Chang et al. BMC Geriatrics (2025) 25:356
https://doi.org/10.1186/s12877-025-06019-z

BMC Geriatrics

RESEARCH

Open Access

Assessing the impact of sleep quality on physical function in Chinese older inpatient

Xinmiao Chang[1], Ying Yuan[1], Jiling Liao[1], Qi Zhou[2] and Wenbin Wu[1*]

Abstract

Background Sleep disorders and physical dysfunction are prevalent in the elderly, particularly among hospitalized individuals, yet the relationship between the two remains unclear. Given China's rapidly aging population, understanding how sleep quality relates to physical function is crucial for informing healthcare practices. This study aims to analyze the relationship between sleep quality and physical function indicators in older patients admitted to internal wards.

Methods In this cross-sectional study, the patients admitted in geriatric department were included. Sleep quality was assessed with 8 items Athens Insomnia Scale (AIS-8). Physical function was evaluated from 3 domains: mobility evaluated by Short Physical Performance Battery (SPPB) and gait speed, muscle strength evaluated by grip and chair rises test, balance performance assessed by Timed Up-and-Go test (TUGT). Logistic regression was applied for statistical analyses, adjusting for confounders.

Results A total of 545 old patients (≥ 60 years) were included. Those with poor sleep quality (AIS-8 ≥ 6) exhibited a higher likelihood of physical dysfunction, the odds ratio (95% confidence interval) was 1.892 (1.037–3.453) for low gait speed, 1.810 (1.110–2.952) for low grip strength, 2.491 (1.496–4.147) for impaired TUGT. Sleep quality components, particularly maintenance and daytime dysfunction, were linked to physical function indicators. Stratified by age, poor sleep quality was associated with a higher incidence of low grip strength and impaired TUGT in participants ≥ 75 years old. But the association wasn't seen in patients < 75 years. Stratified by gender, a significant association of sleep quality with impaired TUGT in female population was observed but not for the male population.

Conclusions Poor sleep quality was associated with reduced physical function, especially in with advancing ageand in women. Targeted interventions to enhance sleep in the elderly may contribute to maintaining physical function and improve the quality of life of such patients.

Clinical trial number Not applicable.

Keywords Sleep, Physical function, Mobility, Muscle strength, Balance, Old patients

*Correspondence:
Wenbin Wu
wwb_bjh@126.com
[1]Department of Geriatrics, Beijing Hospital, National Center of Gerontology, Institute of Geriatric Medicine, Chinese Academy of Medical Sciences, No.1 Dongdan Dahua Road, Dongcheng District, Beijing 100730, China
[2]The Key Laboratory of Geriatrics, Beijing Institute of Geriatrics, Beijing Hospital, National Center of Gerontology, National Health Commission; Institute of Geriatric Medicine, Chinese Academy of Medical Sciences, Beijing 100730, China

Background

The life expectancy in China has been increasing, rising to around 77.3 years in 2019, and it's expected to continue, thus the proportion of people aged 65 and older in China is projected to increase from 12% in 2015 to nearly 27.9% by 2050 [1]. Ageing impacts physical function that is the objectively observable whole-body somatic motor function. Physical function is an important ability needed to maintain activities of daily living and is a key factor in the intrinsic ability of older individuals [2]. Physical function tends to decline with age [3]. Decreased physical function increases the risk of falls and fractures and is strongly associated with frailty, sarcopenia and disability, all of which impact the quality of life and are associated with higher mortality rates [4, 5]. There are several methods for assessing physical function, including grip strength, walking speed, the Short Physical Performance Battery (SPPB), 5 times chair rises test and the Timed Up-and-Go test (TUGT) [6].

Along with physical function, normal sleep pattens also tend to decline with age [7]. A meta-analysis reported the prevalence of sleep disorders in Chinese older adults was 46% [8]. Sleep disorders may affect muscle mass and muscle strength through metabolic, hormonal, and immune factors, thus leading to frailty and decreased physical function [9, 10], ultimately compromising the quality of life [11].

Both sleep disorders and physical dysfunction are more likely to occur in the elderly population, especially in hospitalized elderly individuals. Previous studies on sleep disorders and physical function often focus on populations of young adults, athletes, community-dwelling older adults, or patients with specific diseases, such as cancer or skeletal-muscular disorders [12, 13, 14, 15, 16]. The SONIC study highlighted that sleep disturbances are differentially associated with frailty across age groups in community-dwelling older adults, suggesting that the relationship between sleep and physical decline may vary with advancing age [17].

Inpatient populations may face unique challenges impacting sleep quality, such as unfamiliar hospital environments, interruptions for medical care, and stress from illness. Furthermore, the physical functional status of older adults is vulnerable to the effects of poor sleep, which can impair recovery, prolong hospital stays, and increase the risk of post-discharge complications. Compared with community-dwelling elderly patients, hospitalized elderly patients tend to be more frail (as frailty is a predictor of hospitalization), have poorer physical function, have more severe comorbidities, and thus may be at a higher risk of developing sleep disorders and physical dysfunction [18, 19, 20]. Based on this, we hypothesize that poor sleep quality is associated with impaired physical function in hospitalized Chinese older adults.

Despite multiple studies on sleep and physical function, there is limited research focusing on hospitalized Chinese older adults. Considering China's rapidly aging population, it is important to understanding how sleep quality relates to physical function to inform healthcare practices and improve outcomes. This association may help us identify potential interventions to improve sleep quality and physical function, thus improve the quality of life for older inpatients.

