



## Original article

# Sleep duration in midlife and old age and risk of mortality over a 48-year follow-up: The Helsinki businessmen study (HBS) cohort

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## ABSTRACT

**Objectives:** Both short and long sleep duration have been associated with increased mortality, but there are few truly long-term studies.

**Study design:** This is a cohort study of 2504 men born between 1919 and 1934. In 1974–1975 (mean age 48), participants underwent baseline clinical examinations and sleep duration assessments. A follow-up examination took place 35 years later, in 2010 (mean age 82).

**Main outcome measure:** All-cause mortality data from baseline and from old age were collected through to December 31, 2022.

**Results:** At baseline, short sleep duration ( $\leq 6$  h per night), normal sleep duration ( $>6$  and  $\leq 8$  h), and long sleep duration ( $\geq 8$  h) was reported by 266, 2019 and 219 men, respectively. Men with short sleep duration had higher levels of smoking, alcohol consumption, body mass index, and poorer self-rated health than those with normal sleep duration. During the 48-year follow-up, 2287 men died. The unadjusted hazard ratio for mortality was 1.20 (95 % confidence interval [CI] 1.05–1.37) for short compared with normal sleep duration, but this association vanished after adjustments (1.01, 95 % CI 0.87–1.17). In old age, the corresponding hazard ratios were 1.41 (1.16–1.72) and 1.19 (0.94–1.51) for short sleep duration and 1.33 (1.09–1.63) and 1.31 (1.02–1.67) for long sleep duration.

**Conclusions:** In a comprehensive lifespan follow-up, the modestly increased mortality among men with short sleep duration in midlife was attributed to unhealthy lifestyle factors. In old age both long and short sleep duration seemed to be associated with modestly increased mortality.

[ClinicalTrials.gov](https://clinicaltrials.gov) identifier for the HBS: NCT02526082

## 1. Introduction

Sleep has become an increasingly popular topic of discussion, particularly in relation to the impact of modern, fast-paced lifestyles on sleep disorders and the common use of sleep medications. Poor sleep naturally affects daytime performance, and both insufficient sleep and excessive sleep have been associated with various diseases and health conditions in observational studies [1–14]. As a result, sleep is included also in the American Heart Association's Life's Essential 8 (LE8) metrics [15]. However, it remains uncertain, how harmful deviant sleep duration per se is for overall health and mortality prognosis.

It is difficult, even impossible, to conduct randomised, controlled trials on sleep duration with sufficient length of follow-up. Therefore, the knowledge of long-term harms of variations of sleep is necessarily

based on observational studies, which to date have often relied on relatively short follow-ups. Mendelian randomised analyses, which are more protected from confounding and bias than observational analyses, have suggested that short sleep may be harmful for specific health outcomes [16–20], but confirmation using supplementary approaches which account for time-varying effects, control for wide range of clinical and lifestyle factors and assess fundamental health outcomes across the life course, such as total mortality, are lacking.

In the longitudinal Helsinki Businessmen Study (HBS, [21,22]), sleep duration was asked from the participants both at midlife and in old age, and mortality follow-up from registers almost cover the entire life span of most participants. In the present analyses we related sleep duration both in midlife and in old age to subsequent mortality, with adjustments for various factors known to affect sleep.

