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Feature Article

Leisure-time physical activity and neuropsychiatric symptoms of community-dwelling persons with cognitive impairment

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ABSTRACT

Physical activities are recommended to reduce neuropsychiatric symptoms of nursing home residents with mild dementia. However, relevant information is not available for community-dwelling persons with cognitive impairment. Therefore, this cross-sectional study examined the effects of leisure-time physical activities on cognitively impaired persons' neuropsychiatric symptoms and their family caregivers' distress. Activities were described in terms of their frequency, duration, number of different types, and energy expenditure. Participants were 58 dyads of persons with cognitive impairment and their family caregivers. Data on leisure-time physical activities and neuropsychiatric symptoms were collected using a 7-Day Physical Activity Recall and Chinese Neuropsychiatric Inventory, respectively. The most frequently reported activity was strolling (70.7%). The mean weekly activity frequency, duration, and energy expenditure were 4.52 (SD = 4.27) times, 3.7 (SD = 4.38) h, and 771.47 (SD = 886.38) kcal, respectively. The number of different activity types negatively and significantly predicted cognitively impaired persons' mood and psychosis as well as family caregivers' distress.

Introduction

Dementia is estimated to affect 5–8.5% of older adults (≥65 years old) worldwide by 2030.[1] Before dementia is diagnosed, patients usually have mild cognitive impairment.[1] The majority of these persons with cognitive impairment (PWCI) are community-dwelling and cared for by family caregivers (FCG) in the home.[1,2] However, this situation is aggravated in Asia because of the extraordinary rate of population aging.[3] In addition, most PWCIs present with neuropsychiatric symptoms, affecting FCG health, burden, and distress.[4] In Taiwan community-dwelling PWCIs also manifest slightly higher prevalence rates of and more frequent neuropsychiatric symptoms and affective disorders than their institutionalized counterparts, likely due to FCGs reacting more to neuropsychiatric symptoms than professional caregivers and institutional factors such as use of psychotropic medications.[5]

Physical activity seems to stimulate cognitive function of PWCIs and older healthy adults and reduce neuropsychiatric symptoms.[6–9] Physical activity can be classified into various categories. In this study, we focused on leisure-time physical activity (LTPA) because it reflects individuals' deliberate choice and is closely associated with improved health outcomes.[10] Assessing the effects of LTPA requires measuring the amount of engagement in terms of frequency, the number of LTPA types, duration (time), and energy expenditure (FTTE).[6,11] Better understanding the influence of the individual

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components of FTTE on the neuropsychiatric symptoms of community-dwelling PWCIs and their FCGs would help in designing LTPA interventions for this population.[12]

In addition, physical inactivity is one of seven potentially modifiable factors attributable to about 13% of Alzheimer's disease cases worldwide.[13] However, integrating and maintaining a physical-activity program into daily life is a challenge[14,15] that may be mitigated by designing structured home-based physical-activity programs, to which older adults adhere at higher rates than for center-based interventions.[16] This approach may be especially important for Chinese people who highly value harmonious relationships and closeness, leading them to prefer interacting with family members.[17] Since Taiwan's society, culture, and health care system differ from those in the US,[10,18] Taiwan-specific evidence on dementia care is needed to guide changes in practice and policy in Taiwan.[19] To fill this gap, this study was designed to test the relationships between LTPA indicators and neuropsychiatric symptoms of PWCIs and their FCGs' distress. We hypothesized that:

H1: LTPA of PWCIs is negatively associated with their neuropsychiatric symptoms.

H2: LTPA of PWCIs is negatively associated with their FCGs' distress.

