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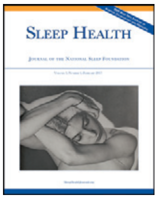

Social support, social strain, sleep quality, and actigraphic sleep characteristics: evidence from a national survey of US adults

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ABSTRACT

Objective: To determine the associations between average family and friend social support and strain over 10 years and sleep quality, sleep efficiency, total sleep time, and night-to-night total sleep time variability.
Participants: Non-institutionalized English-speaking US adults aged 34–81 who participated in the MacArthur Study on Aging: Midlife in the United States.
Measurements: Sleep quality was assessed by the Pittsburgh Sleep Quality Index and by a 7-day daily diary. Sleep efficiency, total sleep time, and night-to-night total sleep time variability were assessed by actigraphy (MiniMitter 64).
Results: Social support, but not social strain, was significantly associated with both self-reported measures of quality (social support $\beta = -1.239$, $P = .019$ for global Pittsburgh Sleep Quality Index scores; social support $\beta = -0.248$, $P = .016$ for diary assessed quality). Lower scores on both quality measures indicate better sleep. In contrast, social strain, but not social support, was significantly associated with sleep efficiency (social strain $\beta = -3.780$, $P = .007$). Social strain, but not social support, was significantly associated with night-to-night sleep variability (social strain $\beta = 0.421$, $P = .034$); however, the overall model was not significant. Neither social support nor social strain was significantly associated with total sleep time.
Conclusion: Social support was significant for self-reported sleep, whereas only social strain was significantly associated with objective sleep parameters. Future research on social relationships and sleep should analyze both positive and negative aspects of relationships in tandem because effects appear to differ based on outcome.

Introduction

The consequences of poor sleep are increasingly understood to affect health, from mortality risk to cardiovascular disease, obesity, diabetes, and many others (see Czeisler[1] [2015] for a summary).[1–5] The significance of sleep to health begs the question: What contributes to poor sleep? The determinants of sleep can be found at different levels of analysis, from the genetic to the social. This article operates at the social psychological level to understand how social support and social strain from family and friends may impact both subjective and objective sleep characteristics. The sleep literature at the social psychological level tends to consider 3 aspects of social relationships: social support, loneliness, and social strain, which are operationally defined as *perceptions* of the supportive, lacking (in connection), or strained aspects of the individual's social network.

The first aspect is social support. Seminal work by Cassel and Cobb in the 1970s established social support as a significant protective factor for a variety of health outcomes.[6–8] These protective effects appear to hold for many aspects of sleep; conversely, a lack of social support is predictive of poor sleep. Low social support is associated with increased odds of shorter self-reported sleep duration, whether duration is operationalized as ≤6 hours, ≤7 hours, or perceived days of insufficient sleep per week.[9–11] When sleep was assessed by actigraphy, however, different results were obtained: emotional support was not predictive of total sleep time (TST) (or sleep quality) but was predictive of lesser wake after sleep onset.[12] Despite some differences between subjective and objective sleep outcomes for TST, it appears that supportive social relationships generally have a positive effect on sleep.

Supportive social relationships are thus highly desirable. When people want social connectedness and yet have their wishes frustrated, the result is conceptualized as loneliness. Loneliness, the second aspect of social relationships, is defined as a *perception* of a lack of social connection. Loneliness contributes to poor sleep efficiency (SE), poor daytime function, and sleep fragmentation but not sleep duration.[13–15] The mechanism by which loneliness affects sleep may include “feelings of vulnerability and unconscious vigilance for

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social threat, implicit cognitions that are antithetical to relaxation and sound sleep."[16 (p4)]

However, as desirable as relationships may be, relationships can themselves be a source of strain. Thus, a third approach builds on the social support literature to include the negative aspects of social relationships. It is important to note that the presence of strain does not necessarily imply the absence of support, for there is evidence to suggest that social support and strain are independent.[17,18] Because a lack of social support is not the same as the presence of strain, analysis of support alone would yield a partial understanding of the effect of social relationships on sleep. To date, however, few articles on sleep have included social strain.[19,20] This appears to be an oversight because the literature indicates that the effects of the negative aspects of social relationships on well-being generally tend to be either as powerful or even more so than the positive aspects of social relationships.[21] If this proposition holds for sleep, then negative aspects of social relationships may have a greater effect on sleep parameters.

