Normative Sleep Data, Cognitive Function and Daily Living Activities in Older Adults in the Community

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Study Objectives: To present normative data of sleep-wake characteristics and to examine risk factors associated with extreme values (ie, in the 5 lower and upper percentiles of the distribution) in older adults.
Design: Cross-sectional telephone survey
Setting: The metropolitan area of Paris, France.
Participants: A total of 7010 randomly selected households were contacted. Among them, 1264 households included at least 1 resident 60 years of age or older; 1,026 subjects agreed to participate (participation rate: 80.9%).
Interventions: None.
Measurements and Results: Subjects were interviewed with the Sleep-EVAL System about their sleeping habits and sleep and psychiatric disorders. In addition, the system administered to all the participants the Psychological General Well-Being Schedule, the Cognitive Difficulties Scale (Mac Nair-R), and an independent living scale. The median nighttime sleep duration was 7 hours without significant difference between the age groups. Factors positively associated with the 5 percentile (4 hours 30 minutes or less) of nighttime sleep duration were obesity, poor health, insomnia, and insomnia accompanied by daytime sleepiness and cognitive impairment. At the other extremity (95th percentile), long sleep (9 hours 30 minutes or more) was associated with organic disease, lack of physical exercise, and lower education. A daytime sleep duration of 1 hour or more (95th percentile) was associated with being a man, cognitive impairment, high blood pressure, obesity, and insomnia. Long sleep latency (95th percentile at 80 minutes) was associated with anxiety, lower education, poor health, insomnia without excessive daytime sleepiness, and obstructive sleep apnea syndrome. Obesity and loss of autonomy in activities of daily living was associated with both early (9 PM or earlier) and late bedtime (1 AM or later) and early (≤ 5 AM) and late (≥ 9 AM) wake-up time.
Conclusions: This study illustrates the usefulness of normal distributions of sleep parameters in the general population to calculate different risk factors associated with extreme values of the normal distribution.
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INTRODUCTION

THE AGING PROCESS IS CHARACTERIZED BY, AMONG OTHER THINGS, CHANGES IN SLEEP-WAKE PATTERNS. SEVERAL EPIDEMIOLOGIC STUDIES HAVE pointed out the increase in sleep disturbances among elderly people, sometimes reaching up to 50% of this specific part of the population.[1-4] This does not mean, however, that these disturbances result in complaints of poor sleep quality. On the other hand, polysomnographic studies on healthy elderly individuals have revealed a significant decrease with age in the total sleep time, the amount of slow-wave sleep, and sleep efficiency and an increase in time awake after sleep onset.[4-9] A shift toward earlier bedtime and earlier wake-up time has also been observed.[10] Epidemiologic studies have been parsimonious in giving information about the sleep of healthy individuals, as if sleeping well was mundane. Considering the large number of individuals who have a variety of sleep complaints, however, sleeping well appears to be an art. Therefore, understanding sleep disturbances consists in studying not only what is considered abnormal, but also what can be qualified as normal and under what circumstances. There are several ways to achieve this goal. Polysomnographic studies with healthy individuals are one of them.[11] Another possibility is to examine sleep-wake data as reported by the individuals with a statistical approach and to define cut-points that will help physicians and healthcare providers to identify individuals at greater risks of having sleep disturbances.

Consequently, this study has 2 aims: first, to present statistical normative sleep data of a community-based elderly sample representative of the general population of the metropolitan area of Paris in terms of sleep-wake characteristics, and, second, to examine variables associated with extreme values (ie, in the fifth lower and upper percentiles) of the sleep-wake characteristics.

METHODS

Study Design

The study was performed by telephone in the metropolitan area of Paris from October 13, 1999, to April 28, 2000. This study was approved by the ethics committee of the Bichat Hospital (Paris). The targeted population consisted of noninstitutionalized individuals 60 years of age or older. This age range represented approximately 4.5 million inhabitants. Telephone numbers were randomly selected to represent the Parisian population according to the 1999 census (INSEE). The Kish method,[12] a controlled selection method, was applied to maintain the representation of the sample according to age and sex.

Disclosure Statement
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Participants

A total of 7010 households were contacted. Among them, 1269 included at least 1 resident 60 years of age or older. A total of 1026 subjects agreed to be interviewed. The participation rate (80.9%) was calculated based on the number of completed interviews (n=1026) divided by the number of eligible telephone numbers, which included all residential numbers not meeting any of the exclusion criteria (N=1,269).

Excluded from the study were subjects younger than 60 years old (n=5392), those who did not speak sufficient French (n=168), and those who suffered from a hearing or speech impairment (n=79) or an illness (n=102) that precluded them from being interviewed.

Interviewers explained the goals of the study to potential participants before requesting verbal consent. Interviews were conducted by telephone using the Sleep-EVAL System at the Xavier Bichat Faculty of Medicine of the Paris 7 University. More details on the methodology can be found elsewhere.[13]

Instrument

The Sleep-EVAL System was specifically designed to administer questionnaires and to conduct epidemiologic studies on mental and sleep disorders in the general population.[14,15] It managed the telephone calls (generation of new numbers and management of appointments and numbers that had to be called back) and the Kish selection procedure. It also kept track of all telephone calls made (date and time, interviewer who called, issue of the call, duration of the call, elapsed time between each call, number of questions asked during the call, and number of times the number was dialed).

The Sleep-EVAL System includes a nonmonotonic, level-2 inference engine endowed with a causal reasoning mode. These features enable the Sleep-EVAL System to formulate a series of diagnostic hypotheses based on the responses provided by a subject (causal reasoning). The nonmonotonic, level-2 inference engine examines these hypotheses and confirms or rejects them through further questions and deductions. Two classifications are implemented in the knowledge base of the Sleep-EVAL System: the Diagnostic and Statistical Manual of Mental Disorders, fourth edition (DSM-IV)[16] and the International Classification of Sleep Disorders (ICSD).[17]

The Sleep-EVAL System formulates initial diagnostic hypotheses on the basis of responses to a standard set of questions posed to all subjects. Concurrent mental diagnoses are allowed in accordance with the DSM-IV. The system terminates the interview once all ICSD and DSM-IV diagnostic possibilities are exhausted. The system selects and phrases the questions to be administered and provides examples and instructions on how to ask them. The interviewer simply reads out the questions as they appear on the monitor and enters the responses. Questions can be close-ended (eg, yes-no, present-absent-unknown, 5-point scale) or open-ended (eg, name of illness, duration). The system has been validated in various contexts and has been demonstrated to be reliable and valid. Five validation studies have been conducted.[18-20]

