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Physical activity in relation to sleep among community-dwelling older adults in China

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Abstract

This cross-sectional study was conducted to describe physical activity and sleep in 290 community-dwelling Chinese older adults and to examine the association between physical activity and poor sleep outcomes. Almost half of the sample were poor sleepers. The majority of the sample regularly participated in walking, some household activity and light sports; yet, only a small portion were involved in work-related activity or in strenuous sports. A greater level of overall physical activity [Odds Ratio (OR) =0.79, 95% confidence interval (CI) = (0.73,0.86)], leisure-time exercise [OR=0.77, 95%CI=(0.68,0.85)], and household activity [OR=0.66, 95%CI=(0.56,0.78)] were associated with reduced likelihood of being poor sleepers and other poor sleep outcomes, independent of covariates including age, sex, education, family income, the number of children, drinking, and sleep hygiene. Future larger scale studies that incorporate both objective and subjective measures are needed to further examine the association and to explore the effects of different types of activity on sleep and other well-beings in older adults.

Keywords

leisure time exercise; non-exercise activity; sleep quality

Introduction

Sleep complaints are common in older adults (Neikrug & Ancoli-Israel, 2010). One-third to one-half of community-dwelling older adults in China self-report poor sleep (Li, Zhong, Wu, & Luo, 2015; Luo et al., 2013; Wang et al., 2016). Common sleep problems include difficulty initiating sleep, difficulty maintaining sleep, early morning awakening, unrestful sleep, and impairment in daytime function (Li, Grandner, Chang, Jungquist, & Porock, 2017). Poor sleep has been related to multiple adverse health outcomes in older adults,

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including impaired cognition (Yaffe, Falvey, & Hoang, 2014), increased risk of falls (Stone et al., 2014), diabetes (Knutson, 2010), cardiovascular diseases (Hoevenaar-Blom et al., 2011), depression (Maglione et al., 2012), and mortality (Mesas et al., 2010).

Functional impairments and decreased social engagement contribute to older adults living a sedentary lifestyle or limiting engagement in physical activity (Godfrey et al., 2013). Prior studies indicate that a sedentary lifestyle may be associated with poor sleep in older adults (Dzierzewski et al., 2014; Morgan, 2003) and being active for 20–30 minutes at least three days a week positively impacts older adults' sleep and overall health (Whitehead & Blaxton, 2017). The central endogenous circadian pacemaker, the suprachiasmatic nucleus, regulates 24-hour circadian rhythms. Physical activity can improve the entrainment of the central circadian pacemaker and serve as an external stimulus to consolidate the sleep-wake pattern (Mistlberger & Skene, 2004; Naylor et al., 2000). Given that older adults' sleep wake patterns are less robust than younger adults (Li, Vitiello, & Gooneratne, 2017), promoting physical activity may be a crucial way to improve sleep in this population (Guimaraes, de Carvalho, Yanaguibashi, & do Prado, 2008; Kredlow, Capozzoli, Hearon, Calkins, & Otto, 2015).

The type of physical activity (e.g., leisure time exercise vs. non-exercise activity) is an essential factor to consider when trying to maximize health benefits in older adults. Leisure time exercise includes walking, light, moderate and strenuous exercise, and recreational physical activities (Washburn, Smith, Jette, & Janney, 1993). Extant literature has supported that exercise regimens, such as walking, or moderate and strength exercise can promote sleep (Reid et al., 2010; Yang, Ho, Chen, & Chien, 2012) and other aspects of physical health in older adults (Yang et al., 2012). Non-exercise activity, such as household and work-related activity, may be particularly relevant in older adults as the ability and interest to engage in formal exercise decreases with aging (Crombie et al., 2004; Whitehead & Blaxton, 2017). However, there is little research examining the health impact of non-exercise activity on aging. The lack of consideration of non-exercise activity in prior research on physical activity in older adults limits our understanding on the relationship between physical activity and older adults' well-being. In this study, both leisure time exercise and non-exercise activities were examined.