This third line of research typically analyzes support and strain together. It consistently finds that negative aspects of relationships influence sleep. High levels of family strain and low levels of family support produce the highest odds of reporting weekly/daily sleep problems.[19] Interpersonal distress is correlated with sleep and arousal.[22] Aversive social ties correlate with poorer self-reported sleep quality, and supportive ties correlate with better sleep quality, with depression as a significant mediator.[20]

Strides have thus been made toward a fuller understanding of how social relationships affect self-reported sleep. However, it is well-known that self-reported and objectively measured sleep outcomes often yield different results, which suggests that they may be distinct phenomena deserving separate analysis.[23–25] In addition, some aspects of self-reported sleep such as global sleep quality and sleep problems do not have straightforward objective analogues. Thus, the literature has left open to investigation whether social support and strain are associated with *objectively* measured sleep parameters such as TST, SE, and night-to-night variability in TST, a parameter of increasing interest due to its association with depressive symptoms and subjective well-being.[26,27] Furthermore, it is unknown whether social support or strain will have the larger effect on objective sleep parameters and if results differ with self-reported sleep. A study employing both objective and subjective sleep outcomes may provide a clearer picture of the effects of social relationships on sleep.

Thus, the questions that motivate this study are: What are the contributions of social support and social strain to sleep quality, efficiency, TST, and night-to-night TST variability? Which has the greater effect on sleep: social support or social strain? It is hypothesized that support should be predictive of higher sleep quality, SE, TST, and lower night-to-night TST variability. Social strain, on the other hand, should be predictive of lower sleep quality, SE, TST, and higher night-to-night TST variability. However, if a comparative claim can be made, strain may have the larger effect, consistent with the literature on well-being.[21] This article thus considers the associations between positive and negative aspects of social relationships and sleep using multiple objective sleep parameters. Furthermore, this article analyzes sleep in a subset of a national probability sample, which is demographically diverse in age, sex, and marital status.

Participants and methods

Data are drawn from the MacArthur study on Midlife Development in the United States (MIDUS), a national probability sample of noninstitutionalized English-speaking adults in the contiguous United States obtained by random-digit-dialing, aged 34-84 at wave II. Of the several waves, the first and second waves of MIDUS (1994-1995 and 2004-2006) and the Biomarker supplement (2004-009) are used. Of the 7108 respondents at wave I, 4963 also responded at wave II. A subsample of this population, 1255 respondents, was assessed for the Biomarker supplement; data were collected 5 to 64 months after wave II. A further subsample participated in the sleep study. After exclusion of missing values on covariates and outcome variables, the total number of observations is 236.

The MIDUS study included a subset of twins and siblings. These observations are retained, necessitating the use of cluster robust standard errors. Cluster robust standard errors allow for intraclass correlation and compensate for overly precise estimates in regressions with possibly dependent observations by inflating standard errors and thus widening confidence intervals.[28]

Outcome variables

Sleep quality was assessed in 2 ways. The Biomarker supplement to MIDUS included the Pittsburgh Sleep Quality Index (PSQI), a widely used and well-known survey instrument intended to measure sleep quality over the previous month. It consists of 19 items used to form 7 component scores: subjective sleep quality, sleep latency, sleep duration, habitual SE, sleep disturbance, use of sleeping meds, and daytime dysfunction. Scores are coded and summed into a global score with a possible range of 0-21.[29] Lower scores represent better sleep.

Biomarker participants were invited to participate in a subsequent 7-day daily diary and actigraphy study. In the daily diary, respondents rated the overall quality of their sleep the previous night on a scale of 1 (very good) to 5 (very poor). The phenomenon of interest is patterns of sleep quality, and thus, the average of these 7 scores was calculated. Lower scores represent better sleep.