Methods

Study design and participants

This was a prospective observational study. The participants were recruited from the patients admitted to the department of geriatrics in Beijing Hospital during December 2020 to December 2023. A total of 648 subjects aged 60 years old or older were invited to participate in a comprehensive geriatric assessment. The included participants were: (1) aged over 60, (2) admitted to the geriatric inpatient ward, (3) had adequate cognitive and functional abilities to respond to the questionnaires. Participants with the following conditions were excluded from the study: (1) unable or unwilling to grant informed consent [9]; (2) inability to complete any of the performance-based tests (32); (3) unable to communicate with the study staff [9]; (4) presented with serious illness or terminal illness interfering with the conduct of the study or interpretation of the results (53); and (5) having significant cognitive impairment or dementia, that could potentially interfere in assessment. Finally, a total of 545 patients participated in the study.

These patients included patients with various diseases, such as tumors, chronic renal failure, chronic heart failure, however, there was no limitation on comorbidities, and they were not people with a specific disease. Because this study required physical function tests and sleep assessments, patients who could not answer questions correctly and were completely unable to undergo physical function tests were excluded, and critically ill and terminal patients were not included.

All participants provided written informed consent, and the protocol was approved by the Ethic Committee of Beijing Hospital. The study was conducted according to the guidelines of the Declaration of Helsinki.

Sleep assessment

Sleep quality was assessed using the 8-item Athens Insomnia Scale (AIS-8). The AIS-8 is a self-administered questionnaire with eight items: (1) sleep induction; (2) awakenings during the night; (3) final awakening; (4) total sleep duration; (5) sleep quality; (6) well-being during the day; (7) functioning capacity during the day; (8) sleepiness during the day. Participants provide subjective sleep estimates based on the previous month. Each item is scored 0–3, with an overall score from 0 to 24. A higher score indicates poorer sleep quality. A total score of six points or higher is identified as insomnia. This cut-off has been shown to have high specificity and sensitivity for distinguishing poor sleepers and healthy controls [21]. This tool is reliable across multiple demographics [22]. In our study, the score summed of the second and the third item was considered as the score of sleep maintenance, and the score of the last three items was indicated as daytime dysfunction. The assessment was conducted within 48-hours of the admission.

Physical function assessment

Physical function was assessed by three indicators: mobility, muscle strength and balance. SPPB and gait speed were used to assess mobility. SPPB is a comprehensive tool to assess mobility, which is made up of three timed tasks including standing balance, gait speed and 5 times chair rises test. The standing balance test involved a semi-tandem stand where participants placed one foot in front of the other such that the big toe of one foot was touching the side of the heel of the other. If participants could not hold the semi-tandem stand for 10 s, they did a side-by-side stand (standing with the feet side-by-side). If they could hold the semi-tandem stand for 10 s, they also attempted a full tandem stand where participants placed one foot in front of the other (touching heel-to-toe) and held this position for as long as they could up to 10 s.

To test gait speed, participants were asked to walk 4 m at their customary walking speed whilst being timed by a stopwatch. The chair rises test involved participants moving from a sitting position on a straight-backed chair to a fully upright standing position five times as quickly as possible with their arms crossed across their chest while being timed. Performance on these tests was measured and reported individually, and also used to calculate a SPPB score. Each test was scored from 0 (could not complete the test or the poorest performance) to 4 (highest level of performance), with an overall score ranging from 0 to 12; a global score equal to or lower than 9 indicated poor mobility. A gait speed which was less than 1.0 m/s was defined as low gait speed.

Muscle strength was measured by grip strength and chair rises test, respectively reflecting upper and lower limb muscle strength. Grip strength was assessed as the highest value of two attempts on the dominant hand using hand-held isokinetic dynamometer (CAMRY EH101). Low grip strength was defined as < 28 kg for men, and < 18 kg for women [23]. The whole time to complete 5 times chair rises test ≥ 12 s was defined as impaired chair rises [24]. TUGT usually represents balance performance. Participants should began seated in a chair with arms and were asked to stand, walk at their customary pace to a marked line at 3 m, then turn and walk back to sit in the chair while being timed. Decreased TUGT was defined as ≥ 20 s for complete the test.

Frailty assessment

Fried frailty phenotype includes 5 items: unexplained weight loss, slowed gait, decreased grip strength, decreased activity, and fatigue. Each item is scored as 1 point. In this study, 0 points means no frailty, and ≥ 1 point is defined as frailty [25].

Covariates

Data were also collected on potential confounders of the study associations. Socio-demographic characteristics, such as gender, age, educational level (≤ high school/> high school), occupation (Manual worker/Brainworker, based on the situation before retirement), living alone, were assessed. Likewise, information on lifestyle-related variables was collected, such as smoking habits (current smoker/past, or never-smoker) and drinking habits (current drinker/past, or never-drinker). Body mass index (BMI) was also calculated from measured weight and height. As the assessment of the elderly was completed within 48 h of admission, the length of hospitalization and inpatient treatment would not have much effect on the assessment results.

