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Original Article

The Impact of Sleep Quality on Cognitive Function in Community-Dwelling Older Adults

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Introduction: Given the high prevalence of poor sleep quality in late adulthood, older adults might be involved with different physical, mental and social consequences of this disorder. Current research was conducted to examine the association between sleep quality and cognitive function in community-dwelling older adults.

Methods: This cross-sectional study was carried out on 800 community-dwelling people aged ≥ 60 years living in Amirkola, North of Iran. The participants were selected by simple random sampling method. Mini-Mental State Examination, and the Pittsburgh Sleep Quality Index (PSQI) were used for data collection. Seven components of the sleep quality were categorized into the four groups (very good, relatively good, relatively poor, and very poor condition). The participants were divided into the two groups based on their cognitive function, and sleep quality was compared between these two groups. Mann-Whitney, Spearman's correlation analysis, Chi-square, Pearson's correlation test and Logistic regression analysis were used to analyze the collected data.

Results: Mean PSQI score among the older adults with normal and abnormal cognitive function was 5.5 ± 3.2 and 5.8 ± 3.3, respectively (p = 0.508). Poor sleep quality was slightly more prevalent in the elderly with cognitive dysfunction (p = 0.775). Logistic regression analysis revealed age (adjusted OR = 1.06; 95% CI: 1.03-1.08; p < 0.001) and level of education (adjusted OR = 0.14; 95% CI: 0.09-0.20; p < 0.001) had a significant impact on cognitive function; PSQI score (p = 0.254), gender (p = 0.661), and administration of sleeping drugs showed no significant effect (p = 0.081).

Conclusion: Among different components of sleep quality, a significant positive association was observed between the frequency of sleep disturbances with cognitive function in older adults; furthermore, older age and lower level of education showed a significant negative effect on cognitive function.

Keywords: Sleep, Cognition, Aged, Health

Introduction

Sleep as an essential factor for "healthy ageing" has attracted increasing concern in recent years (1, 2). Sleep complaints including difficulty falling asleep, frequent waking up during the night, early morning awaking, and daytime sleepiness and napping are common in the late adulthood (3). It is estimated that 50-70% of older people report the sleep disorders; and insomnia has been reported as the most common disorder among this population; 40% of adults over 60 years of age complain of difficulty falling asleep or staying asleep (4).

Sleep disorders in older adults can affect their general functioning and activities of daily living, and are associated with adverse consequences such as increased risk of accidents, chronic fatigue, poorer mental health and

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quality of life (1, 5). In addition to, sleep problems can contribute to cognitive impairment or dementia (6-8).

It has been demonstrated that ageing is associated with incident problems in both sleep and cognitive functioning (9). Meta-analyses demonstrated the impact of different aspects of sleep on cognitive function of older adults (6, 8, 10) Disrupted sleep has been represented as one of the earliest symptoms of Alzheimer's disease (AD), and a bidirectional correlation has been assumed between sleep disorders and cognitive impairment (11).

Working memory, long-term memory, attention, reasoning, processing speed, and executive function have been listed as important cognitive functions that may decline with age (9). Due to high prevalence of age-related cognitive decline in late adulthood, and availability of only palliative treatments for important neurodegenerative disorders such as AD, preventive or delaying approaches have attracted increasing attention in recent years (12). Bio-psycho-socio-environmental factors can determine or change cognition function in old age (13). Proper cognitive functioning can influence healthy ageing (14).

Sleep characteristics that may reduce with age include total sleep time, slow wave sleep, and rapid eye movement (REM) sleep (9, 11). Sleep disturbance in people with cognitive decline can cause poorer outcomes, such as more severe cognitive and neuropsychiatric symptoms, and poorer quality of life (15).

A previous research on people aged ≥ 60 years living in north region of Iran revealed that nearly one in four people had self-reported sleep disorders (16). As a few studies examined the association of sleep quality and cognition in the elderly population (17, 18), this study was conducted to explore the association between sleep quality and cognitive function in community-dwelling older adults.