Total sleep time and SE were calculated by data collected from actigraphs, a sensor worn on the wrist of the nondominant arm that allows tracking of movement. The actigraph used in MIDUS was the MiniMitter Actiwatch 64. Actigraphy is particularly informative of sleep patterns because wrist actigraphs are relatively inexpensive and noninvasive and record data that allow for the calculation of TST, wake time, wake bouts, SE, and many other features of sleep that are useful to the researcher. The 7 TST and SE scores from each night were averaged to form an average of TST and SE over 7 nights. To capture variability across the 7 nights, night-to-night TST variability was calculated using mean squared successive differences (MSSD).[26,30] MSSD was calculated by the differences in successive TST squared, summed, and divided by $n - 1$. This variable was log transformed for normality (log MSSD Shapiro-Wilk $P = .302$). All outcomes were tested for significance of association with each other by Pearson correlation (Table A1).

Social support and strain

The primary independent variables of interest are social support and social strain. Social support and strain are constructed variables that are intended to measure, for support, "one's perceived notions of the caring and understanding exhibited by the network," and for strain, "individuals' general perception of the critical, irritating, and unreliable nature of their network."[31 (p7)] There are 3 network domains: family, friend, and spouse. For friends and family, respondents were asked 4 support questions: how much friends or family "care about you," "understand the way you feel," "how much you can rely on them," and "how much you can open up to them"; strain questions asked how often friends or family "make too many demands on you," "criticize you," "let you down when you are counting on them," and "get on your nerves". Spouse support and strain asked similar questions and 2 more in addition: support questions asked how much can the respondent "relax and be yourself around him or her" and how much does one's spouse "appreciate you"; strain questions asked how often does "he or she argue with you" and "make you feel tense" (see Walen and Lachman[31] [2000] for a detailed treatment).

The domains of interest for this analysis are family and friends. Spousal characteristics were excluded for several reasons. First, the mechanisms by which a bed or cohabitating partner affects sleep (eg, snoring, child caregiving, marital satisfaction) plausibly differ from how family and friends affect sleep, and much of the spouse literature appears to be specific to spouses, or spouses with children, and not social relationships in general. Second, the inclusion of spousal variables results in a loss of nearly a third of the sample because a precondition for reporting spouse support and strain is having a spouse; some others simply did not respond. Third, a spousal analysis may represent a selection bias of the sample.[32] Finally, it is not clear that spousal variables are fully commensurable with friend and family variables (see above). For these reasons, a dedicated analysis on the important domain of spousal relationships seems warranted, and the current article focuses on family and friends. Thus, social support and strain are constructed as the average between family and friend support and strain, and averaged again between waves I and II (see Yang et al[33,34] [2014 and 2016] for a similar treatment).

Levels of average family and friend social support and strain remain relatively stable across a 10-year interval, the modal change is no change, and the vast majority of the variance is captured within 1 unit on either direction of 0 if wave I support and strain scores are subtracted from those from wave II. The object is to capture long-term patterns in social relationships, and thus averages of both waves are used instead of using data from 1 wave only. The assumption is that average levels of support and strain across a decade would not change drastically in the short time between social relationship measurement and sleep measurement.

Control covariates

The following control covariates were included based on prior literature and preliminary bivariate tests of association and regression analyses: self-rated health,[35] dyspnea,[36] and number of chronic conditions[36] as physical health controls; depression[20] (in its dichotomous form as measured by the screening version of the Composite International Diagnostic Interview) as a psychological health control; and age,[37] sex,[38] and marital status as demographic controls.[1] Race was omitted because the data are essentially homogenous in race. Educational attainment, household income, and employment status were found to be insignificant in bivariate tests of association with the outcomes and/or independent variables of interest and/or insignificant as effects in regression models. These were not included in the final analysis. The actigraphy and daily diary analyses include several additional covariates collected in the daily sleep diary: minutes of moderate or vigorous exercise, number of caffeinated drinks, and number of alcoholic drinks were averaged across the 7 days of data collection and included as controls. These are not included in the PSQI analysis because the data were not collected at the same time. The data were cleaned in R and analyzed and visualized in R and STATA SE/IC 14.

Descriptive statistics and plots

Descriptive statistics are shown in Table 1.