In this study, the standard questionnaire of the Sleep-EVAL System covered (1) sociodemographic information; (2) the sleep-wake schedule; (3) symptoms of sleep disorders; (4) sleep hygiene; (5) current and past consumption of alcohol, tobacco, coffee; (6) current and past consumption of medication for sleep, to reduce anxiety, antidepressants; (7) any other type of medication; (8) medical information; (9) height and weight; (10) DSM-IV and ICSD diagnoses; (11) The Cognitive Difficulties Scale (McNair-R);[21,22] (12) the Psychological General Well-Being Schedule;[23,24] (13) the Mini-Mental State Examination[25,26] (praxis was not assessed because it requires a face-to-face meeting); and (14) the Functional Assessment—instrumental activities of daily living (IADL).[27]

Variables

Bedtime was obtained by asking the subjects at what time they went to bed with the intention of sleeping. The sleep latency was obtained by asking the subjects how long it took them to fall asleep once they went to bed with the intention of sleeping. The nighttime sleep duration was obtained by asking to participants how long they slept during the night. Another question was asked about sleep duration during the day. Wake-up time was obtained by asking the subjects at what hour they awakened in the morning. This information was obtained for the last week and last year.

The IADL[27] is an 8-items scale assessing the ability of the subject to perform simple everyday tasks (using the telephone, shopping, preparing food, keeping house, doing laundry, traveling, responsibility for medications, and ability to handle finance). The average score ranged from 0 (totally independent) to 16 (totally dependent). The IADL score was divided into 3 categories: independent (0-4), assistance requested (5-11), and dependent ($\geq$ 12).

Anxiety and depressive mood were assessed using anxiety and depressed mood subscales of the Psychological General Well-Being Schedule.[23,24] Response options for questions in each subscale are scored on a scale of 0 to 5. The anxiety subscale is composed of 5 items. The total score ranges from 0 (high anxiety) to 25 (no anxiety). Anxiety is present when the score is lower than 20. The depressed mood subscale is composed of 3 items. The score range for this subscale is 0 to 15. Depressed mood is present when the score is lower than 10.

The Cognitive Difficulties Scale[21,22] is a 26-item self-reporting measure of memory and general cognitive complaint utilizing Likert-type scaling. The scale is composed of 6 dimensions: Distractibility, Prospective Memory, Orientation, Language, Fine Motor (praxis), and Long-term Memory. Response options for each item are scored on a scale of 0 to 4. The total score ranges from 0 (no difficulty) to 104 (high cognitive difficulties). A score of 46 or higher indicates the presence of at least mild cognitive difficulties.

High blood pressure was defined as either a current diagnosed hypertension, with or without antihypertensive medication, or a blood pressure >160/95 mm Hg).

Body mass index was calculated using the weight in kilograms divided by height (in meters) squared.

Statistical Analyses

Since the recruited sample matched French census data in terms of age and sex distribution, it was unnecessary to apply a post-stratification. Mean, median, and percentiles were calculated for each sleep-wake characteristic. Analyses of variance with posthoc multiple comparison Dunnett C were used to analyze continuous variables. When basic assumptions for the use of these statistical methods were violated, nonparametric tests were also calculated (Kruskal-Wallis and Mann-Whitney tests).

Logistic regressions[28] were used to compute the odds ratios

Table 1—Sociodemographic Characteristics of the Sample

	No.	Men %	Women %	Total %
Age groups, y				
60-64	246	28.9	20.7	24.0
65-69	234	25.7	20.8	22.8
70-74	205	18.0	21.3	20.0
≥75	341	27.4	37.1*	33.2
Marital status				
Single	124	11.4	12.5	12.1
Married	451	67.7	28.0	44.0
Separated/divorced	104	6.6	12.5	10.1
Widowed	347	14.3	46.9*	33.8

* Men vs Women P<.001

Table 2—Nighttime and 24-Hour Sleep Duration by Age Groups and Sex

	Nighttime sleep duration			24-hour sleep duration		
	Mean	SEM	95% CI	Mean	SEM	95% CI
Total sample						
60-64	7:04	0.09	6:53-7:15	7:19	0.12	7:05-7:33
65-69	7:14	0.09	7:03-7:25	7:26	0.10	7:15-7:38
70-74	7:04	0.10	6:52-7:15	7:16	0.10	7:05-7:28
≥75	7:10	0.09	6:59-7:21	7:26	0.10	7:14-7:37
All (≥60)	7:08	0.05	7:02-7:14	7:23	0.05	7:16-7:29
Men						
60-64	7:02	0.14	6:45-7:19	7:25	0.20	7:01-7:49
65-69	7:21	0.14	7:05-7:38	7:38	0.15	7:21-7:56
70-74	7:02	0.15	6:44-7:21	7:16	0.15	6:58-7:34
≥75	7:36	0.16	7:16-7:55	8:01*	0.18	7:39-8:22
All (≥60)	7:16	0.08	7:07-7:25	7:37	0.09	7:26-7:47
Women						
60-64	7:05	0.12	6:52-7:20	7:14	0.13	6:59-7:29
65-69	7:08	0.13	6:53-7:23	7:17	0.13	7:01-7:32
70-74	7:05	0.12	6:50-7:19	7:16	0.13	7:01-7:31
≥75	6:57	0.11	6:44-7:10	7:08	0.11	6:55-7:22
All (≥60)	7:03	0.06	6:56-7:10	7:13	0.06	7:06-7:20

Data are shown in hours:minutes. 95% CI refers to 95% confidence interval of the mean.
Analysis of variance nighttime sleep duration: Age: NS; Sex: $F_{1,1025}$=3.816; *P*=.05; Age × Sex: $F_{3,1025}$=3.134; *P*=.025.
Analysis of variance 24-hour sleep duration: Age, NS; Sex: $F_{1,1025}$10.543; *P*=.001; Age × Sex: $F_{3,1025}$=3.360; *P*=.02
*Posthoc multiple comparison Dunnett C *P*<.05 with 70-74 years of age category.

(OR) associated with (a) long sleep duration, (b) short sleep duration, (c) early bedtime, (d) late bedtime, (e) early wake-up time, and (f) late wake-up time. Dichotomous variables were created for which the absence of the condition (eg, short sleep) included individuals who were between the 26th and 74th percentiles of the values of a given variable. Collinearity between variables (ie, information redundancy) was verified beforehand. Reported differences were significant at .05 or less.