Statistical analysis

Continuous variables that were normally distributed were expressed as means and standard deviation, while nonnormal distribution parameters were given as medians and interquartile ranges (IQR). Additionally, classification variables were reported as frequencies and percentages. Differences in the characteristics according to sleep quality were analysed using *t*-test, Chi-square test or Kruskal-Wallis rank test. The association of poor sleep quality with physical performance was assessed using logistic regression. Covariates were added sequentially to evaluate association at different levels of adjustment. Crude was unadjusted. Model 1 was adjusted for age, gender, BMI. Model 2 was additionally adjusted for educational level, occupation, living alone, smoking habits, drinking habits. Model 2 was also used to assess the association between the sub-components of AIS-8 and physical performance. Furthermore, we assessed if the association varied when participants were stratified by gender or age. All analyses were conducted using SPSS version 27.0, and a *P* value of < 0.05 was considered statistically significant.

Results

A total 545 participants (288 men and 257 women) aged 60 to 98 were included in the analysis. Table 1 shows the characteristics of these participants by sleep quality. According to AIS-8 score, the prevalence of insomnia

Table 1 Characteristics of the study participants stratified by sleep quality

	All participants	Insomnia (AIS ≥ 6)	Non-insomnia (AIS < 6)	*p*-value
Total, n (%)	545	142 (26.1)	403 (73.9)	
Age (y)	78.4 ± 8.2	79.3 ± 8.2	78.1 ± 8.2	0.119
Sex, n(%)				0.116
Male	288 (52.8)	67 (47.2)	221 (54.8)	
Female	257 (47.2)	75 (52.8)	182 (45.2)	
BMI (kg/m^2)	23.4 ± 4.0	23.0 ± 3.7	23.5 ± 4.1	0.268
Education, n(%)				0.625
> High school	272 (49.9)	68 (48.2)	204 (50.6)	
≤High school	272 (49.9)	73 (51.8)	199 (49.4)	
Occupation, n(%)				0.737
Manual workers	137 (25.1)	37 (26.2)	100 (24.8)	
Brainworkers	407 (74.7)	104 (73.8)	303 (75.2)	
Smoking, n(%)				0.304
Smoker	46 (8.4)	9 (6.4)	37 (9.2)	
Non-smoker	498 (91.4)	132 (93.6)	366 (90.8)	
Drinking, n(%)				0.074
Drinker	37 (6.8)	5 (3.5)	32 (92.1)	
Non-drinker	507 (93.0)	136 (96.5)	371 (92.1)	
Living alone, n(%)				0.507
Yes	50 (9.2)	11 (7.8)	39 (9.7)	
No	494 (90.6)	130 (92.2)	364 (90.3)	
Fried frailty phenotype, n(%)				< 0.001***
Frailty	465 (85.3)	132 (97.8)	333 (86.9)	
Non-frailty	53 (9.7)	3 (2.2)	50 (13.1)	
gait speed (m/s)	0.81 ± 0.45	0.71 ± 0.32	0.84 ± 0.48	0.009**
Low gait speed	330 (72.5)	86 (70.1)	244 (80.4)	0.038*
Chair rises (seconds)	15.8 (8.7)	16.7 (8.3)	15.1 (8.5)	0.044*
Impaired chair rises	305 (79.0)	76 (84.4)	229 (77.4)	0.149
Standing balance test score	3.0 (2.0)	2.5 (4.0)	3.0 (2.0)	0.010*
SPPB score	8.0 (6.0)	6.0 (8.0)	8.0 (5.0)	< 0.001***
SPPB ≤ 9, n (%)	370 (67.9)	107 (75.4)	263 (65.3)	0.027*
Grip (kg)	21.7 ± 9.2	19.3 ± 9.2	22.5 ± 9.1	< 0.001
Low grip strength, n (%)	291 (53.4)	85 (69.1)	206 (53.9)	0.003*
TUGT (seconds)	15.2 (11.3)	19.0 (13.1)	14.5 (10.3)	< 0.001***
Impaired TUGT	146 (31.5)	50 (45.0)	96 (27.2)	< 0.001***
AIS-8 score	2.0 (6.0)	9.0 (7.0)	1.0 (3.0)	< 0.001***

Note: A total of 545 subjects were included in this study, of which 1 person completed the assessment of physical function and sleep quality, but did not fill in the basic information, so the sum of the four items of education background, occupation type, smoking and drinking history, and living conditions was 99.8%. There were 27 missing data in the frailty assessment, so the sum was equal to 95%

*=$p < 0.05$

**=$p < 0.01$

***=$p < 0.001$

BMI, body mass index; SPPB, short physical performance battery; TUGT, timed up-and-go test; AIS-8, Athens insomnia scale-8

was 26.1%. The median AIS-8 score was 9.0 for insomnia group, and 1.0 for non-insomnia group. The mean age of insomnia group and non-insomnia group were 79.3 ± 8.2 and 78.1 ± 8.2 years old, respectively.

There were no statistically significant differences between insomnia and non-insomnia with respect to age, sex, BMI, education, occupation, smoking habits, drinking habits and living status. 67.9% had low SPPB score, 72.5% had low gait speed, 53.4% had low grip, 79% had impaired chair rises, and 31.5% had impaired TUGT. Compared with non-insomnia group, the insomnia group had a higher likelihood of poor mobility, low muscle strength and poor balance performance.

