

Socioeconomic Status and Health: The Role of Sleep

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Objective: Examine the role of sleep in the relationship between socioeconomic status (SES) and health. **Method:** Self-reported measures of income and education, sleep quantity and quality, and mental and physical health were obtained in a community sample of 1139 adults. **Results:** More education was associated with higher income ($p < .001$), and higher income was associated with better physical health ($p < .001$) and psychological outcomes ($p < .001$). The effects of income on both mental and physical health were mediated by sleep quality (p values $< .01$), and sleep quantity was related to both measures of health (p values $< .01$) but to neither index of SES. **Conclusion:** Sleep quality may play a mediating role in translating SES into mental and physical well-being, and income seems to mediate the effect of education on sleep and, in turn, health. **Key words:** socioeconomic status; sleep; psychological distress; physical health.

SES = socioeconomic status; DAS = Detroit Area Study.

Socioeconomic status (SES) has long been recognized as a principal determinant of health. Low SES individuals are more likely to suffer from infectious diseases (1, 2), cognitive impairment (3, 4), mental illness (5, 6), heart disease (7, 8), and they are likely to die sooner than individuals of higher socioeconomic status (9, 10). Although the influence of SES on health has been observed for centuries and across cultures (11, 12), the mechanisms for this effect are not well understood (13). Researchers have examined the extent to which the SES–health link may be influenced by factors such as material and lifestyle differences (14–16), exposure to environmental stressors (17, 18), coping skills (19, 20), and perceptions of social support (21, 22). A factor yet to be examined in the context of SES and health is the role of sleep.

Although theories of how and why we sleep have been proposed since the time of Plato and Aristotle, comprehensive empirical research on sleep and its effects did not begin until the middle of the 20th century. This research has identified five distinct stages of sleep, each characterized by differences in brain-wave activity, muscle tension, and endocrine functioning (23). The results of sleep research include not only information about sleep itself, but also about how sleep affects—and is affected by—other important aspects of life, including socioeconomic status and health. For example, there is evidence that low-SES individuals are more likely to suffer from sleep

disturbances (24), that such disorders are associated with poorer health (25), and that sleep can mediate the relationship between stress-related thoughts and immune function (26).

The optimal amount of sleep for most humans appears to be between seven and nine hours per night (23). Periodic sleep deprivation can adversely affect an individual's mood, attention, and ability to concentrate (27–29), whereas long-term sleep loss is linked to fatigue (30, 31), cardiovascular disease (32, 33), and mortality (34, 35). There is also evidence that these potential health effects of chronic sleep debt are independent of risk factors such as demographics, body mass index, physical health status, substance use, and sleep apnea (33–38).

Recently, Van Cauter and Spiegel (39) found that sleep debt is also associated with physiological changes (eg, decreased glucose tolerance, elevated cortisol levels) similar to those observed in aging. In light of these results, Van Cauter and Spiegel hypothesized that sleep may mediate the SES–health relationship by increasing the risk of chronic health conditions prevalent among low-SES groups. However, despite this and other evidence that sleep is related to SES and that it plays an important role in health, there have been no studies to date examining whether sleep actually does mediate the relationship between socioeconomic status and health.

Research on sleep traditionally has examined the effects of sleep quantity; however, a more recent distinction has been made between the amount of sleep people get and the quality of that sleep. In addition to being positively related to socioeconomic status (40), sleep quality has also been associated with better physical health (41, 42) and greater psychological well-being (43, 44). Although the effects of sleep quantity and quality have rarely been compared directly, a notable exception is research by Pilcher, Ginter, and Sadowsky (45), who examined the relative effects of the quantity and quality of sleep on college students' mental and physical health. In two studies involving a total of 117 participants, Pilcher et al. had participants keep a daily sleep log during the week before filling

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out the study surveys. In addition to self-reported sleep quantity and quality, Pilcher et al. (45) also obtained participants' physical health complaints and measures of psychological well-being, including anxiety, depression, and fatigue. Using a series of correlational analyses, both studies found that sleep quantity was marginally related to sleep quality, and that sleep quality was the stronger and more consistent predictor of mental and physical health. These results suggest that sleep quality may be at least as important as sleep quantity in terms of its impact on health.

No studies have been conducted to examine whether these findings generalize to nonstudent populations, nor is there research on the relative impact of sleep quantity and quality on the relationship between SES and health. Although it is possible that either (or both) sleep quantity and sleep quality mediate the effect of SES on health individually, it seems unlikely—given their shared variance—that both would mediate this relationship when examined simultaneously.

