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OBJECTIVE SLEEP DURATION AND HEALTH IN ELDERLY RUSSIANS

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ABSTRACT

It is the first examination of relationship between sleep duration and health in the high mortality context of Russia. Night and daytime sleep durations are measured from self-reporting and from 24 hour heart rate trends (Holter monitoring). The sample of 201 individuals is drawn from the Moscow Lipid Research Clinics (LRC) cohort, followed up since 1975-77. Field works were conducted in 2002-03. Holter data are available for 185 individuals. Although objective and reported mean sleep durations are nearly the same (8 h 14 min and 8 h 07 min), there are significant intra-individual differences. OLS and ordered logit regressions controlling for age and sex reveal significant associations between objective sleep (night and night+day sleep durations, and presence of daytime sleep) and health outcomes. No significant relationships with health outcomes are found for subjective night sleep. For objective sleep, longer sleep corresponds to lower grip strength, poorer self-rated health, poorer immediate recall, and a higher mortality risk score (based on the past mortality experience of the LRC cohort). Long sleep duration is a marker of ill-health and, potentially, mortality. Predictive power increases if objective sleep measures are used, a consideration which is especially important in small-size studies.

Keywords: heart rate, monitoring, Holter, mortality, aging

The relationship between length of sleep and health has been studied in some detail. Analyses of three large follow-up studies have provided compelling evidence of higher mortality risk associated with both short and long sleep durations (1, 2, 3). A summary paper that reviews 18 earlier studies on sleep and health suggests a generally U-shaped relationship between sleep duration and mortality, with long sleep being of more concern than short sleep (4). Elevated mortality risk was found even among persons sleeping a "normal" 8-8.5 hours, compared with those sleeping 7-7.5 hours. Long sleep durations have been linked to higher risk for diabetes (5), heart disease (2), cancer (6), and stroke (7). Because large fractions of the population (25 to 50 percent of people in 7 European countries sleep eight hours or more (8)), these results suggest a potentially high population-attributable risk of longer sleep durations.

Sleep deprivation has generally been found to have a negative effect on cognition (9, 10), but little is known about the effects of long sleep duration on cognition. The relation between sleep and muscular function is also unclear. Some studies have found that sleep deprivation affects endurance

(11, 12). However, another study found no association between sleep duration and the strength of various muscle groups (13).

Most studies use self-reported data on when the respondents go to sleep and when they awaken, however, respondents often report inaccurate information. Important differences between self-reported and polysomnography measurements have been identified (22, 23, 24). Several authors have noted the subjective nature of, and significant errors in, self-reported sleep data (25, 26, 4).

This is the first epidemiological study linking sleep duration with health outcomes in elderly Russians. The Russian situation is of particular interest: During the last three decades this country has been facing an increasing burden of disease and mortality (29). Many scholars connect the Russian health crisis with psychosocial factors (30), which can be related to sleep (31).

This study uses six measures of overall health status: number of mobility limitations, grip strength, immediate recall, self-reported health, perceived stress, and a composite mortality risk score based on risk factors measured approximately 25 years earlier.

MATERIALS AND METHODS

We use data collected by the Moscow Pilot Project on "Biological mechanisms of stress-related hazard in Russia," jointly conducted by the Max Planck Institute of Demographic Research (Rostock, Germany) and the State Research Centre for Preventive Medicine (Moscow). Participants were selected randomly from the survivors of the Moscow Lipid Research Clinic (LRC) cohort. The LRC cohort was originally established in 1975-77 and has served as a central source of epidemiological information about the Russian population for the last two decades (31, 33, 34, 35, 36, 37). 24-hour Holter monitoring was performed by two-channel tape recorders (Schiller AG, Switzerland) according to the guidelines of the American Heart Association (38).

The study subjects were asked to complete diaries which contained the starting and ending times of night and daytime sleep. These data were used for calculation of reported sleep durations. Sleep and activity periods were also identified from the 24-hour heart rate trends based on the original Holter monitor heart rate recordings (Figure 1). HR trends were constructed using one-minute averaging of continuous HR with calculation of maximum, minimum, and mean values. This method allows detection of changes in HR trends related to sleep with high precision.

