

Sleep Duration, Subjective Sleep Need, and Sleep Habits of 40- to 45-Year-Olds in the Hordaland Health Study

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Study Objective: To report the distribution of various sleep parameters in a population-based study.

Design: Population-based cross-sectional study with self-administered questionnaires.

Setting: Conducted as part of the Hordaland Health Study '97-'99 in collaboration with the Norwegian National Health Screening Service.

Participants: 8860 subjects, aged 40 to 45 years, answered the sleep questionnaire part of the study.

Interventions: N/A.

Measurements and results: Reports on habitual bedtimes, rise times, subjective sleep need, and various sleep characteristics were used in this study. Mean (\pm SD) nocturnal sleep duration during weekdays in men was 6 hours 52 minutes (\pm 55 minutes); in women 7 hours 11 minutes (\pm 57 minutes). Mean subjective sleep need was 7 hours 16 minutes (\pm 52 minutes) in men; 7 hours 45 minutes (\pm 52 minutes) in women. Sleep duration was shorter in shift workers and longer in married subjects and in those

living in rural areas. Subjective sleep need was higher in subjects reporting poor subjective health and in subjects living in rural areas. In total, these variables accounted for only around 3% of the variance in sleep duration and sleep need. Ten percent of the men and 12.2% of the women reported frequent insomnia.

Conclusions: The wide distribution of sleep duration and subjective sleep need indicate large interindividual variations in these parameters. There were pronounced sex differences in these variables and in most of the sleep characteristics studied. Shift work, urban-rural living, marital status, and education in men were sources of significant, but small, variations in sleep duration.

Keywords: Sleep duration, subjective sleep need, interindividual variation, insomnia, sex

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INTRODUCTION

RECENTLY IT HAS BEEN DISCUSSED WHETHER A TENDENCY TO SLEEP TOO LITTLE IS BECOMING A COMMON PROBLEM. IT IS GENERALLY BELIEVED THAT PEOPLE today sleep less than they did only 50 years ago.¹ In a Finnish study with more than 12,000 subjects,² the prevalence of insufficient sleep, defined as a difference of 1 hour between self-reports of sleep need and sleep length, was 20.4%. When a ratio between sleep length and subjective sleep need of less than 0.80 was used as a criterion, 12% of 600 randomly selected subjects fulfilled criteria for persistent insufficient sleep in a Swedish study.³ Insufficient sleep may affect performance,⁴ traffic safety,⁵ and quality of life in general.² However, in a recent study, it was concluded that sleep durations in Britain in 2003 were not very different from

what they were in 1969.⁶ Data from other studies suggest that both short and long sleep durations are associated with increased mortality risk and sleep problems, compared with intermediate sleep durations.⁷⁻⁹ Also, recent studies indicate biologic differences between long and short sleepers¹⁰ and individual differences in responses to sleep deprivation¹¹ and shift work,¹² suggesting interindividual differences in sleep need.¹³

Given the known risks associated with insufficient sleep, it is important to obtain information on sleep duration, subjective sleep need, and sleep characteristics in the population; how they vary; and with what they are associated. The present study is an overview of sleep habits and sleep characteristics from a population-based study in which all inhabitants of Hordaland county, Norway, born between 1953 and 1957 were invited to participate.

MATERIAL AND METHODS

Data Collection

The data collection of this study was conducted as part of the Hordaland Health Study '97-'99. This cross-sectional study was conducted during 1997 to 1999 as a collaboration between the National Health Screening Service, the University of Bergen, and the local health services. The study population included all individuals in Hordaland county born between 1953 and 1957 (N=29,400). Hordaland county (population 445,000) is situated in the western part of southern Norway, at the latitude of 60° north. Daylight varies from 19 hours in June to 6 hours in December. The county is situated around and includes the city of Bergen, which is the second largest city in Norway (population 235,000). A total of 8598 men and 9983 women participated, yielding a participation rate of 63% (57% for men and 70% for women).

The study protocol was approved by The Regional Ethics

Disclosure Statement

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Committee and by the Norwegian Data Inspectorate.

The participants completed self-administered questionnaires with information on various health behaviors. They also underwent baseline physiologic measurements not discussed in this paper (height, weight, waist and hip circumference, blood pressure, and heart rate, and provided a nonfasting blood sample). A subgroup of 8860 persons answered a questionnaire with detailed information on sleep habits and problems. Information was collected on bedtime and rise time during the workweek and during free time, as well as on subjective sleep need. In addition, participants answered questions on whether they thought they slept too little, on sleep satisfaction, sleepiness, falling asleep at work, morningness-eveningness, and insomnia. The questionnaire was given to the subjects when they met for the health screening and was submitted by mail when completed. The present paper deals with sleep habits and sleep characteristics using the data from this subgroup.

VARIABLES

Sleep Variables

The subgroup of 3531 men and 5329 women was given a revised version of Karolinska Sleep Questionnaire.¹⁴⁻¹⁶ Variables analyzed in this study were bedtime and rise time during the week and during free time, sleep latency in minutes during the week and in free time, sleepiness during the week and in free time, falling asleep at work or during free time, insufficient sleep, sleep satisfaction, and morningness-eveningness. A question on subjective sleep need (How much sleep do you need?) was answered in hours and minutes. In addition, the variable "søvnløshet" (direct translation: sleeplessness), here called Insomnia, was formulated and added by the National Health Screening Service as one of the standard questions of the national surveys.

