Sleep Duration and Health-Related Quality of Life among Older Adults: A Population-Based Cohort in Spain

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Study Objectives: The few studies that have addressed the association between sleep duration and health-related quality of life (HRQL) were cross-sectional and small-sized, targeted young and middle-aged persons, and did not adjust for the main confounders. This study sought to examine the cross-sectional and longitudinal relationship between habitual sleep duration and HRQL in older adults.

Design: Prospective study conducted from 2001 through 2003. Sleep duration was self-reported in 2001, and HRQL was measured using the SF-36 questionnaire in 2001 and 2003. Analyses were adjusted for the main confounders.

Setting: Community-based study.

Participants: A cohort of 3834 persons representative of the non-institutionalized Spanish population aged 60 years and over.

Intervention: None.

Measurement and Results: In comparison with women who slept 7 hours, those with extreme sleep durations (≤ 5 or ≥ 10 h) reported worse scores on the SF-36 physical and mental scales in 2001. Among men, sleeping ≤ 5 h was associated with a worse score in the role-physical scale in 2001. The magnitude of most of these associations was comparable with the reduction in HRQL associated with aging 10 years. Sleep duration in 2001 failed to predict changes in HRQL between 2001 and 2003.

Conclusion: Extreme sleep durations are a marker of worse HRQL in the elderly.

Keywords: Health-related quality of life, sleep, elderly, Spain

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SEVERAL EPIDEMIOLOGIC STUDIES HAVE OBSERVED THAT SLEEP DURATION IS ASSOCIATED WITH HIGHER MORBIDITY. HENCE, IN COMPARISON WITH PERSONS who sleep 7-8 hours, those sleeping either more or fewer hours have a higher risk of coronary disease,[1,2] arterial hypertension,[3] diabetes,[4,5] and obesity.[6-8] The impact of sleep on health is wide ranging and manifests as higher general mortality among persons with very short- or long-duration sleep.[2,6,9-11]

In addition to general mortality, a useful variable for assessing the global impact of sleep on health is health-related quality of life (HRQL) because it represents the individual perception of how a health problem can affect various spheres of life, physical as well as mental or social. Moreover, sleep duration may possibly affect HRQL even before it has made a sizeable impact on morbidity. To our knowledge, only two papers have previously examined this issue.[12,13] The first analyzed the results of 2 small-sized, cross-sectional studies on university students, and reported no relationship between sleep duration and HRQL as measured by the Cornell Medical Index[12]; the second paper, based on cross-sectional analysis of data on 273 persons aged 40–64 years likewise reported no association between sleep duration and HRQL measured with the Quality of Well-Being Scale.[13] However, these studies did not differentiate between short- and long-duration sleep, and did not adjust their analyses for potential confounders, whether lifestyles or chronic diseases. Furthermore, since both sleep duration[14,15] and HRQL[16,17] decline with age, the results of these 2 studies might not apply to the elderly.

Accordingly, this study assessed the cross-sectional relationship between habitual sleep duration and HRQL among the older adult population of Spain. In addition, it examined the longitudinal association between sleep duration and change in HRQL over 2 years of follow-up.

METHODS

Study Design and Participants

The study methods have been reported elsewhere.[8,18] This was a prospective, population-based cohort study. The cohort was established in 2001 and followed up over 2 years. In 2001, information was obtained on 4008 persons (1739 men and 2269 women) representative of the non-institutionalized Spanish population aged 60 years and over. Subjects were selected using probabilistic sampling by multistage clusters. The clusters were stratified by region of residence and size of municipality. Census sections were then chosen randomly within each cluster, and the households in which information was finally obtained from the subjects were chosen within each section. Information was collected from a total of 420 census sections in Spain, and subjects were selected in age and sex strata. Subjects were replaced for interviews only after 10 failed visits by the interviewer, disability, death, institutionalization, or refusal

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to participate. The study response rate was 71%. Information was gathered by home-based personal interview and physical examination, undertaken by trained and certified personnel.

In 2003, an attempt was made to contact the subjects again; of the total cohort comprising 4008 individuals, only 3235 (1411 men and 1824 women) could be tracked for follow-up. The individuals tracked did not differ significantly from those lost to follow-up in any sociodemographic or lifestyle-related characteristic, except for the number of chronic diseases diagnosed and reported in 2001, which was 1.4 among subjects followed up and 1.2 among those lost to follow-up.[18] In 2003, data were collected by telephone interview conducted by trained staff. In Spain, there is evidence that telephone information on lifestyles and use of healthcare services is reliable and valid against household face-to-face interviews.[19,20]

Informed consent to participate in the study was obtained from each subject and an accompanying family member. The study was approved by the Clinical Research Ethics Committee of the "La Paz" University Hospital in Madrid, Spain.

Study Variables

Main Variables

The dependent variables were HRQL in 2001 and 2003, measured using the Spanish version of the SF-36 questionnaire. This questionnaire is made up of 36 items, which assess the following 8 HRQL components or scales: physical functioning, role-physical, bodily pain, general health, vitality, social functioning, role-emotional, and mental health. Physical functioning, role-physical and bodily pain reflect the physical component of health; social functioning, role-emotional and mental health cover the psychosocial aspects; and vitality and general health give an overall idea of subjective health, and are thus associated with both the physical and mental aspects of HRQL. The SF-36 allows for imputing missing data to individuals who answer more than half the items on a scale. Data were imputed to only 321 persons in 2001 and 177 in 2003. Subjects' answers to any given item receive a numerical score which, after being coded, is ranked on a scale of 0 to 100, so that the higher the score the better the state of health.[21] In general, differences of 3 to 5 points on each scale are deemed clinically relevant.[22] The SF-36 also allows for constructing scores that summarize the physical and mental components of quality of life across the 8 scales. Higher scores of both the physical summary component (PSC) and the mental summary component (MSC) indicate better health. The Spanish version of the SF-36 has been previously used to measure HRQL in the elderly,[16,23] and has demonstrated good reproducibility and validity.[24]

The principal independent variable was habitual sleep duration in 2001, ascertained with the following question: How many hours do you usually sleep per day (including sleep at night and during the day)? This was a closed question in which interviewees had to report the number of hours and minutes, which were then rounded to the nearest integer hour by the interviewer. Information available did not allow distinction between sleep duration in the night and during day time (napping or siesta).

Potential Confounders

In 2001, information was obtained on variables that, both in the existing literature and in our study sample, have shown an association with sleep duration, HRQL or both. Specifically, subjects were asked about their age, sex and leisure-time physical activity (sedentary, occasional activity, regular activity). Weight and height were measured using standardized procedures[25]; body mass index (BMI) was calculated as weight in kilograms divided by the square of the height in meters, with normal weight being defined as BMI 18.5–24.9 kg/m^2, overweight as BMI 25–29.9 kg/m^2, and obesity as BMI $\geq$ 30 kg/m^2.