Methods

Study design and sampling strategy

This observational study -as a part of the second phase of Amirkola Health and Ageing cohort Project (AHAP) (19) - was carried out on adults aged ≥ 60 years, living in Amirkola, northern Iran. All 1616 older people living in this region were invited to participate in the study, by census. The participants were divided into the two groups based on their cognitive function (the first group with cognitive dysfunction, and the second one with normal cognitive function).

Accordingly, assuming a prevalence of 35% of sleep disorders among older adults with cognitive impairment and 25% in older adults without cognitive disorders (16), 95% confidence interval, and 80% study power, the minimum effective sample size was calculated as 325 individuals for each group; and taking into account the drop out of the study population, 400 elderly people for each group were considered. The persons with mental retardation, severe psychiatric disorders such as psychosis, and physical disabilities that prevent them to complete the study questionnaires were excluded.

Data collection and measurements

Demographic characteristics including age, gender, and level of education were collected during direct interview with the elderly. Cognitive function was assessed with Mini-Mental State Examination (MMSE), and sleep quality was evaluated with the Persian translation of the Pittsburgh Sleep Quality Index (PSQI). Psychiatry residents performed the participants' examination, and completed the study questionnaires.

MMSE is used to examine different aspects of cognition including memory, orientation, attention, calculation, and language. The score less than 25/30 is considered as cognitive impairment (20). This questionnaire has been used in multiple studies in Iran and other countries, and the validity and reliability of its Persian translation have been approved (21, 22).

The PSQI is a 19-item questionnaire that measures seven different components, including subjective sleep quality, sleep duration, sleep efficiency, sleep latency, frequency of sleep disturbances, daytime consequences of poor sleep, and use of sleeping drugs. A score above five indicates a poor sleep quality (23). The higher the score, the more problems in the sleep quality are expected (16, 24). In each component of sleep quality, the scores of 0, 1, 2, 3 were rated as very good, relatively good, relatively poor and very poor condition, respectively.

Analytic strategy

Data analysis was performed with SPSS-18 software package. Mann-Whitney, Spearman's correlation analysis, Chi-square, Pearson's correlation test and Logistic regression analysis were used to analyze the collected data. P-value less than 0.05 was considered as significant level.

Ethical considerations

This research has been funded by Babol University of Medical Sciences, Iran with the project number: 970539. The study protocol was approved by the Ethics Committee of Babol University of Medical Sciences with registration code IR.MUBABOL.HRI.REC.1397.053.

Results

Totally, 800 older adults (400 male and 400 female) were recruited in the research. The baseline characteristics of the individuals with and without cognitive impairment is presented in Table 1. This table shows that although poor sleep quality was slightly more prevalent in the elderly with cognitive dysfunction (50.6% versus 49.4%), the difference was not statistically significant ($p = 0.775$). The persons with cognitive dysfunction were older than the elderly who had normal cognitive function ($p < 0.001$). A significant difference was observed in educational level of the two groups; persons with cognitive dysfunction had lower levels of education ($p < 0.001$).

Mean PSQI score among the older adults with normal and abnormal cognitive function was 5.5 ± 3.2 and 5.8 ± 3.3, respectively ($p = 0.508$).

The seven components of sleep quality in the two study groups are compared in Table 2. Chi-square test revealed a significant association between the frequency of sleep disturbances with cognitive function in older adults ($p < 0.001$); and other components of sleep quality did not have a significant association ($p > 0.05$). The elderly with cognitive impairment had more sleep disturbances.

Logistic regression analysis to explore the effect size of different examined characteristics on cognitive function of older adults revealed that age (adjusted odds ratio = 1.06; 95% CI: 1.03-1.08; p < 0.001) and level of education (adjusted OR = 0.14; 95% CI: 0.09-0.20; p < 0.001) had a significant impact on cognitive function; however, PSQI score (p = 0.254), gender (p = 0.661), and administration of sleeping drugs (p =0.081) showed no significant effect. (Table 3)

Table 1. Baseline characteristics of the elderly with and without cognitive impairment