In sum, we know relatively little about the role of sleep in the relationship between SES and health, or the relative importance of sleep quantity and sleep quality in this context. To address these issues, the current study examined the relationships between SES and both mental and physical health within a community sample, as well as the influence of self-reported sleep quantity and quality on these relationships. Specifically, this study tested the following hypotheses:

1. That higher SES participants would report less psychological distress than lower SES participants;
2. That higher SES participants would report better physical health than lower SES participants;
3. That the effect of SES on both mental and physical health will be mediated by either sleep quantity or sleep quality.

METHODS

Participants

The data for the current analyses come from the 1995 Detroit Area Study (DAS). The DAS is a multistage area probability sample of adults residing in Wayne, Oakland, and Macomb counties in Michigan, including the city of Detroit. To obtain more equal numbers of African Americans and whites, African Americans were oversampled in the study. Face-to-face interviews were conducted between April and October of 1995. Of those contacted for participation, 1139 (70%) participated in the study, including 520 whites, 586 African Americans, and 33 of either Asian, Native American, or Hispanic ethnicity. These participants—710 of who were women—ranged in age from 18 to 89 years old, with an average age of 46 years.

Measures

Socioeconomic status. There were two measures of SES; the first, education, indicated the number of years of formal education com-

pleted by participants. Within the current sample, participant education ranged from zero to 17 years of formal schooling, with an average of 13 years of formal education.

The second SES measure was participants' family income for 1994. Of the 1,006 participants who indicated their income, 30% reported incomes of \$16,000 or less, half reported less than \$32,000, 70% reported \$50,000 or less, and the top 10% of incomes were between \$100,000 and \$260,000. To reduce the skewness of this distribution, logarithmic transformations were conducted on these data.

Estimates of sleep quantity and quality. Measures of both sleep quantity and sleep quality were based on participants' subjective estimates. The measure of sleep quantity indicated participants' average amount of sleep (in hours) per night during the previous month, and sleep quality was assessed on a 1 to 5 scale (1 = poor, 2 = fair, 3 = good, 4 = very good, 5 = excellent). Participants reported a range of between 1 and 12 hours of sleep per night, and an average of 6.5 hours of sleep (the 15 participants who reported working nights did not respond to this question). Because any additional health benefits of extremely high levels of sleep are unclear, and because extended periods of sleep are often associated with mental or physical maladies (eg, depression, viral infections), subsequent analyses involving sleep quantity estimates was restricted to the 98% of participants who reported an average of between one and nine hours of sleep per night.

Psychological and physical health. Psychological health was assessed using a six-item index of psychological distress. Participants indicated how often in the preceding 30 days they had felt 1) nervous, 2) hopeless, 3) restless, 4) worthless, 5) that everything was an effort, and 6) so sad that nothing could cheer them up. For each of these items, participants indicated whether they had these feelings "very often" (5), "fairly often" (4), "not too often" (3), "hardly ever" (2), or "never" (1). Responses to the six items were then combined and averaged to create an overall index of psychological distress for each subject ($\alpha = 0.84$). On this overall 1 to 5 scale, participants ranged from 1.0 to 5.0, with an average of 2.0.

Self-reported physical health was assessed using a single item with which participants indicated that their overall physical health was either 1) poor, 2) fair, 3) good, 4) very good, or 5) excellent. Self-reported measures of health have been shown to be valid, predicting health-care utilization and mortality even when controlling for physiological risk factors (46, 47). In addition, single-item estimates of physical health have been highly correlated with other, multi-item health indices (48).

Prior health status. To control for the effects of participants' previous health, an index of prior health status was developed. Participants answered "yes" or "no" to indicate whether they had been diagnosed in the past by a health professional with each of the following conditions: 1) stroke, 2) heart problems, 3) diabetes, 4) nervous-system disorder, 5) cancer, 6) arthritis, 7) stomach ulcers, 8) asthma, 9) liver problems, 10) kidney problems, 11) emphysema, and 12) any circulatory problems. These responses were combined to create an index (from 0–12) of participants' prior health status. Participants ranged from 0 to 9 on this measure, with an average of one prior health condition. Approximately 48% (552) of the participants reported none of these health problems, 26% (295) reported one condition, 13% (144) reported two conditions, 12% (132) reported between three and five conditions, and 1% (16) of the participants reported six or more of these health problems.

Analyses

Two main series of analyses were conducted in this research. First, correlational analyses were performed to determine the zero-

Table 1. Means and SD for Study Measures

Measure	Mean	SD
Education (years)	13.2	2.5
Income (\$)	41,511	36,113
Quantity of sleep (hours)	6.5	1.4
Quality of sleep	3.1	1.2
Psychological distress	2.0	0.8
Physical health	3.4	1.1
Prior health status	5.6	1.5

order relationships between the study measures. Separate path analyses (one for psychological distress and one for physical health) were then conducted to determine the extent to which sleep influenced the relationship between SES and health. Path analysis is the functional equivalent of a series of multiple regressions in which each factor in a model is alternately included as a dependent measure. As a result, path analysis can be used to determine the strength and valence of both direct and indirect (ie, mediating) relationships between variables in a model (49).