Information was also gathered on tobacco use (never smoker, ex-smoker, smoker) and alcohol consumption (never drinker, ex-drinker, moderate consumption, and excess consumption). The threshold between excess and moderate consumption was alcohol intake > 20 g/day in women and > 30 g/day in men. Data were likewise collected on coffee consumption (no consumption, < 1, 1-2, > 2 cups/day), educational level (no formal education, primary, secondary, and university education) and social network, assessed as the number of participants' social ties (marital status, cohabitation, frequent contact with friends, and frequent contact with family).[26]

Cognitive function was measured with the Mini-Examen Cognoscitivo (MEC), a version of the Mini-Mental State Examination (MMSE)[27] that has been adapted and validated for use in the elderly in Spain.[28] The MEC is scored from 0 to 30 points, with a higher score indicating better cognitive performance. Given the influence of age and educational level on cognitive function and the high percentage of elderly Spaniards with low educational level, the recommended definition for cognitive impairment in Spain is a MEC score < 23 (sensitivity 89.8% and specificity 80.8%).[28]

Further data were collected on the following chronic diseases diagnosed by a physician or self-reported: chronic obstructive pulmonary disease, ischemic heart disease, stroke, osteoarthritis, cataracts without treatment, diabetes mellitus, Parkinson disease, cancer at any site, and arterial hypertension. We also gathered data on depression, defined as a self-reported diagnosis of depression or the use antidepressant medication. Previous studies have reported good agreement between self-reported diseases and clinical history in older adults.[29,30] Lastly, participants were asked with a binary question (yes/no) whether they awoke during the night, and whether they took anxiolytics.

In 2003, information was obtained by telephone on the above variables with the exception of cognitive function.

Statistical Analysis

Cross-Sectional Analysis

This analysis examined the relationship between sleep duration and HRQL in 2001. Of the 4008 study participants, we excluded 89 with extreme sleep duration values (< 4 or > 15 hours), 50 with missing data on more than half the items in any SF-36 scale, and 35 who lacked data on confounders. Thus, the analyses were conducted with 3834 individuals (1684 men and 2150 women).

The study associations were summarized with β coefficients and their 95% confidence intervals (CI) obtained from multiple linear regression; the dependent variable was HRQL in 2001, and the principal independent variable was sleep duration in 2001. Sleep duration in hours was modeled with dummies because in previous studies the relationship between sleep and other health variables was not monotonic.[6,7,11] The category of 7 h of sleep was used as reference to allow for comparison with earlier studies on older adults.[8,31-33] Two regression models were constructed. Model 1 was adjusted for age only. Since many of the lifestyles and chronic diseases listed above as potential confounders may be a consequence of or be aggravated by extreme sleep durations, they could be intermediary elements in the relationship between sleep duration and HRQL; and in such a case, it would not be appropriate to adjust for them. Model 2 was adjusted for age as well as all potential confounders measured in 2001. This model is appropriate when these variables influence sleep duration and are associated with HRQL, that is, they act as genuine confounders. All potential confounders were modeled with dummies.

Longitudinal Analysis

To examine whether sleep duration in 2001 predicted the change in HRQL between 2001 and 2003, we used information on the 3235 participants who could be followed up. Of these, we excluded 245 due to death, 602 for not answering the questionnaire personally, 47 due to extreme sleep duration values (< 4 or > 15 h), 8 for lacking data on some SF-36 scale in 2001 or 2003, and 22 for not reporting on some confounder. Thus, the analyses were conducted with 2311 individuals (992 men and 1319 women). In comparison with the 1486 subjects who did not provide follow-up data, the 2311 participating in the longitudinal analysis showed similar characteristics, but were younger (70.2 ± 6.8 years versus 74.2 ± 8.3 years), had more social ties (2.9 ± 1.0 ties versus 2.7 ± 1.1), and had a lower frequency of men (42.9% versus 45.5%), persons with no formal education (48.1% versus 56.3%), sedentary individuals (38.3% versus 51.4%), participants with cognitive impairment (15.1% versus 34.0%), and subjects who awoke from sleep during the night (13.8% versus 17.4%).

The analyses were performed using linear regression, where the dependent variable was the difference in HRQL between 2003 and 2001, and the principal independent variable was sleep duration in 2001. In these models, β regression coefficients assess the 2-year average change in HRQL associated with categories of sleep duration at baseline. A positive coefficient means an improvement in HRQL, while a negative coefficient means a worsening. Two models were constructed; the first adjusted for HRQL in 2001 and age, and the second additionally adjusted for all potential confounders in 2001. Because the study relationship might be influenced by changes in potential confounders over the period 2001–2003, in a secondary analysis the models were also adjusted for the following variables in 2003: physical activity, tobacco use, alcohol consumption, and social network. Adjustment was further made for the number of diseases diagnosed in the period 2001–2003.

The analyses were performed on men and women separately, because there are modest differences in sleep duration[14] and important differences in HRQL[34] between the sexes. To test whether the cross-sectional or longitudinal associations between sleep duration and each SF-36 scale were different in women and men, an *F* test of variance was used, comparing model 2 with 5 interaction terms (sex by sleep category) against the same model without such terms. Statistical tests were 2-sided and statistical significance was set at $P < 0.05$. The analyses were performed with the SAS program, version 9.1 for Windows.[35]

RESULTS

The mean age ± SD of participants was 72.3 ± 7.7 years for women and 71.1 ± 8.1 years for men; habitual sleep duration was 7.9 ± 1.9 h in women and 8.2 ± 2.1 h in men. Participants' characteristics according to habitual sleep duration are described in Table 1. Compared with subjects who had extreme sleep durations (≤ 5 h and ≥ 10 h), those who slept for 7 or 8 hours were younger, engaged in physical activity and consumed alcohol more frequently, had a higher educational level, a greater number of social ties, a lower number of chronic diseases, and a lower frequency of cognitive impairment. Those who slept fewer hours reported more frequently to be depressed and to use anxiolytics. Lastly, the more hours a subject slept, the more likely he/she was to awake during the night. Results were similar in each sex.

Table 2 shows the cross-sectional association between sleep duration and HRQL in women. Model 1, adjusted solely for age, indicates that, compared with women who slept 7 h, those who slept ≤ 5 h or ≥ 10 h had a lower score on all SF-36 scales, save for bodily pain in individuals who slept ≥ 10 h. After adjustment for all potential confounders (model 2), statistical significance was lost in the role-emotional and mental health scales in women who slept ≥ 10 h. In general, HRQL declined progressively for sleep durations ranging from 7 to ≤ 5 or from 7 to ≥ 10 h. Model 2 shows that the association was strong, because as compared with women sleeping 7 h, those who slept ≤ 5 h scored ≥ 6 points lower on most scales and 16 points lower on the role-physical scale. The association was only slightly weaker in those sleeping ≥ 10 h; even so, the score was ≥ 6 points lower on the physical functioning, role-physical, and general health. In general, those with extreme sleep durations also showed worse scores for the PSC and MSC of the SF-36, though the magnitude of the associations was smaller than that observed for individual scales of the SF-36; also the association between MSC and sleeping ≥ 10 h did not achieve statistical significance.