The onset of night sleep can be seen on a HR trend from a sharp decrease in the heart rate followed by a plateau of a long-standing low heart rate (Figure 1). Awakening is identified as a reverse transition from the plateau to a higher heart rate with higher amplitude of fluctuations. Short-term awake periods can be seen on the HR trends (Figure 1).

In our analyses sleep is described by: subjective night sleep duration (from the diary), objective night sleep duration, presence of daytime sleep, and total (day plus night) sleep duration. The last three variables were based on Holter data. Our analyses treat hours of objective and reported night sleep as continuous variables. Daytime sleep was observed in only 39 subjects and its duration was highly variable. It was included as an additive component into the continuous total sleep duration. It was also treated as a dichotomous variable in some regressions ("presence" of daytime sleep).
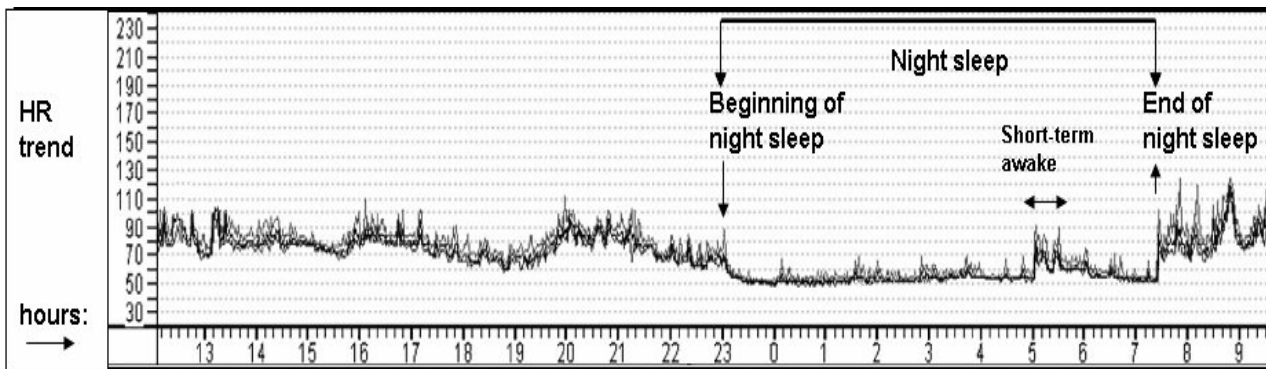
Figure 1. Example of diurnal and nocturnal heart rate dynamics (duration = 21 h 40 min).
HR daytime average = 82 beat/min, HR night average = 58 beat/min, night sleep duration =8 h 50 min, ↓ –
beginning of night sleep, ↑ – end of night sleep.
Moscow Pilot Project "Biological mechanisms of stress-related hazard in Russia", 2002-03.

We used standard regression techniques to examine the relation between each of the six health outcomes and sleep. Self-rated health was modeled as an ordered logit; the other five health outcomes were modeled using ordinary least squares. All analyses were done using STATA 7.0 (43).

RESULTS

Table 3 shows several characteristics of the study sample and of sleep.

All study subjects were retired and living at home in their family context. Average duration of reported night sleep was 494 min (8 h 13 min) with a range of 3 to 12 hours. According to diaries, on average the subject's sleep began at 23 h 07 min. The average time of awakening was 7 h 20 min.

On average, objective night sleep duration was 487 min (8 h 07 min) with a range of 4 to 13 hours. Median duration of night sleep was 8 h 10 min. Five percent of the sample slept less than 5 h 50 min and five percent slept more than 10 h 10 min. On average, night sleep began at 23 h 09 min with 5-th and 95-th percentiles being 21 h 20 min and 01 h 20 min, respectively. The average time of awakening was 7 h 16 min with 5-th and 95-th percentiles at 5 h 20 min and 9 h 17 min.

Regressions of sleep duration on sex and age showed no significant difference between men and women and no significant trend across ages. Thus, the average values of the objective and subjective night sleep durations are almost the same. The two measures have a correlation coefficient of 0.69 (p=0.000). However, individual differences between the two durations are substantial: 47 percent of reported durations differed from the objective ones by more than 30 min. There was no evidence of a consistent bias toward either over- or under-reporting duration. Reported night sleep durations show considerable heaping on integer values: 51 percent of individual sleep durations are 7, 8, 9, or 10 hours, with 18 percent of this majority reporting a sleep duration of 8 hours. Respondents clearly tended to round times of beginning and end of the night sleep resulting in integer durations. By contrast, round numbers of hours constituted only 13 percent of the objective sleep durations.

