Self-Reported Sleep Duration as a Predictor of All-Cause Mortality: Results from the JACC Study, Japan

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Background: Epidemiologic studies have shown that habitual sleeping patterns are associated with all-cause mortality risk. However, sleep duration may be affected by physical, mental, or social conditions, and its impact on health may differ depending on the time or place.

Objectives: To examine the effects of sleep duration on all-cause mortality after adjusting for several covariates, mental condition in particular.

Methods: A total of 104,010 subjects (43,852 men and 60,158 women), aged 40 to 79 years, who enrolled in the JACC Study (Japan Collaborative Cohort Study on Evaluation of Cancer Risk Sponsored by Monbusho) from 1988 to 1990 and were followed for an average of 9.9 years. Average sleep duration on weekdays and covariates, including perceived mental stress and depressive symptoms, were used in the analyses. Relative risks were calculated by Cox’s proportional hazard model separately by sex.

Results: Men tended to sleep longer than women, and the elderly slept longer than younger subjects. Mean sleep duration was 7.5 hours for men and 7.1 hours for women; mode durations were 8 hours (range, 7.5-8.4 hours) and 7 hours (6.5-7.4), respectively. Sleep duration of shorter or longer than 7 hours was associated with a significantly elevated risk of all-cause mortality. However, the significant association with short sleep disappears when adjusted for some covariates among men.

Conclusions: Sleep duration at night of 7 hours was found to show the lowest mortality risk.

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INTRODUCTION

HABITUAL SLEEPING PATTERNS HAVE BEEN SHOWN TO BE ASSOCIATED WITH ALL-CAUSE MORTALITY RISK IN SEVERAL EPIDEMIOLOGIC STUDIES. According to Qureshi and colleagues, who analyzed data from the NHANES I (First National Health and Nutrition Examination Survey Epidemiologic Follow-up Study), sleeping longer than 8 hours a night as well as daytime somnolence are risk factors for all-cause mortality. Newman et al also reported that daytime sleepiness predicted 6-year mortality in an older cohort. Recently, Kripke and colleagues found in their 6-year study that people who slept 7 hours per night had the best survival rate among more than 1.1 million subjects. In contrast, other studies have failed to detect an association between length of sleep time and mortality.

Sleep duration is considered a lifestyle factor, as are physical activity, smoking status, and the like. However, a sleeping pattern is actually not merely a habit one can freely choose but may also be affected by physical, mental, or social conditions. Thus, if the time or place is different, the impact of sleep on health may be different. In this paper, after a 9.9-year follow-up, we use data from the Japan Collaborative Cohort Study for Evaluation of Cancer Risk Sponsored by the Ministry of Education, Culture, Sports, Science and Technology of Japan (JACC study) to examine the effects of sleep duration on all-cause mortality in Japan, while also considering covariates that may influence mortality.

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SUBJECTS AND METHODS

Study Subjects and Data Collection

The JACC study was started between 1988 and 1990, enrolling healthy subjects living in 45 areas in Japan, collecting baseline data using a self-administered questionnaire. Sampling methods and detailed protocols of the JACC study are described elsewhere. We followed 110,792 subjects (44,113 men and 66,679 women), aged 40 to 79 years at baseline.

Follow-up

The date and cause of death were annually confirmed, with the permission of the Director-General of the Prime Minister’s Office (Ministry of Public Management, Home Affairs, Post and Telecommunications), up to the end of 1999 by death certificates. In this JACC study, those individuals who moved away from the study area were treated as study dropouts because deaths after such moves could not be confirmed in our follow-up system. Our entire study design, which makes individual and collective use of epidemiologic and biologic materials (serum only), was approved by the Ethical Board of Nagoya University School of Medicine, where the central secretariat of the JACC study is located.

Sleep Duration

Average sleep duration on weekdays 1 year prior to the survey was 1 of the questions on general health status. Sleep duration was classified into 7 categories based on self-reported responses; less than 4.5 hours (-4 hours); 5, 6, 7, 8, and 9 hours; and equal to or longer than 9.5 hours (10 hours+). Fractional-hour responses were rounded off (eg, 7 hours represented responses from 6.5 to 7.4 hours). Analyses in this paper were limited to subjects whose sleep duration was known, leaving a total of 104,010 subjects (43,852 men and 60,158 women).

Analysis

Relative risks (RRs) were calculated by Cox’s proportional hazard model separately by sex. The deceased were treated as uncensored cases when the event occurred. Those who were known to be alive at the end of 1999, or those who had moved away, were treated as censored cases.
In all analyses, we commonly adjusted age at entry (5-year age groups). For representative mental conditions, we chose perceived mental stress and depressive symptoms. Perceived mental stress was assessed by the question: What is the level of stress in your daily life? The response categories were: extremely high, high, medium, or low. Four psychological or behavioral items were used to judge depressive symptoms in this analysis: (1) Do you think your life is meaningful? (2) Do you think you make decisions quickly? (3) Are you enjoying your life? and (4) Do you feel others rely very much on you? We considered these question items to demonstrate symptoms, such as (1) depressed mood, (2) indecisiveness or diminished ability to think or concentrate, (3) markedly diminished interest or pleasure, and (4) feelings of worthlessness, which were included in the 9 major depressive symptoms of a major depressive episode according to the DSM-IV (Diagnostic and Statistical Manual of Mental Disorders, 4th edition). The response was then dichotomized as either depressive symptom absent (positive or neutral response: score = 0) or as depressive symptom present (negative response: score = 1), and subjects were grouped into those with 0 symptoms, 1 symptom, 1 symptom or 2 or more symptoms. The internal consistency expressed as Cronbach’s coefficient α for the study population was found to be 0.52.