Table 3 shows the cross-sectional association between sleep duration and HRQL in men. In model 1, sleeping ≤ 5 h was associated ($P < 0.05$) with worse role-physical, vitality, mental health, and the PSC of SF-36. On the remaining scales, sleeping ≤ 5 h was also associated with a lower score, though statistical significance was not reached. Similarly, men who slept ≥ 10 h versus 7 h had a statistically lower score ($P < 0.05$) on all SF-36 scales except for the role-emotional scale, and a higher score on the bodily pain scale ($P < 0.05$). In model 2, most of the associations lost statistical significance; only sleeping ≤ 5 h was associated with worse role-physical, and sleeping 9 h with worse vitality. Step-by-step introduction of variables into model 2 showed that physical activity, number of chronic diseases, and intake of anxiolytic medication were the variables that most

Table 1—Baseline Characteristics of the Study Participants, According to Habitual Sleep Duration in 2001

	Sleep duration (hours per 24-h period)						
	≤ 5 hours N = 368	**6 hours N = 451**	**7 hours N = 568**	**8 hours N = 998**	**9 hours N = 631**	**≥ 10 hours N = 818**	**P[1]**
Sex (%)							
Men	32.1	41.0	41.5	47.2	44.8	47.8	< 0.001
Women	67.9	59.0	58.5	52.8	55.2	52.2	
Age (years) [2]	71.4 ± 7.8	71.5 ± 7.7	70.0 ± 7.0	70.6 ± 7.3	72.1 ± 7.8	74.6 ± 8.6	< 0.001
Physical activity (%)							
Inactive	49.8	41.0	38.2	43.7	50.6	55.4	< 0.001
Moderate	48.8	55.5	58.1	52.0	46.0	43.6	
Regular/intense	1.4	3.5	3.7	4.3	3.4	1.0	
BMI (%)							
18.5-24.9 kg/m^2	17.8	14.8	18.1	16.2	18.0	20.4	< 0.001
25-29.9 kg/m^2	42.5	49.0	48.5	44.6	46.9	48.1	
≥ 30 kg/m^2	39.7	36.1	33.4	39.1	35.1	31.5	
Tobacco use (%)							
Non-smoker	75.6	74.0	70.9	67.5	71.1	68.8	0.02
Ex-smoker	17.1	19.1	19.9	22.8	20.9	19.8	
Smoker	7.3	6.9	9.2	9.7	8.0	11.5	
Alcohol (%)							
Never drinker	58.6	53.1	52.5	49.4	54.9	55.9	< 0.001
Ex-drinker	11.9	10.7	8.0	9.3	10.2	12.7	
Moderate consumption[3]	23.8	27.3	29.6	31.9	27.3	22.5	
Excessive consumption[4]	5.6	8.8	9.9	9.4	7.7	8.8	
Coffee (%)							
No consumption	48.1	48.6	45.0	48.0	48.8	55.4	0.02
< 1 cup/d	9.6	9.9	12.6	10.2	11.2	10.2	
1-2 cups/d	27.6	25.6	23.2	24.3	24.6	20.3	
> 2 cups/d	12.6	13.5	15.3	15.0	12.4	12.2	
Education (%)							
No formal	53.3	49.1	48.7	48.2	55.7	61.4	< 0.001
Primary	36.6	35.4	38.4	36.0	33.5	29.2	
Secondary	6.8	9.2	9.0	10.9	8.0	6.9	
University	3.3	6.3	3.8	4.9	2.8	2.5	
Number of social ties[2]	2.8 ± 1.0	2.7 ± 1.0	2.9 ± 1.0	2.9 ± 1.0	2.8 ± 1.0	2.6 ± 1.1	0.001
Number of chronic diseases [2]	1.7 ± 1.2	1.4 ± 1.0	1.2 ± 1.0	1.2 ± 1.1	1.3 ± 1.1	1.4 ± 1.1	< 0.001
Depression (%)	16.9	11.5	10.7	12.3	10.6	12.2	0.06
Cognitive impairment (%)	21.8	21.2	17.2	17.1	21.9	34.2	< 0.001
Arousal from sleep at night (%)	4.0	4.9	8.6	10.7	23.7	30.7	< 0.001
Use of anxiolytics (%)	24.6	18.8	13.2	13.6	15.0	14.7	< 0.001

[1]Obtained from ANOVA for continuous variables and from χ^2 test for categorical variables. [2]Values are means (SD). [3]In men ≤ 30 g alcohol/d; in women ≤ 20 g alcohol/d. [4]In men > 30 g alcohol/d; in women > 20 g alcohol/d.

contributed to the loss of association between sleep duration and HRQL. Of note is that sleeping 8 or ≥ 10 h was associated with a better bodily pain score. Yet, in the case of bodily pain, results depend upon the reference category used for analysis, so that when the analysis was repeated using 8 h as reference, the association between long duration sleep and bodily pain disappeared; in contrast, a worse score was observed among subjects who slept ≤ 5 h (β −8.1; 95% CI −13.8 to −2.4) or 7 h (β -6.8; 95% CI −11.2 to −2.4). When 8 h was used as reference, none of the remaining associations was substantially modified in men and women alike. According to the *F* test of variance, the association between sleep duration and HRQL was different ($P < 0.05$) for men and women on all SF-36 scales (data not shown).

To put the study association into context, Table 4 shows the relationship between HRQL and some of the potential confounders. Among women, the association between extreme sleep duration (≤ 5 or ≥ 10 h) and most of the SF-36 scales was weaker than that between physical activity, use of anxiolytics, number of chronic diseases, and HRQL. It was, however, similar to the reduction in HRQL associated with a 10-year age increase. Furthermore, on some scales, such as role-physical, the reduction in HRQL associated with sleeping ≤ 5 h (β −16.4) was comparable to that associated with suffering from 2 chronic diseases, and greater than that associated with aging 20 years, not doing any physical activity, or consuming anxiolytics. Among men, the reduction in the role-physical score in subjects who slept for ≤ 5 h (β −11.1) was comparable to that associated with aging 20 years, not doing any physical activity, consuming anxiolytics, or suffering from a chronic disease.

Table 5 shows the longitudinal association of sleep duration in 2001 with change in HRQL between 2001 and 2003 among

Table 2—Beta Regression Coefficients (95% Confidence Interval) of the SF-36 Scores in 2001 According to Habitual Sleep Duration in 2001 Among Women