Daytime sleep episodes were found in 39 individuals (21 percent); mean duration was 91 min and ranged from 20 to 210 min.

Table 4 shows the results of the regressions of the six health outcomes on sleep characteristics. Every combination of a health outcome with a sleep variable corresponds to one regression and includes controls for age and sex. The rows of Table 4 present five regression models. The first row shows results from regressions of each health outcome (shown in the columns) on reported night sleep duration; it is comparable to many other studies. The second regresses each outcome on objective night sleep duration. The third regresses each outcome on objective night sleep duration, but with a restricted set of observations (six individuals with night sleep durations of 5.5 hours or

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less excluded). We exclude these six cases because our data do not provide adequate power for us to model accurately the relationship between short sleep and heath outcomes, which, based on previous studies appears to be negative (i.e., very short sleep appears to be associated with poor health outcomes). Thus in effect, the row 3 regressions focus on the vastly predominant portion of our data. The fourth regression uses total sleep as an explanatory variable. The fifth regresses each health outcome on a dichotomous variable indicating the presence or absence of daytime sleep. Number of mobility limitations and the 1970s mortality risk score are significantly (positively) associated with age; right grip strength was significantly (negatively) associated with age (grip strength decreased by about 0.5 kg for each additional year of age); immediate recall was significantly associated with sex (females had lower recall than males) as was grip strength (lower by about 12.2 kg for females compared with males).

Table 4. Effects of objective and reported sleep durations on six health outcomes with adjustment for age and sex.
Moscow Pilot Project "Biological mechanisms of stress-related hazard in Russia", 2002-03.

| Explanatory variable, number of observations, and type of regression | Variable and type of regression | | | | | |
	Mobility limitations, n=185	Right grip strength, n=181	Self-rated health, n=185	Cognitive recall, n=185	Stress Score, n=183	1970s mortality risk score. (Men only), n=144
			OLOGIT			
	OLS	OLS		OLS	OLS	OLS
1. Night sleep, reported	0.02 [0.05] * (0.777) †	-0.59 [0.37] (0.112)	0.04 [0.11] (0.699)	-0.18 [0.10] (0.081)	-0.01 [0.32] (0.979)	0.03 [0.03] (0.342)
2. Night sleep, objective	0.12 [0.06] (0.047)	-1.11 [0.37] (0.004)	0.18 [0.12] (0.127)	-0.26 [0.11] (0.018)	0.47 [0.33] (0.158)	0.05 [0.03] (0.115)
3. Night sleep, objective (if >5.5 h)‡	0.15 [0.06] (0.032)	-1.51 [0.42] (0.000)	0.32 [0.13] (0.018)	-0.35 [0.12] (0.004)	0.65 [0.37] (0.087)	0.07 [0.03] (0.040)
4. Total sleep, objective	0.16 [0.06] (0.005)	-1.19 [0.35] (0.001)	0.22 [0.11] (0.040)	-0.25 [0.10] (0.015)	0.56 [0.07] (0.073)	0.03 [0.03] (0.231)
5. Presence of daytime sleep	0.59 [0.20] (0.003)	-2.54 [1.23] (0.041)	0.61 [0.38] (0.105)	-0.18 [0.36] (0.608)	1.77 [1.07] (0.102)	-0.07 [0.09] (0.446)

* standard errors are given in square brackets. † p-values are given in parentheses.
‡ Six observations with objective night sleep durations less than 5.5 hours are omitted.

CONCLUSION

It is recognized now that mortality is associated with longer sleep (4) even when controls are introduced for potentially confounding factors (3). Mechanisms underlying this important result remain largely unknown and the direction of the causal link is still disputable (44).

Our work provides the first piece of epidemiological evidence on the association between sleep and health outcomes among elderly Russians. It confirms the inverse relationship between duration of sleep and health in a high-mortality and high-stress context. The data suggest that in future studies, long sleep duration should be considered as a candidate risk factor of ill-health and death in Russia.

We also found also that sleep durations based on self-reports have the potential to significantly attenuate the relationships between sleep and health variables.

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