RESULTS

This sample was composed of 1026 subjects 60 years old and over. As seen in Table 1, these subjects were 65 years or older in 76% of the cases. The ratio of men to women changed between age groups, with women representing 66.9% of subjects 75 years of age and older. Women were more frequently widowed, whereas men were more often married (Table 1). More than half of subjects (52%) between 60 and 64 years of age were active (ie, working or doing an activity at least 3 days per week). This rate was 43.2% in the 65- to 69-year-old age group; 40% in the 70- to 74-year-old age group; and 28.2% in the group of subjects aged 75 years or older.

Table 3—Daytime Sleep Duration in Minutes by Age Groups and Sex

	No.	Mean	SEM	95% CI
Total				
60-64	246	12.02	0.03	8.09-15.95
65-69	234	12.32	0.03	8.86-15.79
70-74	205	12.55	0.03	9.08-16.02
≥75	341	15.85	0.03	12.69-19.01
All (≥60)	1026	13.47	0.01	11.71-15.22
Men				
60-64	119	15.34	0.05	9.07-21.61
65-69	106	17.15	0.04	11.83-22.47
70-74	74	13.99	0.04	8.73-19.24
≥75	113	24.69	0.06	17.34-32.04
All (≥60)	412	18.13	0.03	14.96-21.29
Women				
60-64	127	8.92	0.04	4.06-13.77
65-69	128	8.32	0.04	3.82-12.82
70-74	131	11.73	0.04	7.13-16.33
≥75	228	11.47	0.02	8.57-14.37
All (≥60)	614	10.34	0.02	8.35-12.32

95% CI refers to 95% confidence interval of the mean.
Analysis of variance Age: $F_{3,1025}$=2.675; *P*=.046; Sex: $F_{1,1025}$=17.319; *P*<.0001; Age × Sex=NS

Reported Sleep Duration

The average nighttime sleep duration for the sample was 7 hours 8 minutes, with a median of 7 hours 5 minutes. Five percent of the sample slept 4 hours 30 minutes or less (percentile 5) and another 5% slept at least 9 hours 30 minutes (percentile 95). Men had a sleep duration significantly longer than women (F=3.816; P=.05). On the means, this difference was only 7 minutes. The median was 7:30 in men and 7:00 in women. The 95th percentile was at 10 hours for men and 9 hours for women. The nighttime sleep duration was comparable between age groups in both men and women.

The average daytime sleep duration was 13.47 minutes. The median was at 0, the 75th percentile at 15 minutes, and the 95th percentile at 60 minutes. Men slept significantly longer (18.13 minutes) in the daytime than women (10.34 minutes; F:17,319; *P*<.001). Daytime sleep duration was comparable between age groups (Table 3).

The total sleep time during a 24-hour period included nighttime sleep plus daytime sleep. Total sleep time was about 15 minutes longer than the nighttime sleep duration. The difference in total sleep time/nighttime sleep was 20 minutes for men and 10 minutes for women (Table 2). As a result, men, overall, slept 23 minutes more than women (F:10,543; *P*<.001). The most important difference was observed in subjects 75 years of age and older group, in which men slept on average 52 minutes more than women in

the same age group. The median was also different in men (7:50) than in women (7:30). Generally speaking, the total sleep time was comparable between age groups. The only significant difference was observed between men aged 75 or older and those between 70 and 74 years old(Table 2).

Subsequently, we examined satisfaction with sleep, estimation of sleep duration, the feeling of being rested upon awakening, and the absence of daytime sleepiness in relationship to sleep duration. As was expected, the proportion of subjects satisfied with their sleep increased with sleep duration, being nearly 100% in those sleeping more than 9 hours (Table 4). Similarly, subjects who estimated their sleep was adequate (ie, neither too long nor too short) significantly increased with sleep duration. The proportion of subjects feeling rested upon awakening also increased with sleep duration but not as much as for sleep satisfaction and adequate sleep. The proportion of subjects feeling rested upon awakening also increased with sleep duration but not as much as for sleep satisfaction and adequate sleep for which we observed more than 40% discrepancy between the shortest and longest sleep duration. This change was about 20% for feeling rested upon awakening. Surprisingly, the proportion of subjects without daytime sleepiness was comparable between the sleep-duration categories (Table 4). These proportions were comparable between age groups and sex.

We then examined the proportion of subjects who reported being satisfied with their sleep, had adequate sleep duration, felt rested upon awakening, and did not have daytime sleepiness. Interestingly, 18.3% of subjects sleeping less than 5 hours per night met all these specifications. The proportion increased with sleep duration and reached 68.4% in subjects sleeping more than 9 hours per night. The same trend was observed for total sleep time (Table 4).

Reported Sleep Latency

Subjects took on average 24.28 minutes to fall asleep (Table 5); the median was 15 minutes. Five percent of the sample fell asleep immediately (5th percentile). On the opposite end, 5% of the sample took 80 minutes or more to fall asleep. Because of the asymmetry of the distribution and large standard errors, nonparametric tests were used for comparisons between men and women and age groups. No significant difference was observed.

Reported Bedtime and Wake-Up Time

Subjects went to sleep on average at 10:55 PM; the median was at 11:00 PM. Five percent of the sample went to sleep at 9:00 PM or earlier and another 5% at 1:00 AM or later (95th percentile). Bedtime was comparable between men and women (Table 6). As for age group comparisons, only 1 significant difference was observed: men aged 75 years and older went to sleep earlier than those between 65 and 69 year of age (Table 6).

The wake-up time was comparable in men and women and between age groups. The average wake-up time was 7:17 AM, with a median at 7:30 AM. Five percent of the sample woke up at 5 AM or earlier and another 5% at 9 AM or later (Table 6).

Associated Factors

Logistic regressions were calculated to identify factors associated with short and long sleep, early and late bedtime, and wake-up time. In all analyses, the reference category was composed of individuals between the 26th and 74th percentiles (about 50% of the sample).

Variables entered in each model were age groups, sex, activity status, education, consumption of alcohol and coffee, smoking, physical exercise, perception of health, presence of physical disease, hypertension, body mass index, depressive mood, anxiety, level of stress, cognitive difficulty, IADL, and social network. Activity status, depressive mood, level of stress, consumption of alcohol and coffee, and smoking were not significant for all models.