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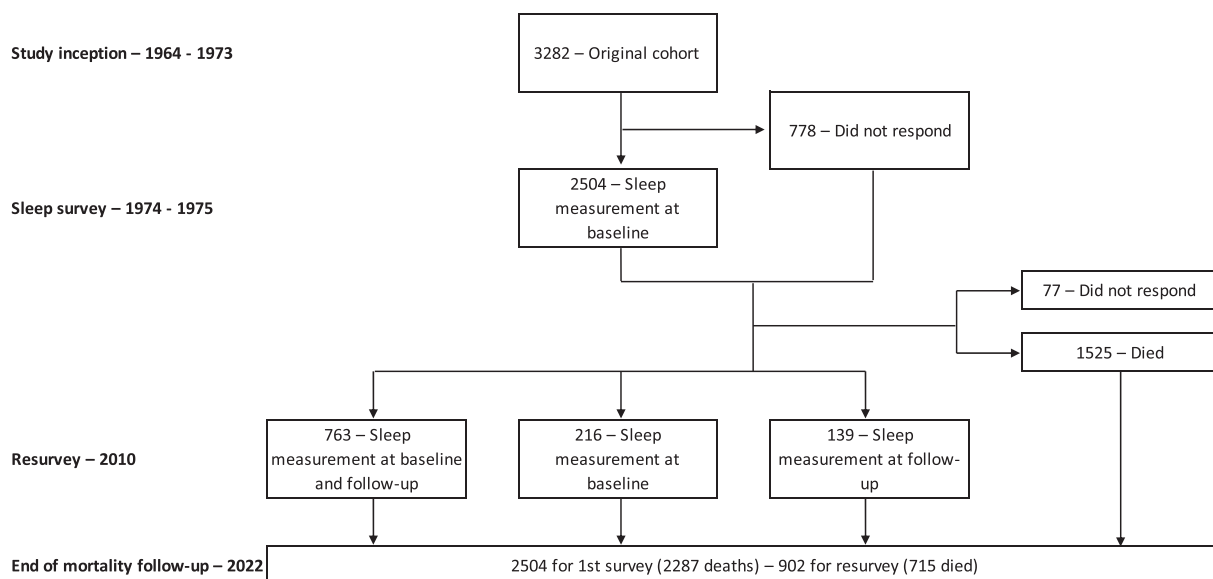


Fig. 1. Helsinki Businessmen Study design and the number of participants.

## 2. Methods

### 2.1. Participants

The HBS cohort has been described in detail previously [21,22]; the HBS is registered as [ClinicalTrials.gov](https://clinicaltrials.gov/ct2/show/study/NCT02526082) identifier: NCT02526082.

In brief, a cohort of men, mostly business-executives born between 1919 and 1934 (original number of HBS participants = 3490), participated in volunteer health check-ups during the 1960s and early 1970s organised by the Finnish Institute of Occupational Health. Over the decades, the cohort has been followed-up using linkage to national registries, regular mailed questionnaire surveys with good response rates, and clinical examinations in random subcohorts. The present analysis includes 2504 men who reported sleep duration at midlife in 1974/75; 902 men also responded to resurvey 35 years later in 2010.

### 2.2. Investigations in 1974/75 and 2010

The baseline examinations in 1974/75 included clinical and laboratory examinations, and questionnaires about lifestyle, durations of work (h/week), vacation (days/year), and self-rated health using a 5-step scale, where “poor” and “very poor” were combined. Body mass index (BMI) was calculated as measured weight divided by height squared. Sleep duration was assessed with a question: How many hours per week do you sleep? That was divided by seven for the analyses. The questionnaire examination in 2010 was directed to all survivors of the original HBS cohort and it included lifestyle factors, present weight, the RAND-36/SF-36 health-related quality of life (HRQoL) instrument (8 domains), questions of the Clinical Dementia Rating (CDR), history of physician-diagnosed chronic conditions, and possible disabilities. Use of sleep drugs was collected from detailed medication lists. In addition to questions about the duration of sleep (How many hours do you sleep nightly?), also the subjective quality of sleep was asked to be graded into “good”, “satisfactory”, or “poor”.

In 2010, frailty index of cumulative deficits [23] was calculated from 30 variables, CDR was presented as sum of boxes [24], and feeling of happiness assessed with a 10 cm line.

### 2.3. Mortality and longevity

Participants were linked with their unique personal identification number (PIN) to electronic health records of the Digital and Population

Data Services Agency ([www.dvv.fi](http://www.dvv.fi)). This agency keeps registry of all Finnish citizens and thus determination of vital status was reliable with minimal loss to follow-up. We retrieved total mortality of the study cohort through December 31, 2022.