Characteristics	With cognitive dysfunction N = 400 number (percent)	With normal cognitive function N = 400 number (percent)	p
Gender			
Male	200 (50)	200 (50)	1.000
Female	200 (50)	200 (50)	
Mean age	72.53 ± 8.01	67.98 ± 6.49	< 0.001
Level of education			
Illiterate	349 (66.6)	175 (33.4)	< 0.001
Up to diploma	47 (19.6)	193 (80.4)	
Higher than diploma	4 (11.1)	32 (88.9)	
Mean PSQI score	5.75 ± 3.34	5.46 ± 3.23	0.507
PSQI score			
≤ 5	227 (49.6)	231 (50.4)	0.775
> 5	173 (50.6)	169 (49.4)	

Table 2. Distribution of older adults with and without cognitive impairment based on the seven components of sleep quality

Components of sleep quality	Rating of each component	With cognitive dysfunction N = 400 number (percent)	With normal cognitive function N = 400 number (percent)	p
Subjective sleep quality	Very good condition	166 (53.2)	146 (46.8)	0.422
	Relatively good condition	195 (47.4)	216 (52.6)	
	Relatively poor condition	26 (48.1)	28 (51.9)	
	Very poor condition	13 (56.5)	10 (43.5)	
Sleep duration	Very good condition	302 (51.4)	285 (48.6)	0.242
	Relatively good condition	37 (40.7)	54 (59.3)	
	Relatively poor condition	36 (52.9)	32 (47.1)	
	Very poor condition	25 (46.3)	29 (53.7)	
Sleep efficiency	Very good condition	306 (48.5)	325 (51.5)	0.204
	Relatively good condition	39 (60.9)	25 (39.1)	
	Relatively poor condition	22 (57.9)	16 (42.1)	
	Very poor condition	33 (49.3)	34 (50.7)	
Sleep latency	Very good condition	93 (52.8)	83 (47.2)	0.609
	Relatively good condition	135 (47.2)	151 (52.8)	
	Relatively poor condition	102 (49.8)	103 (50.2)	
	Very poor condition	70 (52.6)	63 (47.4)	
Frequency of sleep disturbances	Very good condition	2 (100)	0	< 0.001
	Relatively good condition	209 (44.2)	264 (55.8)	
	Relatively poor condition	184 (57.9)	134 (42.1)	
	Very poor condition	5 (71.4)	2 (28.6)	
Daytime consequences of poor sleep	Very good condition	257 (50.6)	251 (49.4)	0.189
	Relatively good condition	63 (42.9)	84 (57.1)	
	Relatively poor condition	27 (52.9)	24 (47.1)	
	Very poor condition	53 (56.4)	41 (43.6)	
Use of sleeping drugs	Very good condition	318 (48.5)	337 (51.5)	0.193
	Relatively good condition	7 (63.6)	4 (36.4)	
	Relatively poor condition	1 (25.0)	3 (75.0)	
	Very poor condition	74 (56.9)	56 (43.1)	

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Table 3. The effect size of different examined characteristics on cognitive function of older adults

Characteristics	Adjusted odds ratio	95% CI	p (Logistic regression analysis)
PSQI* score	0.82	0.58 - 1.16	0.254
Age	1.06	1.03 - 1.08	< 0.001
Gender	0.93	0.66 - 1.30	0.661
Level of education	0.14	0.09 - 0.20	< 0.001
Consumption of sleeping drugs	1.41	0.96 - 2.09	0.081

*PSQI: Pittsburgh Sleep Quality Index

Discussion

Sleep has a key role in cognitive functioning. Poor sleep quality is a common problem in ageing and can result from different factors; furthermore, this disorder can trigger other physical, mental and social-related health problems. This research was performed to explore the impact of sleep quality on cognitive function of community-dwelling older adults.

In our study, 50.6% of the elderly with cognitive dysfunction had impaired sleep quality, although, the difference was not statistically significant. Consistent with our findings, a research on male adults (aged 48–60 years) with chronic work-related sleep disturbances showed no significant effect of sleep disorders on cognitive function (25). A review article represented that 70% of patients in early-stage dementia might have sleep disturbances (15). A case-control study at Italy reported 21.7% poor sleep among patients ≥ 52 years with mild cognitive impairment compared to 15.3% of cognitively healthy controls (26). A cohort study represented that patients with mild cognitive impairment had a frequency of sleep disturbances of any type equal to that of patients with AD (27). A recent meta-analysis revealed that insomnia was associated with 27% higher risk of cognitive disorders; in addition to, four components of sleep quality including daytime dysfunction, inefficient sleep, fragmentation and latency were reported to be associated with 7–16% increased risk of cognitive impairments (6). Sleep problems was reported to be associated with an increased relative risk for the outcome of cognitive impairment (10). However, multiple challenges have been notified regarding the association of cognitive impairment and sleep problems in various studies. The methodological differences, how to define the sleep disorders and assessment tools used to identify sleep problems, and various components used to define cognitive function has been listed as some of these challenges which can make the differences in results (10, 28).