RESULTS

Preliminary Analyses

The means and standard deviations for each of the study measures are shown in Table 1. To determine potential confounds, preliminary analyses were conducted to examine the associations between demographic characteristics (ie, age, ethnicity, gender), prior health status, and the other study measures. Older age was associated with more prior health conditions ($p < .001$), higher sleep quality ($p < .05$), less psychological distress ($p < .01$) and poorer current physical health ($p < .001$). Relative to whites, non-white participants reported significantly less education ($p < .001$), lower income ($p < .001$), fewer hours of sleep ($p < .01$), and poorer physical health ($p < .001$). Women reported lower income ($p < .001$), more hours of sleep ($p < .05$), and poorer physical health ($p < .01$) than men. In addition, better prior health status

was associated with better current physical health ($p < .001$) and lower psychological distress ($p < .001$).

Given the surprising finding that sleep quality was positively related to age, we examined the correlation separately for the younger half (ages 18–42) and older half (ages 43–89) of participants in the study. Self-reported sleep quality increased marginally with age for the younger adults ($r = 0.08, p < .06$), and decreased—though not significantly—among older participants ($r = -0.05, p > .20$). The quadratic trend of the polynomial regression was significant ($t = 2.5, p < .01$), indicating a curvilinear relationship between participants’ age and the quality of their sleep.

Simple and Partial Correlations

Because of the significant associations between the study measures, both simple and partial correlations—controlling for age, ethnicity, gender, and prior health status—were conducted on these data, the results of which are shown in Table 2.

Although somewhat reduced, the interrelationships between the study measures were largely unchanged after controlling for participant demographics and prior health. After controlling for age, gender, ethnicity, and prior health status, more education was associated with higher income ($r = 0.37$), higher quality sleep ($r = 0.12$), lower psychological distress ($r = -0.14$) and better physical health ($r = 0.17$). Similarly, higher income was associated with better sleep quality ($r = 0.17$), lower distress ($r = -0.18$), and better physical health ($r = 0.18$). Sleep quantity was unrelated to either education or income, but was significantly associated with psychological distress ($r = -0.16$) and marginally related to physical health ($r = 0.06$). In addition to its association with sleep quantity ($r = 0.43$), better sleep quality was also related to lower levels of mental distress ($r = -0.33$) and better physical health ($r = 0.26$). Finally, lower psychological

TABLE 2. Simple and Partial Correlations Controlling for Age, Gender, Ethnicity, and Prior Health Status^a

	Education	Income	Sleep		Psychological Distress	Physical Health
			Quantity	Quality		
Education	1.000	.37***	.02	.12***	-.14***	.17***
Income	.39***	1.000	-.04	.17***	-.18***	.18***
Quantity of sleep	.01	-.02	1.000	.43***	-.16***	.06*
Quality of sleep	.13***	.17***	.45***	1.000	-.33***	.26***
Psychological distress	-.16***	-.21***	-.16***	-.34***	1.000	-.23***
Physical health	.25***	.27***	.08**	.27***	-.28***	1.000

^a Numbers below the diagonal represent simple correlations. Numbers above the diagonal represent partial correlations controlling for age, ethnicity, gender, and prior health. Simple correlation sample sizes range from 1,005 to 1,139, and the partial correlation sample size was 972. * $p < .05$; ** $p < .01$; *** $p < .001$.

distress was associated with better physical health ($r = -0.23$).

Path Models

Because sleep quantity was not associated with either measure of socioeconomic status, it was not included as a factor in the path models of psychological distress or physical health. However, participant age, ethnicity, gender, prior health status, and sleep quantity were controlled for in these analyses. This provides a conservative test of the mediational hypothesis, in that it does not include the effects of sleep quality that may be attributable to sleep quantity. In addition, because p values are sensitive to large sample sizes, statistical significance for the path analyses was considered in terms of effect size. Accordingly, only path coefficients of 0.10 or greater are shown in the models.

Psychological distress. Because both education and income were individually related to psychological distress (and to each other), an initial path analysis was conducted to determine whether either measure of SES mediated the effect of the other on psychological health (Fig 1a). When education and income were simultaneously included in the analysis, only income

predicted distress, indicating that the impact of education on psychological distress was mediated by income. More education was related to higher income ($\beta = 0.37, p < .001$), and higher income was associated with lower distress ($\beta = -0.14, p < .001$). When quality of sleep was added to the model (Fig 1b), it was related to income (but not education), and it was the only significant predictor of psychological health. Thus, sleep quality mediated the effect of income on psychological distress, with higher income being associated with better sleep quality ($\beta = 0.14, p < .001$), and better sleep related to lower distress ($\beta = -0.27, p < .001$). The relationship between education and income was essentially unchanged ($\beta = 0.36, p < .001$).