The present study aimed to describe physical activity and sleep in a sample of community dwelling older adults in China and to examine the association between physical activity and sleep outcomes. We examined overall physical activity and physical activity by type. We hypothesized that people with greater levels of physical activity would be less likely to have poor sleep outcomes.

Method

Study Setting and Participants

This was a cross-sectional study with a convenience sample of community dwelling older adults in Changchun City, China. Face-to-face interviews with structured questionnaires were conducted between June and October of 2016. Older adults were eligible for participation if they were: (1) age of 60 years or older, (2) lived in the community, (3) able to

communicate verbally. Participants were excluded if they: (1) were bed bounded and could not walk alone, (2) had dementia or cognitive impairment as indicated by themselves, family members, or according to their medical record. The study was approved by Institutional Review Board of × × University, China. Written informed consent was obtained from each participant prior to the interview.

Measures

Data on participants' demographic and clinical characteristics, physical activity, and sleep were collected.

Demographic and clinical characteristics—Demographic data included age, sex, marital status, level of education, religious belief, and family income. Clinical characteristics consisted of smoking and/or drinking habits, the number of self-reported chronic diseases including cancer, hypertension, hyperlipidemia, cardiovascular disease, stroke, diabetes, renal diseases, and arthritis. We also assessed participants' sleep hygiene using the Chinese Version of Sleep Hygiene Practice Scale (SHPS) (Lin, Cheng, Yang, & Hsu, 2007). This SHPS is a 30-item self-rating questionnaire measuring participants' sleep hygiene practice of arousal-related behaviors, eating or drinking habits prior to sleep, sleep environment, and sleep schedule and timing. Each item is scored based on a scale ranging from 1 (never) to 6 (always). The total score is the composite score of the 30 items. A higher score represents worse sleep hygiene (Lin et al., 2007; Yang, Lin, Hsu, & Cheng, 2010).

Sleep quality was measured by Pittsburgh Sleep Quality Index (PSQI). PSQI assesses an individual's sleep quality in the past month (Buysse et al., 1989). It consists of 19 self-rated questions and five roommate/partner rated questions. Seven sub-domains, namely objective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbances, use of sleeping medication and daytime dysfunction are generated based on the 19 self-rated questions. These seven domains are weighted equally on an ordinal scale from 0 to 3. A global PSQI score ranges from 0 to 21. Higher scores represent more frequent symptoms and worse sleep quality (Buysse et al., 1989). The PSQI has been validated in various populations worldwide, including China (Liu et al., 1996). In a PSQI validation study with a Chinese population, a cut point of 7 was determined to best differentiate good and poor sleepers (Liu et al., 1996). Therefore, the primary outcome variable of our study, poor sleeper, is defined as older adults with PSQI global scores greater than 7 (Cui et al., 2012; Liu et al., 1996). The secondary outcome variables are the seven sleep variables represented by the subdomains of PSQI.

Physical activity was measured by the Physical Activity Scale for the Elderly (PASE). The PASE is a structured questionnaire that measures the quantity and quality of older adult's physical activity in the past week (Washburn et al., 1993). It incorporates measures of three types of physical activities (leisure time exercise, household activity, and work-related activity) for older adults and captures intensity, frequency, and duration of each type of activity. Leisure time exercise was measured by six questions on the participant's involvement in daily activities such as participating in walking or mild, moderate, and strenuous exercise during the past 7 days. The assessment included the duration of physical

activity per day and frequency of each level of physical activity per week (never, 2 days, 3–4 days, and 5–7 days in the past week). The three household activity questions asked the participant's involvement in daily chores using a "yes" or "no" response. The final work-related activity section contained a series of questions on the participant's hours and type of work in the past week. Calculation of the total score was first based on an item-by-item recording procedure. Frequency was multiplied by duration of weekly activity and then divided by 7 to get an average daily activity level. All sets of scores were then summed after multiplying each score by a constant to weigh different components of physical activity (Washburn et al., 1993). The PASE was translated and validated in the Chinese population (Ngai, Cheung, Lam, Chiu, & Fung, 2012; Wu, Su, Fang, & Yeh Chang, 2012) and the Chinese version was used in the present study.