Nighttime Sleep Duration

As seen in Table 7, subjects with a lower education were more likely to sleep 4 hours 30 minutes or less, 4 hours 31 minutes to 6 hours, 8 hours to 9 hours 29 minutes, or 9 hours 30 minutes or more. Obese individuals were more likely to report very short

Table 4—Sleep Qualifiers and Daytime Sleepiness by Sleep Duration

	Satisfied with sleep, %	Adequate sleep duration, %	Without daytime sleepiness, %	Rested upon awakening, %	All conditions, %*
Nighttime sleep duration					
≤4h30	54.2†	31.7†	79.7	60.0	18.3†
4h31-6h00	77.1†	64.1†	85.5	60.6§	35.7†
6h01-7h59	88.7‡	81.6§	82.8	70.8	51.0
8h00-9h29	92.5	92.0	89.3	79.8	61.8
≥9h30	98.0	86.8	86.5	82.7	67.9
24-hour sleep duration					
≤5 hrs	57.3†	37.6†	83.5	66.7	26.6†
5h01-6h15	78.7†	63.4†	89.0	59.2†	36.2†
6h15-7h59	88.3‡	81.2	82.8	67.4	48.0
8h00-9h59	91.7	91.5	88.7	80.1	62.2
≥10 hrs	96.9	85.5	77.9	77.9	58.0

*Satisfied with sleep + adequate sleep duration + rested upon awakening + without excessive daytime sleepiness
†P<.05 with all other sleep duration categories
‡P<.05 only with the longest sleep duration category
§P<.05 with the 2 longest sleep duration categories

Table 5—Sleep Latency in Minutes by Age Groups and Sex

	Mean	SEM	95% CI	Percentiles 5	25	50 (Median)	75	95
Bedtime								
Age groups, y								
60-64	20.00	1.93	16.20-23.79	0	5	15	20	69
65-69	28.22	4.04	20.25-36.18	0	5	15	30	82
70-74	24.14	2.69	18.82-29.46	0	5	15	30	97
≥75	24.69	2.14	20.48-28.90	0	5	15	30	90
All (≥60)	24.28	1.37	21.58-26.98	0	5	15	30	80
Men								
60-64	17.24	2.63	12.02-22.46	0	5	10	15	60
65-69	25.01	6.13	12.85-37.17	0	5	15	28	74
70-74	25.17	6.09	13.00-37.33	0	5	10	23	120
≥75	18.22	1.79	14.67-21.76	0	5	15	23	60
All (≥60)	20.92	2.12	16.75-25.10	0	5	15	20	60
Women								
60-64	22.54	2.79	17.02-28.07	0	5	15	30	92
65-69	30.87	5.38	20.21-41.52	0	5	15	30	120
70-74	23.57	2.50	18.62-28.53	0	5	15	30	90
≥75	28.05	3.10	21.95-34.16	0	5	15	30	120
All (≥60)	26.55	1.80	23.02-30.08	0	5	15	30	120

95% CI refers to 95% confidence interval of the mean.

Table 6—Bedtime and Wake-Up Time by Age Groups and Sex

	Bedtime			Wake-up time		
	Mean	SEM	95% CI	Mean	SEM	95% CI
Age groups						
60-64	22:56	0.10	22:44-23:09	7:14	0.09	7:04-7:25
65-69	23:04	0.08	22:55-23:13	7:18	0.09	7:08-7:28
70-74	23:04	0.09	22:53-23:15	7:16	0.09	7:05-7:26
≥75	22:43*	0.07	22:35-22:52	7:20	0.07	7:11-7:29
All (≥60)	22:55	0.04	22:50-23:00	7:17	0.04	7:13-7:22
Men						
60-64	22:55	0.17	22:34-23:15	7:10	0.15	6:52-7:28
65-69	22:59	0.12	22:45-23:13	7:10	0.13	6:54-7:25
70-74	23:09	0.13	22:53-23:25	7:20	0.14	7:04-7:37
≥75	22:41†	0.12	22:28-22:56	7:34	0.12	7:19-7:48
All (≥60)	22:55	0.07	22:46-23:03	7:18	0.07	7:10-7:26
Women						
60-64	22:58	0.12	22:44-23:12	7:19	0.11	7:06-7:32
65-69	23:07	0.10	22:56-23:19	7:25	0.12	7:11-7:38
70-74	23:02	0.12	22:47-23:16	7:13	0.11	7:00-7:27
≥75	22:44	0.09	22:34-22:54	7:13	0.09	7:03-7:24
All (≥60)	22:56	0.05	22:49-23:02	7:17	0.05	7:11-7:23

95% CI refers to 95% confidence interval of the mean.
*Posthoc multiple comparison Dunnett C $P<.05$ with 65-69 and 70-74 years age categories.
†Posthoc multiple comparison Dunnett C $P<.05$ with 65-69 years age category.

sleep duration (≤4 hours 30 minutes). Poor health was significant only for very short sleep duration (≤4 hours 30 minutes), while the presence of a physical disease was significantly associated with very long sleep (≥ 9 hours 30 minutes). Lack of physical exercise was associated with sleeping 4 hours 31 minutes to 6 hours, 8 hours to 9 hours 29 minutes, or 9 hours 30 minutes or more per night. Insomnia alone and insomnia accompanied by daytime sleepiness were associated with very short sleep duration (≤ 4 hours 30 minutes) and insomnia alone with sleeping between 4 hours 31 minutes and 6 hours. Finally, individuals with cognitive impairment were more likely to have a very short sleep (≤ 4 hours 30 minutes) or short sleep (4 hours 31 minutes to 6 hours).

Total Sleep Time per 24-Hour Period

Sleeping 5 hours or less per 24-hour period (5th percentile) was associated with being illiterate (OR: 3.5 [1.6-8.0]) and with having a poor perception of one's health (OR: 3.4 [1.5-7.3]). Sleeping 6 hours or less per night (25th percentile) was associated with anxiety (OR: 1.7 [1.2-2.6]), being illiterate (OR: 2.1 [1.1-3.9]) or having less than 7 years of schooling (OR: 1.8 [1.2-2.7]), having a limited social network (OR: 1.5 [1.1-2.2]), and having a poor perception of one's health (OR: 1.5 [1.1-2.2]).

Factors associated with a long total sleep time (10 hours or more, 95th percentile) were being aged 75 years or older (OR: 2.2 [1.0-1.9]), being a man (OR: 1.9 [1.1-3.2]), and having a physical disease (OR: 2.1 [1.1-4.1]).

Daytime Sleep Duration

Being a man (OR: 2.8 [1.8-4.4]), having cognitive impairment (OR: 1.7 [1.1-2.6]) or high blood pressure (OR: 1.5 [1.0-2.3]), being obese (OR: 1.8 [1.1-3.0]), and having insomnia (OR: 1.7 [1.1-2.7]) were associated with sleeping 1 hour or more (95th percentile) during the daytime.