The following questions were answered on a 5-point scale (never, a few times per year, a few times per month, several times per week, always): sleepiness at work or during free time, napping during the day, falling asleep (unintentional sleep, "dip of the head") at work or during free time, and insufficient sleep (at least 1 hour less than the subjective sleep need). The question on morningness or eveningness was also answered on a 5-point scale (pronounced morningness; more morningness than eveningness; neither; more eveningness than morningness; pronounced eveningness), as was the questions on sleep satisfaction ("How do you sleep, generally speaking?" very well, quite well, neither well nor bad, quite poorly, very poorly). The question on insomnia was answered on a 4-point scale (never or a few times a year, 1-2 times per month, about once per week, more than once per week.)

Internal consistency of the scales for sleepiness, napping during the day, falling asleep at work, falling asleep during free time, insufficient sleep, sleep satisfaction, morningness-eveningness, and insomnia was calculated by determining the Cronbach α coefficient. For all 8 scales, the coefficient was 0.63. When the scales for napping during the day and morningness-eveningness were excluded, the coefficient was 0.74.

Urban-Rural Living

Participants from the city of Bergen (including suburbs) and from 4 other communities, with more than 70% of the inhabitants living in densely populated areas according to the National Sta-

tistics Bureau, were characterized as urban (2119 men and 3118 women), participants from all other communities were characterized as rural (1082 men and 1477 women).

Socioeconomic Variables

Education level was answered on a 6-point scale (no education, first to seventh grade, seventh to 10th grade, high school, undergraduate, and graduate university education). In Table 3, the levels were compressed into 2 levels: low education (0 to 10th grade) and high education (high school to graduate university exam).

Income level (family income) was answered on a 9-point scale, which was compressed into low income (up to NOK 399,000 (ca. Euro 48,000; US \$58,000)), and high income (NOK 400,000 or above).

Shift Work and Health Variables

A total of 1838 subjects (768 men and 1069 women) answered yes on a question on whether they had shift work or night work or watches. In general, data from these subjects are included in the calculations with one exception: 50 subjects (14 men and 36 women) who had bedtimes at 5:00 am or later (mean 7:32 am for men and 8:23 am for women) were considered night workers, and data from these 50 subjects are not included in the bedtime and rise-time calculations.

Subjects responded on a 4-point scale to a question on subjective health (How is your health now? poor, not quite good, good, very good).

Periods of Data Collection

The data collection took place from October 1997 up to and including June 1999, during all months except July. Data collection during the months of May, June, August, and September took place almost exclusively in Bergen or other areas described as urban. During the other months, there was data collection both in urban and rural areas, but it was unevenly distributed.

Data Reduction and Statistics

The questionnaires were optically scanned. This was reliable for the category questions in which the subjects ticked one of several categories. However, some errors in scanning of the figures given for bedtimes and rise times were detected by checking the original questionnaires when seemingly abnormal figures appeared during data cleaning. A total of 61 questionnaires were controlled in this manner, 54 (0.6% of the material) had obvious errors and were corrected.

The data were analyzed with Statistical Package for the Social Sciences version 11.5 (SPSS, Inc., Chicago, Ill).

Seasonal changes in weekday sleep duration, free-time sleep duration, or subjective sleep need were evaluated with univariate analyses of variance for each sex separately.

We ran stepwise multiple linear regressions for each sex with the weekday sleep duration or subjective sleep need as dependent variables and with the following independent variables: education (6 levels), family income (9 levels), marital status (2 levels), urban-rural living (2 levels), shift work/watches (yes/no), and subjective health (4 levels). Exclusion of outliers more than 3 SDs from the mean did not alter the results, and these results are

Table 1—Bedtime, Rise Time, Time in Bed, Sleep Duration, and Subjective Sleep Need

	Men			Women			Mean Sex Difference
	Mean	Median	SD	Mean	Median	SD	
Bedtime*							
Weekdays	11:13 PM (11:11-11:15)	11:00 PM	0.46	11:05 PM (11:03-11:06)	11:00 PM	0.41	0.08 (0.05-0.11)
Free time	12:02 AM (12:00-12:04)	12:00 AM	0.54	12:01 AM (11:59-12:03)	12:00 AM	0.51	0.01 (-0.01-0.04)
Rise time*							
Weekdays	6:23 AM (6:21-6:26)	6:30 AM	0.51	6:37 AM (6:35-6:39)	6:30 AM	0.48	0.14 (0.11-0.17)
Free time	8:22 AM (8:19-8:25)	8:30 AM	1.06	8:39 AM (8:36-8:41)	9:00 AM	1.02	
Time in bed ^{†‡}							
Weekdays	7.10 (7.08 - 7.13)	7.00	0.54	7.31 (7.29 - 7.33)	7.30	0.54	0.21 (0.18-0.24)
Free time	8.20 (8.17 - 8.23)	8.30	1.03	8.37 (8.35 - 8.40)	8.30	1.03	0.17 (0.14-0.21)
Sleep duration ^{†§}							
Weekdays	6.52 (6.50 - 6.55)	6.55	0.55	7.11 (7.09 - 7.13)	7.15	0.57	0.19 (0.16-0.22)
Free time	8.02 (7.59 - 8.05)	8.00	1.06	8.18 (8.16 - 8.21)	8.24	1.05	0.16 (0.12-0.20)
Sleep duration with frequent naps included [†]							
Weekdays	7.02 (6.59- 7.04)	7.00	0.57	7.22 (7.19 -7.24)	7.25	0.59	0.20 (0.16-0.23)
Subjective sleep need [†]	7.16 (7.14 - 7.19)	7.00	0.52	7.45 (7.43 - 7.47)	8.00	0.52	0.29 (0.26-0.32)