Data analysis

The IBM-SPSS 24.0 was used to input and analyze the data. In the descriptive analyses, means (standard deviations) are presented for continuous variables and frequencies and percentages are presented for categorical variables. Differences in demographic and clinical characteristics between good sleepers (PSQI≤7) and poor sleepers (PSQI>7) were assessed using an independent *t* test for continuous data and a chi-squared test for categorical data.

Regression models were used to examine the independent association of physical activity with the sleep outcomes. In our primary analyses, we used binary logistic regression models to examine the associations between physical activity and the likelihood of being a poor sleeper. The global PASE score (overall level of physical activity) was used as the predictor in model 1 and the three subdomains of PASE were used as predictors in model 2. Significance for the primary analyses were based on $p< 0.05$. In our secondary analyses, we used ordinal logistic regression models to examine the associations between PSQI sub-domains and level of physical activity by following the same procedures of the primary analyses, with significance based on a Bonferroni corrected $p<0.007$ (equals 0.05/7). In all regression models, we adjusted for covariates that were significantly ($p<0.05$) associated with poor sleep in bivariate analyses, including age, sex, the number of children, education, family income, drinking habits, and sleep hygiene.

Results

Characteristics of participants

In total, 300 older adults were recruited and completed the study questionnaires during the individual meeting with a research team member. Ten participants were excluded from the analysis due to incomplete data on PASE or PSQI. The 290 older adults in our final sample were mean aged 69.49 (SD=7.13) years. More than half of the sample was female (53.4%). About 36% of the participants reported no chronic disease diagnosis and 27% reported two or more diagnoses. The most common chronic diseases reported were hypertension (24.8%), heart disease (21.7%), diabetes (13.8%), and arthritis (15.9%). Compared with good sleepers, poor sleepers were older ($p<0.01$) and reported worse sleep hygiene ($p<0.001$). Higher proportion of poor sleepers were female ($p=0.004$), hadless number of children ($p<0.001$), heart disease ($p=0.022$), diabetes ($p=0.006$), and arthritis ($p=0.015$). Detailed

characteristics of the sample overall and by sleep quality groups (good sleepers vs. poor sleepers) are presented in Table 1.

Sleep quality

Of the 290 participants, 129 (44.5%) were classified as poor sleeper (PSQI > 7). Mean PSQI score was 7.49 (SD=3.53). The average bedtime was 21:26 and rise time was 4:43. The mean total sleep time was 6.29 (SD=1.05) hours. Approximately 40% of the sample reported more than 7 hours total sleep time, while only 6.2% reported less than 5 hours. Sleep onset latency of 15 minutes or less and more than 30 minutes was reported in 33.8% and 37.6% of the sample, respectively. Almost 90% of our sample reported a sleep efficiency (the ratio of total sleep time over time in bed) of 75% or above. The three major sleep disturbances reported were waking up during the night or waking up too early in the morning, visits to the toilet, and feeling hot when sleeping. Moreover, 17.6% of the sample used psychoactive medication at least once a week to help with their sleep. Table 2 presents the descriptive analysis of sleep outcomes in detail.

Physical activity

The average score of PASE for the total sample was 121.9 (SD=64.44). Overall, 57.2% of participants spent more than four hours a day in sitting activities, such as reading and watching TV. All participants reported walking outdoors with a mean daily duration of 1.53 hours (SD=1.14). For leisure time exercise, about 28% reported no light sport, 67% no moderate sport, 83% no strenuous sport, and 20% reported no leisure time exercise other than walking. Almost three-quarters of the sample engaged in walking outside the home (71%), with less reporting light (34%), moderate (16.6%), and strenuous (5.5%) activity for more than one hour at least 3 days during the past week. The two most frequently reported mild/moderate physical activities were Tai Chi (13%) and dancing (12%). Almost 90% of the sample reported participation in a household activity during the previous week, with the majority reporting light housework (81.4%). Only 8.6% of participants were involved in work-related activity. Detailed descriptive results on physical activity are summarized in Table 3.