The association of poor sleep quality (AIS-8 ≥ 6) with physical function is reported in Table 2. Participants with poor sleep quality were more likely to have impaired physical performance; fully adjusted OR (95%CI) was 1.892 (1.037–3.453, $p = 0.038$) for low gait speed, 1.810 (1.110–2.952, $p = 0.017$) for low grip strength, 2.491 (1.496–4.147, $p < 0.001$) for impaired TUGT. Poor sleep

Table 2 The association of poor sleep quality (AIS-8 ≥ 6) with physical performance

Physical performance	Non-insomnia (reference)	insomnia	*p*-value
Low SPPB score (≤ 9)			
Crude, OR (95% CI)	1	1.63 (1.05, 2.51)	0.028*
Model1, OR (95% CI)	1	1.59 (0.97,2.61)	0.068
Model2, OR (95% CI)	1	1.62 (0.97, 2.69)	0.064
Low gait speed			
Crude, OR (95% CI)	1	1.75 (1.03, 2.96)	0.039*
Model1, OR (95% CI)	1	1.81 (1.01, 3.27)	0.047*
Model2, OR (95% CI)	1	1.89 (1.04, 3.45)	0.038*
Low grip strength			
Crude, OR (95% CI)	1	1.911 (1.241, 2.944)	0.003**
Model1, OR (95% CI)	1	1.801 (1.110, 2.921)	0.017**
Model2, OR (95% CI)	1	1.81 (1.11, 2.95)	0.017**
Impaired chair rises			
Crude, OR (95% CI)	1	1.59 (0.84, 2.99)	0.151
Model1, OR (95% CI)	1	1.62 (0.84, 3.14)	0.153
Model2, OR (95% CI)	1	1.67 (0.85, 3.29)	0.137
Impaired TUGT			
Crude, OR (95% CI)	1	2.19 (1.41, 3.41)	< 0.001***
Model1, OR (95% CI)	1	2.42 (1.46, 2.00)	< 0.001***
Model2, OR (95% CI)	1	2.49 (1.50, 4.15)	< 0.001***

*=$p < 0.05$

**=$p < 0.01$

***=$p < 0.001$

SPPB, short physical performance battery. TUGT, timed up-and-go test. Crude, no adjusted. Model 1, adjusted for age, gender, BMI; Model 2, additionally adjusted for education, occupation, smoking habits, drinking habits, living status on the base of model1

Table 3 Association between sleep quality components and physical performance

	Sleep induction	Sleep maintenance	Sleep duration	Sleep quality	Daytime dysfunction
Low SPPB score (≤ 9)					
OR (95% CI)	1.25 (0.94, 1.66)	1.199 (1.02, 1.40)	1.26 (0.96, 1.65)	1.29 (1.00, 1.67)	1.21 (1.063, 1.38)
p	0.121	0.023	0.092	0.048	0.004
Low gait speed					
OR (95% CI)	1.210 (0.87, 1.68)	1.208 (1.00, 1.46)	1.36 (0.99, 1.89)	1.66 (1.20, 2.30)	1.39 (1.16, 1.67)
p	0.252	0.048	0.059	0.002	< 0.001
Low grip strength					
OR (95% CI)	0.96 (0.74, 1.254)	1.20 (1.03, 1.41)	1.28 (0.99, 1.67)	1.19 (0.93, 1.51)	1.19 (1.05, 1.35)
p	0.769	0.019	0.063	0.158	0.006
Impaired chair rises					
OR (95% CI)	0.99 (0.70, 1.42)	1.14 (0.92, 1.42)	1.23 (0.85, 1.77)	1.27 (0.90, 1.79)	1.31 (1.06, 1.62)
p	0.991	0.242	0.271	0.181	0.012
Impaired TUGT					
OR (95% CI)	1.38 (1.05, 1.83)	1.32 (1.12, 1.55)	1.46 (1.12, 1.92)	1.55 (1.20, 2.02)	1.36 (1.20, 1.55)
p	0.023	< 0.001	0.006	< 0.001	< 0.001

SPPB, short physical performance battery. TUGT, timed up-and-go test. OR (95%CI) were adjusted for age, gender, BMI, education, occupation, smoking habits, drinking habits, living status

quality had association with low SPPB score (OR = 1.627, 95%CI 1.055–2.510, $p = 0.028$), but no association were found after adjustment for age, gender, BMI, education, occupation, smoking, drinking, and living status (OR = 1.618, 95%CI 0.973–2.691, $p = 0.064$). No association was found between sleep quality and impaired chair rises.

Table 3 shows the association between sleep quality components with physical function indicators. The components associated with low SPPB score were poor sleep maintenance (OR = 1.199, 95%CI 1.025–1.402), poor sleep quality (OR = 1.293, 95%CI 1.002–1.669) and daytime dysfunction (OR = 1.213, 95%CI 1.063–1.385). Similarly, the above three components were also associate with low gait speed, the OR (95%) was 1.208

