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Original Article

Physical Activity Level and Sleep Quality in Community-Dwelling Older Adults. A Cross-Sectional Study

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Sleep Sci

Abstract

The worldwide increase in life expectancy has resulted in a significant aging of the population. The physiological and functional changes that result from the aging process, changes in sleep patterns, and the prevalence of chronic diseases affect the health and well-being of individuals aged over 60.

Objective The aim of this study was to investigate the relationship between levels of physical activity (PA) and sleep quality in community-dwelling older adults.

Methods This is a cross-sectional study, with the participants randomly recruited according to the region and street in which they live. The Pittsburgh Sleep Quality Index (PSQI) was applied to assess sleep quality, the Modified Baecke Questionnaire for the Elderly (MBQ-E) to assess PA levels, as well as questionnaires to obtain social, demographic and anthropometric data. Multivariable regression analyses were conducted with PA activity as the independent variable and sleep quality as the dependent variable of interest, while also considering all potential covariates.

Results A total of 503 older adults were analyzed, of whom 377 (75%) were classified as inactive and only 126 (25%) as active. Among the participants, 344 (68.4%) had poor sleep quality, 86 (17.1%) had symptoms of insomnia, and 57 (11.5%) reported complaints of excessive daytime sleepiness. We found that 128 participants (25.4%) consumed alcohol and 41 (8.2%) were current smokers. Multivariate regression results showed an inverse association between PA levels and sleep (Beta coefficient = −0.67 ([95% confidence interval = −1.29 to −0.04]).

Conclusions The results of the study indicate that being physically inactive is associated with poor sleep quality.

Keywords
- sleep
- physical activity
- older adults

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Introduction

Population aging worldwide and the increase in life expectancy are topics of scientific, public, private and social interest.[1] It is important to prevent and recognize the risk factors associated with the decline in physical, physiological and mental functions that can accompany aging,[2] so that older adults do not have to live in a state of greater dependence, and be subject to limitations and insecurity.

In addition to the physical, mental and cognitive problems that accompany aging, sleep complaints are also very common in this population. A highly common sleep complaint in older adults is insomnia. This sleep disorder is often understood as a consequence of aging and is not diagnosed by healthcare professionals.[3,4] There are some age-related physiological changes that can affect sleep without directly compromising physical, cognitive, and functional abilities[5]. However, sleep complaints are commonly accompanied by impairments in the performance of daytime activities[6] promoting, for example, fatigue,[7] daytime sleepiness,[8] musculoskeletal pain[9,10] and even a decrease in physical activity (PA).[8] There are several age-related factors that can affect sleep,[11] but there are also a range of factors not related to age that can influence sleep quality, such as alcohol[12,13] and tobacco consumption[14,15].

In general, aging is associated with a reduction in levels of physical activity (PA)[16]; however, this is a modifiable lifestyle factor, and can, therefore, be a focus of health promotion strategies. The World Health Organization (WHO) has important recommendations on the practice of physical activity for older adults (over 65), the main one being " should do at least 150–300 minutes of moderate-intensity aerobic physical activity; or at least 75–150 minutes of vigorous-intensity aerobic physical activity; or an equivalent combination of moderate- and vigorous-intensity activity throughout the week." As part of their weekly physical activity, older adults should do varied multicomponent physical activity that emphasizes functional balance and strength training at moderate or greater intensity, on 3 or more days a week, to enhance functional capacity and to prevent falls. Older people who are physically active have better functional capabilities and PA also helps to prevent falls, something which is very important in respect of older adults' health.[17–19] Therefore, it is important that health professionals encourage older adults to follow the WHO recommendations for physical activity.

Although the benefits of physical activity in this population are well known, the chance of older adults reaching the levels of physical activity recommended by the WHO are very low.[19] However, the evidence suggests that individuals with good sleep quality of adequate duration are more likely to comply with these recommendations.[20] Thus, it is important to understand this association between sleep and physical activity in older adults when developing health promotion strategies aimed at this population. Therefore, cross-sectional studies of community-dwelling adults, as a first step, and cohort studies, to properly understand this association over time, are needed to provide more robust evidence and better understand this relationship.

Previous studies investigating the relationship between physical activity levels and sleep quality have often relied on convenience sampling or small sample sizes. A study by Araraki et al., based on a secondary analysis of a large dataset, represented a significant contribution to this field, as it aimed to determine whether older adult males who met the WHO's recommended activity levels exhibited improved sleep quality.[21] However, the findings of this study cannot be extrapolated to the general population as its focus was only on older men.