Due to technical reasons causes of death from Statistics Finland were only available up to 31 December 2007 (1045 deaths). Causes were divided into three groups: cardiovascular (ICD-9 codes 390–459,  $n = 442$ ), cancer (140–239,  $n = 311$ ), and other causes ( $n = 292$ ).

Living up to 90 years of age was taken as a measure of longevity; on the average 20 % has reached this age in the whole HBS cohort.

### 2.4. Statistical analyses

Statistical analyses were performed with NCSS 2020 software (NCSS, Kaysville, Utah) and Stata Stata/MP 17.0 for Mac (College Station, TX). For the analyses, the diurnal duration of sleep was divided in three groups:  $\leq 6$ ,  $>6$  and  $\leq 8$ , and  $> 8$  h. Continuous variables are shown as means with SDs or medians with interquartile ranges (IQR). Spearman rank correlation and analysis of covariance (ANCOVA) were used to compare groups. Kaplan-Meier curves were constructed with age as the time scale to compare mortality in the sleep duration groups during the 48-year follow-up. In addition, we plotted parametric survival curves based on Weibull models with and without covariates (baseline smoking, alcohol, BMI, and self-rated health) with age as the time scale.

After finding little evidence against the assumption of proportional hazards, predictors of all-cause deaths were examined using Cox proportional hazards models. In these analyses time-scale was from the baseline examination in 1974/75 until death or December 31, 2022. Results are presented as hazard ratios (HR) and their 95 % confidence intervals (CI) with sleep duration of 7–8 h as the reference. For men with baseline (midlife) data, we analysed total 48-year follow-up. In addition, we analysed 12-year mortality (from 2010 until death or December 31, 2022) for all men ( $n = 902$ ) who reported sleep duration at old age in 2010. For selection of covariates in mortality analyses we used differences between sleep duration groups at baseline in midlife and in old age as well as direct acyclic graphs (DAGs [25], SUPPLEMENTARY Fig. 1).

For mortality during total follow-up, we performed sensitivity analyses to control for reverse causality by excluding participants who died between baseline and 1980 ( $n = 103$ ), or had chronic medications or diseases at baseline ( $n = 593$ ).

**Table 1**  
Characteristics according to sleep duration at baseline in 1974/75.

Characteristic <sup>a</sup>	Sleep duration, h			p-value for linear trend or heterogeneity
	≤6	>6 and ≤8	>8	
N (%)	266 (10.6)	2019 (80.6)	219 (8.7)	
Age, yr	48.1 (4.9)	47.8 (4.0)	47.6 (4.4)	0.31
Sleep, h/day	5.7 (0.5) <sup>b</sup>	7.3 (0.4)	8.7 (0.4) <sup>b</sup>	<0.001
Work, h/week	49.6 (11.4)	47.3 (9.0)	44.3 (10.4)	0.19
Vacation, d/yr	26.5 (14.7)	27.6 (13.5)	29.1 (14.8)	0.037
Self-rated health, %				<0.001
Very good	3.5	6.5	6.0	
Good	34.4	43.6	42.6	
Average	49.8	44.0	44.4	
Poor or very poor	12.4	5.9	6.9	
BMI, kg/m <sup>2</sup>	26.5 (1.5)	25.8 (3.1)	26.2 (3.0)	0.002
Smokers, n = 675, %	33.5	26.0	27.5	0.037
Alcohol, g/week	213.8 (172.9) <sup>b</sup>	157.4 (175.2)	152.9 (171.7)	<0.001
Systolic blood pressure, mmHg	144 (27.7)	143 (27.0)	142 (25.2)	0.65
Diastolic blood pressure, mmHg	92 (16.3)	92 (13.5)	93 (14.8)	0.54
One-hour glucose, mmol/L	7.5 (3.3) <sup>b</sup>	7.1 (2.7)	7.0 (3.0)	0.02
Plasma cholesterol, mmol/L	6.2 (1.3)	6.3 (1.3)	6.3 (1.2)	0.49
Plasma triglycerides, mmol/L	1.6 (1.1)	1.6 (0.9)	1.7 (1.0)	0.80
Mean proportion reaching 90 years of age, %	18.4	25.4	25.2	0.045

<sup>a</sup> Data are Means (SD) unless otherwise stated.