Analytic strategy

Ordinary least squares (OLS) regression is used to regress social support and strain on all sleep variables, including the PSQI. Although the PSQI is discrete-quantitative, it is underdispersed (mean = 5.64, SD = 3.21) and thus violates the Poisson assumption that the mean and variance parameter are equal. Negative binomial models are not used because although these models are generalizations of the Poisson, these models can account for over-, but not under-, dispersion. The assumption in this OLS analysis is that the discrete quantitative PSQI data arose as a result of an underlying normally distributed data-generating process. Average sleep quality obtained from the daily diary is approximately normally distributed but does not pass a Shapiro-Wilk test ($P = .032$). Sleep efficiency is unimodal, left skewed, and right truncated because efficiency cannot surpass 100% (actual max =93.6%). The statistic of interest is the conditional mean, the univariate mean does not differ substantially from the median (median = 79.51, mean = 82.76), and therefore OLS regression is used. Total sleep time (Shapiro-Wilk $P = .078$) and log-transformed MSSD (Shapiro-Wilk $P = .302$) are approximately normally distributed. Cluster robust standard errors are reported (clustered on family number). In all regressions, the largest category by frequency is set as the reference (eg, married, female, not depressed). Models were checked for multicollinearity by variance inflation factors. Functional form specification was tested by the Ramsey RESET test for omitted variable bias by the powers of the fitted values and powers of the independent variables. Residuals were checked visually by their distributions and by a Shapiro-Wilk test for normality.

Table 1
Descriptive statistics[a] for data drawn from Midlife in the United States: A National Longitudinal Study of Health & Well-Being (n = 236)

Statistic	n	Mean	SD	Min	Max
PSQI	236	5.644	3.213	1	17
Daily sleep quality	236	2.315	0.680	1	4.857
SE	236	82.759	8.132	44.271	93.609
TST	236	6.410	0.985	2.556	9.562
Log MSSD[b]	236	8.454	1.009	5.511	10.611
Support	236	3.397	0.462	1.875	4
Strain	236	1.966	0.397	1	3
Age	236	53.610	11.668	34	81
Female	133	0.564			
Marital status					
Married	178	0.754			
Divorced	23	0.097			
Widowed	11	0.047			
Never married	24	0.101			
Self-rated health					
Average	19	0.085			
Good	68	0.288			
Very good	101	0.428			
Excellent	48	0.203			
Depressed	22	0.093			
No. chronic conditions	236	2.089	1.967	0	10
Dyspnea	236	0.424	0.695	0	3
Average alcoholic drinks	236	0.561	1.050	0	7.286
Average minutes of exercise	236	39.988	47.640	0	377.143
Average caffeinated drinks	236	2.432	2.031	0	12.143

[a] Proportions reported for categorical variables.
[b] Log MSSD is the log of the mean square of successive differences in TST (night-to-night TST variability).

Results

For the PSQI, social support is significant ($\beta = -1.239$, $P = .019$; Table 2). The 95% confidence interval indicates that with each unit increase in social support, a respondent's PSQI score is plausibly expected to decrease (better quality) anywhere from 0.206 to 2.271 units. Social strain is not significant ($\beta = 0.079$, $P = .876$). This model accounts for approximately 20.33% of the variance ($F = 4.01$, $P < .001$, n = 236).

[1] There was only 1 individual reporting poor self-rated health; this was recoded to average health.

Table 2
Ordinary least squares regression results[a,b] of social support and social strain on PSQI global scores, daily sleep quality, SE, TST, and night-to-night variability in TST (log MSSD) (n = 236)

	PSQI	Daily sleep quality	SE	TST	Night-to-night variability in TST
	β (CR SE)	β (CR SE)	β (CR SE)	β (CR SE)	β (CR SE)
Support	−1.239* (0.524)	−0.248* (0.101)	−1.999 (1.251)	−0.119 (0.152)	−0.011 (0.171)
Strain	0.079 (0.508)	0.102 (0.122)	−3.780** (1.376)	0.024 (0.198)	0.421* (0.197)
Constant	9.158*** (2.549)	3.109*** (0.697)	106.624*** (6.983)	7.118*** (0.920)	7.705*** (0.882)
Observations	236	236	236	236	236
R^2	0.2033	0.1402	0.2334	0.1610	0.0882
F statistic	4.01***	2.78***	3.74***	2.70***	1.54

[a] Models adjusted for age, sex, marital status, self-rated health, depression, number of chronic conditions, and dyspnea. Average daily sleep quality, SE, TST, and night-to-night variability in TST models additionally adjusted for average minutes of exercise, average alcoholic drinks, and average caffeinated drinks. Lower values on the PSQI and the daily sleep diary represent higher quality sleep. Cluster robust standard errors reported in parentheses.
[b] The fully adjusted model results (reported in the table) are substantively similar to parsimonious models in which only sociodemographics (age, sex, and marital status) are controlled. In these reduced models, support and strain remain significant or nonsignificant consistent with the reported results. Analyses available on request.
* $P < .05$.
** $P < .01$.
*** $P < .001$.