Being a man (OR: 1.5 [1.0-2.3]); being aged 65 to 69 years (OR: 3.1 [1.1-3.8]), 70 to 74 years (OR: 2.9 [1.5-5.4]) or 75 years or older (OR: 2.1 [1.2-3.8]); having more than 12 years of education (OR: 2.6 [1.0-6.7]); lack of physical exercise (OR: 1.4 [1.0-2.1]); and having insomnia (OR: 2.0 [1.3-3.1]) or obstructive sleep apnea syndrome (OR: 3.8 [1.5-9.8]) were associated with sleeping 15 to 59 minutes (75th-94th percentile) during the daytime.

Table 7—Factors Associated With Nighttime Sleep Duration

	Categories of sleep duration[a]			
	≤ 4h30	4h31-6h00	8h00-9h29	≥9h30
Male	1.4[0.6-3.2]	1.1[0.7-1.6]	1.2[0.8-1.8]	2.4[1.2-5.1]*
Education				
0 year	7.3[2.6-21.0]†	2.1[1.0-4.2]*	0.8[0.4-1.8]	0.9[0.2-4.5]
1-7 years	2.9[1.2-7.2]*	2.5[1.6-4.0]†	1.6[1.0-2.6]*	4.2[1.6-10.6]*
8-10 years	1.8[0.7-4.7]	1.5[0.9-2.5]	1.1[0.7-1.9]	1.6[0.5-4.7]
11-12 years	1.8[0.6-5.4]	1.6[0.9-2.8]	0.9[0.5-1.6]	1.9[0.6-5.6]
> 12 years	1.0	1.0	1.0	1.0
BMI (Kg/m^2)				
< 20	0.7[0.2-2.0]	1.2[0.6-2.3]	0.9[0.5-1.7]	0.4[0.1-2.0]
20-25	1.0	1.0	1.0	1.0
25.1-27	0.6[0.2-1.6]	0.8[0.5-1.4]	0.8[0.5-1.3]	0.8[0.3-2.1]
> 27	3.6[1.0-13.1]*	1.9[0.7-5.6]	0.6[0.2-2.0]	1.6[0.7-3.4]
Health				
Good	1.0	1.0	1.0	1.0
Moderate	1.2[0.6-2.7]	1.3[0.9-2.1]	0.8[0.5-1.3]	1.4[0.6-3.6]
Poor	3.6[1.2-10.8]*	1.0[0.4-2.5]	0.8[0.3-2.1]	0.0[0.0-0.0]
No physical exercise	1.7[0.8-3.6]	2.0[1.4-2.9]†	1.7[1.2-2.4]*	2.4[1.2-4.8]*
High blood pressure	0.8[0.3-1.7]	1.4[0.9-2.1]	1.5[1.0-2.2]*	0.7[0.3-1.7]
Physical disease	1.2[0.5-2.6]	1.1[0.7-1.7]	1.2[0.8-1.8]	2.1[1.0-5.0]*
Insomnia & EDS				
No insomnia & no EDS	1.0	1.0	1.0	1.0
Insomnia alone	2.9[1.3-6.7]†	1.9[1.2-2.8]†	0.8[0.5-1.2]	0.9[0.4-2.2]
EDS alone	1.7[0.3-10.1]	1.0[0.4-2.4]	0.5[0.2-1.2]	0.6[0.1-5.8]
Insomnia + EDS	3.6[1.2-11.0]*	1.6[0.9-3.0]	0.8[0.4-1.6]	1.0[0.2-4.0]
Cognitive impairment	2.2[1.2-4.2]*	1.5[1.0-2.2]*	1.1[0.8-1.6]	1.2[0.5-2.7]

*$P<.05$
†$P<.01$
BMI refers to body mass index; EDS, excessive daytime sleepiness
[a]Based on 5th, 25th-75th, and 95th percentiles, reference is from 26th to 74th percentiles.

Sleep Latency

Anxiety (OR: 4.2 [1.9-9.1]), being illiterate (OR: 5.4 [1.6-18.4]) or having less than 7 years of schooling (OR: 3.2 [1.2-8.8]), poor health (OR: 3.6 [1.8-7.3]), insomnia without excessive daytime sleepiness (OR: 3.7 [1.5-8.9]), and obstructive sleep apnea syndrome (OR: 6.6 [1.1-9.5]) were associated with a sleep latency greater than or equal to 80 minutes (95th percentile).

Factors associated with a sleep latency between 30 to 79 minutes were being a woman (OR: 1.5 [1.0-2.1]), insomnia (OR: 2.1 [1.4-3.1]) and having insomnia with excessive daytime sleepiness (OR: 2.2 [1.2-3.9]).

Bedtime and Wake-Up Time

As seen in Table 8, lower education level was associated with early bedtime and wake-up time. Obesity (body mass index > 27 kg/m^2) was related to both early and late bedtime and late wake-up time. Loss of autonomy in daily activities was associated with both early and late bedtime and early and late wake-up time. Subjects who perceived their health as being poor were more likely to have a late bedtime and an early wake-up time. Subjects who did not perform physical exercise were more likely to have a late bedtime. Insomnia and excessive daytime sleepiness were significantly associated only with early bedtime.

DISCUSSION

This study was conducted in subjects between the ages of 60 and 101 years who were living in the community and aimed to provide statistical normative sleep data for these people. It also aimed to examine which variables were associated with extreme values in sleep duration, sleep latency, and sleep-wake schedule. These objectives were achieved using 2 main statistical strategies. First, we examined how reported nighttime sleep duration, daytime sleep duration, sleep latency, bedtime, and wake-up time were distributed within the sample using central measure tendencies (means and medians). Second, we used the percentiles to segment the sample and looked for specific patterns to emerge for each segment. This procedure allowed us to verify to what extent a deviation to the median may relate to physical or mental diseases and impairment.

Sleep Duration

In this study, the median nighttime sleep duration was 7 hours for the whole sample. The average sleep duration remained unchanged with age except among men, in whom it increased about 30 minutes in men aged 75 or older. This observation is consistent with the results of a recent meta-analysis on quantitative sleep parameters. This study reported that total sleep time significantly decreased with age in healthy adults but not significantly after 60 years of age.

