, and fund raising.

**QUALIFICATIONS:** The successful candidate will possess an appropriate terminal degree and a distinguished record of teaching; experience in generating and supporting development of external funding from a variety of sources; familiarity with current education policy issues and quality assurance practices; proven competence in strategic planning, fund-raising, and resource management.

**Physical presence in Armenia during the entire academic year is not required.**

**CV, letter of application & three references should be sent to:**

AUAC, 300 Lakeside Drive, 5th Fl., Oakland, CA 94612

**ATTN: Gaiane Khachatryan, Recruitment Coordinator; gaiane@auac.net; FAX: (510) 208-3576.**

EOE

**Beth Israel Deaconess Medical Center**

**Grant Writer**

The Department of Emergency Medicine at Beth Israel Deaconess Medical Center, an affiliate of Harvard Medical School, is seeking a grant writer to work with its diverse faculty to facilitate the research and grant process. The Department of Emergency Medicine has over thirty faculty members with ongoing research in multiple areas including sepsis, critical care, cardiology, women’s health, international, EMS/disaster, and medical education.

This position is responsible for working with the emergency medicine faculty on research projects and writing, preparing, and editing new and renewal grant proposals from federal, state, and private funding sources. Responsibilities include: identification of new funding sources, facilitation of work groups for the preparation of grant proposals, management of the pre-submission process, and assistance with the post-awarded monitoring process. Candidate must possess excellent research, writing, and analytical (including biostatistical) skills, strong organizational and team skills. Candidate must work effectively under deadlines. The ideal candidate should have a strong research background in healthcare or public health. A PhD, MPH, or terminal degree in a relevant field is required. Full benefits, salary, and academic appointment at Harvard Medical School commensurate with experience. EOE

**PLEASE CONTACT:**

Jonathan Fisher, MD, MPH
Department of Emergency Medicine
Beth Israel Deaconess Medical Center
One Deaconess Rd (WCC2)
Boston, MA 02215
Jfisher2@bidmc.harvard.edu
(617-754-2345)

**AMERICAN UNIVERSITY OF ARMENIA (AUA)**

(Affiliate of the University of California)

**Dean, College of Health Sciences (Public Health)**

AUA is a privately endowed independent American institution of higher education in Armenia.

**RESPONSIBILITIES:** Provide academic leadership in all aspects of the College, including strategic planning, curriculum, program growth and development, hiring and evaluation of faculty, spurring regional and international recruitment of MPH students, fiscal management, outcome assessment, and fund raising.

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**ATTN: Gaiane Khachatryan, Recruitment Coordinator; gaiane@auac.net; FAX: (510) 208-3576.**

EOE