For average daily diary reported sleep quality, social support is significant ($\beta = -0.248$, $P = .015$). The 95% confidence interval indicates that with each unit increase in social support, sleep quality scores are expected to decrease (better quality) anywhere from 0.049 to 0.447 unit. Social strain is not significant ($\beta = 0.102$, $P = .406$). This model accounts for approximately 14.02% of the variance (F = 2.78, $P < .001$, n = 236).

For SE, social strain is significant ($\beta = -3.780$, $P = .007$), whereas a similar claim cannot be made for social support because it is not significant at the .05 level ($\beta = -1.999$, $P = .111$). The 95% confidence interval for social strain indicates that SE is expected to decrease anywhere from 1.066 to 6.494 percentage points with each unit increase in social strain. This model explains approximately 23.34% of the variance (F = 3.74, $P < .001$, n = 236).

For TST, neither support nor strain was significant (social support $\beta = -0.119$, $P = .434$; social strain $\beta = 0.024$, $P = .903$). Very few covariates were significant. Sex was significant: men slept, on average, 39.15 fewer minutes than women ($P < .001$). This model accounts for approximately 16.10% of the variance (F = 2.70, $P < .001$, n = 236). A logistic regression run on TST split into dichotomy at <7 hours (not shown) produced similarly insignificant results for support and strain (social support $P = .288$, social strain $P = .539$).

For log-transformed night-to-night variability in TST, social strain is significant ($\beta = 0.421$, $P = .034$), whereas social support is not significant ($\beta = -0.011$, $P = .948$). Aside from social strain, only 1 other covariate, number of chronic conditions, was significant ($\beta = 0.088$, $P = .028$). However, the full model is not significant (F = 1.54, $P = .088$, n = 236).

Discussion

We are now in a position to evaluate these results. The results of this analysis suggest that social support, but not social strain, is consequential for subjectively assessed sleep quality. This partially supports the findings of Ailshire and Burgard[19] (2013) and Kent et al [20] (2015) that both support and strain contribute to self-reported sleep problems or quality.[2] The mechanisms by which support may protect sleep quality specifically can only be speculated at this point, although social support as a protective factor for health generally is a well-studied concept. See Cohen et al[39] (2000) or Thoits[40] (2011) for a discussion of social support measures and mechanisms.

Different results were obtained with actigraphically assessed parameters. Objectively assessed SE was not associated with social support, whereas it was significantly associated with social strain. For objective SE, because only social strain was significantly associated with SE, it has the greater effect. Social strain might operate through a similar mechanism as loneliness: heightened vigilance. Further research may test this pathway.

Total sleep time appears to be insensitive to both social support and strain as measured and analyzed for this article. This result is consistent with that of Troxel et al[12] (2010) who similarly did not find significant effects for support on actigraphically assessed TST. The literature on social relationships and TST or insufficient sleep appears to be mixed (see “Introduction”). How social relationships and sleep are measured (ie, actigraphy, perceived insufficiency, self-reported duration) may matter. Although social strain was significantly associated with night-to-night TST variability, and indeed was 1 of only 2 covariates significant in the model, the overall model was not significant.

Support was significant for self-reported sleep quality and not for objective SE; however, this does not diminish the importance of sleep quality because self-reported sleep quality and objective efficiency are not equivalent aspects of sleep. It was earlier suggested that subjective and objective assessments of sleep may represent distinct phenomena. For example, it has been suggested that the PSQI may, in fact, measure dissatisfaction or psychological symptoms rather than sleep characteristics.[24,25] If this is true, then the results of this article suggest that social support is associated with psychological characteristics operationalized as sleep quality but not actual sleep. Therein may lie the striking difference in empirical results.

