

Article

# Sleep Duration and Sleep Quality as Predictors of Health in Elderly Individuals

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**Abstract:** The main purpose of the present study was to explore the associations of sleep duration and sleep quality with self-rated health. In this cross-sectional study, participants were 894 elderly individuals. Self-rated health, sleep duration, and sleep quality were self-reported. The associations were examined using multiple logistic regression analyses. After adjusting for sex, physical activity, smoking consumption, alcohol consumption, psychological distress, socioeconomic status, and chronic disease/s, sleeping <6 h (OR (Odds ratio) = 3.21; 95% CI (95 percent confident interval) 1.61 to 6.39), 6–7 h (OR = 2.47; 95% CI 1.40 to 4.36), 8–9 h (OR = 3.26; 95% CI 1.82 to 5.83), and >9 h (OR = 3.62; 95% CI 1.57 to 8.34) and having 'poor' sleep quality ( $\geq 5$  points; OR = 2.33; 95% CI 1.46 to 3.73) were associated with 'poor' self-rated health. When sleep duration and sleep quality were entered simultaneously into the model, the same associations remained. Our findings provide evidence that both 'short' and 'long' sleep and 'poor' sleep quality are associated with 'poor' self-rated health. Thus, interventions that promote healthy sleep hygiene in the elderly are warranted.

**Keywords:** sleep hygiene; health; old people; association; logistic regression

## 1. Introduction

Sleep duration is an important factor that contributes to overall health status [1]. It has been reported that extreme values of sleep duration (both short and long sleep) are associated with higher levels of mortality rates [2,3] and increased incidence of cardiovascular [4] and metabolic [5] diseases. Along with sleep duration, sleep quality is also a part of sleep hygiene that is remotely associated with health [6]. Specifically, a study by Hulvej Rod et al. [7] showed that men and women with sleep disturbances were more likely to develop cardiovascular and metabolic diseases, yet men with  $\geq 3$  types of sleep disturbances had a higher risk of committing suicide.

Self-rated health has become an increasingly common tool for measuring a subjective perception of health [1]. Previous studies have shown that self-rated health serves as a good predictor of objective health status [8] and is associated with health outcomes [9].

Associations between sleep duration and self-rated health have been well-documented in young [10,11] and general populations [12,13]. In both groups, studies have shown a U-shaped association between sleep duration and self-rated health, that is, both short and long sleep are associated with 'poor' self-rated health. Only a handful of studies examined the same associations in the elderly [6,14] and showed similar results, where both 'short' and 'long' sleep duration were associated with reporting 'poor' self-rated health. However, studies examining the associations between sleep quality and self-rated health are lacking, especially in the elderly population.

In general, the elderly experience many physical and psychological changes, of which sleep duration and sleep quality play an important role [15]. Studies have also shown that sleep

disturbances increase with age [16] and the prevalence of such disturbances is higher than 50% in community-dwelling elderly people [17]. On the other hand, self-rated health in the elderly is driven by numerous factors, of which sleep hygiene is an important determinant of such perception. That being said, it is necessary to explore the associations of both sleep duration and sleep quality with self-rated health in the elderly in order to create effective strategies and policies that would leverage good sleep hygiene and lead to higher levels of health.

Therefore, the main purpose of the present study was to explore the associations of sleep duration and sleep quality with self-rated health. We hypothesized that both 'short' and 'long' sleep duration and 'poor' sleep quality, entered separately and simultaneously into the models, would be associated with 'poor' self-rated health in elderly individuals.