	Sleep duration (hours per 24-hour period)					
	≤ 5	**6**	**7**	**8**	**9**	**≥ 10**
N	**250**	**265**	**332**	**528**	**348**	**427**
Model 1						
Physical functioning	−12.56 (−16.88 to −8.25)***	–4.30 (–8.53 to –0.07)*	Ref.	–3.37 (–6.97 to 0.23)	–5.05 (–9.01 to –1.10)**	–12.20 (–16.03 to –8.36)***
Role-physical	−21.77 (−28.26 to −15.28)***	–4.61 (–10.98 to 1.76)	Ref.	–3.35 (–8.77 to 2.07)	–3.85 (–9.80 to 2.10)	–9.76 (–15.54 to –3.99)**
Bodily pain	−13.03 (−17.71 to −8.35)***	–3.67 (–8.27 to 0.92)	Ref.	0.75 (–3.16 to 4.66)	0.15 (–4.14 to 4.45)	–3.32 (–7.49 to 0.85)
General health	−10.35 (−13.56 to −7.14)***	–2.33 (–5.49 to 0.82)	Ref.	–2.50 (–5.2 to 0.2)	–6.15 (–9.10 to -3.21)***	–9.93 (–12.79 to –7.07)***
Vitality	−11.76 (−15.48 to −8.04)***	–3.05 (–6.70 to 0.60)	Ref.	–0.16 (–3.26 to 2.95)	–4.75 (–8.16 to –1.34)**	–7.95 (–11.26 to –4.64)***
Social functioning	−10.97 (−15.43 to −6.51)**	–1.57 (–5.95 to 2.81)	Ref.	–1.40 (–5.12 to 2.33)	–4.43 (–8.52 to –0.34)	–10.70 (–14.67 to –6.72)***
Role-emotional	−12.58 (−18.14 to −7.02)***	2.79 (–2.66 to 8.24)	Ref.	0.41 (–4.23 to 5.06)	–1.49 (–6.59 to 3.61)	–5.33 (–10.28 to –0.38)*
Mental health	−7.18 (−10.63 to −3.74)***	0.35 (–3.03 to 3.73)	Ref.	3.01 (0.13 to 5.89)*	–0.05 (–3.21 to 3.11)	–3.7 (–6.69 to –0.62)*
PSC[1]	−5.77 (−7.44 to −4.09) ***	−2.28 (−3.93 to −0.64)**	Ref.	−1.57 (−2.97 to −0.17)*	−2.06 (−3.60 to −0.53)**	−4.20 (−5.68 to −2.71)***
MCS[2]	−3.52 (−5.35 to −1.68)***	0.91 (−0.89 to 2.72)	Ref.	1.19 (−0.34 to 2.72)	−0.48 (−2.16 to 1.21)	−1.98 (−3.62 to −0.35)*
Model 2						
Physical functioning	−7.15 (−11.12 to −3.18)***	−3.02 (−6.90 to 0.84)	Ref.	−1.59 (−4.85 to 1.68)	−1.53 (−5.16 to 2.11)	−6.38 (−9.96 to -2.80)***
Role-physical	−16.44 (−22.86 to −10.03)***	−3.74 (−9.99 to 2.52)	Ref.	−1.95 (−7.23 to 3.33)	−1.30 (−7.19 to 4.59)	−6.11 (−11.89 to -0.33)*
Bodily pain	−7.94 (−12.45 to −3.43)***	−2.64 (−7.04 to 1.75)	Ref.	1.75 (−1.96 to 5.47)	2.86 (−1.28 to 6.99)	1.46 (−2.60 to 5.53)
General health	−6.43 (−9.39 to −3.48)***	−1.75 (−4.62 to 1.13)	Ref.	−1.79 (−4.23 to 0.64)	−4.20 (−6.92 to -1.49)**	−6.15 (−8.81 to -3.49)***
Vitality	−7.53 (−11.04 to −4.02)***	−2.62 (−6.05 to 0.79)	Ref.	0.93 (−1.95 to 3.83)	−2.31 (−5.53 to 0.91)	−3.83 (−6.99 to -0.66)**
Social functioning	−6.73 (−10.94 to −2.51)***	−1.01 (−5.11 to 3.09)	Ref.	0.07 (−3.39 to 3.54)	−1.05 (−4.91 to 2.81)	−5.23 (−9.03 to -1.44)**
Role-emotional	−8.45 (−13.87 to −3.02)**	3.02 (−2.27 to 8.31)	Ref.	1.36 (−3.10 to 5.83)	0.17 (−5.15 to 4.81)	−1.44 (−6.33 to 3.44)
Mental health	−3.53 (−6.79 to −0.26)*	0.80 (−2.39 to 3.98)	Ref.	3.71 (1.02 to 6.40)**	1.41 (−1.58 to 4.41)	−0.98 (−3.92 to 1.97)
PSC[1]	−3.81 (−5.39 to −2.24)***	−1.84 (−3.37 to −0.30)*	Ref.	−1.03 (−2.33 to 0.26)	−0.82 (−2.26 to 0.63)	−2.25 (−3.67 to -0.83)**
MSC[2]	−1.99 (−3.74 to −0.23)*	0.96 (−0.75 to 2.67)	Ref.	1.54 (0.09 to 2.98)*	0.17 (−1.44 to 1.79)	−0.55 (−2.14 to 1.03)

*P < 0.05; **P < 0.01; ***P < 0.001. [1]PSC: Physical summary component of the SF-36. [2]MSC: Mental summary components of the SF-36. Model 1: adjusted for age (60-69, 70-79, ≥ 80 years). Model 2: adjusted for age (60-69, 70-79, ≥ 80 years), physical activity (inactive, moderate, regular/intense), BMI (normal weight, overweight, obesity), tobacco use (non-smoker, ex-smoker, smoker), alcohol consumption (never drinkers, ex-drinker, moderate consumption, excess consumption), coffee consumption (no consumption, < 1, 1-2, ≥ 2 cups/day), educational level (no formal education, primary, secondary and university education), number of social ties, number of chronic diseases (0, 1, ≥ 2), depression, cognitive impairment, arousal from sleep at night, intake of anxiolytic medication.

women. In model 1, sleeping ≤ 5 h or ≥ 10 h was associated with a worse score on 4 of the 8 SF-36 scales. In model 2, however, all the associations decreased in magnitude and lost statistical significance. Table 6 shows the longitudinal association in men. In model 1, compared with subjects who slept 7 h, those sleeping ≤ 5 h or ≥ 9 h reported worse change in role-physical scores, and those sleeping 6 h worse change in bodily pain scores. The results were similar in model 2, though the association between sleeping ≥ 10 h and the change in role-physical scale lost statistical significance. The results of the longitudinal analyses did not vary materially in either sex when model 2 was additionally adjusted for physical activity, tobacco use, alcohol consumption, and social network in 2003, and for the number of diseases diagnosed in the period 2001–2003 (data not shown).

Analyses were repeated including the 89 individuals who slept < 4 h or > 15 h, and similar results were obtained (data not shown).

DISCUSSION

Our results show that extreme sleep durations (≤ 5 or ≥ 10 h) are associated with lower HRQL in older adults, on both physical and mental scales. However, after adjustment for potential confounders, this association lost statistical significance in men, except for worse role-physical in those with short-duration sleep. Lastly, sleep duration did not predict HRQL at 2 years of follow-up.

Basically, there are three possible explanations for the association between sleep duration and HRQL: uncontrolled confounding, reverse causation, and a causal relationship. An example of confounding might be sleep problems, which could lead to prolonged sleep duration in order to cover the sleeper's needs. There is evidence that sleep quality and satisfaction are associated with HRQL to a greater extent than is sleep duration per se.[12,13]. Although sleep quality was not measured, the analyses were adjusted for quality indicators such as use of anxiolytics and arousal from sleep at night. Also a frequent cause of sleep problems is sleep apnea. However, our analyses also adjusted for BMI and frequent sleep arousal, both of which are correlates of sleep apnea,[36] so that it is unlikely that this would affect our results. Nonetheless, there was a substantial change in results from model 1 to model 2 in women, so that a certain residual confounding cannot be completely ruled out. Another cause of poor sleep is restless legs syndrome (RLS), which is also associated with worse HRQL.[37] Unfortunately, analyses did not adjust for RLS due to lack of data.