In multivariate analyses, we further adjusted several factors known to be associated with all-cause mortality (ie, smoking status [current smoker, ex-smoker, or never-smoked], alcohol drinking status [currently drinking alcohol, stopped drinking alcohol, or never drank alcohol], physical activity [exercise more than 1 hour per week or exercise less than 1 hour per week], education [attended school up to 15 years old, 18-year-old, or older than 18 years], and marital status [married or single]). Moreover, additional examinations were conducted to exclude those people whose events occurred within 2 years after baseline. Statistical analysis was performed using SAS® at the Nagoya University Computation Center.

RESULTS

The most frequent self-reported sleep duration was 8 hours among men and 7 hours among women, with average respective sleep durations of 7.48 hours and 7.12 hours. Sleep duration tended to increase with age. Sociodemographic characteristics of each group are shown in Table 1. Compared with 7-hour sleepers, shorter and longer sleepers of both sexes were older, less likely to have a spouse, less educated, and more likely to have a history of stroke, myocardial infarction, or cancer; had more depressive symptoms; and took more naps. Women who smoked were more likely to be short or long sleepers than to be 7-hour sleepers. Shorter-duration sleepers of both sexes were more aware of high mental stress, and fewer of the men who slept less than 7 hours smoked.

A total of 11,071 deaths (6,623 men and 4,448 women) had occurred as of the end of 1999. As shown in Table 2, there was a U-shaped association between sleep duration and mortality among both men and women, with the nadir of the curve at 7 hours a night. Those who slept less than 4 hours had an elevated RR of 1.62 (95% CI, 1.26–2.09) in men and 1.60 (1.28–2.02) in women, compared with those who slept 7 hours. A sleep duration of longer than 7 hours was associated with a significantly elevated risk of all-cause mortality: 1.11 (1.05–1.19), 1.26 (1.15–1.37), and 1.73 (1.58–1.90), respectively, in men who slept 8, 9, and 10 hours or longer, and 1.23 (1.14–1.33), 1.35 (1.20–1.51), and 1.92 (1.70–2.17), respectively, in women who slept 8, 9, and 10 hours or longer. The hazard ratios for sleep duration adjusted for mental conditions and covariates are shown in Table 2. Although the best survival rate was also found among those who slept 7 hours, the association changed to a J-curve among men (ie, the significantly increased risk disappeared for those men who slept less than 7 hours). After performing additional analyses that excluded subjects whose events occurred within 2 years after baseline, materially unaltered findings emerged.

DISCUSSION

Previous investigators have reported shorter sleep duration as a weak but significant risk factor for all-cause mortality.2-7 Nighttime insomnia has also been found to be associated with all-cause mortality.15 Our present analysis confirmed a significant association between shorter sleep duration and risk of all-cause mortality. Spiegel and colleagues16 found that sleep debt may increase the severity of age-related chronic disorders, such as diabetes and hypertension. Therefore, shorter sleep duration might be fatal. However, among men, relative risks turned out to be smaller and less significant when data were adjusted for potential confounders. This might be due to the fact that shorter sleep duration indicates insufficient rest but could also result from debilitating mental health, poorer lifestyle, worsening physical conditions or diseases, or a combination of factors.
Furthermore, given the fact that the association between short sleep and mortality risk following covariate adjustment disappeared only among men, some work-related social factors may also be as confounders. However, it is difficult to distinguish which among a number of factors has more impact on mortality. More-detailed studies on the relationship of mental or physical health, lifestyle, and social factors with shorter sleep duration may provide new information in this regard.

Longer sleep duration was pinpointed as a risk factor for all-cause mortality in the present study, a finding consistent with previous studies.1-4,7,17 The mechanism underlying this association is not clear. It is possible that worsening physical conditions might work as a covariate in both longer sleep duration and mortality. When worsening physical conditions simultaneously lead to both longer sleep duration and higher mortality, it may be difficult to regard longer sleep duration as having a cause-effect relationship with all-cause mortality. Even so, longer sleep duration as a predictor of all-cause mortality does merit further scrutiny, and strategies should be developed to address longer sleep from a public-health perspective.