## 2. Materials and Methods

### 2.1. Study Participants

In this cross-sectional study, participants were elderly individuals (mean age  $80 \pm 3$  years; 56.0% of women) from the city of Zagreb. In the city of Zagreb, there are in total of 10 nursing homes with approximately 4000 users. At the first stage, we randomly selected five out of ten nursing homes, with 2000 users. At the second stage, we contacted principles, head nurses, and social workers of each home to help us organize the protocol. At the time this study was conducted, each nursing home had 250–300 users and the univariate analysis revealed no statistical differences in the size of the nursing homes ( $p = 0.897$ ). Data collection in each home was done in groups of 15–20 people. The criteria for selecting participants were: Age  $\geq 65$ , free of cognitive disabilities, and physically independent. First, we explained the main purpose of the study and possible reasons for conducting a study. Second, we briefly explained the risks of the study. Out of 2000 users, we collected the data from 1187 users. However, by checking the data, we extracted those with missing data ( $N = 153$ ) and those who did not want to participate in the study ( $N = 140$ ). Our final sample was based on 894 (894/1187; 75% response rate) elderly individuals from all five nursing homes. All the procedures were anonymous and in accordance with the Declaration of Helsinki and approved by the Institutional Review Board of the Faculty of Kinesiology. Additionally, before the study began, each participant had given their written informed consent to participate in the study and the approval to use the obtained data for scientific contribution. All the data will be provided to others by reasonable request from the corresponding author.

### 2.2. Outcome Variable

We used oneitem question to assess self-rated health: 'How would you rate your health'? Answers were arranged along a Likert-type scale as follow: (1) Very poor, (2) poor, (3) fair, (4) good, and (5) excellent. We dichotomized the outcome variable into 'good' (fair, good, and excellent) vs. 'poor' (poor and very poor) self-rated health. Previous studies have shown that self-rated health is a reliable measure to assess overall health status and is associated with mortality [18].

### 2.3. Independent Variables

Sleep duration was assessed by asking participants the following question: 'On average, how many hours of sleep do you get in a 24-h period'? The response was a numerical variable. Finally, we categorized the response into 5 groups for the current analysis:  $\leq 6$  h, 6–7 h, 7–8 h, 8–9 h, and  $>9$  h.

To assess sleep quality, we used the Pittsburgh Sleep Quality Index (PSQI) [19]. It is composed of 19 questions, which create 7 major components [19]. All seven components are then summed up to create a scale from 0 to 21 points. Buysse et al. [19] proposed that the score of  $<5$  denoted 'good' sleep quality, while  $\geq 5$  denoted 'poor' sleep quality.

#### 2.4. Covariates

To assess PA (Physical activity) in the last 7 days, we used the adapted version of the International Physical Activity Questionnaire-short form, a reliable and valid instrument designed to measure physical activity in respondents aged  $\geq 65$  [20]. The questionnaire provides information about the time and number of days spent in light, moderate, and vigorous intensity physical activity. For each participant, we calculated the time spent in moderate and vigorous physical activity. According to the World Health Organization [21], elderly people aged  $\geq 65$  should participate in ‘at least 150 min of moderate-intensity aerobic PA throughout the week or do at least 75 min of vigorous-intensity aerobic PA throughout the week or an equivalent combination of both’. Thus, we categorized the participants who met the aforementioned recommendation as ‘sufficiently’ active compared with the participants who did not meet the recommended levels as ‘insufficiently’ active. Smoking status was categorized as: (1) Nonsmoker/former smoker vs. (2) present smoker. Alcohol consumption was used as a covariate and was assessed by one question: “In the past week, did you consume an alcoholic drink?” with ‘Yes’ and ‘No’ answers. Psychological distress was assessed using Kessler’s six-item questionnaire [22]. The questionnaire has been described elsewhere [22]. Each question is scored from 0 (none of the time) to 4 (all of the time). Scores of each question are summed up between 0 and 24, with a lower score indicating a lower level of psychological distress. Kessler et al. [22] showed that responses  $< 13$  points vs.  $\geq 13$  points discriminated participants without and with psychological distress. Internal consistency for the questionnaire in our study was satisfactory (Cronbach’s alpha = 0.76). Socioeconomic status was assessed by one item question: ‘How would you perceive your socioeconomic status?’ Responses were arranged along a three-item scale as follows: (1) Below average, (2) average, and (3) above average. The presence or absence of a chronic disease was asked by one item question: ‘Have you ever been told by a doctor, that you suffer from any kind of chronic disease?’ with ‘Yes’ and ‘No’ answers. Sex (men and women) was entered in as a covariate.