Older age and lower level of education showed a significant effect on cognitive function of the participants. This result is consistent with another research on more than 1000 older individuals whose cognitive function were examined for up to 24 years, and concluded that age is associated with neuropathologic changes in brain and late life cognition. Younger age and higher level of education were associated with better cognitive function in older adults (29). Another research at Italy reported that patients with cognitive dysfunction had lower years of education (9.6 years) compared to the healthy controls (12.5 years of education) (26). There are different prepositions about the association between the level of education and cognitive function. Some evidence emphasizes that the number of years of education is positively correlated with the cognitive function and can cause lower risk of dementia in old age. Higher level of education might affect the person's cognitive ability, and attenuate aging-associated declines in cognition. Educational attainment might exert its influence on old-age cognitive function by contributing to individual differences in cognitive skills throughout the adulthood (30, 31). Some other support that education does not alter the rate of cognitive decline for formal knowledge, however, education is a relevant characteristic for understanding cognitive performance in late adulthood (32).

In our study mean PSQI score had no significant difference among the older adults with normal or abnormal cognitive function. A research in Eastern China reported mean PSQI score as 6.60 in patients with AD compared with the score of 2.25 in healthy individuals as controls (33). Another research revealed that individuals with sleep disorders might have a 1.55 and 1.65 times higher risk of AD, and cognitive impairment than persons without sleep problems, respectively; and it is expected that people with sleep problems might have a 1.68 times higher risk for the combined outcome of cognitive impairment and/or AD (10). Different results might be due to differences in the study population, mean age of participants, comorbid physical and mental disorders, the scales used for assessment of sleep disturbances, taking into account the confounding factors such as drinking alcohol, tea or caffeine, and sleep hygiene principles. Previous studies suggested sleep disorders could influence neuronal injury biomarkers that are related to cognitive impairment; furthermore, better sleep quality could modulate the preventive effects of other biological and environmental factors on brain (6). Abnormal sleep duration has been represented as a risk factor for incident dementia, and also an early indicator of brain neurodegeneration (34). Sleep has a key role in cognitive functioning. To have enough high-quality sleep can support numerous aspects of physical and mental health in older adults (35); and for people with poor sleep, cognitive impairment is a common outcome.

This research showed a significant association between frequency of sleep disturbances with

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cognitive function in older adults. Sleep can promote restorative neuropsychological functions for older adults, to remove metabolic waste and to prevent the accumulation of harmful mediators in the brain. In addition to, sleep disturbances may emerge as a result of brain atrophy or as a consequence of mood disorders which are common in cognitive impairments (10, 34). A bi-directional relationship has been demonstrated between sleep and cognitive impairments. Sleep disturbances can be considered as either indicators for Alzheimer's pathology or as a mechanism mediating increased risk of this disorder (36).

Conclusion

Among different components of sleep quality, a significant positive association was observed between the frequency of sleep disturbances with cognitive function in older adults; furthermore, older age and lower level of education showed a significant negative effect on cognitive function.

Study limitation

We used MMSE questionnaire to evaluate cognitive functioning of older adults. This measure has less diagnostic accuracy than structured interviews or brain imaging approaches. Also, we did not examine some behavioral factors affecting on sleep quality such as dietary habits, exercise, smoking, alcohol and caffeine consumption. These points can be represented as the limitations of this study.

It is suggested for future studies to consider comorbid disorders, and behavioral factors that might have influences on sleep quality.

Conflict of interests

The authors declare that there is no conflict of interests.

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Authors´ contribution

MB, FK, SRH, AB and SM contributed to research design and data collection.

AB performed data analysis.

All authors reviewed and approved the final version of the manuscript to be published.

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