Associations between physical activity and sleep outcomes

Table 4 represents results on the adjusted associations between participant's physical activity and sleep outcomes. Odds ratios (ORs) reflect the odds of being a poor sleeper or having a greater level of sleep problems (7 subdomains of PSQI) associated with a 10-unit increase in the PASE global score or the scores of three subdomains.

Our primary analyses revealed that older adults with greater levels of physical, leisure time and household activity were associated with decreased risk of being a poor sleeper. In detail, overall physical activity (Model 1: OR=0.79, $p<0.001$), leisure time exercise (Model 2: OR=0.76, $p<0.001$) and household activity (Model 2: OR=0.66, $p<0.001$) were negatively associated with the likelihood of being a poor sleeper, independent of age, sex, education, family income, number of children, drinking, and sleep hygiene. Every 10-unit increase in scores of overall physical activity, leisure time exercise, and household activity were associated with 21%, 24%, and 34% reduced risk of being a poor sleeper (PSQI>7),

respectively. In terms of work-related activity, there was no significant association with the likelihood of being a poor sleeper ($p>0.05$).

In our secondary analyses, we found older adults with higher overall levels of physical, leisure time and household activity tended to have decreased domain scores that reflected decreased severity of poor sleep outcomes, including poor subjective sleep quality, extended sleep latency, insufficient sleep efficiency, inadequate sleep duration, sleep disturbances, daytime dysfunction, and sleep medication use. In model 1, increased overall level of physical activity was significantly associated with reduced likelihood of all seven self-reported poor sleep outcomes. In model 2, leisure time exercise was significantly associated with reduced likelihood of self-reported poor subjective sleep, extended sleep latency, insufficient sleep efficiency, inadequate sleep duration, and sleep medication use. In addition, household related activity was negatively associated with the likelihood of poor subjective sleep quality, sleep disturbances, and sleep medication use. Work related activity was only associated with the likelihood of self-reported daytime dysfunction. These results suggested that older adults' leisure time exercise and household activity were associated with decreased risk for specific poor sleep outcomes and the associations were independent of each other.

Discussion

We investigated the self-reported level of physical activity and sleep quality in 290 community dwelling Chinese older adults and examined the cross-sectional associations between level of physical activity and the likelihood of having poor sleep outcomes. The majority of our sample regularly participated in walking, some household activity and light sports; yet, only a small portion were involved in work-related activity (8.6%) or in strenuous sports (17.2%). Almost half (44.5%) of the sample were poor sleepers. We found that a greater level of physical activity was associated with reduced likelihood of reporting poor sleep outcomes, independent of covariates including age, sex, education, family income, the number of children, drinking, and sleep hygiene. Our results also indicate that both leisure time exercise and household activity were independently associated with reduced risk of poor sleep outcomes.

The high prevalence of poor sleep in our sample was consistent with findings from studies in both Chinese older adults and older adults in other parts of the world (Neikrug & Ancoli-Israel, 2010). Approximately 43.3% and 46.4% of Chinese older adults in Xi'an and Changsha reported poor sleep quality in two prior studies from China (Liu et al., 2014; Wang & Li, 2012). Similarly, half of the participants in a sample of 9,282 older adults in the U.S. reported sleep problems (Foley et al., 1995).

The mean PASE global score (121.88 [SD=64.44]) in the present study was slightly higher than that reported in older adults in Japan (mean=114.9; SD=44.9) (Hagiwara, Ito, Sawai, & Kazuma, 2008), Hong Kong (mean=104.4, SD=47.1) (Ngai et al., 2012) and the United States (mean=102.9, SD=64.1) (Washburn et al., 1993). The PASE score was slightly lower than that reported in a small scale study (n=31) from Taiwan, China (mean=181.1, SD=69.3) (Yu & Chou, 2014). We found that more than half of our sample spent at least four hours of

sitting activities a day. A recent systematic review of studies from more than 10 countries reported an average of 5.3 hours of daily sedentary time in older adults. (Harvey, Chastin, & Skelton, 2015).