Other studies, despite using larger samples, have not specifically focused on community-dwelling older adults that were randomly selected, but rather relied on volunteers aged 50 or older, which limits the generalizability of the results to the older population and compromises external validity.[22] In contrast, the present study implemented robust randomization techniques to recruit older adults from diverse socioeconomic backgrounds, ethnicities, and educational levels, thus enhancing its representativeness and generalizability. By recruiting participants in a randomized manner, this study aimed to enhance the reliability of the data obtained. This approach ensures that potential confounding variables are minimized, allowing for a more accurate assessment of the association between physical activity levels and sleep quality in this demographic. The sample for this study comprised older adults from various socioeconomic strata, which is pertinent as socioeconomic status influences population health behaviors, beliefs, educational attainment, and levels of physical activity. Additionally, employing a cross-sectional design enabled the investigation of this relationship at a single point in time, providing valuable insights into the concurrent status of physical activity and sleep quality among older adults in the community. This study, and future methodologically robust studies, can provide reliable data to help to better understand the interplay between physical activity and sleep quality, ultimately informing interventions aimed at improving the health and well-being of older adults. Knowledge about the sleep and physical activity of older adults can be useful for the implementation of measures that promote healthier aging.

Therefore, the objective of this cross-sectional study was to investigate the relationship between physical activity levels and sleep quality in community-dwelling older adults. The hypothesis of this study is that physically inactive older adults will have a worse quality of sleep than those who are active.

Materials and Methods

Study design

This is a cross-sectional study, and was approved by the Research Ethics Committee of the Universidade Estadual Paulista (CAAE:63835617.0.0000.5402). The sample was recruited in the city of Presidente Prudente-SP, and was randomized by zip code, with the city being divided into five regions (east, west, north, south and center). Approximately 100 older adults from each region were recruited.

Participants

To be eligible for this study, the volunteers had to be 60 years old or over and be able to understand the questions contained in the questionnaires administered. To determine this, the Mini Mental State Examination (MMSE),[23] adapted for the Brazilian population was used. Participants who reached the cutoff point scores were considered to have preserved cognitive abilities, and were therefore included in the study. The cutoff point MMSE scores were as follows: 13 for people who were illiterate, 18 for those with low and medium schooling, and 26 for those with high schooling. All data were entered into the online Research Electronic Data Capture (REDCap) platform and exported to an Excel spreadsheet.

Sample size

The sample size calculation for this study was based on previous research by Austin et al. (2015) and Bujang et al. (2017) for multivariate regression analysis. According to these studies, 10 to 15 participants are required per independent variable. As five predictors were utilized in this study, a total of 90 participants were required (including an additional 20% to account for potential losses), to achieve a statistical power of at least 80%. However, this study is a secondary analysis using data from a large epidemiological, multicenter study on the prevalence of low back pain (not yet published). Thus, the sample size exceeded the calculated sample size, including data from 503 older adults.[24,25]

Data Collection

At baseline, all volunteers were interviewed in their homes. First, the research was explained to the older adults, and if he/she agreed to participate in the study, a series of questionnaires was administered. All volunteers who agreed to participate in the study signed an informed consent form. The duration of the interview was on average 45 minutes. Demographic and anthropometric variables were collected, including age, sex, body mass index, alcohol and tobacco consumption, and the following questionnaires were applied in the study:

The Pittsburgh Sleep Quality Index (PSQI): This questionnaire contains 21 questions that assess subjective sleep quality, with a score that varies between 0 and 21, higher values indicating worse sleep quality. This results of the questionnaire were characterized as follows – participants with scores equal to or less than 6 were classified as having good sleep, those with scores between 7 and 12 were classified as having poor sleep, and those with scores above 12 were classified as having symptoms of insomnia. This classification was used for descriptive analysis.[26] The PSQI has shown good internal consistency and test – retest reliability.[27,28]

The Epworth Sleepiness Scale (ESS): This consists of eight everyday scenarios, with the participants asked to rate their likelihood of falling asleep in each one using scores between 0 and 3, as follows: 0) none; 1) small; 2) moderate and 3) high. The maximum possible score is 24 points, and scores above 10 were considered to be indicative of excessive daytime sleepiness.[29]

The Modified Baecke Questionnaire for the Elderly (M-BPAQ): This consists of a series of questions on three domains related to physical activity: work, sports, and leisure performed in the last 12 months.[29,30] Volunteers were classified according to their level of physical activity.[31] First, the 75th quartile was identified, and those who had a score equal to or greater than 75th were characterized as "physically active" and the remaining volunteers were classified as "insufficiently active"[32]. This questionnaire has been validated for use with older adults in Brazil.[33]

Comorbidities were assessed using a self-administered questionnaire.[34] This questionnaire includes a list of 12 predefined medical issues or comorbidities frequently observed in older individuals. Additionally, participants had the option to add up to three other comorbidities if they were not included in the provided list. For this study, participants were asked to rate a maximum of 15 comorbidities. The responses were categorized into 0 comorbidities, 1–3 comorbidities, and 4 or more comorbidities for descriptive analysis purpose.