Physical health. To control for potential confounding effects of negative affectivity on self-reported sleep and overall health, psychological distress was controlled for in the path model of physical health. In the initial path model of physical health (with education and income included as predictors), income again mediated the effect of education on health (Figure 2a). More education was associated with higher income ($\beta = 0.33, p < .001$), and higher income was related to better physical health ($\beta = 0.12, p < .001$). As in the model of psychological distress, sleep quality mediated the relationship between income and physical

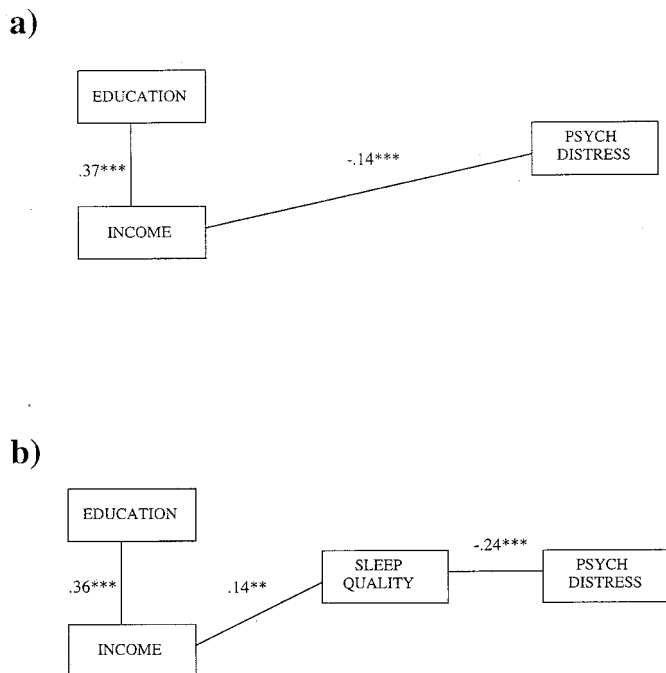


Fig. 1. Path models ($N = 960$) predicting psychological distress from (a) education and income, and (b) education, income, and sleep quality (controlling for age, gender, ethnicity, prior health status, and sleep quantity). Models show standardized regression coefficients. ** $p < .01$, *** $p < .001$.

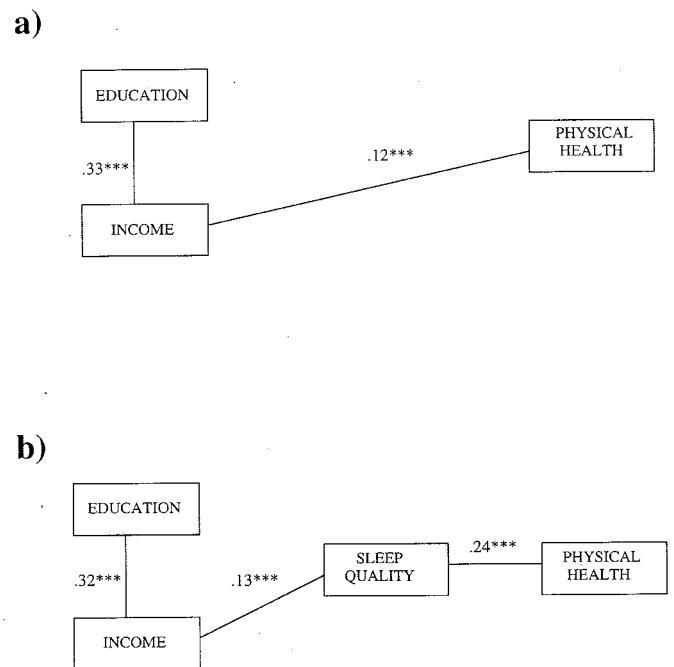


Fig. 2. Path models ($N = 960$) predicting physical health from (a) education and income, and (b) education, income, and sleep quality (controlling for age, gender, ethnicity, prior health status, sleep quantity, and psychological distress). Models show standardized regression coefficients. ** $p < .01$, *** $p < .001$.

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health (Figure 2*b*), with higher income related to better sleep quality ($\beta = 0.13$, $p < .001$), and better sleep associated with better physical health ($\beta = 0.24$, $p < .001$). Similarly, the relationship between education and income was also significant ($\beta = 0.32$, $p < .001$).