Methods

Design, participants and settings

This cross-sectional study was conducted between August 2010 and July 2012 with approval of the study hospital's ethics committees (IRB number 97–0483B). A convenience dyad sample of PWCIs and their FCGs was recruited from the memory disorder clinics of a teaching hospital and a community hospital as well as the geriatric psychiatry clinics of two teaching hospitals in northern Taiwan. PWCI eligibility was determined by medical record review for these inclusion criteria: (1) having an FCG who provided direct care or supervised their care in the previous 3 months (co-residency was not required), (2) diagnosed with dementia based on DSM-IV criteria[20] with consensus agreement among the chief neurologists at the clinical sites, and (3) dementia severity score of 0.5 (very mild dementia) to 2 (moderate dementia) determined by the Clinical Dementia Rating (CDR).[21] Individuals in this dementia-severity range were chosen as most of them live in the community. PWCIs were excluded for: (1) acute illness, severe hearing or visual problems, (2) acute agitation requiring emergency treatment, (3) chronic alcohol abuse or use of drugs affecting central nervous system function, (4) diagnosed with a major psychiatric disorder within the last 2 years, and (5) neurological or systemic illness (e.g., delirium, hypoxia, or unstable thyroid dysfunction).

FCGs were included if they met these criteria: (1) >18 years old, and (2) willing to participate in this study. FCGs were excluded if they (1) reported a cognitive disorder such as severe memory problems or demonstrated a major affective disorder, (2) had a hearing or visual impairment that was not adequately corrected, (3) were prescribed drugs known to impair or enhance attention, e.g., antidepressants, barbiturates or other depressants, amphetamines, and (4) had insufficient command of Mandarin, Taiwanese or Hakka.

Of the 74 dyads screened, six were excluded for reasons related to the PWCIs' death ($n = 1$), refusal to participate ($n = 2$), nursing home placement ($n = 1$), and change of FCG ($n = 2$). Of the remaining 68 dyads, eight were excluded for reasons related to the FCGs: refusal to fill out the 7-Day Physical Activity Recall ($n = 2$), and not meeting the inclusion criteria ($n = 6$). Two other FCGs were excluded because they failed to provide complete data for calculating energy expenditure of PWCIs. The characteristics of these two FCGs and the other FCG participants did not differ. However, our older participants were less educated and our FCGs were younger than a representative sample of Taiwanese PWCI-FCG dyads.[22] Our final sample consisted of 58 dyads with complete data, which was within our estimated sample size of 50–100, calculated using a minimum significant R square with a power of 0.80 for 5–10 independent variables at an alpha level of 0.50.[23]

Procedures

Participating physicians referred the dyads to trained research assistants who conducted the initial interview in the clinics and explained the study purpose. Data on cognitively impaired participants' Chinese Mini Mental State Examination (MMSE)[24–26] and CDR[21,27,28] were collected by medical chart review. Other data were obtained in face-to-face interviews. After obtaining dyads' informed consents, the research assistants visited dyads at the PWCIs' homes to collect data on the measures described below.

Measures

Cognitive function

Older participants' global cognitive function was assessed by trained hospital staff using the Chinese MMSE.[24,25] MMSE scores range from 0 to 30; higher scores indicate higher levels of global cognitive function. The MMSE has been shown to be adequate for assessing the elderly in Taiwan.[26]

Dementia severity

Dementia severity, as determined by the on-site psychiatrist using the Chinese CDR,[21,27,28] was extracted from the medical chart by the research assistants. The CDR assesses impairment in six cognitive categories (memory, orientation, judgment and problem solving, community affairs, home and hobbies, and personal care) on a 5-point scale (none = 0, questionable = 0.5, mild = 1, moderate = 2 and severe = 3).[27] The Chinese CDR global score has an inter-rater reliability (kappa coefficient) of 0.63.[28]

Depressive symptoms

Depressive symptoms of PWCIs were self-reported to research assistants using the Chinese GDS-S.[29,30] The GDS-S has 15 yes/no questions, with higher scores indicating more depressive symptoms. Cronbach's alpha of the GDS-S in Taiwanese PWCIs was 0.81,[31] while the Cronbach's alpha coefficient was 0.62 in this study.

Performance of activities of daily living (ADL)

Older participants' ADL performance was reported by FCGs to research assistants using the CBI,[32] which assesses ability in eating, transferring, grooming, toileting, bathing, walking, climbing stairs, dressing, as well as bowel and bladder control. Scores range from 0 (total dependence) to 100 (total independence); higher scores indicate better functioning. The CBI had an excellent Cronbach's alpha coefficient of 0.94 in hospitalized stroke patients and moderate-to-excellent agreement between raters for individual items (kappa = 0.53–0.94) and total score (intra-class correlation coefficient [ICC] = 0.94).[33] In this study, the CBI had a Cronbach's alpha coefficient = 0.76.