<sup>b</sup> Statistically significant difference compared to the group with sleep duration 7–8 h.

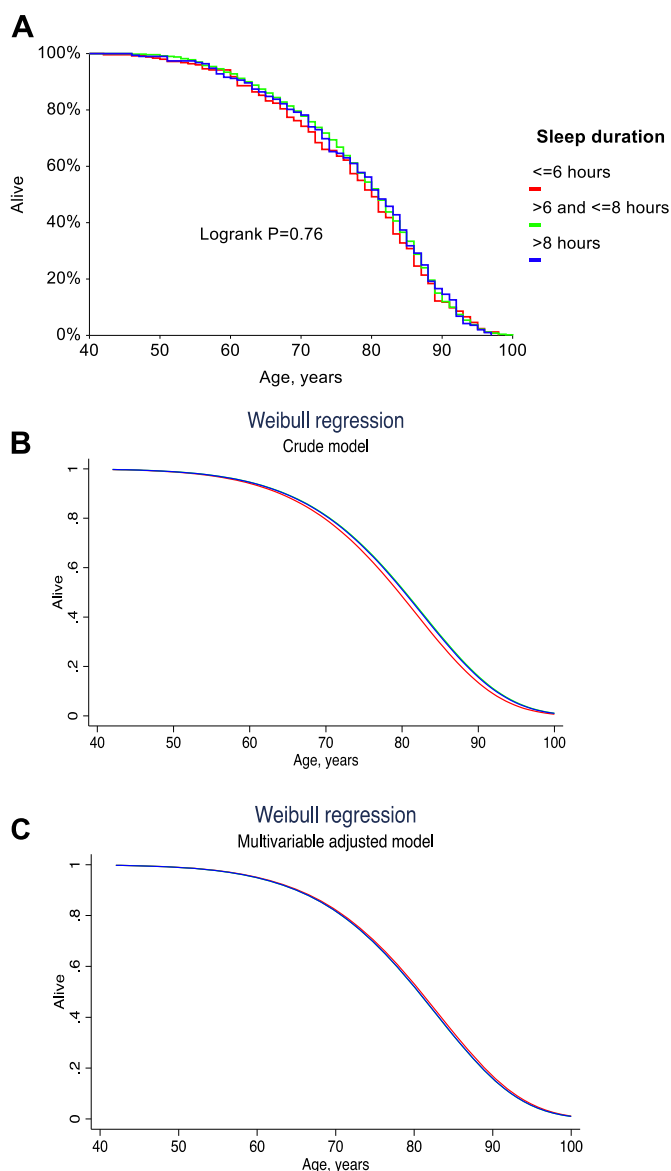
### 3. Results

#### 3.1. Characteristics of sleep duration groups in midlife

Flow chart of the examinations is shown in Fig. 1. At baseline, the 2504 men were home-dwelling, 1955 (78.1 %) were without chronic diseases and medications and 2494 (99.6 %) were in active work life. Baseline characteristics according to sleep duration groups are shown in Table 1. Mean age of the cohort was 47.8 years (SD 4.1; median 48, IQR 44–51) and mean duration of sleep was 7.2 h (SD 0.8, median 7.1 h, IQR 6.9–7.9). Mean ages between the sleep duration groups were comparable, but men with sleep duration ≤6 h had the longest working hours and shortest vacations and their BMI and one-hour post-load glucose were higher than in other groups. Men with shorter sleep also smoked more and consumed more alcohol and the distribution of self-rated health was worse than in other groups.