Sleep Quality/Quantity Interaction

Although getting relatively little sleep, some individuals may nonetheless be very efficient sleepers. As a result, in addition to their direct effects, sleep quality and quantity may also interact to influence health. To test for this moderating effect, the sleep quality-by-quantity interaction term was tested, after controlling for the main effects of sleep quality and quantity. While no moderating effect was found for psychological distress ($p > .15$), the interaction term was negatively associated with self-reported physical health ($\beta = -0.39$, $p < .05$), indicating that the impact of sleep quality on physical health increased as participants got less sleep.

DISCUSSION

In the current research, more education and higher income were individually associated with both lower psychological distress and better self-reported physical health, even when controlling for age, gender, ethnicity, and prior health status. When education, income, and sleep quality were combined to predict health, income mediated the impact of education, and sleep quality mediated the effect of income on mental and physical well-being. These findings are consistent with previous research on SES and health, and they support the hypothesis that sleep partially mediates this relationship. Although statistically significant, many of the relationships in this study were relatively modest. This is not particularly surprising, given the myriad factors influencing SES, sleep, and health, several of which were controlled for in these analyses. The pattern of results was virtually identical in both models of health, indicating that these effects, though modest, appear to be robust.

The current results also suggest more specific relationships between measures of socioeconomic status, sleep, and mental and physical health. While education and income were highly related to each other, only income was directly related to the other variables in the model. The fact that higher income—but not more education—was associated with better sleep quality suggests that more education may improve the quality of people's sleep, but only to the extent that it increases their income. This may be due to the fact that educational attainment is likely to affect an individu-

al's subsequent occupational opportunities (and hence their income), and thus may exert a more distal influence on sleep and, eventually, health.

Similarly, sleep quantity and quality were strongly related to each other, yet they were associated quite differently with the other measures in the study. Sleep quality played a mediating role in both models of health (even when sleep quantity was controlled for), while sleep quantity was less strongly related to either mental or physical well-being, and it was unrelated to either measure of SES. These results are largely consistent with those reported by Pilcher et al., in that the effects of sleep quality on health were both greater than, and independent of, those of sleep quantity (45). These findings illustrate the importance of distinguishing between sleep quality and quantity in the context of SES and health. They also suggest that sleep may play a role in translating SES into health, although the critical issue may be how well, rather than how long, people are able to sleep. If better quality sleep is a key to better health, it would be useful for future research to identify the elements that constitute sleep quality, as well as its psychological and behavioral determinants.

The current findings provide qualified support for a moderating effect of sleep on well-being, in particular self-reported physical health. Controlling for the main effects of each, sleep quality and quantity interacted (negatively) to affect physical health. These results suggest that sleep quality may have a greater impact on physical health for those who get less sleep, and—given the symmetrical nature of interactions—that getting more sleep may be particularly important among those whose sleep quality is poor.

Although quality of sleep was the stronger health predictor, sleep quantity was significantly correlated with both sleep quality and health, even when controlling for age, ethnicity, gender, and prior health status. These results differ somewhat from those of Pilcher et al., who found that sleep quantity was only marginally associated with sleep quality, and that only two of 20 correlations between measures of sleep quantity and health were statistically significant. Differences in significance levels between the two studies are partly attributable to their respective sample sizes; however there are some effect-size differences as well (eg, the relationships between sleep quantity and psychological distress). These may reflect differences between student and community samples, or the fact that these investigations used different indices of both sleep and health. Although absolute standardization of such measures may not be feasible (nor even desirable), future studies using both multi-item and overall mea-

asures of SES, sleep, and health would enable more direct comparisons of results between populations.

The finding that self-reported sleep quality was positively correlated with participant age differs from a large body of previous research indicating that sleep quality is negatively related to aging, while some research has found no association (50, 51). Given the large sample, the number of zero-order analyses, and its relatively small effect size, this result may simply reflect Type I error. It is also possible that the relationship between sleep quality and age is curvilinear, ie, more positive among younger adults, becoming increasingly negative as people grow older. This trend was found in the current study, as well as in previous research examining the impact of aging on sleep quality among different age groups (52, 53).

A principal limitation of the current research is the cross-sectional nature of the analyses. While significant associations were found between measures of SES, sleep, and health, we cannot discern from these data the temporal order or causal direction of these relationships. For example, while poor sleep quality may well lead to poorer health, poor health may also contribute to poor sleep quality, and either (or both) may lead to lower income. However, the current analyses did control for an index of prior health status, suggesting that the noted effects of income and sleep quality were not merely a function of participants' previous health. In addition, because education is typically established early in life, its causal impact on subsequent income, sleep, and health is clearer. Although longitudinal studies demonstrating the link between SES and health are numerous (20, 26, 54), they have yet to examine the role of sleep in this context. Such information would be helpful in assessing the extent to which sleep is a determinant, or merely a reflection, of socioeconomic status and/or health.