#### 2.5. Data Analysis

Basic descriptive statistics of the study participants are presented as frequencies (n) and percentages (%). Differences between categorical variables were analyzed using the Chi-square test. To examine the associations of sleep duration and sleep quality with self-rated health, we used multiple logistic regression analysis by using subcommand contrast. Additionally, we tested the variables for multicollinearity using variance inflation factors (VIF), normality of residuals using the normal probability plot, and histogram of residuals and heteroscedasticity using the standardized residuals versus predicted plot. The VIF ranged between 1.10 and 1.63, showing no multicollinearity, and other assumptions were also met. In model 1, we examined the association between sleep duration (7–8 h as referent value) and ‘poor’ self-rated health. In model 2, we examined the association between sleep quality (‘good’ as referent value) and ‘poor’ self-rated health. Finally, we entered sleep duration and sleep quality simultaneously into model 3, to examine the associations with ‘poor’ self-rated health. All three models were adjusted for sex, physical activity, smoking consumption, alcohol consumption, psychological distress, socioeconomic status, and chronic disease/s. Significance was set at  $\alpha = 0.05$  and it was two-sided (2-sided). All the analyses were performed in the Statistical Package for Social Sciences Software, V.22 (IBM Corp, Armonk, New York, NY, USA).

### 3. Results

Basic descriptive statistics of the study participants are presented in Table 1. In general, a higher percentage of individuals sleeping 6 h, 6–7 h, 8–9 h, and  $> 9$  h reported having ‘poor’ self-rated health ( $p < 0.001$ ). Also, a higher percentage of individuals who reported ‘poor’ sleep quality had ‘poor’ self-rated health ( $p < 0.001$ ). Among the covariates, ‘insufficiently’ active participants who did smoke or consume alcohol and who had ‘high’ psychological distress reported ‘poor’ self-rated health. Finally,

those individuals with the presence of chronic disease/s more frequently reported having 'poor' self-rated health, compared to those with no chronic disease/s ( $p < 0.001$ ).

**Table 1.** Basic descriptive statistics of the study participants ( $N = 894$ ).

Study Variables	Total ( $N = 894$ )	'Poor' Self-Rated Health ( $N = 132$ )	'Good' Self-Rated Health ( $N = 762$ )	$p$ -Value *
	$N$ (%)	$N$ (%)	$N$ (%)	
<b>Sleep duration</b>				
<6 h	76 (8.5)	23 (17.4)	53 (7.0)	
6–7 h	150 (16.8)	29 (22.0)	121 (15.9)	
7–8 h	486 (54.4)	38 (28.8)	448 (58.8)	
8–9 h	132 (14.8)	31 (23.5)	101 (13.3)	
>9 h	50 (5.6)	11 (8.3)	39 (5.1)	<0.001
<b>Sleep quality</b>				
Poor	483 (54.0)	102 (77.3)	381 (50.0)	
Good	411 (46.0)	30 (22.7)	381 (50.0)	0.001
<b>Sex</b>				
Men	393 (44.0)	50 (37.9)	343 (45.0)	
Women	501 (56.0)	82 (62.1)	419 (55.0)	0.130
<b>Physical activity</b>				
Insufficiently	505 (56.5)	97 (73.5)	408 (53.5)	
Sufficiently	389 (43.5)	35 (26.5)	354 (46.5)	<0.001
<b>Smoking consumption</b>				
Yes	281 (31.4)	60 (45.5)	221 (29.0)	
No	613 (68.6)	72 (54.5)	541 (71.0)	<0.001
<b>Alcohol consumption</b>				
Yes	227 (25.4)	44 (33.3)	183 (24.0)	
No	667 (74.6)	88 (66.7)	576 (76.0)	0.030
<b>Psychological distress</b>				
High	124 (13.9)	56 (42.4)	68 (8.9)	
Low	770 (86.1)	76 (57.6)	694 (91.1)	<0.001
<b>Socioeconomic status</b>				
Low	33 (3.7)	7 (5.3)	26 (3.4)	
Middle/high	861 (96.3)	125 (94.7)	736 (96.6)	0.313
<b>Chronic Disease/s</b>				
Yes	115 (12.9)	44 (33.3)	71 (9.3)	
No	779 (87.1)	88 (66.7)	691 (90.7)	<0.001