Long nighttime sleep duration (8 hours or more) and short nighttime sleep duration (6 hours or less) have been associated with an excess of mortality.[29,30] Similarly, daytime sleep has been associated with an excess of mortality.[31-33] Although we did not

Table 8—Factors Associated With Early and Late Bedtime and Wake-Up Time

	Bedtime		Wake-up time	
	≤ 9 PM	≥1 AM	≤5 AM	≥9 AM
Education, y				
0	4.6[1.4-15.4]*	0.5[0.1-2.0]	2.6[1.0-6.9]*	2.8[1.1-6.9]*
1-7	5.9[2.5-13.9]†	0.5[0.2-1.2]	2.7[1.3-5.3]*	1.4[0.7-2.9]
8-10	2.7[1.1-6.9]*	1.0[0.4-2.5]	0.6[0.2-1.6]	1.1[0.5-2.3]
11-12	0.5[0.1-2.5]	0.5[0.2-1.7]	0.9[0.3-2.7]	2.5[1.1-5.8]*
> 12	1.0	1.0	1.0	1.0
Body mass index, kg/m^2				
< 20	2.0[0.7-5.6]	2.0[0.7-6.3]	0.9[0.3-2.8]	1.0[0.4-2.3]
20-25	1.0	1.0	1.0	1.0
25.1-27	0.7[0.3-1.8]	0.8[0.3-2.5]	1.1[0.4-2.7]	1.8[0.9-3.7]
> 27	2.2[1.1-4.3]*	2.6[1.2-5.9]*	1.5[0.7-3.4]	2.2[1.3-4.0]*
Health				
Good	1.0	1.0	1.0	1.0
Moderate	1.7[0.8-3.6]	1.3[0.7-2.6]	0.6[0.3-1.5]	1.2[0.6-2.4]
Poor	2.3[0.6-8.8]	3.4[1.2-9.4]*	4.8[1.0-23.1]*	2.4[0.6-9.3]
IADL				
Independent	1.0	1.0	1.0	1.0
Needs assistance	1.6[0.9-3.1]	2.6[1.2-5.7]*	1.5[0.7-3.0]	0.9[0.5-1.5]
Dependent	6.5[2.1-20.5]†	1.0[0.2-4.6]	3.5[1.0-12.2]*	3.3[1.3-8.4]*
No physical exercise	1.0[0.5-1.9]	1.8[1.0-3.2]*	0.5[0.2-1.0]	1.2[0.7-2.0]
Insomnia & EDS				
No insomnia & no EDS	1.0	1.0	1.0	1.0
Insomnia alone	1.5[0.8-2.9]	0.7[0.3-1.4]	0.9[0.5-1.8]	0.7[0.4-1.3]
EDS alone	0.3[0.0-3.5]	0.7[0.1-3.7]	0.3[0.0-3.5]	1.7[0.5-6.4]
Insomnia + EDS	4.6[1.7-12.4]†	0.8[0.2-2.9]	1.9[0.6-5.7]	1.5[0.6-3.6]
Depressive mood	1.9[0.8-4.5]	2.3[1.1-4.8]*	0.9[0.4-2.5]	1.2[0.6-2.6]
Anxiety	0.4[0.2-1.1]	1.9[1.0-3.9]*	0.4[0.2-1.3]	2.0[1.1-3.5]*

*P<.05
†P<.01
IADL refers to instrumental activities of daily living; EDS, excessive daytime sleepiness

perform a follow-up for the survival rate in this sample, we found that the presence of physical disease and a lack of physical activity were associated with long sleep duration (9 hours 30 minutes or more), while the presence of cognitive impairment, hypertension, insomnia, and obesity were associated with sleeping 1 hour or more during the daytime and with short sleep duration (4 hours 30 minutes or less). Therefore, long or short sleep duration and daytime sleep were associated with various conditions that may contribute to a shorter life expectancy.

We found 4 variables that played significant role on sleep duration and sleep-wake schedule: (1) poor health status and organic disease, (2) lack of physical exercise, (3) cognitive difficulties, and (4) obesity.

Health Status

Poor health status was associated with factors related to insomnia: short sleep duration, long sleep latency (≥ 80 minutes), late bedtime, and early wake-up time. A similar finding has been observed in other epidemiologic studies in elderly populations.[34-38] For example, a 3-year longitudinal study with 6800 elderly subjects[34] showed that the incidence of insomnia was higher in subjects with heart disease, stroke, incident hip-fracture, and respiratory symptoms. Furthermore, the persistence of insomnia over the 3-year period was associated with heart disease, incident diabetes, baseline respiratory symptoms, and stroke.

Lack of Physical Exercise

Interestingly, individuals who did not exercise were more likely to be long sleepers (9 hours 30 minutes or more) or short sleepers (between 4 hours 31 minutes and 6 hours). Some studies have shown the beneficial effects of exercise on sleep quality for elderly people by increasing the sleep efficiency and reducing the time awake after sleep onset.[3,39-40] In addition to the beneficial effects of moderate exercise on health, reserving a specific time of day for exercise may help to keep temporal markers.

Cognitive Difficulties

Cognitive impairment was positively associated with a nighttime sleep duration of 6 hours or less and daytime sleep duration of 1 hour or more. Sleep-disordered breathing has been reported to be related to cognitive decline,[41-43] although others have found that daytime sleepiness is the primary factor in this association.[44] Our previous work[13] and current results would support this last finding: although reported symptoms of sleep-disordered breathing were associated with daytime sleepiness and cognitive impairment, the most straightforward association was found between daytime sleepiness and cognitive impairment. Similarly, total sleep deprivation,[45] rapid eye movement sleep-deprivation,[46] and insomnia[47] have all been associated with decline in cognitive performance.

Obesity

In this study, obese individuals were more likely to be short sleepers (4 hours 30 minutes or less) and to sleep 1 hour or more during the daytime. These findings are congruent with those of clinical studies[48,49] performed with obese patients without sleep apnea compared with nonobese healthy controls. It has been reported that obese patients have a lower percentage of sleep time during the night[50] and a longer percentage of sleep time during the day,[48] a lower sleep efficiency, and more daytime sleepiness as measured on the Epworth Sleepiness Scale.[49] Late bedtime (beyond midnight) has been associated with obesity in 1 study.[51] Mechanisms between sleep, slept debt, and obesity are not yet fully understood. Recent research has pointed out that sleep deprivation leads to endocrine and metabolic changes associated with diabetes and weight gain.[52]

Limitations of the Study

Some limitations of our study need to be underlined. First, this study was performed with elderly subjects still living in the community. As such, many of them were still active (working, doing volunteer work, being members of social clubs, helping their children, etc.) even after 74 years of age. Therefore, the most disabled elderly people were not included in this study. Second, our method did not allow for the assessment of the most-impaired individuals, such as the elderly with important cognitive deficits or those with speech or hearing impairments. Third, we did not have objective data on cognitive difficulties and daytime sleepiness apart from questions about orientation and memory from the Mini-Mental State Examination. Some may argue that self-reporting of cognitive difficulties may not be as good as objective measures of cognitive functions. However, a study done by Geerling et al[53] showed that self-reported memory difficulties was a strong predictor of incident Alzheimer disease in older persons.