*Data are presented as clock time for the mean (99% confidence intervals) and medians and as hours and minutes, h.min, for the SD and mean sex difference.

[†]Data are presented as hours and minutes, h.min, (99% confidence intervals)

[‡]Rise time minus bedtime

[§]Time in bed minus sleep latency

^{||}P < .0005

not reported.

We also dichotomized the following sleep characteristics: sleepiness at work or during free time, napping, falling asleep at work, insufficient sleep, and poor sleep satisfaction. We ran logistic regression analysis to identify risk factors for having “poor” sleep characteristics. Covariates in each analysis were weekday sleep duration (continuous variable), subjective sleep need (continuous variable), morningness-eveningness (3 categories), and insomnia (3 categories).

Student t tests and χ^2 analyses were used to assess effects by sex. We used a 2-sided statistical significance level of P = .01.

RESULTS

Bedtime, Rise Time, Time in Bed, Sleep Duration, and Sleep Latency

Mean values, medians, and SD of reported bedtimes and rise times during the weekdays and during free time are given in Table 1, as is calculated time in bed (rise time minus bedtime), sleep duration (time in bed minus sleep latency), and reported subjective sleep need. Mean sleep duration, including the total sleep of frequent nappers, was also calculated.

Twenty-seven percent of the men and 29% of the women reported napping at least several times a week. Two thirds of these (601 men and 854 women) also reported nap length. When nap length was added to the night sleep in these subjects, total sleep was 7 hours 31 minutes (99% confidence interval [CI] 7.25-7.38) in men, compared with night sleep of 6 hours 41 minutes (6.34-6.47) in the same men. In the women nappers, the total sleep was 7 hours 50 minutes (7.45-7.55), whereas mean night sleep was 6 hours 55 minutes (6.50-7.01) in the same subjects.

The distribution of sleep latencies on weekdays was quite skewed. In men, mean sleep latency on weekdays was 18.3 minutes (17.5-19.2) and in women, 20.3 minutes (19.5-21.1), while the median was 10.5 minutes in men and 15 minutes in women.

Fifty percent of the men and 48% of the women had sleep latencies of 10 minutes or less, as suggested from the median. Sleep latencies of 20 minutes or less were reported by 76% of the men and 70.8% of the women. The distribution of sleep latencies during free time did not differ from that of weekday latencies (data not shown).

Table 2A shows the distribution of sleep duration on weekdays and during free time in both sexes. It appears that 40% of the men and more than 50% of the women slept 7 to 8 hours or more on weekdays.

Relationship Between Sleep Duration and Subjective Sleep Need

There was a positive correlation between sleep duration and subjective sleep need in both sexes (men: Spearman rho = 0.38, P < .01; women: Spearman rho = 0.31, P < .01).

Table 2B shows the distribution of subjective sleep need. More than 40% of the men and 55% of the women reported a subjective sleep need of 7.5 to 8 hours. However, a subjective sleep need of 7 hours or less was reported by 52.9% of the men and 29.5% of the women.

Table 2C shows the ratio of sleep duration to subjective sleep need. Eleven percent of the men and 13% of the women had a ratio of sleep duration to subjective sleep need of less than 0.80, suggesting insufficient sleep,³ while approximately one third of both sexes slept equal to or longer than their reported subjective sleep need. In fact, 10% of the men and 7% of the women had a ratio of 1.10 and above. Mean sleep duration was 2 hours shorter in subjects with a ratio less than 0.80, than in subjects with a ratio of 1.10 and higher (men 5 hours 35 minutes vs 7 hours 37 minutes; women 5 hours 56 minutes vs 8 hours 13 minutes). Mean subjective sleep need was 1.5 hours longer in subjects with a ratio under 0.80 than in subjects with a ratio over 1.1 (men 7 hours 55 minutes vs 6 hours 28 minutes; women 8 hours 26 minutes vs 6 hours 59 minutes). The differences in sleep duration and subjective

Table 2—Distribution of Sleep Duration During Weekdays and Free Time, Subjective Sleep Need, and Ratio of Sleep Duration Weekdays to Subjective Sleep Need