Neuropsychiatric symptoms

Older participants' neuropsychiatric symptoms were reported by FCGs to research assistants using the CNPI,[34] which assesses the severity and frequency of 12 neuropsychiatric symptoms. Higher scores indicate more severe neuropsychiatric symptoms.[35] The CNPI had a Cronbach's alpha coefficient of 0.78 in Taiwanese patients with Alzheimer's disease.[34] In this study, Cronbach's alpha

coefficient was 0.82. We grouped CNPI scores into four outcomes. The first three outcomes were based on factor analyses of the CNPI[34] and NPI,[36] as well as suggestions that neuropsychiatric symptoms occur in clusters associated with neurodegeneration in specific brain areas.[37] These three outcomes were: (1) mood and psychosis (delusions, depression, anxiety, and aberrant motor activity), (2) psychomotor regulation (agitation, euphoria, and irritability), and (3) social engagement (apathy and disinhibition). The fourth outcome was total CNPI score.

FCG distress

FCGs' distress due to neuropsychiatric symptoms of care recipients was assessed using the Caregiver Distress Scale of the CNPI.[34,38] FCGs rate their own distress from 0 (not at all distressing) to 5 (very severely or extremely distressing) toward 12 psychiatric symptoms of care recipients. We measured FCG distress in three dimensions corresponding to the neuropsychological symptom grouping for the older participants: (1) distress toward care recipient's mood and psychosis, (2) distress toward care recipient's psychomotor regulatory behaviors, and (3) distress toward care recipient's apathy and disinhibition behaviors. We also measured total distress. Cronbach's alphas of the CNPI-Caregiver Distress Scale were 0.72 in Taiwanese patients with Alzheimer's disease[34] and 0.86 in this study.

Frequency, type, time, and energy expenditure of LTPA

The LTPA of cognitively impaired participants was recorded by FCGs using a researcher-developed 7-Day Physical Activity Recall for the number of LTPA types, frequency and duration of LTPA for the prior 7 days. In this study, the 2-week test-retest reliability of the 7-Day Physical Activity Recall demonstrated significant ICC for frequency, duration, and number of types of 0.88, 0.94, and 0.84, respectively.

The first three LTPA indicators (frequency, time, and number of types) were used to calculate LTPA energy expenditure defined as $\geq$3 kcal per kg per day on a single major activity.[39] This definition is considered the most rigorous[40] and has been used to assess physical activity in Taiwan.[10,41] Energy expenditure is measured in metabolic equivalents (MET). One MET is defined as the energy expended during quiet sitting, which is 1.2 kcal/min for a 70 kg individual. For each common LTPA, a MET value was assigned based on previous research.[42] Guidelines suggest that moderately active Asians should expend 750 kcal/week.[10,43] To meet this guideline, an average person weighing 60 kg would need to participate in a 5-MET physical activity for five 30 min sessions/week.[44] Energy expenditure for each LTPA was calculated as [MET value] $\times$ [frequency of activity in the past week] $\times$ [duration of this activity (hours)] $\times$ [body weight (kg)].

Statistical analysis

We used PASW Statistics 18 software (SPSS, Inc., Chicago, IL, USA) for analyses. Data were first analyzed using descriptive statistics (frequencies, means, and standard deviations), cleaned for errors, and examined for normal distribution. All data met normality criteria. The relationships among LTPA indicators, neuropsychiatric outcomes, and FCG distress were determined using multiple regression analyses where we controlled for care recipients' characteristics (dementia stage, depressive symptoms, and ADL performance) that were significantly correlated with outcomes. These characteristics were entered as the first block of predictors in the multiple regression models. Then LTPA indicators significantly associated with outcomes were entered as the second block of predictors. The percentages of variance and changes in variance explained by the predictors for each outcome are reported.[23]

Results

Characteristics of participants

Among the 58 PWCIs, the majority (67.2%) was female, with a mean age of 79.2 years and a mean educational level of 5.6 years. The largest proportion (37.9%) received no education and about half were widowed (51.7%). Nearly half (48.3%) were diagnosed with Alzheimer's disease. Half (50%) had a CDR score of 0.5 (mild dementia), while 37.9% had a CDR score of 1 (moderate dementia). Since only seven participants had a CDR score of 2, we combined them with those having a CDR of 1 for further analysis. Mean MMSE, CBI, and GDS-S scores were 17.8, 85.9, and 3.0, respectively (Table 1).