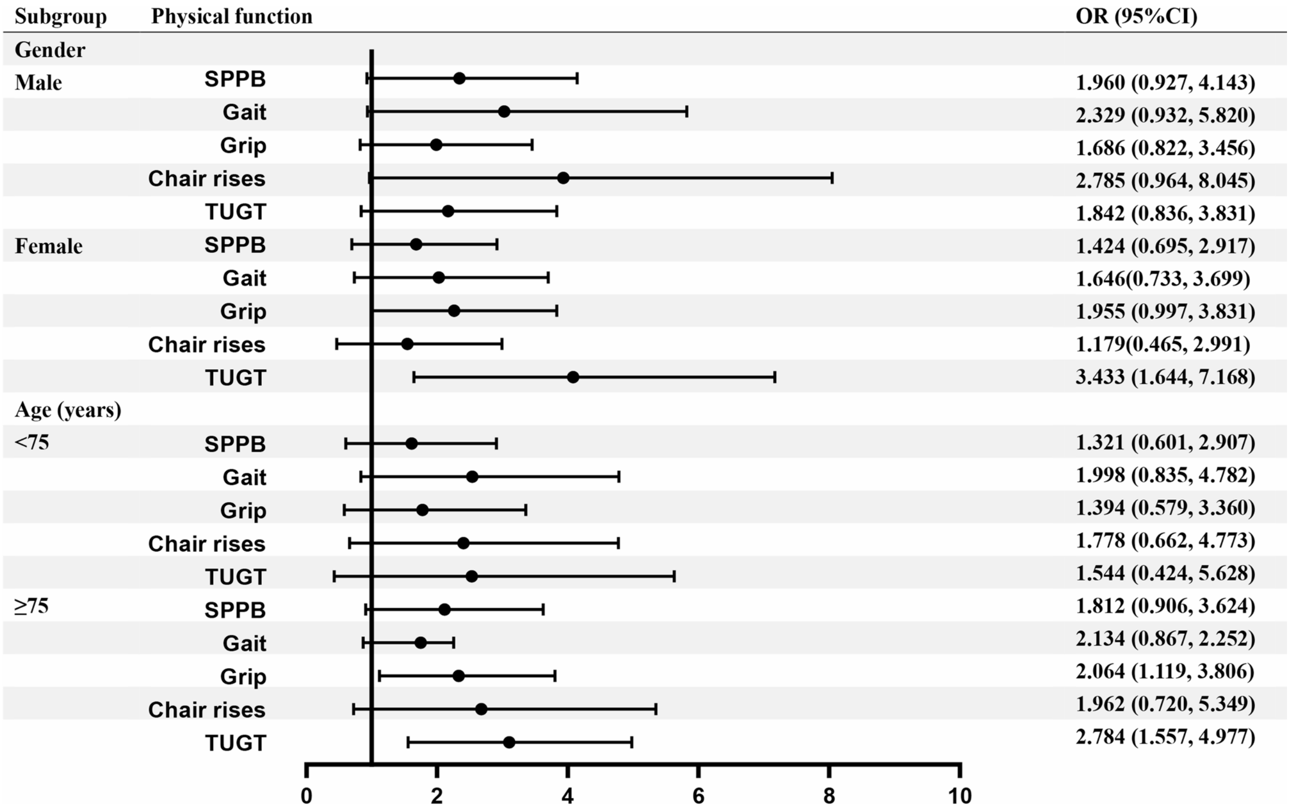

Fig. 1 The association of poor sleep quality (AIS-8 ≥ 6) with physical performance stratified by gender or age. SPPB, short physical performance battery; TUGT, timed up-and-go test. Subgroup analysis by gender (288 males and 257 females) and age (183 people under 75 years old and 362 people over 75 years old), except for stratified by variables, models were adjusted by age, gender, BMI, education, occupation, smoking habits, drinking habits, living status

(1.001–1.458), 1.657 (1.198–2.292), 1.391 (1.158–1.670), respectively. Low grip strength was associated with poor sleep maintenance (OR = 1.204, 95%CI 1.030–1.406) and daytime dysfunction (OR = 1.193, 95%CI 1.053–1.353), while only daytime dysfunction was related to impaired chair rises (OR = 1.312, 1.062–1.622). All of the sleep quality components were associated with impaired TUGT, the OR (95%CI) was 1.382 (1.046–1.827) for sleep induction, 1.318 (1.124–1.547) for sleep maintenance, 1.464 (1.117–1.919) for sleep duration, 1.554 (1.196–2.021) for sleep quality, 1.363 (1.197–1.553) for daytime dysfunction, which indicated that longer sleep induction, poorer sleep maintenance, shorter sleep duration, poorer sleep quality, more daytime dysfunction were associated with a higher likelihood of balance dysfunction.

We also performed subgroup analysis to find out possible differences in the association according to gender and age. As shown in Fig. 1, when stratified by age, poor sleep quality was associated with a higher incidence of low grip strength and impaired TUGT in ≥ 75 years old group. No association was seen in < 75 years old group. A significant association of sleep quality with TUGT in the female population was observed but not for the male population. Neither in female nor male population, poor sleep quality had statistically significant association with mobility or muscle strength.

Discussion

This study found that patients with poor sleep quality had worse physical function, and poor sleep quality was associated with low gait speed, low grip strength and impaired balance performance. Poor sleep maintenance and daytime dysfunction were associated with impaired mobility and low grip strength, while only daytime dysfunction was associated with impaired chair rises. All sub-components of sleep quality were associated with impaired TUGT.

After stratifying by age, we found that among older adults aged 75 years or older, poor sleep quality was associated with low grip strength and impaired balance performance. In contrast, among older adults younger than 75 years old, poor sleep quality was not associated with any of the three indicators of physical function. After stratifying by gender, we found that after adjusting for confounders, poor sleep quality was associated with impaired balance performance, while not associated with impaired mobility nor low muscle strength in women. In men, poor sleep quality was not associated with any of the three indicators of physical function.