The second explanation is reverse causation. For instance, long-duration sleep could be an early symptom of disease; despite the analyses adjusted for the number of chronic diseases and for lifestyle habits that lead to chronic diseases, there could be undiagnosed subclinical diseases that alter HRQL, and this might in turn affect sleep duration. Examples of these diseases are osteoporosis, which cause pain and can affect sleep, or initial stages of heart failure, which may reduce physical functioning or vitality, and modify sleep duration. Another possible example of reverse causation is cognitive impairment, which is associated with extreme sleep duration (Table 1). At baseline, the percentage of individuals with cognitive impairment was 15.1% among the 2311 participants in the longitudinal analyses and 34% among the 1486 individuals with no follow-up data.

Table 3—Beta Regression Coefficients (95% Confidence Interval) of the SF-36 Scores in 2001 According to Habitual Sleep Duration in 2001 Among Men

	Sleep duration (hours per 24-hour period)					
	≤ 5	**6**	**7**	**8**	**9**	**≥ 10**
n	**118**	**185**	**236**	**470**	**283**	**392**
Model 1						
Physical functioning	−5.75 (−12.03 to 0.53)	−2.65 (−8.13 to 2.82)	Ref.	−1.19 (−5.64 to 3.25)	−4.47 (−9.40 to 0.45)	−7.41 (−12.03 to −2.80)***
Role-physical	−15.90 (−24.89 to −6.92)***	−3.63 (−11.47 to 4.21)	Ref.	−4.16 (−10.52 to 2.20)	−5.53 (−2.58 to 1.52)	−7.71 (−14.32 to −1.10)*
Bodily pain	−5.27 (−11.79 to 1.25)	1.24 (−4.44 to 6.93)	Ref.	6.45 (1.84 to 11.07)**	2.23 (−2.89 to 7.34)	5.32 (0.52 to 10.11)*
General health	−4.56 (−9.66 to 0.55)	−2.81 (−7.27 to 1.64)	Ref.	0.83 (−2.78 to 4.45)	−4.37 (−8.37 to −0.36)*	−5.53 (−9.29 to −1.78)**
Vitality	−8.09 (−13.59 to −2.58)*	−3.40 (−8.20 to 1.41)	Ref.	−2.19 (−6.09 to 1.70)	−7.78 (−12.10 to −3.46)**	−8.72 (−12.77 to −4.67)***
Social functioning	−3.76 (−9.54 to 2.02)	−3.26 (−8.30 to 1.78)	Ref.	−3.56 (−7.65 to 0.53)	−0.94 (−5.47 to 3.60)	−6.82 (−11.07 to −2.57)**
Role-emotional	−1.99 (−8.39 to 4.42)	−3.06 (−8.65 to 2.52)	Ref.	−0.53 (−5.06 to 4.00)	0.93 (−4.09 to 5.95)	−2.34 (−7.05 to 2.37)
Mental health	−4.85 (−9.55 to −0.16)*	−4.44 (−8.54 to −0.35)*	Ref.	−0.26 (−3.59 to 3.06)	-0.81 (−4.49 to 2.87)	−4.07 (−7.52 to −0.61)*
PSC[1]	−3.28 (−5.73 to −0.82)**	−0.37 (−2.51 to 1.77)	Ref.	0.23 (−1.50 to 1.97)	−1.76 (−3.68 to 0.17)	−1.72 (−3.52 to 0.086)
MCS[2]	−1.28 (−3.54 to 0.98)	−2.02 (−3.99 to −0.04)*	Ref.	−0.85 (−2.45 to 0.75)	−0.29 (−2.07 to 1.48)	−2.27 (−3.93 to −0.60)**
Model 2						
Physical functioning	−1.18 (−6.71 to 4.35)	−0.73 (−4.13 to 5.59)	Ref.	0.20 (−3.71 to 4.11)	−1.40 (−5.76 to 2.95)	−0.63 (−3.54 to 4.81)
Role-physical	−11.10 (−19.73 to −2.46)*	−0.88 (−8.47 to 6.70)	Ref.	−3.62 (−9.73 to 2.48)	−4.46 (−11.27 to 2.35)	−1.78 (−8.30 to 4.75)
Bodily pain	−1.59 (−7.73 to 4.55)	3.01 (−2.39 to 8.40)	Ref.	6.56 (2.22 to 10.91)**	4.65 (−0.19 to 9.50)	9.46 (4.82 to 14.10)***
General health	−0.64 (−5.16 to 3.88)	0.13 (−3.84 to 4.09)	Ref.	1.56 (−1.63 to 4.76)	−1.49 (−5.06 to 2.07)	0.67 (−2.74 to 4.08)
Vitality	−4.45 (−9.45 to 0.55)	−0.55 (−4.94 to 3.84)	Ref.	−1.81 (−5.34 to 1.72)	−5.84 (−9.79 to −1.90)**	−2.22 (−6.00 to 1.56)
Social functioning	−0.37 (−5.63 to 4.89)	−0.69 (−5.31 to 3.91)	Ref.	−2.67 (−6.38 to 1.05)	0.53 (−3.61 to 4.68)	−0.26 (−4.23 to 3.72)
Role-emotional	1.74 (−4.36 to 7.84)	−1.12 (−6.47 to 4.23)	Ref.	0.22 (−4.09 to 4.53)	1.53 (−3.28 to 6.33)	1.35 (−3.26 to 5.95)
Mental health	−0.76 (−5.02 to 3.50)	−1.30 (−5.05 to 2.44)	Ref.	0.54 (−2.47 to 3.55)	−0.02 (−3.37 to 3.34)	−0.50 (−3.71 to 2.72)
PSC[1]	−1.74 (−3.95 to 0.47)	0.63 (−1.31 to 2.57)	Ref.	0.49 (−1.07 to 2.06)	−0.55 (−2.29 to 1.19)	1.05 (−0.62 to 2.72)
MSC[2]	0.30 (−1.77 to 2.37)	−0.85 (−2.67 to 0.97)	Ref.	−0.54 (−2.01 to 0.92)	−0.13 (−1.77 to 1.50)	−0.61 (−2.18 to 0.95)

*P < 0.05; **P < 0.01; ***P < 0.001. [1]PSC: Physical summary component of the SF-36. [2]MSC: Mental summary component of the SF-36. Model 1: adjusted for age (60-69, 70-79, ≥ 80 years). Model 2: adjusted for age (60-69, 70-79, ≥ 80 years), physical activity (inactive, moderate, regular/intense), BMI (normal weight, overweight, obesity), tobacco use (non-smoker, ex-smoker, smoker), alcohol consumption (never drinker, ex-drinker, moderate consumption, excess consumption), coffee consumption (no consumption, < 1, 1-2, ≥ 2 cups/day), educational level (no formal education, primary, secondary and university education), number of social ties, number of chronic diseases (0, 1, ≥ 2), depression, cognitive impairment, arousal from sleep at night, intake of anxiolytic medication.