Hours	A. Sleep duration								B. Subjective sleep need					
	Weekdays				Free time				Weekdays		Free time			
	Men		Women		Men		Women		Men	Women	Men	Women		
No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	
< 4	28	0.9	31	0.7	20	0.7	11	0.3	10	0.3	5	0.1		
4 - 5	89	2.8	78	1.8	36	1.1	39	0.9	55	1.7	15	0.3		
5 - 6	409	11.6	372	8.5	89	2.8	93	2.1	355	11.3	185	4.2		
6 - 7	1331	42.6	1400	31.9	393	12.5	384	8.7	1241	39.4	1083	24.8		
7 - 8	1058	33.9	1926	43.8	1051	33.3	1277	29.0	1286	40.8	2393	54.8		
8 - 9	174	5.6	516	11.7	1177	37.3	1736	39.5	162	5.1	527	12.1		
9 - 10	23	0.9	55	1.3	338	10.7	721	16.4	37	1.2	140	3.2		
> 10	5	0.2	16	0.4	50	1.6	135	3.1	5	0.2	20	0.5		

Hours	C. Ratio of sleep duration during the week to sleep need			
	Men		Women	
	No.	%	No.	%
< 0.80	325	11.1	500	12.9
0.80-0.89	499	17.0	833	21.5
0.90-0.99	1119	38.2	1428	36.8
1.00-1.09	686	23.4	828	21.4
1.10 >	300	10.2	287	7.4

tive sleep need between all levels of the ratio were significant at $P < .0005$ in both sexes.

Seasonal Distribution

There were no significant differences of sleep duration during the week or during free time, or of subjective sleep need, according to which month, which season, or which half-year data were collected, when controlled for urban-rural living (all tests $P > .20$; data not shown).

Sleep Duration and Subjective Sleep Need in Relationship to Socioeconomic Factors and Subjective Health

Table 3 shows variations in weekday sleep duration and subjective sleep need in relationship to various cofactors.

Sleep Duration

Men with high education levels (see Methods) slept longer during the week than did men with low education levels. Women with high family income slept less during the week than did women with low incomes. Married or cohabitating men and women both slept more than single men and women. Subjects living in rural areas, especially women, slept longer during the week than did subjects living in urban areas. Men and women who reported shift work or watches slept less than those who did not.

To adjust for possible confounding effects, we ran multiple-regression analyses using sleep duration on weekdays as the dependent variable, and education, family income, marriage status, urban-rural living, shift work or watches, and subjective health as independent variables.

Less than 3% of the variance was explained by this model in men ($r^2 = 0.027$). Significant contributions were given by shift work or watches ($r^2 = 0.013$, $P < .001$) and education ($r^2 = 0.006$, $P < .001$) and by marriage status ($r^2 = 0.004$, $P < .01$) and urban-rural living ($r^2 = 0.003$, $P < .01$). Income and subjective health did not contribute to the model in men.

In women, the model explained 3.4% of the variance ($r^2 = 0.034$). Significant contributions were given by shift work or watches ($r^2 = 0.015$, $P < .001$) and urban-rural living ($r^2 = 0.011$, P

$< .001$), marriage status ($r^2 = 0.004$, $P < .001$), and family income ($r^2 = 0.002$, $P < .01$). Education and subjective health did not contribute statistically significantly to the model.

Subjective Sleep Need

Among men, low family income was associated with higher subjective sleep need (Table 3B). Both men and women living in rural areas reported higher subjective sleep needs than those living in urban areas, while shift work did not make any difference. Subjective health, family income, and marriage status (all $P < .001$) and urban-rural living ($P < .01$) explained 2.1% of the variance in men ($r^2 = 0.021$). Of the variables described above, only subjective health and urban-rural living gave significant contributions to the model in women ($P < .001$), and this model explained only 1.6% of the variance in subjective sleep need.

Sleep Characteristics

Table 4 shows the frequency of several characteristics related to sleep and/or waking. In the table, the 5-point scale in the questionnaire is compressed to 3 points.

Sleepiness

About 12% of the men and 15% of the women reported frequent sleepiness at work or during free time, whereas over 40% of both sexes were never sleepy.

Naps

Women had slightly longer naps than men, 48 minutes (99% CI, 47-50 minutes) in women versus 45 minutes (43-46 minutes) in men. Frequent nappers (defined as napping several times a week to always) had longer naps (54 minutes [52-56 minutes]) than infrequent (never/a few times a year) nappers (39 minutes [37-42 minutes]).

Falling Asleep at Work or During Free Time

Of the men, 8.5% and of the women, 3.6% reported that they

Table 3—Weekday Sleep Duration (hours.minutes) and Subjective Sleep Need (hours.minutes) Associated With Education Level, Family Income, Marital Status, Urban/Rural Living, Shift Work and Subjective Health