Among the 58 FCGs, the majority was female (66.7%), with a mean age of 50.9 years and a mean education level of 11.7 years. Most caregivers were married (89.7%), and 56.9% did not have a job outside their home. The largest proportion of caregivers was the sons of care recipients (29.3%), followed by daughters-in-law (22.4%). The majority of FCGs lived with others (71.7%), and only 17 (28.3%) hired a helper for their care recipients (Table 1).

LTPA indicators of cognitively impaired participants

The most frequent type of LTPA was strolling (70.7%), followed by qigong (10.3%, a Chinese breathing exercise involving body postures, movement, and mental concentration) and gardening (8.6%). The mean number of LTPA types, frequency of any LTPA, LTPA duration, and energy expended were 1.0 (SD = 0.7), 4.5 (SD = 4.3) times/week, 3.7 (SD = 4.4) hours/week, and 771.5 (SD = 886.4) kcal/week, respectively. Thirteen (22.4%) participants did not engage in any LTPA.

Multiple regression models

The four multiple regression models for PWCIs revealed that only the number of LTPA types significantly predicted CNPI dimension 1 (mood and psychosis). The variance explained was 22%, and the change in variance due to the number of LTPA types ($\Delta R^2 = 6\%$) was significant. The four multiple regression models for FCGs showed that PWCIs' dementia stage and number of LTPA types significantly predicted FCG distress for CNPI dimension 1, FCG distress for CNPI dimension 2, and FCG total distress, explaining 30%, 33% and 39% of the variance, respectively. The changes in variance due to the number of LTPA types were significant ($\Delta R^2 = 6\%–8\%$) (Table 2).

Discussion

The results of this study suggest that participation in LTPA affects neuropsychiatric symptoms of older Taiwanese PWCIs and the distress of their FCG. We report four important findings. First, the most frequent reported LTPAs for participants were strolling, qigong, and gardening, consistent with population-based reports that walking is the most popular activity of Taiwanese adults[41] and older Canadian adults with and without chronic diseases.[45] Slightly more of our PWCIs (36.2%) expended $\geq$ 750 kcal energy per week in LTPA than older Taiwanese adults (31.5%) in a previous study.[10] Among our participants, 22.4% did not engage in any LTPA, less than that reported (41.7%) for older Taiwanese adults.[10] This difference is likely due to our dyads being recruited from memory clinics, where the benefits of LTPA may have been emphasized, encouraging them to engage in more activities than most older Taiwanese adults. However, both our older Taiwanese participants and those in the previous study[10] had higher rates of not participating in any LTPA than their Canadian counterparts.[45] This

Table 1
Demographic and clinical characteristics of participants with cognitive impairment and their family caregivers ($N = 58$).