Thus, longitudinal analyses were conducted on a subgroup with better cognitive performance. If the cross-sectional association between extreme sleep duration and worse HRQL was partly due to reverse causation by poorer cognitive function, this might have contributed to a lack of association in the longitudinal analyses. In theory, the problem of reverse causality could be solved through our longitudinal analysis, in which sleep duration was measured before HRQL, and baseline HRQL was additionally adjusted for. Yet, the only demonstrated effects of sleep on health are those produced in the short term (days or weeks).[1] If these were the only important sleep effects, their impact on HRQL could be demonstrated only with a very short follow-up or even with a cross-sectional analysis. In our study, there was a substantial change between the results of the cross-sectional and the longitudinal analyses. Since the mechanisms whereby sleep could affect health in the long term are not clear, it is difficult to know whether the temporal relationship between sleep and HRQL is better reflected in the cross-sectional analysis or in the longitudinal analysis over two years.

The third explanation for the study relationship is that sleep duration itself causes worse HRQL. In our study, the associations observed tend to be fairly strong, which traditionally supports a causal relationship.[38] Another classic criterion of causality is the temporal relationship of the association, commented above. A further criterion is consistency across studies. Our results can be compared with those of studies on sleep duration and self-rated health, which roughly coincide with the SF-36 general health scale. One study on adults aged 50–65 years reported no significant associations.[39] In an international study, however, university students who slept < 7 h reported poor health more frequently.[40] Similarly, another study on rural elders showed that those who slept longer had worse subjective health and worse physical functioning.[41] Lastly, a study on adults aged 20 years and over observed that both short- and long-duration sleep were associated with worse health.[42] Hence, most of the literature supports that extreme sleep durations are associated with worse health.

Causality could also be inferred from biological plausibility.[38] There is evidence of some mechanisms for the negative effects of short-duration sleep on health. Specifically, sleep restriction produces fatigue and daytime sleepiness. Also sleep restriction results in a series of adverse physiologic effects, such as hypertension, activation of the sympathetic nervous system, impaired glycemic control, and increased inflammation markers.[1,43] This could contribute to explain the worse HRQL among short-duration sleepers in the cross-sectional analyses. However, data on mechanisms of the association between long-duration sleep and worse HRQL are sparser still. Although further research into the biologic and social mechanisms of the study association is needed, it is reassuring that the strongest association, among both sexes in the cross-sectional study and among men in the longitudinal study, was observed between short-duration sleep and worse role-physical, since it is clear that sleep restriction causes fatigue and sleepiness. Recent data have confirmed a worse physical performance in elderly women with extreme sleep durations measured by actigraphy.[44]

An additional causality criterion is coherence with existing epidemiologic knowledge. If sleep duration is causally associated with HRQL, it would be expected that sleep problems, which frequently accompany extreme sleep durations, were

Table 4—Beta Regression Coefficients of the SF-36 Scores in 2001 According to Some Lifestyles and the Number of Chronic Diseases in 2001

	Physical functioning	Role-physical	Bodily pain	General health	Vitality	Social functioning	Role-emotional	Mental health	PSC[1]	MSC[2]
Men										
Age (years)[3]										
70-79	−2.3	−3.2	−0.4	1.1	0.4	−0.8	1.9	0.8	−0.8	0.8
≥ 80	−13.5***	−6.1*	−3.6	0.96	−2.9	−3.1	−1.7	1.7	−3.4***	1.2
Physical activity[3]										
Moderate	11.4***	4.9*	4.6**	7.0***	6.5***	7.6***	1.3	1.8	3.8***	0.6
Regular/Intense	19.7***	11.3*	−1.5	16.5***	16.4***	14.3***	4.8	8.8***	5.9***	3.7**
Intake of anxiolytic medication[3]	−6.9***	9.8**	−5.2*	−7.2***	−6.2**	−9.5***	−10.8***	−11.0***	−1.8*	−5.0***
Number of diseases[3]										
1	−5.6***	−7.3**	−9.3***	−5.3***	−5.6***	−2.9*	0.9	−2.3*	−3.4***	0.05
≥ 2	−16.0***	−16.3***	−18.8***	−13.3***	−13.5***	−5.8***	−5.3**	−7.5***	−7.4***	1.5*
Women										
Age (years)[3]										
70-79	−5.1***	−2.5	−1.4	1.4	0.5	−0.2	−0.2	1.4	−1.2*	1.0
≥ 80	−19.6***	−11.2***	−0.8	2.4*	−2.2	−2.9	−3.5	0.2	−4.1***	1.2
Physical activity[3]										
Moderate	14.0***	7.4***	8.0***	6.4***	7.6***	10.4***	5.1***	2.7**	4.5***	1.4**
Regular/Intense	19.3***	1.8	14.0***	12.0***	13.8***	8.9*	5.6	7.9**	5.7***	2.7
Intake of anxiolytic medication[3]	−5.9***	−7.9***	−6.2***	−3.3***	−4.1***	−6.2***	−5.9***	−7.4***	−1.8***	−2.8***
Number of diseases[3]										
1	−7.3***	−7.7***	−10.3***	−6.7***	−4.6***	−1.2	−3.6	−2.5*	−3.6***	−0.2
≥ 2	−14.0***	−19.8***	−19.2***	−12.6***	−11.1***	−8.2***	−9.5***	−6.1***	−7.2***	−1.9**

*$P < 0.05$; **$P < 0.01$; ***$P < 0.001$. [1]PSC: Physical summary score of the SF-36. [2]MSC: Mental summary score of the SF-36. [3]The reference categories are: age < 69 years, normal weight, physically inactive, intake of anxiolytic medication (no), no disease diagnosed. Linear regression adjusted for age, physical activity (inactive, moderate, regular/intense), BMI (normal weight, overweight, obesity), tobacco use (non-smoker, ex-smoker, smoker), alcohol consumption (never drinkers, ex-drinker, moderate consumption, excess consumption), coffee consumption (no consumption, < 1, 1-2, ≥ 2 cups/day), educational level (no formal education, primary, secondary and university education), number of social ties, number of chronic diseases (0, 1, ≥ 2), depression, cognitive impairment, arousal from sleep at night, intake of anxiolytic medication.

also associated with poor HRQL. There is evidence that symptoms of insomnia, including difficulty initiating and maintaining sleep and daytime sleepiness, are associated with a decrease in HRQL measured with the SF-36, in studies conducted among older adults in the United States,[45-48] Australia,[49] Germany,[50] and Japan.[51] There is also evidence from one clinical trial showing that treatment of primary insomnia with a hypnotic improved several scales on the SF-36 over six months.[52] Lastly, disturbed sleep, as measured by actigraphy and polysomnography, has been associated with poorer physical function in older adults.[53]

Also, if the study relationship is causal, we would expect the sleep duration to be associated with several health and social problems conceptually close to HRQL. Tworoger et al reported that shorter sleep duration was associated with cognitive impairment in cross-sectional analyses, but not over a 2-year follow-up, among women 70 to 81 years in the Nurses' Health Study.[33] Groeger et al found only minor differences in enjoyment/satisfaction with life, success/achievement, and effort/vital energy across categories of sleep duration in individuals aged 16–96 years from Great Britain.[54] Lastly, Bliwise et al found no substantial associations between sleep duration and several measures of disease and psychosocial function in subjects between the ages of 50 and 65 years.[55] Thus, data for coherence with previous epidemiologic knowledge are only fairly, but not totally, compatible with a causal relationship between sleep duration and HRQL.