Statistical Analysis

For the descriptive analysis of the data, the mean and standard deviation values were used for the continuous variables. For categorical variables, frequencies and percentages were used.

To assess whether physical activity was associated with sleep quality, multivariable linear regression was used. The multivariable linear regression analyses were performed with the bootstrapping technique (1000 samples) to deal with the problem of over-fitting[35]. For the multivariable regression models, the potential covariates were included. Hence, the multivariable model for each outcome measure had the same five variables, namely: age[36,37], gender,[38] alcohol consumption,[39] smoking habits[40] and daytime sleepiness.[41] The choice of a priori covariates was based on scientific evidence related to both physical activity (independent variable) and sleep quality (dependent variable). Therefore, the statistical models met the necessary prerequisites for using the test. Multicollinearity ($r < 0.6$) was not found among the continuous independent variables, and the values of the variance inflation factor for each variable were not greater than 2.5 in all stages.

Results

Data from 503 older adults were collected between March and December 2017. As described in ►**Table 1**, 346 (68.8%) of the older adults included in the study were women. Of the volunteers in this study, 377 (75%) were classified as inactive and 126 (25%) as active. In respect of the sleep quality of the volunteers, 344 (68.4%) reported having poor sleep quality and 86 (17.1%) had symptoms of insomnia. Only 58 (11.5%) reported having complaints of excessive daytime sleepiness. We found that 128 (25.4%) of the participants drank alcohol, and 322 (64%) of the participants were never smokers, and 41 (8.2%) were ex-smokers. The results presented in ►**Table 1** show that 41.6% of women and 60.5% of men reported having

Table 1 Sample characterization

Variables	All ($n = 503$)	Women	Men
		($n = 346$)	($n = 157$)
Age (years), mean SD	71.82 (± 7.96)	71.55 (7.66)	72.42 (8.58)
BMI (Kg/m^2), mean SD	27.11 (± 4.78)	27.49 (4.92)	26.28 (4.36)
Alcohol consumption, n (%)			
Yes	128 (25.4%)	66 (19.1%)	62 (39.5%)
No	375 (74.6%)	280 (80.9%)	95 (60.5%)
Smoking habits, n (%)			
Never smoked	322 (64%)	255 (73.7%)	67 (42.7%)
Ex-smoker	140 (27.8%)	69 (19.9%)	71 (45.2%)
Current smoker	41 (8.2%)	22 (6.4%)	19 (12.1%)
Socioeconomic states, n (%)			
Class. A (>R$15,760,01)	3 (0.6)	2 (0.6%)	1 (0.6%)
Class. B (R$ 7,880.01 to R$ 15,760)	11. 9 (2.2%)	7 (2%)	4 (2.5%)
Class. C (R$ 3,152,01 to R$ 7,880)	50 (9.9%)	29 (8.4%)	21 (13.4%)
Class. D (R$ 1,576,01 to R$ 3,152)	105 (20.9%)	63 (18.2%)	42 (26.8%)
Class. E (until R$1,576)	292 (58,1%)	204 (59%)	88 (56.1%)
No income	42 (8.3%)	41 (11.8%)	1 (0.6%)
Comorbidities, n (%)			
Without Comorbidities	42 (8.3%)	23 (6.6%)	19 (12.1%)
1 to 3 comorbidities	239 (47.5%)	144 (41.6%)	95 (60.5%)
4 or more comorbidities	222 (44.1%)	179 (51.7%)	43 (27.4%)
Physical activity (M-BPAQ)			
Active, n (%)	126 (25%)	86 (24.9%)	40 (25.5%)
Inactive, n (%)	377 (75%)	260 (75.1%)	117 (74.5%)
Sleep quality (PSQI 0–21)	9.50 (± 3.10)	9.84 (3.21)	8.77 (2.71)
Sleep quality categories, n (%)			
Good sleepers (≤6 points)	73 (14.5%)	22 (6.4%)	12 9 (7.6%)
Poor sleepers (7–12 points)	344 (68.4%)	185 (53.5%)	110 (70.1%)
Insomnia symptoms (>12points)	86 (17.1%)	139 (40.2%)	35 (22.5%)
Daytime Sleepiness (ESS 0–24)	4.67 (±3.77)	4.52 (3.88)	5.01 (3.50)
Daytime Sleepiness, n (%)			
Without sleepiness (≤10 points)	445 (88.5%)	252 (72.8)	126 (80.3%)
With sleepiness (>10 points)	58 (11.5%)	32 (9.2%)	12 (7.6%)