Previous studies on sleep disorders and physical performance have focused on sleep duration rather than sleep quality. Studies have found that either too short or too long sleep duration is associated with physical dysfunction [16, 26, 27]. A few studies have focused on the relationship between sleep quality and physical function. Most assessments of sleep quality have chosen single question such as "do you think you slept enough during the past month" or the Pittsburgh Sleep Quality Index (PSQI) [27, 28]. Some studies have analyzed the relationship between sleep disorders and sarcopenia, with physical performance as a parameter of sarcopenia. However, in these studies, physical performance often be evaluated by single indicator, such as gait speed or SPPB [29, 30]. A large-scale British study found that poor sleep quality was associated with low SPPB scores and low grip strength, but the association was different among men and women [28]. Another Spanish study assessed physical function using frailty, SPPB, and grip strength, and sleep quality using PSQI, and reported that poor sleep quality was associated with frailty, low SPPB scores, and low grip strength, while the duration of sleep was not related to physical function [31]. A study of Chinese older women found no difference in PSQI total score and all of the PSQI components between sarcopenia and non-sarcopenia groups [30]. In the present study, sleep quality was assessed with the AIS-8, and the assessment of physical function was comprehensive including mobility, muscle strength and balance function. The results indicate that poor sleep quality was associated with gait speed, upper limb muscle strength and balance function in the whole populations, but not with SPPB scores or lower limb muscle strength. The variation in these results may be explainedby the fact that the methods used to assess sleep quality and physical function are not identical and the study populations are different in terms of demographics, cultural or lifestyle differences in activity levels, diet, and daily routines [32].

Similar to our results, Mizuno et al. (SONIC study) older adults and identified age as a modifier of the sleep-physical function relationship, though our cohort (hospitalized patients) exhibited higher baseline impairment (e.g., 67.9% had low SPPB scores) compared to community-dwelling participants in SONIC [17]. While the SONIC study focused on frailty as an outcome, our results extended these findings by demonstrating that specific sleep components such as sleep maintenance, daytime dysfunction, were independently linked to declines in mobility, strength, and balance; suggesting that sleep disruptions may contribute to physical dysfunction through multiple pathways. This study also analyzed the relationship between sleep quality components and physical function and found that sleep maintenance and daytime dysfunction were associated with SPPB scores, gait speed and grip strength, which represented mobility and muscle strength. These results were similar to previous literature [28, 31]. Poor sleep maintenance can lead to insufficient deep sleep, which is necessary for muscle repair and overall recovery [33]. Without this restorative phase, muscle strength and endurance (as measured by grip strength and gait speed) may diminish.

Few studies assessing the relationship between sleep disorders and physical function stratified by age [24]. In order to analyze the relationship between sleep quality and physical function in different age groups, our study stratified the old participants by age and found that in the older cohort aged over 75, poor sleep quality was associated with low grip strength and impaired balance performance, unlike in those aged 60–75. Sarcopenia or the decrease in muscle mass and strength with age may be exacerbated by sleep disturbances in the older cohort, thereby impacting grip strength more significantly. Similarly, balance performance is impacted by combined effects of reduced muscle strength, slower reflexes, and impaired coordination, which become more pronounced with advanced age. This suggests that sleep quality should be of greater concern in older old adults and thus may have a greater impact on upper limb muscle strength and balance function.

Several previous studies have found gender differences in the relationship between sleep disorders and physical performance [24]. One study found that poor sleep quality was associated with reduced grip strength in women, while among men, poor sleep quality was associated with low SPPB scores [28]. The gender differences in the impact of sleep quality on physical performance likely arise from distinct biological and physiological factors, such as hormonal influences, body composition, and differences in sleep architecture. Reduced estrogen in postmenopausal women can lead to decreased muscle strength [34], making measures like grip strength more sensitive to sleep disruptions in women. Men, however, are more prone to sleep apnea [35] and have higher muscle mass, which may make composite performance metrics like the SPPB. In our study, only impaired balance performance was associated with poor sleep quality in women. This may also be explained by post-menopausal impairments in balance control [36]. Sleep quality has no relationship with mobility or muscle strength indicators in both genders.

Although sleep quality of elderly populations of several demographics has been assessed, to the best of our knowledge, this is the initial study investigating sleep quality and physical function among Chinese old patients admitted in internal wards. Compared with community-dwelling old adults, elderly inpatients in the geriatric department may have poorer physical function. Thus, the relationship between sleep quality and physical function in them may be different with that in community-dwelling adults. This study also categorizes older adults into younger old adults and older old adults according to age, in order to explore the relationship between sleep disorders and physical performance changes with ageing.

A limitation of this study is that the presence of obstructive sleep apnea-hypopnea syndrome (OSAHS) was not considered. The prevalence of OSAHS ranges from 4 to 9% in adults and can be as high as 32.5% in the elderly, with a tendency for the prevalence to increase with age [37, 38]。OSAHS causes hypoxemia, which causes a decrease in muscle mass and muscle strength, leading to physical dysfunction. The prevalence of OSAHS is positively correlated with BMI, so we adjusted BMI in our analyses. Secondly, the data on sleep quality was collected by self-reported, which may have been affected recall bias. Currently, the most accurate method for assessing sleep patterns is polysomnography, however, polysomnography testing is cumbersome and unsuitable for large sample studies. The AIS-8 is widely used in clinical practice with good reliability and validity. In the future, wearable sleep monitoring devices may be considered for sleep assessment along with subjective questionnaires. Third, this study is a cross-sectional study and cannot indicate causality.