	No.	Men	N	Women	Mean sex difference
A. Sleep Duration					
Education					
High	1514	6.57 (6.53-7.00) **	2144	7.10 (7.07-7.13)	0.13 (0.09-0.18)***
Low	1600	6.48 (6.44-6.52)	2226	7.12 (7.09-7.16)	0.24 (0.19-0.29)***
Family income					
≥ 400 000	1551	6.55 (6.52-6.69)	2055	7.09 (7.06-7.12)*	0.13 (0.09-0.18)***
< 400 000	1526	6.48 (6.44-6.52)	2135	7.13 (7.10-7.17)	0.25 (0.20-0.30)***
Married/Cohabitant					
Yes	2670	6.54 (6.51-6.57) *	3690	7.13 (7.10-7.15)**	0.19 (0.16-0.22)***
No	402	6.43 (6.34-6.51)	575	7.02 (6.55-7.08)	0.19 (0.08-0.29) ***
Urban-rural					
Urban	2077	6.51 (6.48-6.54) *	2985	7.07 (7.05-7.10)**	0.17 (0.12-0.21)***
Rural	1060	6.55 (6.51-6.59)	1421	7.19 (7.16-7.23)	0.25 (0.19-0.30)***
Shift work/watches					
Yes	719	6.41 (6.34-6.48)**	975	6.58 (6.53-7.04)**	0.17 (0.09-0.21) ***
No	2338	6.55 (6.53-6.58)	3189	7.14 (7.12-7.17)	0.19 (0.15-0.22) ***
Subjective health					
Good	2778	6.53 (6.50-6.56)	3801	7.12 (7.09-7.14)	0.19 (0.17-0.21) ***
Poor	340	6.47 (6.37-6.56)	564	7.07(7.00-7.15)	0.20 (0.11-0.29) ***
B. Subjective sleep need					
Education					
High	1537	7.19 (7.16-7.22)	2074	7.45 (7.43-7.48)	0.27 (0.23-0.31) ***
Low	1603	7.14 (7.11-7.18)	2258	7.45 (7.42-7.48)	0.31 (0.26-0.36) ***
Family income					
≥ 400 000	1551	7.14 (7.11-7.17) **	1993	7.42 (7.39-7.45)	0.28 (0.24-0.32) ***
< 400 000	1530	7.18 (7.14-7.22)	2160	7.48 (7.45-4.51)	0.30 (0.25-0.35) ***
Married/Cohabitant					
Yes	2674	7.16 (7.13-7.18) **	3629	7.45 (7.43-7.49)	0.29 (0.26-0.31) ***
No	404	7.20 (7.13-7.27)	589	7.47 (7.41-7.53)	0.27 (0.20-0.34) ***
Urban-rural					
Urban	2113	7.14 (7.11-7.17) *	2950	7.43 (7.41-7.46)**	0.30 (0.26-0.33) ***
Rural	1037	7.22 (7.17-7.26)	1418	7.49 (7.46-7.53)	0.27 (0.22-0.33) ***
Shift work/watches					
Yes	766	7.17 (7.12-7.23)	994	7.44 (7.40-7.49)	0.27 (0.20-0.34) ***
No	2291	7.16 (7.13-7.18)	3084	7.45 (7.42-7.47)	0.29 (0.25-0.32) ***
Subjective health					
Good	2774	7.15 (7.13-7.18)**	3725	7.43 (7.41-7.45)**	0.28 (0.25-0.31) ***
Poor	357	7.29 (7.20-7.37)	609	7.59 (7.52-8.06)	0.30 (0.19-0.41) ***

Data are presented as means (99% confidence intervals); all values are mutually adjusted.

*P < .01

**P < .001

***P < .0005

fell asleep at work at least a few times a month, while more than 90% (96.4 % of women) never or very seldom did so.

Insufficient Sleep

About 20% reported getting at least 1 hour less than their subjective sleep need several times a week or always. However, about 40% of both sexes reported that this occurred only a few times a year or never.

Sleep Satisfaction

Close to 80% of the subjects reported good to very good satisfaction with their sleep. Six percent reported poor or very poor sleep satisfaction.

Morningness-Eveningness

More subjects reported evening preference—around 40%—than morning preference—around 30%. The difference was larger in women than in men.

Insomnia

Ten percent of the men and 12% of the women reported insomnia one or more times per week, equaling 11.4% of the total material. An additional 20% of both sexes reported insomnia 1 to 2 times per month.

Relationship Between Sleep Characteristics and Sleep Duration, Subjective Sleep Need, and Insomnia

Table 5 shows to what extent sleep duration, subjective sleep

Table 4—Sleep Characteristics

	Men (n=3531)		Women (n=5329)		Sex difference χ^2 P <
	Respondents, no.	%	Respondents, no.	%	
Sleepiness at work or during free time	3194		5170		P < .0005
Never or a few times a year		46.3		40.2	
A few times a month		42.0		45.2	
Several times a week to always		11.7		14.6	
Napping during the day	3191		5226		P = .034
Never or a few times a year		40.1		37.7	
A few times a month		33.3		33.4	
Several times a week to always		26.5		28.9	
Falling asleep at work	3087		4997		P < .0005
Never or a few times a year		91.5		96.4	
A few times a month		7.4		3.2	
Several times a week to always		1.1		0.4	
Falling asleep during free time	3346		5153		P = .072
Never or a few times a year		76.4		78.6	
A few times a month		19.3		17.6	
Several times a week to always		4.3		3.8	
Insufficient sleep (at least 1 h less than needed)	3165		5106		P = .009
Never or a few times a year		42.8		41.4	
A few times a month		38.3		36.9	
Several times a week to always		18.9		21.7	
Sleep satisfaction	3235		5261		P = .003
Very good to good		77.2		79.9	
Neither good nor poor		16.8		14.1	
Poor to very poor		5.9		6.0	
Morningness or eveningness	3237		5246		P < .0005
Morningness		33.8		30.2	
Neither		28.1		25.1	
Eveningness		38.1		44.7	
Insomnia	3213		5213		P = .010
Never or a few times a year		70.7		67.7	
1-2 times/month		19.3		20.1	
About 1 time/week		5.2		6.5	
> 1 time/week		4.8		5.7	

Five category responses (see Methods) are compressed to 3 categories.