Finally, it is not easy to understand why, in our study, the associations varied with sex. Nevertheless, there are precedents for sex differences in this research field. For instance, in the Whitehall II Study, short-duration sleep was associated with a higher prevalence of hypertension among women rather than men.[56] In contrast, in a large cohort of volunteers from the American Cancer Society, the association between (short-duration) sleep and mortality was stronger in men than in women.[57]

Our study is unique because it covered a representative sample of the older adult population of a whole country, and included a longitudinal follow-up. Moreover, it examined the impact of sleep duration on a good number of different health dimensions. Among its possible limitations is that sleep duration was self-reported. Nevertheless, this variable correlates well with objective actigraphic measurements.[58] Moreover, sleep duration in our study was similar to that reported in a previous study on another representative sample of Spanish elderly.[59] A further limitation is that sleep duration in 2003 was not measured, which is important because we do not know the stability of this variable over time or the induction time of the health effects of sleep. Similarly, we did not asked about the reasons for short-duration sleep (insomnia, work or family responsibilities, watching nighttime television, lesser sleep need of certain individuals) and for long-duration sleep (medication, greater sleep need of certain individuals, absence of work or family obligations), which could affect HRQL differently. Lastly, it is possible that the results may not apply to populations having sunlight exposures, lifestyle habits (e.g., diet, physical activity) and lifestyles (work and leisure timetables) other than those of Mediterranean countries. Moreover, an association between sleep duration and subsequent change in HRQL over a follow-up longer than two years cannot still be ruled out.

Taking into account the above considerations, we conclude that extreme sleep durations are a marker of worse HRQL in senior

Table 5—Beta Regression Coefficients (95% Confidence Interval) of Change on the SF-36 Scores Between 2001 and 2003 According to Usual Sleep Duration in 2001 Among Women

	Sleep duration (hours per 24-hour period)					
	≤ 5	6	7	8	9	≥ 10
N	**167**	**181**	**211**	**347**	**214**	**199**
Model 1						
Physical functioning	−4.69 (−9.07 to −0.31)*	−1.07 (−5.32 to 3.19)	Ref.	0.95 (−2.72 to 4.62)	–2.21 (–6.28 to 1.87)	–3.09 (–7.29 to 1.12)
Role-physical	–0.87 (–8.29 to 6.54)	5.94 (–1.22 to 13.10)	Ref.	4.17 (–2.00 to 10.33)	3.30 (–3.56 to 10.16)	–4.82 (–11.86 to 2.23)
Bodily pain	–3.45 (–8.92 to 2.01)	0.85 (–4.45 to 6.15)	Ref.	3.66 (–0.91 to 8.22)	–0.66 (–5.74 to 4.41)	–0.14 (–5.35 to 5.07)
General health	–4.84 (–8.37 to –1.31)**	–0.34 (–3.77 to 3.09)	Ref.	0.38 (–2.57 to 3.34)	0.67 (–2.62 to 3.96)	0.66 (–2.73 to 4.06)
Vitality	–2.73 (–7.25 to 1.79)	0.51 (–3.89 to 4.90)	Ref.	–0.95 (–4.73 to 2.84)	–0.82 (–5.03 to 3.38)	–4.46 (–8.79 to –0.14)*
Social functioning	–1.33 (–6.59 to 3.92)	0.60 (–4.51 to 5.72)	Ref.	1.98 (–2.43 to 6.39)	0.10 (–4.80 to 5.01)	–3.77 (–8.85 to 1.28)
Role-emotional	–4.07 (–11.58 to 3.44)	–1.16 (–8.49 to 6.17)	Ref.	4.06 (–2.26 to 10.38)	–2.13 (–9.14 to 4.89)	–7.76 (–14.96 to –0.57)*
Mental health	–2.61 (–6.77 to 1.55)	–0.98 (–5.03 to 3.08)	Ref.	–1.04 (–4.54 to 2.46)	–1.81 (–5.70 to 2.07)	–3.41 (–7.40 to 0.58)
PSC[1]	–1.09 (–2.55 to 0.37)	0.41 (–1.01 to 1.83)	Ref.	1.15 (–0.07 to 2.37)	–0.04 (–1.39 to 1.32)	–0.13 (–1.53 to 1.26)
MCS[2]	–0.99 (–3.19 to 1.20)	–0.49 (–2.63 to 1.65)	Ref.	–0.02 (–1.87 to 1.83)	–0.64 (–2.70 to 1.41)	–2.60 (–4.71 to –0.49)*
Model 2						
Physical functioning	–3.57 (–7.96 to 0.81)	–0.67 (–4.92 to 3.59)	Ref.	1.56 (–2.07 to 5.19)	–.85 (–4.93 to 3.23)	–2.02 (–6.26 to 2.21)
Role-physical	0.56 (–6.86 to 7.99)	5.10 (–2.06 to 12.26)	Ref.	4.11 (–2.01 to 10.22)	4.81 (–2.06 to 11.68)	–2.19 (–9.30 to 4.93)
Bodily pain	–2.01 (–7.47 to 3.46)	0.78 (–4.53 to 6.07)	Ref.	3.69 (–0.84 to 8.21)	0.37 (–4.72 to 5.45)	0.47 (–4.79 to 5.74)
General health	–2.99 (–6.51 to 0.53)	0.54 (–2.89 to 3.96)	Ref.	0.88 (–2.05 to 3.80)	0.83 (–2.46 to 4.11)	1.05 (–2.36 to 4.46)
Vitality	–1.03 (–5.53 to 3.47)	0.38 (–3.99 to 4.75)	Ref.	0.09 (–3.64 to 3.82)	–0.10 (–4.29 to 4.09)	–3.58 (–7.92 to 0.77)
Social functioning	0.45 (–4.82 to 5.71)	0.38 (–4.74 to 5.50)	Ref.	2.91 (–1.47 to 7.28)	1.64 (–3.27 to 6.56)	–2.24 (–7.33 to 2.84)
Role-emotional	–0.94 (–8.44 to 6.55)	–0.45 (–7.75 to 6.84)	Ref.	5.34 (–0.90 to 11.58)	0.69 (–6.31 to 7.69)	–3.98 (–11.23 to 3.27)
Mental health	–1.69 (–5.87 to 2.49)	–1.34 (–5.40 to 2.73)	Ref.	–0.43 (–3.91 to 3.05)	–1.11 (–5.01 to 2.79)	–2.47 (–6.50 to 1.57)
PSC[1]	–0.56 (–2.01 to 0.89)	0.54 (–0.86 to 1.95)	Ref.	1.31 (0.10 to 2.51)	0.37 (–0.98 to 1.72)	0.24 (–1.16 to 1.64)
MSC[2]	–0.15 (–2.34 to 2.05)	–0.55 (–2.68 to 1.59)	Ref.	0.42 (–1.41 to 2.25)	–0.10 (–2.15 to 1.95)	–1.80 (–3.92 to 0.32)

*P < 0.05; **P < 0.01. [1]PSC: Physical summary component of the SF-36. [2]MHS: Mental summary component of the SF-36. Model 1: adjusted for age (60-69, 70-79, ≥ 80 years) and health-related quality of life in 2001. Model 2: adjusted for age (60-69, 70-79, ≥ 80 years), health-related quality of life in 2001, physical activity (inactive, moderate, regular/intense), BMI (normal weight, overweight, obesity), tobacco use (non-smoker, ex-smoker, smoker), alcohol consumption (never drinker, ex-drinker, moderate consumption, excess consumption), coffee consumption (no consumption, < 1, 1-2, ≥ 2 cups/day), educational level (no formal education, primary, secondary and university education), number of social ties, number of chronic diseases (0, 1, ≥ 2), depression, cognitive impairment, arousal from sleep at night, intake of anxiolytic medication.