Given the potential impact of sleep disturbances on mobility, muscle strength, and balance; this study emphasizes the need for targeted interventions to improve sleep in this population. Addressing sleep quality through non-pharmacological approaches, such as cognitive behavioral therapy for insomnia, physical activity, and sleep hygiene education, may contribute to better physical function and overall health outcomes. Additionally, integrating sleep assessments into routine geriatric care could aid in identifying individuals at higher risk of functional decline, ultimately supporting fall prevention strategies and enhancing rehabilitation efforts. Future studies may explore the underlying mechanisms linking sleep disturbances to physical impairment and evaluate the effectiveness of tailored interventions in improving both sleep quality and functional independence in older adults.

Conclusions

In conclusion, we found that in elderly inpatients in geriatric department, poor sleep quality was associated with decreased physical function, particularly in terms of low gait speed, low grip strength and impaired TUGT. This association was more pronounced in elder patients ≥ 75 years old and had sex differences. More prospective cohort studies are needed in the future to explicit the relationship and clarify its causality.

Acknowledgements

We thank Dr. Yuting Kang for helping with statistic analysis.

Author contributions

XC: Conceptualization, Methodology, Formal analysis, Data curation, Writing-original draft. JL: Investigation. YY: Investigation. QZ: Data curation, Formal analysis, Writing-review and editing. WW: Data curation, Funding acquisition, Project administration, Writing-review and editing.

Funding

This work was supported by National Key Research and Development Program for Active Health and Technology Response to Aging (grant number 2020YFC2009000), and Clinical Research Fund for Central High-level Hospitals (grant number BJ-2022-181).

Data availability

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

All participants provided written informed consent, and the protocol was approved by the Ethic Committee of Beijing Hospital.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Received: 4 November 2024 / Accepted: 5 May 2025
Published online: 20 May 2025

References

1. Luo Y, Su B, Zheng X. Trends and challenges for population and health during population Aging - China, 2015–2050. China CDC Wkly. 2021;3(28):593–8.
2. Cesari M, Araujo de Carvalho I, Amuthavalli Thiyagarajan J, Cooper C, Martin FC, Reginster JY, et al. Evidence for the domains supporting the construct of intrinsic capacity. Journals Gerontol Ser Biol Sci Med Sci. 2018;73(12):1653–60.
3. Manini TM, Pahor M. Physical activity and maintaining physical function in older adults. Br J Sports Med. 2009;43(1):28–31.
4. Lauretani F, Ticinesi A, Gionti L, Prati B, Nouvenne A, Tana C, et al. Short-Physical performance battery (SPPB) score is associated with falls in older outpatients. Aging Clin Exp Res. 2019;31(10):1435–42.
5. de Fátima Ribeiro Silva C, Ohara DG, Matos AP, Pinto A, Pegorari MS. Short physical performance battery as a measure of physical performance and mortality predictor in older adults: A comprehensive literature review. Int J Environ Res Public Health. 2021;18(20).
6. Liu J, Ding Q, Zhou B, Liu X, Liu J, Liu Y, et al. Chinese expert consensus on diagnosis and treatment for elderly with sarcopenia (2021). Chin J Geriatr. 2021;40(08):943–52.
7. Crowley K. Sleep and sleep disorders in older adults. Neuropsychol Rev. 2011;21(1):41–53.
8. Wang Z, Zhao M, Chen T, Guo Z. Sleep disturbance prevalence rate among Chinese older people: a meta-analysis. Chin Gen Pract. 2022;25(16):2036–43.
9. Baniak LM, Yang K, Choi J, Chasens ER. Long sleep duration is associated with increased frailty risk in older Community-Dwelling adults. J Aging Health. 2020;32(1):42–51.
10. Rubio-Arias J, Rodríguez-Fernández R, Andreu L, Martínez-Aranda LM, Martínez-Rodriguez A, Ramos-Campo DJ. Effect of sleep quality on the prevalence of sarcopenia in older adults: A systematic review with Meta-Analysis. J Clin Med. 2019;8(12).
11. Reimer MA, Flemons WW. Quality of life in sleep disorders. Sleep Med Rev. 2003;7(4):335–49.
12. Patrick Y, Lee A, Raha O, Pillai K, Gupta S, Sethi S, et al. Effects of sleep deprivation on cognitive and physical performance in university students. Sleep Biol Rhythms. 2017;15(3):217–25.