Table 5 – Mutually adjusted odds ratios and 99% confidence intervals (CI)* for sleepiness at work or during free time, napping, falling asleep at work, insufficient sleep and sleep satisfaction.

Risk factors:	Odds ratios (and 99% CI) for reporting:				
	Sleepiness at work or during free time**	Napping**	Falling asleep at work***	Insufficient sleep**	Sleep satisfaction****
Sleep duration weekdays (per hour)	0.7 (0.6-0.8)	0.7 (0.6-0.7)	0.7 (0.6-0.8)	0.4 (0.3 -0.4)	0.6 (0.5-0.8)
Subjective sleep need (per hour)	1.9 (1.8-2.2)	1.3 (1.1-1.4)	1.2 (1.0-1.5)	1.9 (1.6-2.1)	1.1 (0.9-1.4)
Insomnia					
Never or a few times/year	1.0	1.0	1.0	1.0	1.0
1-2 times/month	1.7 (1.3-2.3)	1.1 (0.9-1.4)	1.6 (1.1-2.3)	1.6 (1.2-2.0)	4.4 (2.4-8.0)
Once or more/week	4.5 (3.2-6.0)	0.8 (0.6-1.0)	2.5 (1.6-3.8)	7.0 (5.2-9.3)	66.2 (39.6-110.9)

*Also adjusted for gender, education (continuous, six levels), income (continuous, nine levels), marriage status (2 categories), urban/rural living (2 categories), shift work (yes/no) morningness-eveningness, and subjective health (4 categories). Confidence intervals that do not include one are printed in bold.

** several times a week to always

*** a few times a month to always

**** poor to very poor

need, and insomnia are risk factors for sleepiness at work or during free time, napping, falling asleep at work, insufficient sleep, and sleep satisfaction. Insomnia was the strongest risk factor for

sleepiness, falling asleep at work, insufficient sleep, and, in particular, poor sleep satisfaction, but not for napping. Sleep duration was inversely associated with all the outcomes, and short

sleep duration was a risk factor, particularly for insufficient sleep. High subjective sleep need was a moderate risk factor for sleepiness and insufficient sleep, with almost doubling of the risk of sleepiness and insufficient sleep per hour of reported subjective sleep need. Sex was not a significant risk factor, except for falling asleep at work; men were at 2.6-fold elevated risk (99% CI = 1.8-3.6) as compared with women. We also adjusted for morningness-eveningness, which was a significant risk factor only for insufficient sleep (odds ratio = 1.4 for eveningness vs morningness, 99% CI = 1.0-2.0 in both sexes), and for shift work, which was not an independent predictor of any of the outcomes (data not shown).

DISCUSSION

The present study is an overview of the self-reported sleep habits and sleep characteristics in a population of 40- to 45-year-old men and women and an investigation of some basic relationships within these data. There were large interindividual differences in sleep duration, sleep need, and sleep sufficiency. Mean values of sleep duration did not differ much from those of studies conducted in other countries. Sex differences were pronounced in most variables studied.

In a study of self-reported sleep measures, Gehrman et al¹⁷ found that quantitative estimates of usual sleep behavior were highly reliable. However, it should be kept in mind that the data reported here are subjective, self-reported from memory on a single occasion, and provided as a traditional point estimate.¹⁷ The quality of the data may therefore vary with the question asked. It is reasonable to suggest that the weekday time-in-bed data are of fairly good quality, as they are based on statements of habitual bedtime and rise time, eliminating the high variation in sleep-latency data, although it should be remembered that waking periods during the night were not reported. For free time, however, the subjects tended to report bedtimes and rise times in whole hours, since these variables probably vary more during free time than during the work week. For this reason, the relationships between socioeconomic and other factors and sleep duration were computed for the weekday sleep-duration data only.

The distribution of weekday sleep duration was quite wide. This is consistent with results reported in Finnish,¹⁸ Japanese,⁸ and British⁶ populations. Sleep duration varied in relationship to work situation, and urban or rural living, and inconsistently with socioeconomic variables. However, these factors only explained around 3% of the sleep-duration variance in this population. Subjects who reported having shift work had a mean of 15 minutes shorter sleep duration than did subjects who did not report working shifts. Shift workers may sleep less, depending on their shift schedule¹²; also, shift workers in the age group of the present subjects often have sleep problems.¹⁹ The longer sleep duration in rural areas may be related to more outdoor work and, therefore, more physical activity, which may increase sleep in trained subjects,²⁰ more exposure to daylight which may be beneficial for sleep regulation, and possibly a more relaxed lifestyle. Men with high education slept longer than men with low education. This may be related to the well-known association of socioeconomic factors and health.²¹ Subjective sleep quality, although not sleep duration, has been demonstrated to be related to socioeconomic factors.²² It has been suggested that sleep may play a role in translating socioeconomic factors into health.^{22,23} Interestingly, women with high family income slept less than women with low

family income, suggesting “double workload” in these women. In our study, subjective health had no impact on sleep duration when we controlled for the above-mentioned factors.