#### 3.2. Mortality and longevity of baseline sleep duration groups

During the total follow-up of up to 48 years, 2287 (91.6 %) men died, survival curves are shown in Fig. 2. to compare sleep duration groups. The distribution of cardiovascular, cancer and deaths due to other causes (data of cause of death only available up to 2007) was almost identical ( $p = 0.99$ ) in the sleep duration groups. The proportion of men reaching 90 years of age was lowest (18.4 %) in the group with the shortest sleep duration (ANCOVA  $p = 0.045$ ). In unadjusted Cox analysis with sleep duration 7–8 h as reference, hazard ratio for all-cause mortality was 1.20 (95 % CI 1.05, 1.37) for short sleep. After multivariable adjustment for age, baseline smoking, alcohol, BMI, and self-rated



**Fig. 2.** Survival curves of sleep duration groups defined in midlife. Kaplan-Meier plot (Panel A), Weibull plot without covariates (Panel B) and with covariates (baseline smoking, alcohol, body mass index, and self-rated health) (Panel C).

health this association attenuated and short sleep duration was not associated with mortality risk (HR 1.01, 95 % CI 0.87, 1.17) (Table 2). Sensitivity analyses excluding deaths during first 5 follow-up years and participants with chronic conditions at baseline corroborated the findings; actually short sleep was associated with lower mortality risk (HR 0.83, 95 % CI 0.70, 0.98), while long sleep remained nonsignificant (HR 0.96, 95 % CI 0.80, 1.15).

#### 3.3. Characteristics of baseline sleep duration groups in old age

By 2010, of the 2504 men with baseline sleep duration 171 (64.3 %), 1227 (60.8 %), and 127 (58.0 %) men had died in the ≤6 h, 7–8 h and > 8 h groups, respectively ( $p = 0.049$ ). The surviving 763 men of the baseline groups were at mean age of 82.2 years (SD 3.7, median 82, IQR 79–85) (SUPPLEMENTARY Table S1). Sleep durations at baseline and resurvey were significantly correlated (Pearson  $r = 0.22$ ,  $p < 0.001$ ) and difference between the original sleep groups remained for sleep duration and alcohol consumption. Use of sleep medication was lowest among

**Table 2**

Hazards ratios of 48-year mortality according to baseline sleep duration (N = 2504).

Sleep duration in 1974/75, h/day	N	Hazards ratio (95 % confidence interval) for mortality			
		Model 1 <sup>a</sup>	Model 2 <sup>b</sup>	Model 3 <sup>c</sup>	Model 4 <sup>d</sup>
<=6	266 (249)	1.20 (1.05–1.37)	1.13 (0.99–1.29)	1.03 (0.88–1.20)	1.01 (0.87–1.17)
>6 and <=8	2019 (1838)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
>8	219 (200)	1.00 (0.87–1.16)	1.01 (0.87–1.17)	1.03 (0.88–1.22)	1.02 (0.86–1.20)

<sup>a</sup> Unadjusted.

<sup>b</sup> Adjusted for age.

<sup>c</sup> Adjusted for age, baseline smoking, alcohol, and body mass index.

<sup>d</sup> Adjusted for age, baseline smoking, alcohol, body mass index, and self-rated health.

baseline long sleepers, variables related to frailty, cognition and HRQoL were not different in old age between baseline sleep groups.

### 3.4. Characteristics according to contemporary sleep duration in old age

Analyses in old age (2010 onwards) included 763 men with baseline data but also 139 men of the original HBS cohort, who responded to questionnaire survey in 2010, but of whom baseline sleep duration was not available. Characteristics of these 902 participants according to contemporary sleep duration are shown in Table 3.