It is worth noting, however, that global PSQI scores were significantly associated with all actigraphic sleep parameters in bivariate tests of association (Table A1), consistent with a previous analysis using MIDUS data.[27] The interpretation here would be that the PSQI measures psychological symptoms and that these psychological symptoms are significantly associated with objective sleep measurement. Still, the fact that there are significant associations between the PSQI and sleep characteristics is noteworthy because these results contrast with earlier reports that did not find any statistically significant associations between PSQI scores and TST or SE obtained by actigraphy or polysomnography.[24,25] There are several possibilities for the lack of agreement. First, the current analysis includes data with possibly dependent observations, although further subsetting to remove dependence revealed still significant Pearson correlations. Second, the PSQI

[2] In a preliminary analysis of the PSQI in a larger sample (n = 947), both support and strain were significant in regressions with the PSQI used both as a continuous and dichotomous (>5) outcome. This larger sample (n = 947) is comparable to the reported sample (n = 236) in mean age (55.17 vs 53.61), proportion of female (0.53 vs 0.56), and marital status (proportions of 0.72 vs 0.75 married, 0.14 vs 0.10 divorced, 0.05 vs 0.05 widowed, and 0.08 vs 0.10 never married, respectively). The failure to find significance for social strain in the current analysis for the PSQI may derive from reduced statistical power. Further research may test this hypothesis. Analyses available on request.

and actigraphy data were not collected at the same time in MIDUS, although this would seem to make correlation less likely, not more. A third more likely explanation is that different results were obtained because they were tested on different samples. Because it was not the intent of the current analysis to test the concordance of the PSQI and actigraphy parameters, further investigation may be warranted.

his article has several limitations. This article focused on chronic levels of support and strain and thus did not address acute events of support and strain. The shorter-term effects of social relationships were not captured in this analysis. Furthermore, this article operated at the social psychological level. As such, perceptions of social support and strain were analyzed, not actual or received support and strain. The literature indicates that social support is variously measured. Thus, care should be taken to be explicit about how social support is operationalized and measured.[39]

For theoretical and practical reasons, spouses were omitted from the analysis. A rich sociological literature indicates that there are many important aspects particular to spousal relationships and sleep such as marital satisfaction, night-time caregiving, snoring, and children coming home later at night.[41–43] Many of these articles highlight a distinct inequality for women. Thus, the effects of spousal support and strain on sleep parameters deserve more attention in a dedicated analysis with a theoretical framework that emphasizes gender. Another omission was race. The data for this analysis, although diverse in age, sex, and marital status, were not diverse in race. Thus, the results may only generalize to white American adults. Whether the findings hold for other racial/ethnic groups remains an open question.

A final limitation lies in the uncertain direction of causation. Although all sleep parameters were measured after support and strain were measured, causality cannot be inferred. For example, it is possible that the sleep data in MIDUS represent patterns of sleep that existed previous to measurement of support and strain; sleep could have simply been measured after support and strain instead of being influenced by them. The relationship between sleep and social relationships may be bidirectional; longitudinal research may test this hypothesis.

Despite these limitations, this article advances knowledge of the associations between family and friend relationships and multiple sleep parameters, adding to the broader literature of the social determinants of sleep. In *The Civilizing Process* (1939), Norbert Elias observed that "sleeping has been increasingly shifted behind the scenes of social life."[44 (p138)] Although this may be historically true, sleep appears to remain sensitive to social influences, a fact that becomes clearer with each addition to the growing literature on the social determinants of sleep.

Disclosure

The author declares no conflicts of interest.

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Appendix A

Table A1
Pearson correlations of the PSQI, daily sleep quality, SE, TST, and night-to-night variability in TST (log MSSD)[a]

	PSQI	Daily sleep quality	SE	TST
Daily sleep quality	0.434			
	(<.001)			
SE	−0.205	−0.086		
	(.002)	(.191)		
TST	−0.131	−0.001	0.572	
	(.044)	(.991)	(<.001)	
log MSSD	0.226	0.040	−0.315	−0.087
	(.001)	(.545)	(<.001)	(.182)

[a] *P* values reported in parentheses.

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