The distribution of reported subjective sleep need was also quite wide. This is similar to the reports in the Hublin et al's Finnish study² and also to the “Sleep in America” poll.²⁴ In these studies, subjective sleep need was defined as the amount of sleep needed “to be alert the next day,”²² or “not to feel sleepy the next day.”²⁴ In the present study, no such definition was given. It may be speculated on how our subjects interpreted the question on subjective sleep need. Their reports may have been based on available health information or on the subjects' own experience and, related to this, may have depended on the subjects' acquired sleep habits. The wide distribution, together with the strong correlation between sleep duration and subjective sleep need, points toward the two last possibilities. In our study, reported subjective sleep need, like sleep duration, was higher in rural than in urban areas. Slightly higher subjective sleep need was reported by men with lower than men with higher income. We also found that subjective sleep need was higher in subjects reporting poor subjective health than in subjects reporting good health. These findings are consistent with the associations between the socioeconomic factors, health, and sleep discussed above²¹⁻²³ and with findings of an association of sleep quality with subjective health complaints.²⁵ Shift work and marital status had no influence on subjective sleep need. The factors discussed, however, only explained less than 2% of the subjective sleep need variance.

The low impact of socioeconomic factors may be a consequence of the Norwegian society being relatively homogenous. Another reason why we were able to explain only a small part of the variance in sleep duration and subjective sleep need may be that these interindividual differences are explained by numerous physiologic and genetic factors that we did not measure. Differences between long and short sleepers in nocturnal plasma melatonin levels and body temperature and in early-morning onset of the cortisol increase have been demonstrated, suggesting a longer biologic night in long sleepers than in short sleepers.¹⁰ Interindividual differences in impairment from sleep deprivation have been described that are not due to variations in sleep history.¹¹ Genetic aspects of sleep control are beginning to be evaluated,²⁶ and it has been demonstrated that homeostatic regulation of sleep in mice is under genetic control.²⁷ Recently, a simple model system for sleep is being developed using the fruit fly.²⁸ In this species, different mutant lines have been demonstrated for a wide distribution of sleep amounts.²⁹

Approximately 20% of both sexes reported sleeping 1 hour less than their subjective sleep need, the definition of insufficient sleep given by Hublin et al.² However, similar to the finding by Broman et al,³ only 11% of men and 13% of women had insufficient sleep according to their criterion on insufficient sleep, a ratio of sleep duration to subjective sleep need of less than 0.80. This is corroborated by the reported frequent daytime sleepiness, which was less than 15% in both sexes. Our study indicates a quite wide distribution on the question on sleep insufficiency. About one third of our subjects had a ratio less than 0.9, another third had a ratio between 0.9 and 1, and about one-third slept as much as or more than their subjective sleep need. Thus, in the present population, the main trend is more of that of adequate sleep than of insufficient sleep, when comparing sleep duration to reported

subjective sleep need. As expected, sleep duration was shorter than the population average in subjects with sleep insufficiency, indicated by a low ratio. More unexpectedly, these subjects also reported a much higher subjective sleep need than the population average. Since poor subjective health was associated with high subjective sleep need, this may suggest poor health in insufficient sleepers. The subjects sleeping longer than their subjective sleep need, as expected, had longer sleep duration but also reported a shorter subjective sleep need than the population average. Possibly, core sleep, as described by Horne,³⁰ was reported by these subjects as their subjective sleep need, while the rest of the night was optional sleep bordering on oversleep.³⁰

Naps were an important part of total sleep in some subjects. Mean night sleep duration in our nappers was shorter than in the whole population, consistent with findings of reduced night sleep in older subjects who took siesta naps.³¹ However, adding the naps to the night sleep gave a total sleep duration in the nappers as much as 50 minutes longer than their mean night sleep duration and increased the mean sleep duration in the whole sample by 10 minutes in both sexes. Unlike sleepiness, insomnia or high subjective sleep need was not a risk factor for napping, suggesting a sleep pattern of choice rather than of necessity. Our findings on napping underline the problem of getting adequate information on daily sleep without getting information about napping, as pointed out by Ferrara and De Gennaro.¹ Unfortunately, detailed nap information was only given by 20% of the subjects. Thus, while the nap data illustrate the problem, we felt that the data from the night sleep duration were more reliable; therefore, these data were used in the further analysis and discussion of sleep duration.

According to our data, 40- to 45-year-olds report bedtimes and rise times that indicate a mean time in bed during the workweek of a little over 7 hours in men and 7.5 hours in women. Mean sleep duration during the workweek was approximately 20 minutes shorter than time in bed in both sexes, corresponding to the mean sleep latency of around 20 minutes.