Abbreviations: BMI, Body Mass Index; ESS, Epworth Sleepiness Scale; M-BPAQ, Modified Baecke Questionnaire for the Elderly; PSQI, Pittsburgh Quality of Sleep Index.

1 to 3 comorbidities, while 51.7% of women and 27.4% of men had 4 or more comorbidities.

The multivariable regression model is presented in ►**Table 2**. The results showed that being inactive was associated with worse sleep quality after controlling for the covariates, age, gender, alcohol use and smoking, and sleepiness (b coefficient, −0.67; 95% confidence interval [CI], −1.29 to −0.04). This means that for every 1-point reduction in the score of the Modified Baecke Questionnaire for the older adults, there was an average increase of 0.67 points in the sleep quality questionnaire score. The multivariable regression model explained 4% of the total variance.

Discussion

Our study aimed to investigate the relationship between physical activity and sleep quality among community-dwelling older adults. Our findings revealed that those who were active reported better sleep quality compared with those who were inactive, after controlling for the covariates age,

Table 2 Multivariable regression analyses with physical activity as independent variable and sleep quality as the dependent variable of interest and all potential covariates

Model	*Covariables*	*F R^2 (R^2Adjust)*	*Beta (95% CI)*	*p-value*
	Independent Variable: Physical Activity Dependent Variable: Sleep Quality		*Bootstrap for Coefficients*	
	(Constant)	3.71 4% (3%)	11.74 (9.10 to 14.38)	0.000
	Age		−0.01 (−0.04 to 0.02)	0.502
($n = 503$)	Gender		−1.01 (−1.62 to −0.39)	0.001
	Physical Activity		**−0.67 (−1.29 to −0.04)**	**0.035**
	Smoking habits		0.12 (−0.32 to 0.57)	0.582
	Alcohol use		−0.54 (−1.19 to 0.10)	0.097
	Daytime sleepiness		0.04 (−0.03 to 0.11)	0.251

Physical Activity: Modified Baecke Questionnaire for the Elderly (M-BPAQ) [participants with a score equal to or greater than the 75th percentile were classified as "physically active" and the other participants classified as "insufficiently active]; Daytime sleepiness: Epworth Sleepiness Scale; Sleep quality: Pittsburgh Quality of Sleep Index [PSQI].

gender, smoking habits, alcohol use, and daytime sleepiness symptoms. In addition, women reported more complaints of insomnia compared with men. Previous epidemiological studies have shown that being female is an independent risk factor for sleep disorders.[42,43] One of the reasons that may affect sleep quality in women is hormonal changes occurring during menopause.[44] Estradiol levels decrease during and after menopause, while follicle-stimulating hormone levels increase. These hormonal changes can cause sleep problems; as a result, sleep quality may decrease.[45] Additionally, there are differences in comorbidities between men and women.[46] Our study showed that 51.7% of women but only 27.4% of men reported having four or more comorbidities.

Evidence from cross-sectional studies has demonstrated that people who engage in physical activity have better sleep quality than those who are sedentary.[47,48] Total sleep duration, sleep onset latency and sleep quality have been shown to have significant improvement.[49] Moreover, sleep quality has been shown to predict subsequent exercise behavior,[47] and sleep deprivation has negative effects on physical performance. Our findings are consistent with previous studies, demonstrating that physically active older individuals reported a better perception of their sleep compared with those who were inactive. According to a review study, the physiopathology of poor sleep is associated with increased levels of cortisol and inflammation, which can cause joint and muscle damage, resulting in higher pain levels and a decrease in the speed of recovery.[20]

Knowledge about the effects of physical activity on sleep focuses mainly on the direct and indirect mechanisms associated with well-being and metabolic changes.[50] Among the best known of these are the changes that physical activity exerts on the regulation of body temperature,[51] the central nervous system, the control of energy consumption and conservation,[52] and anxiety levels,[53] which have all been shown to be capable of improving objective and subjective sleep parameters.[50]

Arakaki et al. (2022) demonstrated that male older adults who were classified as inactive using the International Physical Activity Questionnaire (IPAQ), based on the cut-off point established by the World Health Organization (WHO), had worse sleep quality ($\beta = -2.15$ (95%CI: −3.91 to −0.39)) than those who were active.[21] This previous study supports the findings of this study that low levels of physical activity are associated with sleep complaints. However, the study only included male older adults, and had a limited sample size ($n = 63$), while our study included both community-dwelling men and women who were selected randomly from the older adult population of the city of Presidente Prudente. Moreover, our sample was much larger, comprising 503 individuals, providing greater weight and reducing the effect of bias associated with small sample sizes.