	n (%)	*M* (SD)	Missing
Characteristic			
Participants with cognitive impairment			
Gender			
Male	19 (32.8)		
Female	39 (67.2)		
Age (years)		79.2 (7.4)	
Education (years)		5.6 (5.0)	1
No formal education	22 (37.9)		
Primary school	16 (27.6)		
Junior high school	8 (13.8)		
High school or above	11 (19.0)		
Marital status			
Married	27 (45.8)		
Separated	1 (1.7)		
Widowed	30 (51.7)		
Dementia diagnosis			1
Alzheimer's disease	28 (48.3)		
Vascular dementia	17 (29.3)		
Mild cognitive impairment	9 (15.5)		
Other	3 (5.2)		
Clinical dementia rating (0–5)			
0.5	29 (50)		
1	22 (37.9)		
2	7 (12.1)		
MMSE score (0–30)		17.8 (4.9)	
CBI (0–100)[a]		85.9 (21.3)	
Number of comorbidities[a]		1.7 (1.2)	
GDS-S (0–15) (patient self-report)		3.0 (2.5)	
Leisure-time physical activity[a,b]			
Yes	45 (77.6)		
No	13 (22.4)		
Total CNPI score (0–144)		15.2 (16.9)	
CNPI factor 1 (0–60)		6.9 (7.7)	
CNPI factor 2 (0–36)		3.2 (4.7)	
CNPI factor 3 (0–24)		1.2 (2.1)	
Family caregivers			
Gender			
Male	19 (33.3)		
Female	39 (66.7)		
Age (years)		50.9 (12.83)	
Education (years)		11.7 (4.89)	
None	3 (5.3)		
Primary school	9 (15.5)		
Junior high school	7 (12.1)		
High school	15 (25.9)		
College or above	24 (41.2)		1
Marital status			
Married	52 (89.66)		
Single	5 (8.62)		
Divorced	1 (1.72)		
Occupation			
Unemployed	33 (56.9)		
Business	8 (13.79)		
Service	5 (8.62)		
Part-time	5 (8.62)		
Other	7 (12.07)		
Relationship to care recipient			
Son	17 (29.31)		
Daughter-in-law	13 (22.41)		
Daughter	13 (21.7)		
Wife	9 (15.52)		
Husband	3 (5.17)		
Other	3 (5.17)		
Living with others			
Yes	43 (71.7)		
No	16 (26.7)		
Hired helper			
Yes	17 (28.3)		
No	41 (71.7)		
FCG distress total CNPI score (0–60)		8.5 (8.85)	
FCG distress CNPI factor 1 (0–20)		3.59 (3.52)	
FCG distress CNPI factor 2 (0–15)		1.97 (2.6)	
FCG distress CNPI factor 3 (0–10)		0.72 (1.25)	

MMSE, Mini-Mental State Examination; CBI, Chinese Barthel Index; GDS-S, Geriatric Depression Scale-short form; CNPI, Chinese Neuropsychiatric Inventory.
[a] FCG report for patient.
[b] Seven-day physical activity recall.

difference may be due to cultural influences. For example, Chinese Canadians were reported to primarily engage in passive leisure activities because of culturally valuing high intrinsic motivation, low effort, and seeking happiness or relaxation in activities rather than external rewards.[17] Chinese people highly value harmonious relationships and closeness, leading them to prefer interacting with family members. This tendency may lead to LTPA constraints due to older adults using their leisure time to care for grandchildren.[46]

Second, our regression results showed that the number of LTPA types significantly predicted neuropsychiatric symptoms, particularly mood and psychosis. This result is consistent with the notion that physical activity enhances plasticity in brain areas involved in neuropsychiatric symptoms and echoes a report that actively "engaging" activities reduced restless behaviors of dementia patients in day care centers; with each increment in number of engaging activities, individuals' restless behaviors decreased over the next 3 months.[47] Similarly, the amount or dose of participation in physical, mental, and social dimensions of leisure activities was significantly related to lower dementia risk for community-dwelling elderly in Sweden[48] and China.[49] These empirical studies suggest that variation in LTPA benefits older adults' cognition, which may reduce their neuropsychiatric symptoms.

Our third finding is that the most important LTPA indicator of FCG distress was the number of activity types. This result may be explained by more physically active care recipients manifesting fewer neuropsychiatric symptoms, resulting in less distress for their FCGs. However, the variances and changes in variance due to the effects of LTPA type on PWCI neuropsychiatric symptoms and FCG distress were not great, indicating that these outcomes may be influenced by other variables such as experience and appraisal of the restorative aspects of leisure activities.[50]

Fourth, FCG distress was predicted by care recipient's dementia stage (CDR). This result may be due to the association of care recipients' greater dementia severity with more psychosis and aggressiveness,[4] leading to FCG distress. Thus, FCG support of care recipient's engagement in LTPA through dementia stage-appropriate stimulation and instructions may be essential to reduce FCG distress.[51]