Table 6—Beta Regression Coefficients (95% Confidence Interval) of Change on the SF-36 Scores Between 2001 and 2003 According to Usual Sleep Duration in 2001 Among Men

	Sleep duration (hours per 24-hour period)					
	≤ 5	6	7	8	9	≥ 10
N	**81**	**107**	**157**	**287**	**159**	**201**
Model 1						
Physical functioning	1.28 (–4.78 to 7.33)	–0.38 (–5.93 to 5.16)	Ref.	1.03 (–3.36 to 5.43)	–2.82 (–7.81 to 2.16)	–0.26 (–4.98 to 4.45)
Role-physical	–15.8 (–26.0 to –5.62)**	–6.58 (–15.88 to 2.72)	Ref.	–0.23 (–7.61 to 7.15)	–13.64 (–22.10 to –5.27)**	–9.94 (–17.85 to –2.03)*
Bodily pain	–1.51 (–8.84 to 5.82)	–8.22 (–14.92 to –1.52)*	Ref.	–1.39 (–6.73 to 3.95)	–2.89 (–8.92 to 3.14)	–0.52 (–6.23 to 5.19)
General health	–0.55 (–5.71 to 4.61)	0.06 (–4.66 to 4.79)	Ref.	–0.55 (–4.30 to 3.19)	–0.99 (–5.25 to 3.26)	0.55 (–3.47 to 4.58)
Vitality	3.06 (–3.25 to 9.38)	–1.07 (–6.85 to 4.70)	Ref.	1.87 (–2.72 to 6.45)	–0.77 (–5.98 to 4.44)	2.13 (–2.79 to 7.05)
Social functioning	–0.78 (–7.36 to 5.80)	–5.37 (–11.39 to 0.64)	Ref.	4.06 (–0.71 to 8.84)	0.02 (–5.40 to 5.43)	–2.75 (–7.86 to 2.36)
Role-emotional	–6.90 (–16.22 to 2.41)	–5.57 (–14.08 to 2.94)	Ref.	–1.46 (–5.29 to 8.22)	–4.43 (–12.09 to 3.23)	–3.25 (–10.49 to 3.99)
Mental health	0.98 (–4.56 to 6.53)	–2.00 (–7.07 to 3.07)	Ref.	1.42 (–2.60 to 5.45)	–2.67 (–7.23 to 1.89)	0.90 (–3.41 to 5.21)
PSC[1]	0.11 (–1.81 to 2.04)	–1.09 (–2.85 to 0.67)	Ref.	0.04 (–1.36 to 1.43)	–0.64 (–2.22 to 0.94)	–0.03 (–1.53 to 1.46)
MCS[2]	–0.74 (–3.54 to 2.06)	–1.55 (–4.11 to 1.00)	Ref.	1.17 (–0.86 to 3.20)	–1.05 (–3.36 to 1.25)	–0.42 (–2.59 to 1.76)
Model 2						
Physical functioning	−1.49 (−4.63 to 7.60)	–0.23 (–5.90 to 5.44)	Ref.	0.81 (–3.64 to 5.24)	–2.00 (–7.07 to 3.06)	0.38 (–4.50 to 5.26)
Role-physical	−14.92 (−25.17 to –4.67)**	–4.14 (–13.63 to 5.36)	Ref.	–0.27 (–7.71 to 7.17)	–10.41 (–18.89 to –1.92)*	–5.22 (–13.40 to 2.96)
Bodily pain	–0.88 (–8.20 to 6.44)	–5.95 (–12.74 to 0.84)	Ref.	–0.93 (–6.28 to 4.41)	–-1.03 (–7.10 to 5.05)	2.30 (–3.59 to 8.19)
General health	–0.36 (–5.60 to 4.89)	0.41 (–4.44 to 5.27)	Ref.	–1.04 (–4.84 to 2.77)	–-0.92 (–5.26 to 3.42)	–0.14 (–4.33 to 4.04)
Vitality	4.08 (–2.22 to 10.38)	0.40 (–5.44 to 6.25)	Ref.	1.03 (–3.55 to 5.61)	–-0.20 (–5.43 to 5.03)	2.28 (–2.76 to 7.31)
Social functioning	–0.64 (–7.23 to 5.96)	–3.43 (–9.55 to 2.68)	Ref.	3.07 (–1.72 to 7.86)	1.12 (–4.34 to 6.59)	–1.34 (–6.61 to 3.92)
Role-emotional	–3.95 (–13.36 to 5.45)	–3.00 (–11.70 to 5.69)	Ref.	2.03 (–4.79 to 8.84)	–3.06 (–10.83 to 4.71)	–0.35 (–7.86 to 7.15)
Mental health	1.09 (–4.50 to 6.69)	–0.77 (–5.96 to 4.42)	Ref.	1.01 (–3.05 to 5.08)	–2.19 (–6.83 to 2.45)	2.29 (–2.18 to 6.76)
PSC[1]	0.25 (1.69 to 2.19)	–0.75 (–2.55 to 1.05)	Ref.	–0.02 (–1.43 to 1.40)	–0.28 (–1.89 to 1.33)	0.27 (–1.28 to 1.82)
MSC[2]	–0.27 (–3.09 to 2.55)	–0.72 (–3.34 to 1.89)	Ref.	0.97 (–1.08 to 3.01)	–0.73 (–3.07 to 1.60)	0.28 (–1.97 to 2.53)

*P < 0.05; **P < 0.01. [1]PSC: Physical summary component of the SF-36. [2]MSC: Mental summary component of the SF-36. Model 1: adjusted for age (60-69, 70-79, ≥ 80 years) and health-related quality of life in 2001. Model 2: adjusted for age (60-69, 70-79, ≥ 80 years), health-related quality of life in 2001, physical activity (inactive, moderate, regular/intense), BMI (normal weight, overweight, obesity), tobacco use (non-smoker, ex-smoker, smoker), alcohol consumption (never drinker, ex-drinker, moderate consumption, excess consumption), coffee consumption (no consumption, < 1, 1-2, ≥ 2 cups/day), educational level (no formal education, primary, secondary and university education), number of social ties, number of chronic diseases (0, 1, ≥ 2), depression, cognitive impairment, arousal from sleep at night, intake of anxiolytic medication.

citizens. Our results, however, should be interpreted with caution, given the very short follow-up time and the lack of follow-up data for sleep duration. Moreover, we have observed a sex difference in the study association, which was not anticipated. Because of it and the incomplete fulfillment of several causality criteria in epidemiology, we are still far from establishing that sleep duration is causally related to HRQL. As this is one of the first studies of its kind in older adults, its results should be confirmed in future studies. Furthermore, advance in this field requires a better knowledge of the biologic and social mechanisms underlying the relationship between sleep duration and health.

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