Our study has 1 methodologic limitation: sleep duration was self-reported and thus not objectively confirmed. Regarding this point, if misclassification of sleep duration occurred at random, the estimated RR might approach the null. However, if subjects tended to report their sleep duration as longer, and such a condition might influence their all-cause mortality risk, then it could be called a “bias.” According to Bliwise and his coworkers,18 a depressed mood is associated with both underestimations and overestimations of habitual sleep times. Therefore, they recommended taking mental-health factors into account when assessing sleep duration.

### Table 2—Relative risks of all-cause mortality according to sleep duration by sex

<table>
<thead>
<tr>
<th>Sleep duration</th>
<th>No. Person</th>
<th>Deaths</th>
<th>RR (95% CI)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>-4 hours</td>
<td>224</td>
<td>2162</td>
<td>1.22 (0.99, 1.48)</td>
<td>0.08</td>
</tr>
<tr>
<td>5 hours</td>
<td>1202</td>
<td>1038</td>
<td>1.28 (1.03, 1.59)</td>
<td>0.02</td>
</tr>
<tr>
<td>10 hours+</td>
<td>1769</td>
<td>1647</td>
<td>1.32 (1.11, 1.56)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Subjects excluded whose events occurred within 2 years after entry</td>
<td>238</td>
<td>208</td>
<td>1.22 (0.99, 1.48)</td>
<td>0.08</td>
</tr>
</tbody>
</table>

RR refers to relative risk; CI, confidence interval.
account when examining the relationship between reported sleep duration and mortality. To counteract the damage from this kind of bias, we added perceived mental stress and depression as covariates and found that the significant relation between longer sleep duration and all-cause mortality remained unchanged.

Both longer and shorter sleep durations were associated with all-cause mortality in our study. Sleep duration itself could be influenced by unknown physical and psychological conditions, in which case our findings would not necessarily indicate that changing sleep duration positively toward 7 hours would be likely to reduce the all-cause mortality risk. However, even if no biologic cause-and-effect relationships exist, regarding shorter and particularly longer sleepers as a high-risk population of all-cause mortality might still be important in terms of improving public health. A follow-up study that includes sleep-related factors other than sleep duration, together with objective sleep measurements, is undoubtedly warranted to confirm the associations between sleep and all-cause mortality risk.

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The present members of the JACC Study and their affiliations are as follows: Dr. Akiko Tamakoshi (present chairman of the study group), Nagoya University Graduate School of Medicine; Dr. Mitsuru Mori, Sapporo Medical University School of Medicine; Dr. Yutaka Motoshahi, Akita University School of Medicine; Dr. Ichiro Tsuji, Tohoku University Graduate School of Medicine; Dr. Yoshikazu Nakamura, Jichi Medical School; Dr. Hiroyasu Iso, Institute of Community Medicine, University of Tsukuba; Dr. Haruo Mikami, Chiba Cancer Center; Dr. Yutaka Inaba, Juntendo University School of Medicine; Dr. Yoshinori Ito, Nagoya University Graduate School of Medicine; Dr. Hideaki Toyoshima, Nagoya University Graduate School of Medicine; Dr. Shogo Kikuchi, Aichi Medical University School of Medicine; Dr. Akio Koizumi, Graduate School of Medicine and Faculty of Medicine, Kyoto University; Dr. Takashi Kawamura, Kyoto University Center for Student Health; Dr. Yoshiyuki Watanabe, Kyoto Prefectural University of Medicine, Research Institute for Neurological Diseases and Geriatrics; Dr. Tsuneharu Miki, Kyoto Prefectural University of Medicine; Dr. Chigusa Date, Faculty of Human Environmental Sciences, Mukogawa Women’s University ; Dr. Kyomori Sakata, Wakayama Medical University; Dr. Takayuki Nose, Tottori University Faculty of Medicine; Dr. Norihiko Hayakawa, Research Institute for Radiation Biology and Medicine, Hiroshima University; Dr. Takesumi Yoshimura, Institute of Industrial Ecological Sciences, University of Occupational and Environmental Health, Japan; Dr. Katsuhiko Fukuda, Kurume University School of Medicine; Dr. Naoyuki Okamoto, Kanagawa Cancer Center; Dr. Hideo Shio, Shiga Medical Center; Dr. Yoshiyuki Ohno, Nagoya University Graduate School of Medicine; Dr. Tomoyuki Kitagawa, Cancer Institute of the Japanese Foundation for Cancer Research; Dr. Toshio Kuroki, Gifu University; and Dr. Kazuo Tajima, Aichi Cancer Center Research Institute.

The past investigators of the study group were listed in the reference13 except for the following 7 members (affiliations are those where they participated in the study): Dr. Takashi Shimamoto, Institute of Community Medicine, University of Tsukuba; Dr. Heizo Tanaka, Medical Research Institute, Tokyo Medical and Dental University; Dr. Shigeru Hisamichi, Tohoku University Graduate School of Medicine; Dr. Takaichiro Suzuki, Research Institute, Osaka Medical Center for Cancer and Cardiovascular Diseases; Dr. Tsutomu Hashimoto, Wakayama Medical University; and Dr. Teruo Ishibashi, Asama General Hospital.

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