Taken together, these results suggest the need for public health campaigns to promote PWCIs' engagement in LTPA. In this regard, several strategies have been proposed. For example, older adults can choose different goals and activities or prioritize them (referred to as selection strategies), when they must restrict previous activities due to age-related losses.[52,53] Optimization strategies refer to engaging in activities that stimulate the body and mind, thus increasing one's capacity to continue participating.[50,53] Finally, compensating strategies may be used to continue engaging in chosen activities despite reduced or lost capacities, e.g., using a hearing aid or cane to compensate for hearing loss or poor balance.[53,54] However, older adults are not a uniform population. Different individuals may use different strategies. Tailoring LTPA to PWCIs' preferences may be most beneficial in designing interventions to reduce their neuropsychiatric symptoms.[55]

Engaging PWCIs in regular LTPA will require assistance from FCGs and health professionals.[52] Adherence to an LTPA program can be improved with the activity diary used in this study due to its direct feedback on the association between LTPA and PWCIs' well-being. The diary may also provide the basis for developing innovative ways to guide and support PWCIs in engaging in LTPA.[56]

Table 2
Multiple regression analyses for cognitively impaired participants' CNPI and FCG distress ($N = 58$).

	CNPI dimension 1 (mood and psychosis)	FCG distress CNPI dimension 1 (mood and psychosis)	FCG distress CNPI dimension 2 (psychomotor regulation)	FCG total CNPI distress
	β			
Model 1 (care recipients' baseline characteristics)				
CDR	0.27	0.34[b]	0.51[c]	0.42[b]
GDS-S	0.08	0.14	–	0.1
CBI	−0.17	−0.1	−0.04	−0.21
Regression model				
R^2	0.16	0.22	0.27	0.33
F	3.39[a]	5.02[b]	10.34[c]	8.77[c]
Model 2 (care recipient characteristics & LTPA covariates)				
CDR	0.23	0.33[a]	0.48[c]	0.39[b]
GDS-S	0.60	0.15	–	0.10
CBI	−0.05	0.03	−0.07	−0.09
Types of LTPA	−0.28[a]	−0.31[a]	−0.27[a]	−0.28[a]
Regression model				
R^2	0.22	0.30	0.33	0.39
F value	3.77[b]	5.54[b]	8.95[c]	8.53[c]
ΔF	4.30[a]	5.77[a]	4.76[a]	5.58[a]
ΔR^2	0.06	0.08	0.06	0.06

CDR, Clinical Dementia Rating scale; GDS-S, Geriatric Depression Scale-short form; CBI, Chinese Barthel Index; CNPI, Chinese Neuropsychiatric Inventory; FCG, family caregiver; LTPA, leisure-time physical activity.
[a] $p < 0.05$. [b] $p < 0.01$. [c] $p < 0.001$.

Health care professionals could also help FCG-PWCI dyads by using strategies such as situational analysis, goal setting, and homework activities.[57] Multidisciplinary approaches also are needed, e.g., designing dementia-friendly communities, including parks, gyms, and sidewalks as well as specially trained professionals such as community health nurses, social workers, exercise instructors, and physicians. FCGs' needs should be considered as well.

This study had several limitations. First, the study dyads were not randomly sampled; all were from northern Taiwan. The LTPA indicators in our sample might have differed from those living in other areas of Taiwan. Second, the sample size was relatively small but sufficient for the current statistical analysis. Caution should be taken in generalizing our results to FCG-PWCI dyads in other areas. Third, this study used a cross-sectional design which cannot determine causal relationships. To understand the neuropsychiatric effects of participation in LTPA, future studies could use a longitudinal design with a larger sample to clarify the relationship between PWCIs' activity levels and neuropsychiatric symptoms.

Fourth, a rating bias may have occurred in FCGs' assessment on the 7-Day Physical Activity Recall. However, informant-reported measures of PWCIs' behaviors and quality of life were found to be reliable and valid.[31,58] Nonetheless, caregiver ratings may be impacted by factors such as their depressive symptoms and quality of the dyad relationship.[31,58,59] Future studies should control for these confounding factors and PWCI-related factors, such as cardiovascular factors,[60] APOE 4 genotype,[61] as well as social and cognitive components of activities.[55] It is also important to investigate what LTPA types for PWCIs at different disease stages can produce positive clinical outcomes such as cognitive, behavioral and affective benefits and test the changes of outcome variance of these leisure activity types. FCGs of PWCIs also need training programs to help them implement an LTPA plan at home.[62]

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