A second limitation of this study is the use of participant self-reports. While this does not necessarily make such data unreliable (55), it can pose methodological challenges, including the measurement of socioeconomic status, particularly income. As found here and elsewhere, research participants are often reluctant to report their personal income. This can reduce effective sample sizes and may limit the generalizability of the results, suggesting the importance of developing additional strategies for obtaining information about socioeconomic status. However, the current results also indicate that self-reported education and income can be useful for understanding health, although income appears to exert the more proximal impact on mental and physical well-being. These differential effects reflect the multidimensional nature of SES, and they illustrate the importance of measuring

these dimensions separately, while evaluating their impact simultaneously.

A related limitation involves the subjective estimates of sleep quantity and quality. People appear to consistently underestimate both the amount of time they sleep (56, 57), as well as the number of arousals they experience during that sleep (57, 58). This suggests that current participants' estimates of their sleep quality may be inflated, while their estimated sleep duration may be artificially low. On the other hand, subjective estimates of both sleep quality and quantity have been found to be strongly correlated with their objective counterparts (59, 60, 61), indicating that self-reports and objective measures of sleep may be linear scales of one another. Taken together, these results suggest that differences between subjective and objective sleep measures may be more problematic for absolute sleep estimates than for the relationships between sleep and other health-related factors. The use of objective measures in future sleep research will be necessary to address these issues more directly.

It is also important for future research to clarify the functional distinctions between different measures of sleep, particularly sleep quality. For example, although age is consistently associated with differences in neural and endocrine functioning, its effect on subjective estimates of sleep quality are less uniform. Although indices such as sleep-onset latency, sleep stages, arousals, hormone secretion, glucose tolerance, sleep satisfaction, restfulness, and overall subjective estimates all reflect sleep quality, they are likely to have varying degrees of overlap, as well as differential effects on other outcomes. Such clarification would not only enable more meaningful comparisons between objective measures and self reports but may also help to identify which aspects of sleep are most important in terms of health.

To this end, it may be useful to distinguish between at least three groups of sleep indices: physiological (eg, brain-wave activity, hormone levels), behavioral (eg, total sleep time, number of arousals), and psychological (eg, sleep satisfaction, exhaustion). Physiological measurements—which can be made with great precision—appear to be most consistent, while behavioral indicators are likely the most appropriate for direct comparisons between subjective estimates and objective observations. Although the most variable, psychological sleep measures are the least costly to obtain, and may represent the aggregate impact of the physiological and behavioral aspects of sleep. Future comparisons within and between each of these areas could provide a better understanding of their respective (and combined) effects on mental and physical well-being.

The current research was conducted to investigate

the link between socioeconomic status and health, and to examine the role of sleep in this relationship. In this sample of adults, participants' education operated through income to affect mental and physical health, and these health effects of income were themselves mediated by participants' sleep quality. These findings indicate that sleep may play a significant role in translating socioeconomic status into health, and they suggest the importance of future research on how SES may affect people's sleep, and how sleep may in turn influence the quality, and perhaps length, of their lives.