In a study of 400 British adults, Reyner and Horne³² recorded sleep logs in 3 age groups, the 1 closest to our material had a sleep-period time in men of 6 hours 49 minutes and in women of 7 hours 34 minutes; thus, their results were very similar to ours. In a large Finnish study carried out in 1975, a mean sleep length of 7.9 hours (7 hours 54 minutes) in 18- to 60+-year-old subjects was reported.¹⁸ In the 2002 “Sleep in America” poll,²⁴ comprising 1010 subjects over 18 years of age, mean sleep duration was 6.7 hours (6 hours 42 minutes) in men and 7.0 hours in women. Thus weekday sleep duration in our 40- to 45-year-olds tended to be shorter than the sleep duration reported in the 1975 Finnish study but fairly similar to that of the American study, considering that the American sample also included older people. In a small sample of 96 female office employees, aged 19 to 62 years, we found a mean time in bed of 7.4 hours (7 hours 24 minutes),³³ only slightly shorter than in our present study. Self-reported sleep duration was 6 hours 55 minutes in a sample of 273 volunteers aged 40 to 64 years who lived on the west coast of the United States.³⁴ A recent representative British survey covering 16- 93-year-olds reported a mean sleep duration of 7.04 hours for both sexes and a somewhat shorter time in the 40- to 49-year-old men.⁶ These studies have been carried out in different countries, in different size groups, in variable age groups, with different methods of sampling, and with different types of questions posed to the participants. Yet,

the mean values of sleep duration seem to vary surprisingly little, taking into account the fairly wide distribution. Interestingly, Kleitman and Kleitman, in their 1953 report³⁵ on sleep patterns in the Arctic, concluded that an average of 7 hours of sleep per night is probably compatible with the maintenance of well-being in human adults.

The difference in time in bed between weekday and free time was more than 1 hour in both sexes and double the difference between the weekday and free time in the “Sleep in America” poll.²⁴ Rise time was 2 hours later during free time than during the week in both sexes. This may suggest some recovery of sleep debt during free time, or it may reflect oversleep³⁰ or indulgence—the pleasure of not having to rise early—and could be connected to the higher frequency of eveningness than morningness preference found in this group of subjects.

There was no seasonal variation of sleep duration or subjective sleep need in the present normal population, despite the large variation in daylight during the year in which the data were collected. This is consistent with polygraphic findings from a small group of healthy men from Tromsø, Norway (latitude 70° north).³⁶ Kleitman and Kleitman,³⁵ in their 1951 interviews on sleep habits of people living in Tromsø, reported a 1 hour longer sleep duration in winter than in summer. However, rise time was the same during the 2 seasons, and bedtime in the winter was probably affected by the fact that electricity was turned off at 9:00 pm throughout the year.³⁵

The question on insomnia in the present study was unqualified as to the content of the term employed. The prevalence of insomnia, as defined by the occurrence once per week or more, was 11.4% in the whole population. This is close to the prevalence of 11.7% reported in a study by Pallesen et al³⁷ on a representative adult Norwegian sample, employing Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSMIV) inclusion criteria. Both are lower than the overall prevalence of insomnia symptoms of 37.6% in a Finnish population.³⁸ However, these authors also report much lower prevalence (11.3%) when using DSMIV criteria. Much higher values, 58%, are reported from the “Sleep in America” poll, using somewhat broader criteria,²⁴ making it difficult to directly compare the data sets. The Finnish finding³⁸ of a global sleep dissatisfaction of 11.9% is higher than the 6% in our sample who reported poor or very poor sleep satisfaction. In a representative sample from Germany, however, global sleep dissatisfaction was reported by 7% of 4115 subjects aged 15 years or older,³⁹ which was closer to our finding. In our subjects, poor sleep satisfaction was clearly associated with insomnia; insomnia was also the main risk factor for sleepiness, falling asleep at work, and reported insufficient sleep.

More subjects reported eveningness than morningness. In a study comparing young (25-38 years) and middle-aged (40-58 years) subjects, the middle-aged subjects tended toward a phase advance of sleep and temperature rhythms.⁴⁰ We also found a higher report of eveningness in the women. This is contrary to findings from a study⁴¹ using the Horne-Ostberg questionnaire in which an evening preference in men was described, although in younger (students aged 18-30 years) subjects than ours. We did not use this questionnaire; thus, the data are not quite comparable. Our finding may relate to the higher subjective sleep need in women and to a finding of higher need for sleep in subjects who score higher on the eveningness scale.⁴²

Sex differences in sleep duration and, especially, subjective sleep need were quite conspicuous in our material. Not all the studies cited above on sleep duration focus on sex differences. However, Reyner and Horne³² found significant sex differences in sleep duration, as did Jean-Louis et al,³⁴ Broman et al,³ and, recently, Groeger et al⁶ in the age group 40 to 49 years, all with higher values in women. A higher sleep need in women than in men has also been reported by Lindberg et al.⁴³ The higher subjective sleep need in women may be some of the background for the higher frequency of insomnia in women. The reason for the higher reports of subjective sleep need in women is not clear. Other sleep characteristics also differ between sexes, and sex hormones, endogenous or exogenous, may play a role (see Manber et al⁴⁴ for a review).

In conclusion, the main trend in the present population is more that of adequate sleep than of insufficient sleep, when comparing sleep duration to reported subjective sleep need. The study underlines the interindividual variability in sleep duration as well as in subjective sleep need. Shift work, urban-rural living, marital status, and socioeconomic factors contributed significantly to the variance in sleep duration, while subjective health, urban-rural living, and socioeconomic factors contributed to the variance in subjective sleep need. Only a very small part of the variance for both sleep duration and subjective sleep need was explained by these factors. This suggests that physiologic and genetic factors may be important for the interindividual variation of sleep duration and subjective sleep need.

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