As our results show, the attempt to delineate normal sleep in elderly individuals based on statistical norms has some interest, but it also has drawbacks. Indeed, no matter the sleep duration, it remains that a sizeable number of subjects are "not where they are expected to be." For example, more than half of short sleepers felt rested upon awakening or were satisfied with their sleep, and nearly 20% had no complaint commonly associated with various sleep disorders. Does this mean that subjective measures are better indicators of normal sleep? Not necessarily, because, if this were the case, we should have found find most of the independent factors (eg, obesity, cognitive impairment, reported symptoms of sleep-disordered breathing, physical illness) to be negatively associated with positive perception of the sleep. There is no operational definition of normal sleep to date. This situation could explain why some mortality studies have obtained contradictory results with regard to the importance of sleep duration on mortality risk.[54,55]

CONCLUSIONS

This is the first epidemiologic study linking the sleep-wake schedule of an elderly representative sample with sleep and mental and organic diseases in terms of risk factors. It shows: (1) The variation around the median of nighttime sleep duration (7 hours) is about 2 hours. (2) Health issues already arise at the 25th and 75th percentiles of nighttime sleep duration, sleep latency, and daytime sleep. Therefore, even a moderate deviation from the norm (ie, values surrounding the median) is associated with various problems. (3) Lack of physical exercise appears clearly to be a risk factor of long and short sleep. (4) Obesity also appears to be related to short nighttime sleep and prolonged sleep during the daytime. (5) When examining the 2 extreme ranges of the sleep duration, health risk factors increase and cognitive performance decrease.

Finally, we believe that the comorbidity of organic and mental disorders in the elderly population must be reexamined using the median range of 7 hours of sleep per night with a variation of 2 hours (more than 6 to less than 8 hours). These normative data must be confirmed in surveys from different countries, with different cultures, climate, and light exposure.

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REFERENCES

1. Ohayon MM. Epidemiology of insomnia: what we know and what we still need to learn. Sleep Med Rev 2002;6:97-111.
2. Ohayon MM, Zulley J, Guilleminault C, Smirne S, Priest RG. How age and daytime activities are related to insomnia in the general population? Consequences for elderly people. J Am Geriatr Soc 2001;49:360-6.
3. Maggi S, Langlois JA, Minicuci N, et al. Sleep complaints in community-dwelling older persons: prevalence, associated factors, and reported causes. J Am Geriatr Soc 1998;46:161-8.
4. Brabbins CJ, Dewey ME, Copeland JRM, et al. Insomnia in the elderly: prevalence, gender differences and relationships with morbidity and mortality. Int J Geriatr Psychiatry 1993;8:473-80.
5. Monk TH, Reynolds CF 3rd, Buysse DJ, et al. Circadian characteristics of healthy 80-year-olds and their relationship to objectively recorded sleep. J Gerontol 1991;46:M171-5.
6. Buysse DJ, Monk TH, Reynolds CF 3rd, Mesiano D, Houck PR, Kupfer DJ. Patterns of sleep episodes in young and elderly adults during a 36-hour constant routine. Sleep 1993;16:632-7.
7. Haimov I, Lavie P. Circadian characteristics of sleep propensity function in healthy elderly: a comparison with young adults. Sleep 1997;20:294-300.
8. Pressman MR, Fry JM. What is normal sleep in elderly? Clin Geriatr Med 1988;4:71-81.
9. Bliwise DL. Sleep in normal aging and dementia. Sleep 1993;16:40-81.
10. Reyner A, Horne JA. Gender- and age-related differences in sleep determined by home-recorded sleep logs and actimetry from 400 adults. Sleep 1995;18:127-34.
11. Ohayon MM, Carskadon MA, Guilleminault C, Vitiello MV. Meta-analysis of quantitative sleep parameters from childhood to old age in healthy individuals: developing normative sleep values across the human lifespan. Sleep 2004;27:1255-73.
12. Kish L. Survey Sampling. New York: John Wiley & Sons; 1965.
13. Ohayon MM, Vechierrini MF. Daytime sleepiness is an independent predictive factor for cognitive impairment in the elderly population. Arch Intern Med 2002;162:201-8.
14. Ohayon M. Knowledge Based System Eval Decisional Trees and Questionnaires. Ottawa: National Library of Canada, 1995.
15. Ohayon M. Improving decision making processes with the fuzzy logic approach in the epidemiology of sleep disorders. J Psychosom Res 1999; 47:297-311.
16. International Classification of Sleep Disorders: Diagnostic and Coding Manual, revised. Rochester, Minnesota: American Sleep Disorders Association; 1997.