\* Chi-square test

The associations of sleep duration and sleep quality with 'poor' self-rated health are presented in Table 2. In model 1, sleeping <6 h (OR = 3.21; 95% CI 1.61 to 6.39), 6–7 h (OR = 2.47; 95% CI 1.40 to 4.36), 8–9 h (OR = 3.26; 95% CI 1.82 to 5.83), and >9 h (OR = 3.62; 95% CI 1.57 to 8.34) was associated with 'poor' self-rated health. In model 2, 'poor' sleep quality (OR = 2.33; 95% CI 1.46 to 3.73) was associated with 'poor' self-rated health. When sleep duration and sleep quality were entered simultaneously into model 3, sleeping <6 h (OR = 2.60; 95% CI 1.29 to 5.23), 6–7 h (OR = 2.04; 95% CI 1.14 to 3.64), 8–9 h (OR = 3.18; 95% CI 1.77 to 5.74), and >9 h (OR = 3.59; 95% CI 1.53 to 8.41) and having 'poor' sleep quality (OR = 2.06; 95% CI 1.26 to 3.38) remained associated with 'poor' self-rated health.

**Table 2.** The associations of sleep duration and sleep quality with ‘poor’ self-rated health in the study participants ( $N = 894$ ).

Study Variables	Model 1	Model 2	Model 3
	OR (95% CI)	OR (95% CI)	OR (95% CI)
<b>Sleep duration</b>			
<6 h	3.21 (1.61 to 6.39) ***		2.60 (1.29 to 5.23) **
6–7 h	2.47 (1.40 to 4.36) ***		2.04 (1.14 to 3.64) *
7–8 h	Ref.		Ref.
8–9 h	3.26 (1.82 to 5.83) ***		3.18 (1.77 to 5.74) ***
>9 h	3.62 (1.57 to 8.34) **		3.59 (1.53 to 8.41) **
<b>Sleep quality</b>			
Good		Ref.	Ref.
Poor		2.33 (1.46 to 3.73) ***	2.06 (1.26 to 3.38) **
<b>Sex</b>			
Men	Ref.	Ref.	Ref.
Women	0.81 (0.52 to 1.27)	0.94 (0.61 to 1.46)	0.85 (0.54 to 1.35)
<b>Physical activity</b>			
Sufficiently	Ref.	Ref.	Ref.
Insufficiently	1.80 (1.12 to 2.90) **	1.61 (1.01 to 2.56) *	1.70 (1.05 to 2.75) *
<b>Smoking consumption</b>			
No	Ref.	Ref.	Ref.
Yes	1.70 (1.09 to 2.65) *	1.65 (1.07 to 2.56) *	1.65 (1.06 to 2.57) *
<b>Alcohol consumption</b>			
No	Ref.	Ref.	Ref.
Yes	1.55 (0.97 to 2.46)	1.59 (1.00 to 2.53) *	1.65 (1.03 to 2.64) *
<b>Psychological distress</b>			
Low	Ref.	Ref.	Ref.
High	5.89 (3.67 to 9.48) ***	5.09 (3.18 to 8.14) ***	5.08 (3.12 to 8.26) ***
<b>Socioeconomic status</b>			
Middle/high	Ref.	Ref.	Ref.
Low	0.77 (0.27 to 2.19)	0.97 (0.36 to 2.67)	0.75 (0.26 to 2.14)
<b>Chronic disease/s</b>			
No	Ref.	Ref.	Ref.
Yes	3.57 (2.16 to 5.89) ***	3.95 (2.42 to 6.43) ***	3.51 (2.12 to 5.81) ***

**Model 1:** Examine the association between sleep duration and ‘poor’ self-rated health adjusted for sex, physical activity, smoking consumption, alcohol consumption, psychological distress, socioeconomic status, and chronic disease/s.; **Model 2:** Examine the association between sleep quality and ‘poor’ self-rated health adjusted for sex, physical activity, smoking consumption, alcohol consumption, psychological distress, socioeconomic status, and chronic disease/s; **Model 3:** Examine the associations of sleep duration and sleep quality with ‘poor’ self-rated health adjusted for sex, physical activity, smoking consumption, alcohol consumption, psychological distress, socioeconomic status, and chronic disease/s; \*  $p < 0.05$ ; \*\*  $p < 0.01$ ; \*\*\*  $p < 0.001$ .