Most of the sample were regularly engaged in some form of physical activity. For example, more than 70% of older adults walked outside for more than an hour at least three days per week, 64.8% participated in light sports at least 3 days/week, and 81.4% participated in household activity. Dancing and Tai Chi were the two most reported leisure time activities other than walking outside. Tai Chi is a very common traditional exercise in Chinese older adults. The popularity of dancing found in our sample may be related to a common phenomenon of “Plaza Dancing” in Chinese older women in recent years. More and more middle aged and retired women join Plaza Dancing due to its low cost and convenience for participation. Work related activity was relatively rare in this group, which can be explained by the relatively young retirement age in China, 50–55 years for female and 55–60 years for male.

Aligned with prior studies (Dzierzewski et al., 2014; King, Oman, Brassington, Bliwise, & Haskell, 1997; Reid et al., 2010), our findings suggest that older adults with greater overall physical activity were less likely to report poor sleep outcomes. All significant and non-significant associations between physical activity measures and sleep outcomes were in the expected direction. Two studies found that being more active or spending more time on exercise and physical activity resulted in better sleep outcomes at night, such as better subjective sleep quality, increased sleep duration, sleep efficiency, and decreased sleep onset latency (Dzierzewski et al., 2014; King et al., 1997). The biological underpinnings of this relationship are not fully understood. Many physiological changes during physical activity could potentially promote sleep, including increased core body temperature, improved heart rate and cerebral blood flow, metabolic activity, increased melatonin secretion, improved medical comorbidities, decreased depressive symptomatology, and improved immune function (King et al., 2008; Melancon, Lorrain, & Dionne, 2014; Santos, Tufik, & De Mello, 2007). However, empirical evidence on physical activity and sleep is mixed. One study investigated the influence of physical activity on sleep in community-dwelling Chinese older adults using the PSQI and PASE and failed to find a significant association between physical activity and sleep quality after adjusting for study covariates (Wu et al., 2012). The nonsignificant findings may be due to variations in study design and lack of control of possible confounders.

In addition to overall physical activity, we examined the three different types of physical activity in relation to the poor sleep outcomes. The three types of activity were entered in the same model. Therefore, the associations of each type of activity with sleep outcomes were independent of the other two types of activity. Our results suggest that greater leisure time exercise and non-exercise household activity were both independently and inversely associated with being a poor sleeper and having certain poor sleep problems, but leisure time exercise was associated with more poor sleep outcomes than the non-exercise household activity. Work-related activity, which was only reported in a few participants, was not associated with any poor sleep outcomes other than daytime dysfunction. In conjunction with our results, Whitehead et al. reported the positive impact of both exercise and non-

exercise on sleep quality (Whitehead & Blaxton, 2017). They also reported that purposeful exercise tended to have more beneficial effects on older adults' wellbeing in terms of affect, perceived stress, and perceived health than non-exercise activity, such as household activity. They suggested that non-exercise activity could not replace formal and purposeful exercise to achieve health benefits in aging.

The current study is one of the few studies that concurrently considered quantitative physical activity level and sleep quality in Chinese older adults. We examined both overall physical activity and three subtypes of physical activity in relation to poor sleep outcomes, which provides valuable information for further interventions aimed at improving sleep outcomes in older adults. However, a few limitations of the current study need to be addressed. First, we used a convenience sample from one city in China, which limits our ability to generalize the findings to the whole Chinese older adult population. Second, sleep and physical activity were assessed by self-reported measures and no objective measures were included in the current study. Although the PSQI and PASE provide more context and details regarding sleep and physical activity, we still believe objective measures such as Actigraphy and polysomnography, should be used to complement the subjective measures. Third, some statistically significant associations between physical activity and the seven sub-sleep outcomes (e.g. OR>0.9) may not be large enough to reach clinical significance, which limits our ability to provide clinically relevant recommendations. Finally, due to our cross-sectional design, we only examined associations which does not allow us to infer causality.

Future larger scale studies that incorporate both objective and subjective measures are needed to further examine the association between sleep and physical activity. Additionally, future research should explore whether the association between physical activity and sleep in older adults differs by the type of physical activity and the effects of different types of activity on sleep and other well-beings in older adults.

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Table 1

Demographic and Clinical Characteristics between Good Sleeprs and Poor Sleeprs.