17. Diagnostic and statistical manual of mental disorders fourth edition (DSM-IV). Washington: American Psychiatric Association; 1994.
18. Ohayon MM, Guilleminault C, Zulley J, Palombini L, Raab H. Validation of the Sleep-EVAL system against clinical assessments of sleep disorders and polysomnographic data. Sleep 1999;22:925-30.
19. Ohayon MM, Guilleminault C, Zulley J, et al. Validation of the Sleep-EVAL system against clinical assessments of sleep disorders and polysomnographic data. Sleep 1999;22:925-30.
20. Hosn R, Shapiro CM, Ohayon MM. Diagnostic concordance between sleep specialists and the sleep-EVAL system in routine clinical evaluations. Abstract. J Sleep Res 2000;9(suppl 1):86.
21. Derouesne C, Dealberto MJ, Boyer P, et al. Empirical evaluation of the cognitive difficulties scale for assessment of memory complaints in general practice: a study of 1628 cognitively normal subjects aged 45-75 years. Intern J Geriatric Psychiatr 1993;8:599-607.
22. McNair D, Kahn R. Self-assessment of cognitive deficits. In: Crook T, Ferris S, Bartus R, eds. Assessment in Geriatric Psychopharmacology. New Canaan, Conn: Mark Powley and Associates; 1983:137-43.
23. Dupuy HJ. Chapter 9: The Psychological General Well-Being (PGWB) Index. Appendix I: Selected test instruments. In: Wenger NK, Mattson ME, et al. Assessment of Quality of Life in Clinical Trials of Cardiovascular Therapies. Le Jacq Publishing Inc.; 1984:170-83; 353-6.
24. McDowel I, Newell C. Measuring Health—A Guide to Rating Scales and Questionnaires, 2nd ed. Oxford University Press; 1996:206-13.
25. Folstein MF, Folstein SE, McHugh PR. "Mini-mental state." A practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res 1975;12:189-98.
26. Crum RM, Anthony JC, Bassett SS, Folstein MF. Population-based norms for the Mini-Mental state examination by age and educational level. JAMA 1993;269:2386-91
27. Lawton MP, Brody EM. Assessment of older people: self-maintaining and instrumental activities of daily living. Gerontologist 1969;9:179-86
28. Hosmer DW, Lemeshow S. Applied Logistic Regression. New-York: John Wiley & Sons; 1989.
29. Kripke DF, Garfinkel L, Wingard DL, Klauber MR, Marler MR. Mortality associated with sleep duration and insomnia. Arch Gen Psychiatry 2002;59:131-6.
30. Burazeri G, Gofin J, Kark JD. Over 8 hours of sleep—marker of increased mortality in Mediterranean population: follow-up population study. Croat Med J 2003;44:193-8.
31. Bursztyn M, Ginsberg G, Stessman J. The siesta and mortality in the elderly: effect of rest without sleep and daytime sleep duration. Sleep 2002;25:187-91.
32. Newman AB, Spiekerman CF, Enright P, et al. Daytime sleepiness predicts mortality and cardiovascular disease in older adults. The Cardiovascular Health Study Research Group. J Am Geriatr Soc 2000;48:115-23.
33. Bursztyn M, Ginsberg G, Hammerman-Rozenberg R, Stessman The siesta in the elderly: risk factor for mortality? J Arch Intern Med 1999;159:1582-6.
34. Foley DJ, Monjan A, Simonsick EM, Wallace RB, Blazer DG. Incidence and remission of insomnia among elderly adults: an epidemiologic study of 6,800 persons over three years. Sleep 1999;22(Suppl 2):S366-72.
35. Henderson S, Jorm AF, Scott LR, Mackinnon AJ, Christensen H, Korten AE. Insomnia in the elderly: its prevalence and correlates in the general population. Med J Aust 1995;162:22-4.
36. Foley DJ, Monjan AA, Brown SL, Simonsick EM, Wallace RB, Blazer DG. Sleep complaints among elderly persons: an epidemiologic study of three communities. Sleep 1995;18:425-32.
37. Newman AB, Enright PL, Manolio TA, Haponik EF, Wahl PW. Sleep disturbance, psychosocial correlates, and cardiovascular disease in 5201 older adults: the Cardiovascular Health Study. J Am Geriatr Soc 1997;45:1-7.
38. Tanaka H, Taira K, Arakawa M, et al. Short naps and exercise improve sleep quality and mental health in the elderly. Psychiatry Clin Neurosci 2002;56:233-4.
39. Shirota A, Tamaki M, Hayashi M, Hori T. Effects of daytime activity on nocturnal sleep in the elderly. Psychiatry Clin Neurosci 2000;54:309-10.
40. King AC, Oman RF, Brassington GS, Bliwise DL, Haskell WL. Moderate-intensity exercise and self-rated quality of sleep in older adults. A randomized controlled trial. JAMA 1997;277:32-7.
41. Dealberto MJ, Pajot N, Courbon D et al. Breathing disorders during sleep and cognitive performance in an older community sample: The EVA study. J Am Geriatr Soc 1996; 44:1287–94.
42. Naegele B, Thouvard V, Pepin JL, et al. Deficits of cognitive executive functions in patients with sleep apnea syndrome. Sleep 1995;18:43-52.
43. Cheshire K, Engleman H, Deary I, Shapiro C, Douglas NJ. Factors impairing daytime performance in patients with sleep apnea/hypopnea syndrome. Arch Intern Med 1992;152:538-41.
44. Cohen-Zion M, Stepnowsky C, Marler, Shochat T, Kripke DF, Ancoli-Israel S. Changes in cognitive function associated with sleep disordered breathing in older people. J Am Geriatr Soc 2001;49:1622-7.
45. Lee HJ, Kim L, Suh KY. Cognitive deterioration and changes of P300 during total sleep deprivation. Psychiatry Clin Neurosci 2003;57:490-6.
46. Davis CJ, Harding JW, Wright JW. REM sleep deprivation-induced deficits in the latency-to-peak induction and maintenance of long-term potentiation within the CA1 region of the hippocampus. Brain Res 2003;973:293-7.
47. Cricco M, Simonsick EM, Foley DJ. The impact of insomnia on cognitive functioning in older adults. J Am Geriatr Soc 2001;49:1185-9.
48. Vgontzas A, Bixler EO, Tan T-L, Kantner D, Martin LF, Kales A. Obesity without sleep apnea is associated with daytime sleepiness. Arch Int Med 1998; 58:1333-7.
49. Resta O, Foschino Barbaro MP, et al. Low sleep quality and daytime sleepiness in obese patients without obstructive sleep apnoea syndrome. J Intern Med 2003;253:536-43.
50. Vorona RD, Winn MP, Babineau TW, Eng BP, Feldman HR, Ware JC. Overweight and obese patients in a primary care population report less sleep than patients with a normal body mass index. Arch Intern Med 2005;165:25-30.
51. Shigeta H, Shigeta M, Nakazawa A, Nakamura N, Yoshikawa T. Lifestyle, obesity, and insulin resistance. Diabetes Care 2001;24:608.
52. Taheri S, Lin L, Austin D, Young T, Mignot E. Short sleep duration is associated with reduced leptin, elevated ghrelin, and increased body mass index. PLoS Med 2004;1:210-7.
53. Geerlings MI, Jonker C, Bouter LM, Ader HJ, Schmand B. Association between memory complaints and incident Alzheimer's disease in elderly people with normal baseline cognition. Am J Psychiatry 1999;156:531-7.
54. Burazeri G, Gofin J, Kark JD. Siesta and mortality in a Mediterranean population: a community study in Jerusalem. Sleep. 2003;26:578-84.
55. Mallon L, Broman JE, Hetta J. Sleep complaints predict coronary artery disease mortality in males: a 12-year follow-up study of a middle-aged Swedish population. J Intern Med 2002;251:207-16.