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REFERENCES

- Court SD. Epidemiology and natural history of respiratory infections in children. *J Clin Pathol* 1968;2:30-7.
- Gordis L, Lilienfeld A, Rodriquez R. Studies in the epidemiology and preventability of rheumatic fever: socio-economic factors and the incidence of acute attacks. *J Chronic Dis* 1969;21:655-66.
- Katzman R. Education and the prevalence of dementia and Alzheimer's disease. *Neurol* 1993;43:13-20.
- Stern Y, Gurlard B, Tatemichi TK, Tang MS, Wilder D, Mayeux R. Influence of education and occupation on the incidence of Alzheimer's disease. *JAMA* 1994;272:1004-10.
- Abramson JH. Emotional disorder, status inconsistency and migration: a health questionnaire survey in Jerusalem. *Milbank Q* 1966;44:23-48.
- Kessler RC, Cleary PD. Social class and psychological distress. *Am Sociol Rev* 1980;45:463-78.
- Luepker RV, Rosamond WD, Murphy R, Sprafka JM, Folsom AR, McGovern PG, Blackburn H. Socioeconomic status and coronary heart disease risk factor trends: the Minnesota Heart Survey. *Circulation* 1993;88:2172-9.
- Reynes JF, Lasater TM, Feldman H, Assaf AR, Carleton RA. Education and risk factors for coronary heart disease: results from a New England community. *Am J Prev Med* 1993;9:365-71.
- Marmot MG, Ryff CD, Bumpass LL, Shipley M, Marks NF. Social inequalities in health: next questions and converging evidence. *Soc Sci Med* 1997;44:901-10.
- Stockwell EG, Goza FW, Luse VO. Infectious disease mortality among adults by race and socioeconomic status: metropolitan Ohio, 1989-1991. *Soc Biol* 1997;44:148-52.
- Antonovsky A. Social class, life expectancy and overall mortality. *Milbank Q* 1967;45:31-73.
- Dennis BH, Zhukovsky GS, Shestov DB, Davis CE, Deev AD, Kim H, Tyroler HA. The association of education with coronary heart disease mortality in the USSR Lipid Research Clinics Study. *Int J Epidemiol* 1993;22:420-7.
- Adler NE, Boyce T, Chesney MA, Cohen S, Folkman S, Kahn RL, Syme SL. Socioeconomic status and health: the challenge of the gradient. *Am Psychol* 1994;49:15-24.
- Blane D. An assessment of the Black Report's "explanations of health inequalities." *Sociol Health Illn* 1985;7:423-45.
- Davey-Smith G, Blane D, Bartley M. Explanations for socioeconomic differentials in mortality: evidence from Britain and elsewhere. *Eur J Public Health* 1994;133-44.
- Townsend P, Davidson N. The Black Report. In: Townsend P, Davidson N, Whitehead M, editors. *Inequalities in health*. London: Penguin; 1988.
- Dohrenwend BS, Dohrenwend BP. Hypotheses about stress processes linking social class to various types of Psychopathology II. *Am J Community Psychol* 1981;9:146-59.
- Kessler RC. Stress, social status and psychological distress. *J Health Soc Behav* 1979;20:259-72.
- McLeod JD, Kessler RC. Socioeconomic status differences in vulnerability to undesirable life events. *J Health Soc Behav* 1990;31:162-72.
- Stronks K, van de Mheen H, Looman CW, Mackenbach JP. The importance of psychosocial stressors for socio-economic inequalities in perceived health. *Soc Sci Med* 1998;46:611-23.
- Murrell SA, Norris FH. Differential social support and life change as contributors to the social class distress relationship in older adults. *Psychol Aging* 1991;6:223-31.
- Thoits PA. Explaining distributions of psychological vulnerability: lack of social support in the face of life stress. *Soc Forces* 1984;63:453-81.
- Dement WC, Vaughan C. The promise of sleep: a pioneer in sleep medicine explores the vital connection between health, happiness, and a good night's sleep. New York: Delacorte; 1999.
- Hunt SM, McEwen J, McKenna SP. Social inequalities and perceived health. *Eff Health Care* 1985;2:151-60.
- Segovia J, Bartlett RF, Edwards AC. The association between self-assessed health status and individual health practices. *Can J Public Health* 1989;80:32-7.
- Hall M, Baum A, Buysse MD, Prigerson HG, Kupfer DJ, Reynolds CF. Sleep as a mediator of the stress-immune relationship. *Psychosom Med* 1998;60:48-51.
- Pilcher JJ, Huffcutt AI. Effects of sleep deprivation on performance: a meta-analysis. *Sleep* 1996;19:318-26.
- Leonard C, Fanning N, Attwood J, Buckley M. The effect of fatigue, sleep deprivation and onerous working hours on the physical and mental well being of pre-registration house officers. *Ir J Med Sci* 1998;167:22-5.
- Pilcher JJ, Walters AS. How sleep deprivation affects psychological variables related to college students' cognitive performance. *J Am Coll Health* 1997;46:121-6.
- Johnson LC, MacLeod WL. Sleep and awake behavior during gradual sleep reduction. *Percept Mot Skills* 1973;36:87-97.
- Friedman J, Globus GG, Huntley A. Performance and mood during and after gradual sleep reduction. *Psychophysiology* 1977;14:245-50.
- Naitoh P, Kelly TL, Englund C. Health effects of sleep deprivation. *Occup Med* 1990;5:209-37.
- Appels A, de Vos Y, van Diest R, Hoppner P, Mulder P, de Groen J. Are sleep complaints predictive of future myocardial infarction? *Act Nerv Super (Praha)* 1987;29:147-51.
- Kojima M, Wakai K, Kawamura T, Tamakoshi A, Aoki R, Lin Y, Nakayama T, Horibe H, Aoki N, Ohno Y. Sleep patterns and total mortality: a 12-year follow-up study in Japan. *J Epidemiol* 2000;10:87-93.
- Wingard DL, Berkman LF, Brand RJ. A multivariate analysis of health-related practices: a nine-year mortality follow-up of the Alameda County Study. *Am J Epidemiol* 1982;116:765-75.
- Schwartz S, McDowell AW, Cole SR, Corroni-Huntley J, Hays JC, Blazer D. Insomnia and heart disease: a review of epidemiologic studies. *J Psychosom Res* 1999;47:313-33.
- Roehrs T, Conway W, Wittig R, Zorick F, Sickestell J, Roth T.