13. Fullagar HH, Skorski S, Duffield R, Hammes D, Coutts AJ, Meyer T. Sleep and athletic performance: the effects of sleep loss on exercise performance, and physiological and cognitive responses to exercise. Sports Med (Auckland NZ). 2015;45(2):161–86.
14. Wilcox S, Brenes GA, Levine D, Sevick MA, Shumaker SA, Craven T. Factors related to sleep disturbance in older adults experiencing knee pain or knee pain with radiographic evidence of knee osteoarthritis. J Am Geriatr Soc. 2000;48(10):1241–51.
15. Loh KP, Pandya C, Zittel J, Kadambi S, Flannery M, Reizine N, et al. Associations of sleep disturbance with physical function and cognition in older adults with cancer. Supportive Care Cancer: Official J Multinational Association Supportive Care Cancer. 2017;25(10):3161–9.
16. Zhan Q, Zhao J, Guo Q, Niu J, Yu C, Ding W, et al. Association of sleep duration with physical performance in Hemodialysis patients: A multicenter Cross-Sectional study. Nephron. 2023;147(5):260–5.
17. Mizuno T, Godai K, Kabayama M, Akasaka H, Kido M, Isaka M, et al. Age group differences in the association between sleep status and frailty among Community-Dwelling older adults: the SONIC study. Gerontol Geriatric Med. 2023;9:23337214231205432.
18. Kojima G. Frailty as a predictor of hospitalisation among community-dwelling older people: a systematic review and meta-analysis. J Epidemiol Commun Health. 2016;70(7):722–9.
19. Ehlenbach WJ, Larson EB, Curtis JR, Hough CL. Physical function and disability after acute care and critical illness hospitalizations in a prospective cohort of older adults. J Am Geriatr Soc. 2015;63(10):2061–9.
20. Rodrigues LP, de Oliveira Rezende AT, Delpino FM, Mendonça CR, Noll M, Nunes BP et al. Association between Multimorbidity and hospitalization in older adults: systematic review and meta-analysis. Age Ageing. 2022;51(7).
21. Soldatos CR, Dikeos DG, Paparrigopoulos TJ. Athens insomnia scale: validation of an instrument based on ICD-10 criteria. J Psychosom Res. 2000;48(6):555–60.
22. Jahrami H, Trabelsi K, Saif Z, Manzar MD, BaHammam AS, Vitiello MV. Reliability generalization meta-analysis of the Athens insomnia scale and its translations: examining internal consistency and test-retest validity. Sleep Med. 2023;111:133–45.
23. Chen LK, Woo J, Assantachai P, Auyeung TW, Chou MY, Iijima K, et al. Asian working group for sarcopenia: 2019 consensus update on sarcopenia diagnosis and treatment. J Am Med Dir Assoc. 2020;21(3):300–e72.
24. Lv X, Peng W, Jia B, Lin P, Yang Z. Longitudinal association of sleep duration with possible sarcopenia: evidence from CHARLS. BMJ Open. 2024;14(3):e079237.
25. Fried LP, Tangen CM, Walston J, Newman AB, Hirsch C, Gottdiener J, et al. Frailty in older adults: evidence for a phenotype. Journals Gerontol Ser Biol Sci Med Sci. 2001;56(3):M146–56.
26. Pourmotabbed A, Ghaedi E, Babaei A, Mohammadi H, Khazaie H, Jalili C, et al. Sleep duration and sarcopenia risk: a systematic review and dose-response meta-analysis. Sleep Breath = Schlaf Atmung. 2020;24(4):1267–78.
27. Han P, Hou L, Liang Z, Chen W, Li J, Cheng Y, et al. Both short and long sleep durations are risk factors for sarcopenia in Suburban-Dwelling older Chinese individuals: A 3-Year longitudinal study. Nat Sci Sleep. 2022;14:1089–96.
28. Denison HJ, Jameson KA, Sayer AA, Patel HP, Edwards MH, Arora T, et al. Poor sleep quality and physical performance in older adults. Sleep Health. 2021;7(2):205–11.
29. Liu Z, Wang H, Zhang X. Relationship between sarcopenia and sleep quality in elderly women. Chin J Osteoporsis Bone Mineral Reserch. 2020;5(13):432–9.
30. Zheng K, Chen H, Wu X, Xia L. The correlation between sleep disorders and sarcopenia in aCommunity-based elderly population. Int J Geriatr. 2024;45(3):278–83.
31. Arias-Fernández L, Smith-Plaza AM, Barrera-Castillo M, Prado-Suárez J, Lopez-Garcia E, Rodríguez-Artalejo F, et al. Sleep patterns and physical function in older adults attending primary health care. Fam Pract. 2021;38(2):147–53.
32. Zou S, Feng G, Li D, Ge P, Wang S, Liu T, et al. Lifestyles and health-related quality of life in Chinese people: a National family study. BMC Public Health. 2022;22(1):2208.
33. Desai D, Momin A, Hirpara P, Jha H, Thaker R, Patel J. Exploring the role of circadian rhythms in sleep and recovery: A review Article. Cureus. 2024;16(6):e61568.
34. Maltais ML, Desroches J, Dionne IJ. Changes in muscle mass and strength after menopause. J Musculoskel Neuronal Interact. 2009;9(4):186–97.
35. Jordan AS, McEvoy RD. Gender differences in sleep apnea: epidemiology, clinical presentation and pathogenic mechanisms. Sleep Med Rev. 2003;7(5):377–89.
36. Espírito Santo J, Aibar-Almazán A, Martínez-Amat A, de Loureiro NEM, Brandão-Loureiro V, Lavilla-Lerma ML et al. Menopausal symptoms, postural balance, and functional mobility in Middle-Aged postmenopausal women. Diagnostics (Basel Switzerland). 2021;11(12).
37. Schroeder K, Gurenlian JR. Recognizing poor sleep quality factors during oral health evaluations. Clin Med Res. 2019;17(1–2):20–8.
38. Branch SRDSGRD, Association SM. Prevalence of obstructive sleep apnea-hypopnea syndrome in Chinese adults aged over 30 year in Shanghai. Chin J Tuberculosis Respiratory Dis. 2003;26(5):268–72.

Publisher's note