Compared with younger people, older adults are more susceptible to decreased total sleep time, morning awakenings, sleep fragmentation and a lower proportion of slow-wave sleep.[11] In our study, descriptive analysis revealed that 68.4% of participants reported poor sleep quality, while 17.1% exhibited symptoms of insomnia, thus corroborating the sleep profile reported in other studies of older adults. According to the study by Delbari et al. (2023), women had a 45% higher likelihood of reporting poor sleep quality than men, even after adjusting for potential covariates (OR = 0.55, 95% CI: 0.46 to 0.66).[22] Although the statistical approach used in our study differed from that used in the study, the results are similar. In our study, 40.2% of women but only 22.5% of men reported insomnia [Beta coefficient= −1.01 (95% CI −1.62 to −0.39), $p = 0.001$].

Delbari et al. authors assessed the activity level of the older adults using the Physical Activity Scale for the Elderly (PASE) questionnaire. The results showed a significant relationship between physical activity and sleep quality, with an increase of one unit in the PASE score reducing the odds of poor sleep quality by one percent (OR = 0.99, 95% CI: 0.998 to 0.999).[22] However, this study should be interpreted with caution in relation to the older adults, as it used a sample aged 55 or over. We used a different questionnaire, the Modified Baecke Questionnaire for the Elderly, which is a

validated tool for use with older adults. Because this questionnaire provides a dimensionless score, we opted to categorize individuals based on the 75th percentile, with those classified above it considered as active and those below as inactive. Our results showed that active elderly individuals reported better sleep quality than inactive ones, corroborating with the study.

A study undertaken in Portugal by Ramos et al. (2019) reported that both older adults with good sleep quality and poor sleep quality undertook at least 20 minutes of moderate to vigorous physical activity per day.[54] However, only 41.6% of the participants were classified as active according to the WHO recommendations. Although this study utilized objective measures (accelerometer) to assess physical activity levels, a validated questionnaire for evaluating sleep quality was not employed, necessitating careful interpretation of the results. In our study, only 25% of the sample was classified as active, even less than the previous study. Perhaps in Brazil, the participants were of low income with fewer opportunities to engage in physical activities compared with Portugal.

Physical exercise affects sleep through body temperature, which can contribute positively to improving sleep in the older adults. For example, it is thought that thermoregulation plays a role in the relationship between exercise and sleep; It is postulated that increases in body temperature resulting from exercise promote sleep mechanisms associated with heat loss and changes in blood flow that can facilitate the onset of sleep due to the activation of mechanisms associated with the hypothalamus.[55]

On a motivational and psychological level, the practice of physical activity requires a motivational component to ensure the continuity of physical activity.[56] Older adults may not feel competent or skilled enough to exercise and be deterred by psychological and functional limitations, which represent a barrier to activity and may help to explain the low adherence to physical activity in this group of people.

This study shows that staying physically active promotes better sleep, and that inactive older adults are more likely to have worse sleep. However, some important limitations should be noted. First, only self-reported measures for the assessment of both sleep quality and levels of physical activity were used. Second, older adults often use of a range of medications (including sleep inducing drugs), but the possible effect of this on sleep and physical activity was not investigated in this study. Third, it was not possible to follow the participants temporally, and thus obtain a measure of the effect of the interaction of time on the outcomes presented. Fourth, we did not have access to the employment status of the participants. This is particularly important as shift work could have been a variable affecting sleep quality. A final limitation is that we did not evaluate in detail the type of exercise. Future studies should identify the type, duration and intensity of exercise that produces the best outcomes in terms of improved sleep and healthy aging in older adults.

Conclusions

The results of this study revealed an association between inactivity and poor sleep quality. Staying physically active can promote better sleep and quality of life in older adults. Physical activity can be applied at different levels and is a modifiable risk factor with a strong impact on the promotion of healthy aging in older adults.

Data Availability Statement

The raw data was stored at REDCap. Derived data supporting the findings of this study are available from the corresponding author PKM upon request.

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Conflict of Interest

The authors report there are no competing interests to declare.

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