- Sleep-wake complaints in patients with sleep-related respiratory disturbances. *Am Rev Respir Dis* 1985;132:520–3.
38. Dickel MJ, Mosko SS. Morbidity cut-offs for sleep apnea and periodic leg movements in predicting subjective complaints in seniors. *Sleep* 1990;13:155–66.
 39. Van Cauter E, Spiegel K. Sleep as a mediator of the relationship between socioeconomic status and health: a hypothesis. *Ann N Y Acad Sci* 1999;896:254–61.
 40. Geroldi C, Frisoni GB, Rozzini R, De Leo D. Principal lifetime occupation and sleep quality in the elderly. *Gerontology* 1996;42:163–69.
 41. Barton J, Spelten E, Totterdell P, Smith L. Is there an optimum number of night shifts? Relationship between sleep, health and well-being. *Work Stress* 1995;9:109–23.
 42. Lewin DS, Dahl RE. Importance of sleep in the management of pediatric pain. *Dev Behav Pediatr* 1999;20:244–52.
 43. Bliwise NG. Factors related to sleep quality in health elderly women. *Psychol Aging* 1992;7:83–8.
 44. Shaver JL, Paulsen VM. Sleep, psychological distress, and somatic symptoms in perimenopausal women. *Fam Pract Res J* 1993;13:373–84.
 45. Pilcher JL, Ginter DR, Sadowsky B. Sleep quality versus sleep quantity: relationships between sleep and measures of health, well-being and sleepiness in college students. *J Psychosom Res* 1997;42:583–96.
 46. Bierman AS, Bubolz TA, Fisher ES, Wasson JH. How well does a single question about health predict the financial health of medicare managed care plans? *Eff Clin Pract* 1999;2:56–62.
 47. Idler EL, Angel RJ. Self-rated health and mortality in the NHANES-I epidemiologic follow-up study. *Am J Public Health* 1990;80:446–52.
 48. Williams DR, Yu Y, Jackson JS, Anderson NB. Racial differences in physical and mental health: socio-economic status, stress and discrimination. *J Health Psychol* 1997;2:335–51.
 49. Baron RM, Kenny DA. The moderator-mediator variable distinction in social science research: conceptual, strategic, and statistical considerations. *J Pers Soc Psychol* 1986;51:1173–82.
 50. Landolt HP, Dijk DJ, Achermann P, Borbely AA. Effect of age on the sleep EEG: slow-wave activity and spindle frequency activity in young and middle-aged men. *Brain Res* 1996;738:205–12.
 51. Middelkoop HA, Smilde-van den Doel DA, Neven AK, Kamphuisen HA, Springer CP. Subjective sleep characteristics of 1,485 males and females aged 50–93: effects of sex and age, and factors related to self-evaluated quality of sleep. *J Gerontol* 1996;51:M108–15.
 52. Hoch CC, Dew MA, Reynolds CF, Buysse DJ, Nowell PD, Monk TH, Mazumdar S, Borland MD, Miewald J, Kupfer DJ. Longitudinal changes in diary- and laboratory-based sleep measures in healthy “old old” and “young old” subjects: a three-year follow-up. *Sleep* 1997;20:192–202.
 53. Asplund R. Sleep disorders in the elderly. *Drugs Aging* 1999;14:91–103.
 54. Marmot MG, Shipley MJ, Rose G. Inequalities in death—specific explanations of a general pattern? *Lancet* 1984;80:1003–6.
 55. Fox NL, Sexton M, Hebel JR, Thompson B. The reliability of self-reports of smoking and alcohol consumption by pregnant women. *Addict Behav* 1989;14:187–95.
 56. McCall WV, Turpin E, Reboussin D, Edinger JD, Haponik EF. Subjective estimates of sleep differences from polysomnographic measurements in obstructive sleep apnea patients. *Sleep* 18: 646–50.
 57. Carskadon MA, Dement WC, Mitler MM, Guilleminault C, Zarcone VP, Spiegel R. Self-reports versus sleep laboratory findings in 122 drug-free subjects with complaints of chronic insomnia. *Am J Psychiatry* 133:1382–8.
 58. Baker FC, Maloney S, Driver HS. A comparison of subjective estimates of sleep with objective polysomnographic data in healthy men and women. *J Psychosom Res* 47:335–41.
 59. Aschoff J. Estimates on the duration of sleep and wakefulness made in isolation. *Chronobiol Int* 1992;9:1–10.
 60. Ajilore O, Stickgold R, Rittenhouse CD, Hobson JA. Nightcap: laboratory- and home-based evaluation of a portable sleep monitor. *Psychophysiology* 1995;32:92–8.
 61. Armitage R, Trivedi M, Hoffman R, Rush AJ. Relationship between objective and subjective sleep measures in depressed patients and healthy controls. *Depress Anxiety* 1997;5:97–102.