In contrast to the situation in midlife, significant differences were not seen in BMI, alcohol consumption, nor smoking between the sleep duration groups. Compared to the group with 7–8 h sleep duration, both short and long sleepers had higher frailty index, generally poorer HRQoL according the RAND-36 instrument, and signs of lower cognitive function (CDR). Use of sleep medication was highest among men with short sleep and subjective sleep quality was positively associated with sleep duration (Spearman  $r = 0.40$ ,  $p < 0.001$ ).

### 3.5. Mortality according to contemporary sleep duration in old age

The association of contemporary sleep duration in 2010 ( $n = 902$ ) with 12-year mortality is shown in Table 4. With 7–8-h sleep as reference and without adjustments, both short sleep (HR 1.41, 95 % CI 1.16, 1.72) and long sleep (HR 1.33, 95 % CI 1.09, 1.63) were associated with 12-year mortality. After full adjustments with variables which were also used at baseline (contemporary age, BMI, smoking, alcohol consumption, self-rated health) the association remained significant for long sleep (HR 1.31, 95 % CI 1.02, 1.67). Separate analyses adjusting for age, frailty, cognition, sleep quality and sleep medication (which were significantly different between sleep duration groups in old age) corroborated the findings for long sleep (HR 1.27, 95 % CI 1.02, 1.57), while the result for short sleep was marginal (HR 1.23, 95 % CI 0.99, 1.52).

## 4. Discussion

In this cohort study of males with a comprehensive lifespan follow-up, short sleep duration reported in healthy midlife was associated with increased 48-year mortality before but not after statistical control for lifestyle factors (smoking, alcohol consumption) and body mass index. Long sleep duration in midlife was not associated with mortality irrespective of adjustments. In old age, short sleep and long sleep were associated with higher frailty index, poorer physical and cognitive functioning and use of sleep medication, while lifestyle factors were not significantly different between contemporary sleep duration groups.

**Table 3**

Characteristics according to sleep duration at resurvey in 2010 ( $n = 902$ ).

Characteristic <sup>a</sup>	Sleep duration, h			p for linear trend or heterogeneity
	<=6	>6 and <=8	>8	
N (%)	155 (17.2)	595 (66.0)	152 (16.8)	
Age, yr	82.8 (3.7) <sup>b</sup>	82.0 (4.9)	81.9 (3.7)	0.042
Sleep, h/day	5.6 (0.7) <sup>b</sup>	7.4 (0.4)	9.3 (0.7) <sup>b</sup>	<0.001
Subjective sleep quality				<0.001
Good	18.5	42.6	73.2	
Satisfactory	57.6	52.1	23.5	
Poor	23.8	5.3	3.4	
BMI, kg/m <sup>2</sup>	25.7 (5.0)	25.1 (4.9)	24.8 (4.9)	0.14
Smokers, n (%)	5 (3.2)	39 (6.6)	7 (4.6)	0.22
Alcohol, g/week	75.6 (125.7)	87.3 (124.4)	82.4 (124.5)	0.52
Regular weekly physical activity, %	80.7	85.0	81.1	0.29
Self-rated health, %				0.02
Very good	2.6	3.7	6.7	
Good	24.3	27.7	26.7	
Average	25.7.2	35.0	28.0	
Poor or very poor	47.7	33.6	38.7	
Frailty index, Mean (SE)	0.18 (0.1) <sup>b</sup>	0.16 (0.1)	0.18 (0.1) <sup>b</sup>	0.007
Median (IQR)	0.17 (0.13–0.24)	0.14 (0.1–0.21)	0.17 (0.1–0.23)	
RAND-36 domains, points				
Physical function	66.0 (26.1) <sup>b</sup>	72.5 (26.8)	68.8 (25.9)	0.011
Role physical	58.6 (39.8) <sup>b</sup>	68.9 (39.0)	59.7 (40.7) <sup>b</sup>	0.002
Role mental	71.9 (37.3)	78.4 (36.6)	70.9 (37.0) <sup>b</sup>	0.023
Mental health	80.0 (14.9) <sup>b</sup>	83.4 (14.6)	81.0 (14.8)	0.018
Vitality	70.5 (16.2) <sup>b</sup>	76.0 (17.1)	72.4 (16.0) <sup>b</sup>	<0.001
Perceived pain	75.9 (22.4)	78.4 (22.0)	77.1 (22.2)	0.43
Social function	80.1 (21.2) <sup>b</sup>	85.5 (22.0)	79.5 (22.2) <sup>b</sup>	<0.001
General health	54.2 (18.7) <sup>b</sup>	58.6 (17.1)	56.2 (18.5)	0.019
Clinical dementia rating, sum of boxes, mean	0.97	0.72	1.38 <sup>b</sup>	<0.001
Happiness, 0–100 (best), mean	74.2	74.6	74.6	0.96
Reported use of sleep medication, %	25.2	9.9	11.8	<0.001