Variables		**Overall Sample (N=290)**	**Good sleeper (n=161)**	**Poor sleeper (n=129)**	***P***
Age	Overall	69.49 (7.13)	68.09 (6.39)	71.25 (7.63)	**<0.001**
	60~69	162 (55.9)	104 (64.2)	58 (35.8)	**0.001**
	70~79	102 (35.2)	49 (48)	53 (52.0)	
	≥80	26 (9.0)	8 (30.8)	18 (69.2)	
Male		135 (46.6)	87 (50.0)	48 (37.2)	**0.004**
Status of spouse	No	86 (29.7)	42 (26.1)	44 (34.1)	0.116
	Deceased	63 (21.7)	32 (19.9)	31 (24,0)	
	Healthy	141 (48.6)	87 (50.0)	54 (41.9)	
Number of children	None	17 (5.8)	7 (4.3)	10 (7.8)	**0.025**
	1	93 (32.1)	43 (26.7)	50 (38.8)	
	≥2	180 (62.1)	111 (68.9)	69 (53.5)	
Religious belief		67 (23.1)	39 (24.2)	28 (21.7)	0.613
Monthly Household Income	<1000 yuan	55 (19.0)	22 (13.7)	33 (25.6)	**0.003**
	1000–2000 yuan	102 (35.2)	52 (32.3)	50 (38.8)	
	2000–3000 yuan	93 (32.1)	57 (35.4)	36 (27.9)	
	>3000 yuan	40 (13.8)	30 (18.6)	10 (7,8)	
Education	Illiterate and Elementary school	87 (30)	37 (23.0)	50 (57.5)	**0.031**
	Middle School	100 (34.5)	59 (36.6)	41 (31.8)	
	High school and above	103 (35.6)	65 (40.4)	38 (29.5)	
Smoking		102 (35.2)	49 (30.4)	53 (41.1)	0.059
Drinking		100 (34.5)	65 (40.4)	35 (27.1)	**0.018**
Sleep Hygiene		63.2 (12.19)	54.1 (9.87)	63.24 (12.89)	**<0.001**
Number of chronic diseases	Healthy	105 (36.2)	78 (48.4)	27 (20.9)	**<0.001**
	One	107 (36.9)	58 (36.0)	49 (38.0)	
	Two	47 (16.2)	14 (8.7)	33 (25.6)	
	Three and more	31 (10.7)	11 (6.8)	20 (15.5)	
Hypertension		72 (24.8)	39 (24.2)	33 (25.6)	0.790

Variables	**Overall Sample (N=290)**	**Good sleeper (n=161)**	**Poor sleeper (n=129)**	***P***
Heart disease	63 (21.7)	27 (16.7)	36 (25.6)	**0.022**
Diabetes	40 (13.8)	14 (8.7)	26 (21.2)	**0.006**
Arthritis	46 (15.9)	18 (11.2)	28 (21.7)	**0.015**

Note. Continuous variables were presented as Mean (Standard deviation). Categorical variables were presented as N (%). All $p<0.05$ were marked in bold.

Table 2

Descriptive Analysis of Sleep Quality by PSQI Domains.

Domain Score	0	1	2	3
Subjective sleep quality	19 (6.6)	192 (66.2)	69 (23.8)	10 (3.4)
Sleep latency	98 (33.8)	83 (28.6)	93 (32.1)	16 (5.5)
Sleep duration	114 (39.3)	100 (34.5)	58 (20.0)	18 (6.2)
Sleep efficiency	169 (58.3)	90 (31.0)	21 (7.2)	10 (3.4)
Sleep disturbances	2 (0.7)	139 (47.9)	142 (49.0)	7 (2.4)
Daytime sleepiness&dysfunction	49 (16.9)	116 (40.0)	88 (30.3)	37 (12.8)
Sleep medication use	239 (82.4)	51 (17.6)	0 (0)	0 (0)

Note. Data were presented as *N*(%). 0 stands for optimal status. Higher domain scores mean worse sleep problems. PSQI stands for Pittsburgh Sleep Quality Index

Table 3

Descriptive Statistics of Participants' Physical Activity.