#### 4. Discussion

The main purpose of the present study was to explore the associations of sleep duration and sleep quality with self-rated health. Our study shows that both ‘short’ and ‘long’ sleep duration and ‘poor’ sleep quality were associated with ‘poor’ self-rated health, after adjusting for numerous covariates.

Previous studies have also shown that ‘short’ sleep duration is associated with ‘poor’ self-rated health in the populations of young adults [11], adults [12,13], and the elderly [6,14]. Contrary to our findings, Steptoe et al. [10] showed that only ‘short’ sleep duration was associated with ‘poor’ self-rated health in a sample of 17,456 university students. Even no association between sleep duration and self-rated health was found [23]. In general, evidence shows that both short and long sleep duration are associated with increased rates of mortality [2,3] and higher incidence of cardiovascular and metabolic diseases [4,5]. Additionally, short and long sleep duration impair mood and cognitive functioning [24], increase daytime fatigue [25], and are associated with numerous negative health

outcomes, such as impaired glucose intolerance [26] and increased risk for chronic diseases [4,5]. One previous study proposed an inverse association, that is, 'poor' self-rated health led to 'short' and 'long' sleep duration [12]; yet we are unable to make such a conclusion, due to the cross-sectional nature of our data. However, it is possible that the association between 'short' and 'long' sleep duration and 'poor' self-rated health is bidirectional.

Our results also showed that 'poor' sleep quality was associated with 'poor' self-rated health, independently of 'short' and 'long' sleep duration. When sleep duration and sleep quality were entered simultaneously into the model, both variables remained associated with 'poor' self-rated health. To the best of the authors' knowledge, this is the first exploration of the associations of both sleep duration and sleep quality with self-rated health in a sample of elderly individuals. Since this is the first of such studies, our results were explained in the highlights of similar studies [27,28]. Specifically, Paunio et al. [27] and Rissanen et al. [28] showed that 'poor' sleep quality was associated with 'poor' life satisfaction in the general population. Our results could be explained by the fact that life satisfaction was strongly associated with self-rated health in previous studies [29]. Moreover, previous studies have shown that both 'poor' self-rated health and 'poor' life satisfaction' are associated with negative health outcomes [30]. Thus, although we did not use the same variables, our study shows a strong association between 'poor' sleep quality and 'poor' self-rated health in a relatively large sample of elderly individuals.

This study has several strengths. First, we randomly selected five nursing homes and conducted a study among a relatively high number of individuals ( $N = 894$ ), minimizing the risk of measurement bias. Second, we used previously validated questionnaires to assess PA, sleep duration, and sleep quality. Third, all three models were adjusted for sex, physical activity, smoking consumption, alcohol consumption, psychological distress, socioeconomic status, and chronic disease/s.

However, our study has several limitations. Due to a cross-sectional design, the associations between sleep duration and sleep quality with self-rated health must be interpreted with caution. It is possible that 'poor' self-rated health led to both 'short' and 'long' sleep duration and 'poor' sleep quality. Although we used validated questionnaires, our second limitation was the usage of self-reported measures. Third, we were lacking in collecting information about physiological parameters and daylight exposure, even though daylight exposure has a beneficial effect on well-being and psychological functioning [31]. Fourth, we based our sample only on elderly individuals situated in nursing homes in the city of Zagreb. However, free-living individuals might have had different levels of self-rated health and sleep, leading to different associations. Future studies should use objective methods (accelerometry, polysomnography) and follow-up methodology in order to better capture and understand the causality between sleep hygiene and self-rated health.

In conclusion, our study shows that 'short' and 'long' sleep duration and 'poor' sleep quality were associated with 'poor' self-rated health in a sample of elderly individuals living in nursing homes. Thus, special policies and strategies that promote sleep hygiene in order to increase self-rated health are warranted.

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