<sup>a</sup> Data are Means (SD) unless otherwise stated. IQR = interquartile range.

<sup>b</sup> Statistically significant difference compared to the group with sleep duration 7–8 h.

Long sleep in old age was associated with higher mortality risk even after various adjustments, while the effect of short sleep was less clear.

### 4.1. Strengths

The strengths of our study include its very long follow-up and the possibility to assess sleep duration also in old age, 35 years after the baseline assessment. Unlike in most other studies with right censored follow-ups [1–3,9,13], our mortality surveillance extended until death of over 90 % of the participants therefore covering virtually the entire lifespan of the study population. Our study also benefitted from data on a wide range of clinical characteristics and risk factors and a repeated survey which allowed us to confirm the persistence of sleep duration,

**Table 4**

Hazards ratios of 12-year mortality according to contemporary sleep duration group in 2010 (n = 902).

	N (dead)	Hazard ratio (95 % confidence interval) for mortality			
		Model 1 <sup>a</sup>	Model 2 <sup>b</sup>	Model 3 <sup>c</sup>	Model 4 <sup>d</sup>
Sleep duration groups in 2010, h					
<=6	155 (137)	1.41 (1.16–1.72)	1.26 (1.03–1.54)	1.28 (1.01–1.62)	1.19 (0.94–1.51)
>6 and <=8	595 (451)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
>8	152 (127)	1.33 (1.09–1.63)	1.34 (1.10–1.64)	1.29 (1.01–1.65)	1.31 (1.02–1.67)

Variables selected for adjustments were not necessarily significantly different between contemporary sleep duration groups, but were used to be comparable to baseline adjustments.

<sup>a</sup> Unadjusted.

<sup>b</sup> Adjusted for age.

<sup>c</sup> Adjusted for variables in 2010: age, alcohol consumption, BMI and smoking.

<sup>d</sup> Adjusted for age, alcohol consumption, BMI, smoking and self-rated health.

lifestyle profiles and prevalence of old-age frailty and cognition among men with short sleep. While sleep durations in midlife and old age were moderately correlated, the impact of contemporary sleep duration on subsequent mortality seemed different between midlife and old age.

#### 4.2. Possible mechanisms

What are potential explanations for the key findings, *ie* no adjusted association between midlife sleep duration and mortality, but increased mortality risk for long sleepers in old age. Current literature of sleep duration and mortality is vast but often inconsistent and controversial. However, sleep – its duration and quality is widely recognised as an important lifestyle contributor to health [26]. For example, increase risk of obesity and diabetes, hypertension and cardiovascular diseases have been associated with both short and long sleep duration. Possible mechanisms include that sleep itself affects physiological processes and their disturbances lead to adverse effects. Another possibility is reverse causality. Accordingly, poor sleep would be induced by lifestyle, stress and concomitant diseases, which are the real causes of mortality risk (APPENDIX Fig. 1). The true sequence of events cannot easily be solved with observational studies and randomised controlled trials (RCTs) would be needed comparing more vs. less sleep. There are some RCTs, for example, a recent one showing that controlled prolongation of sleep duration led to weight loss [27].