PASE	**Score** *Mean (SD)*					
Global PASE	121.9 (66.4)					
Sedentary activity			**> 4h/day & 5–7 days/week**			
			N (%)			
			166 (57.2)			
PASE domains		Hours/day	No activity	<lh & 3d/w	>lh & >3d/w	>2h & > 3d/w
		Mean (SD)	*N (%)*	*N (%)*	*N (%)*	*N (%)*
Leisure time exercise	59.4 (42.8)					
Walking outside home		1.53 (1.14)	0 (0)	77 (26.6)	206 (71.0)	99 (34.1)
Light sports		0.68 (0.86)	81 (27.9)	89 (30.7)	99 (34.1)	27 (9.3)
Moderate sports		0.26 (0.46)	193 (66.6)	39 (13.4)	48 (16.6)	4 (1.4)
Strenuous sports		0.09 (0.29)	240 (82.8)	18 (6.2)	16 (5.5)	2 (0.7)
Muscle strength / endurance exercise		0.22 (0.35)	151 (52.1)	107 (36.9)	14 (4.8)	2 (0.7)
Household activity	54.5 (30.7)	None N (%)	Light N (%)	Heavy N (%)	Caring other N (%)	Others N (%)
		30 (10.3)	236 (81.4)	201 (69.3)	81 (27.9)	62 (21.4)
Work-related activity	7.9 (28.1)	None N (%)	Any N (%)			
		265 (91.4)	25 (8.6)			

Note. Continuous variables were presented as *Mean* (Standard deviation). Categorical variables were presented as *N* (%). PASE stands for Physical Activity Scale for the Elderly

Table 4

Associations between PASE Global Score and Poor Sleep quality and PSQI Subdomains.

Sleep Variables	Model 1			Model 2								
	Overall PASE			Leisure time excersise			Non-exercise activity					
							Household Activity			Work-related Activity		
	OR	**95% CI**	***P***	**OR**	**95% CI**	***P***	**OR**	**95% CI**	***P***	**OR**	**95% CI**	***P***
Poor sleeper (PSQI>7)	**0.79**	0.73,0.86	<0.001	**0.76**	0.68,0.85	<0.001	**0.66**	0.56,0.78	<0.001	0.99	0.85,1.14	0.840
Subdomains of PSQI												
Subjective Sleep Quality	**0.89**	0.85,0.94	<0.001	**0.86**	0.76,0.92	<0.001	**0.84**	0.76,0.93	0.001	1.05	0.94,1.17	0.377
Sleep Latency	**0.93**	0.89,0.96	<0.001	**0.88**	0.83,093	<0.001	0.97	0.90,1.05	0.432	0.99	0.91,1.08	0.833
Sleep Duration	**0.91**	0.88,0.95	<0.001	**0.87**	0.82,0.92	<0.001	0.90	0.83,0.97	0.100	1.00	0.92,1.09	0.920
Sleep Efficiency	**0.89**	0.84,0.94	<0.001	**0.85**	0.79,0.92	<0.001	0.90	0.82,0.99	0.035	0.93	0.82,0.95	0.237
Sleep Disturbances	**0.91**	0.87,0.95	<0.001	0.93	0.87,1.00	0.037	**0.86**	0.79,0.94	0.001	0.95	0.86,1.04	0.264
Daytime Dysfunction	**0.94**	0.90,097	<0.001	0.94	0.89,0.99	0.030	0.96	0.89,1.03	0.230	**0.88**	0.82,0.96	0.006
Sleep Medication	**0.83**	0.75,0.91	<0.001	**0.82**	0.73,0.93	0.003	**0.75**	0.64,0.87	<0.001	1.13	0.96,1.32	0.144

Note. PASE stands for Physical Activity Scale for the Elderly. PSQI stands for Pittsburgh Sleep Quality Index. OR stands for odds ratio. 95% CI stands for 95% confidence interval. All models were adjusted for age, sex, family income, number of children, education, drinking, and sleep hygiene. OR of statistical significant findings were marked bold.