Our results in midlife – especially among healthy participants – may indicate that short sleep is either constitutional (there was a significant correlation between sleep duration in midlife and old age), or affected by unhealthy lifestyle. Therefore, no effect on mortality is seen after adjustments. In old age, on the other hand, sleep duration is mainly affected by health conditions like cognitive disorders [28], although the effect of long sleep on mortality remained after adjustments at hand. We did not measure important conditions like sleep apnea and residual confounding may explain the associations.

Our results do not negate the importance of sleep and various procedures which could reduce environmental factors disturbing adequate sleep [29]. The results may, however, relieve distress among those who cannot reach 7 to 8- h sleep duration. Lifestyle factors and their correction is probably more important.

#### 4.3. Limitations

Our study had a relatively small sample size and included only community-dwelling white men of higher social class. High social status of the participants reduces bias arising from socioeconomic differences, which may affect sleep via multiple mechanisms (lifestyle, stress, differences in morbidity and drug treatments). Further studies including women and other ethnic groups are warranted to examine the generalisability of our findings.

Sleep duration was self-reported at baseline and 35-year follow-up, giving a possibility to assess correlation of sleep duration across the

life course. Considering that the National Sleep Foundation recommends 7 to 9 h of sleep for individuals younger than 65 years [30], the selected cutpoints (<=6, >6 and <=8, and >8 h) may have resulted in the misclassification of men as long sleepers during midlife. In our cohort, only 28 men (1.1 % of the total) reported sleeping 9 or more hours during midlife. In an additional mortality analysis, the multivariable-adjusted hazard ratio for this group, compared to those sleeping between >6 and < 9 h, was 1.41 (95 % CI 0.94–2.11). Although imprecisely estimated, this finding is consistent with our main analysis suggesting a link between longer sleep and mortality in old age.

Data on sleep were based on self-report and studies comparing self-reported and accelerometer/actigraphy-based sleep durations have found that the respondents tend to overestimate their sleep duration [31,32]. A further limitation is that sleep quality and use of sleep medications were only assessed in old age.

## 5. Conclusions

Our findings suggest that the effect of short sleep ( $\leq 6$  h of sleep nightly) in midlife on mortality risk during life-course is nil after adjusting for lifestyle factors associated with sleep duration. Neither did long sleep in midlife show an association with long-term mortality. However, the situation was different in old age when contemporary long sleep, and less consistently short sleep, was associated with subsequent mortality despite adjustments.

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.maturitas.2024.107964>.

## Contributors

Timo E Strandberg participated in data collection and drafting and editing of the paper.

Kaisu H Pitkälä participated in data analysis and revision of the paper.

Mika Kivimäki participated in data analysis and revision of the paper.

All authors saw and approved the final version and no other person made a substantial contribution to the paper.

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The funding sources had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.



## Ethical approval

The HBS study and the mortality follow-up has been approved by the ethical committee of the Department of Medicine, Helsinki University Hospital.

## Provenance and peer review

This article was not commissioned and was externally peer reviewed.

## Research data (data sharing and collaboration)

There are no linked research data sets for this paper. The pseudonymised questionnaire data used in this study can be shared by request to Timo Strandberg ([timo.strandberg@helsinki.fi](mailto:timo.strandberg@helsinki.fi)). Sharing of linked health records requires separate permission from Statistics Finland.

## Declaration of competing interest

TES has had various cooperation (educational, consultative, research with several pharmaceutical companies (Amgen, Novartis, Orion, San-kyo, Sanofi). TES and MK were supported by Finnish Foundation for Cardiovascular Research. MK was also supported by the Wellcome Trust (221854/Z/20/Z), the Medical Research Council (S011676), the National Institute on Aging (R01AG056477), and the Academy of Finland (350426). KHP reports no disclosures.

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