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RESEARCH ARTICLE

Alternative Formulations of Job Strain and Sleep Disturbances: A Longitudinal Study in the United States

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ABSTRACT

Background: Sleep disturbances are a major public health concern in the United States, leading to adverse health outcomes. In the working population, job strain has been identified as an important risk factor for sleep disturbances, but evidence from the United States remained limited. This study aimed to examine longitudinal associations between job strain and sleep disturbances in the United States, with a focus on the alternative formulations of job strain.

Methods: A total of 1721 participants were drawn from two waves of the Midlife in the United States (MIDUS) study, with an average 9-year follow-up period. Job strain was measured using Karasek's Job-Demand-Control model and operationalized in six formulations: standard quadrant, simplified quadrant, linear, quotient, logarithm quotient, and quartile based on quotient. Generalized Estimating Equations were used to estimate longitudinal associations of alternative formulations of job strain at baseline with sleep disturbances across follow-up. Corrected Quasi-likelihood Information Criterion (QICu) was used to assess the goodness of fit.

Results: All approaches showed that higher job strain at baseline was significantly associated with an increase in sleep disturbances across follow-up. QICu scores indicated that continuous Demand-Control formulations (linear, quotient, logarithm quotient) had better model performance of 4602.66, 4604.28, and 4601.99, respectively. The logarithm quotient showed the best fit.

Conclusions: Our findings imply the importance of early workplace interventions in reducing job strain to improve sleep hygiene. They further show that the continuous formulations quantifying job strain were more consistent and robust, which provides suggestions for future workplace health research in the United States.

This work was performed at the University of California Los Angeles.

1 | Introduction

Sleep disturbances have been a major public health concern, with recent statistics indicating that approximately 1 in 7 adults experienced difficulty falling asleep, and 1 in 6 adults had trouble staying asleep in the United States [1]. Sleep problems were linked with adverse health outcomes, including hypertension, cardiovascular disease, obesity, and premature mortality [2–6]. Among the working population, the significant impact of sleep problems on work productivity [7] and workplace injuries [8] has led to extensive examination of its relationship with occupational factors [9]. Among them, job strain, characterized as a combination of high job demands and low job control in the established work stress model proposed by Karasek [10], has been identified as an important risk factor for sleep disturbances in working populations [9, 11]. Internationally, studies have consistently shown significant associations between high job strain and increased risk of insomnia across Europe and Asia [11–14]. On the other hand, research within the context of the United States work environment has been limited. For instance, Knudsen et al. quantified job demands (including work overload, role conflict, repetitive tasks) and job control (referring to job autonomy) in a cross-sectional study, and found only work overload showed significant associations with poor sleep quality [15]. One recent longitudinal study indicated that workers with higher job demands tended to have poorer sleep outcomes, including sleep disturbances [16]. However, Karasek defined psychological job strain as the combined effects of both demand and control [10], rather than a single element of the working environment. Currently, a research gap persists on the role of job strain, i.e., a combination of demand and control, in sleep disturbances in the United States.

Despite the wide use of Karasek's model, there is no definitive consensus on the operationalizations of job strain, as various approaches to job strain have been formulated. The most common approach is quadrant form, formulated by combinations of demands and control dichotomized by either sample medians or population medians [10]. Other popular formulations are (1) a continuous but nonlinear approach as the quotient form, which divides demands by control [17–21]; (2) a continuous but linear approach by subtracting demands by control, giving equal weights to both components [17–21]; and (3) a quartile or tertile approach by dividing the quotient form into four or three categories, respectively, to examine threshold effects [20, 22]. So far, few studies have systematically examined alternative formulations of job strain in association with health [17–22]. In a survey among hospital workers in Switzerland, Courviosier and Perneger demonstrated that linear, quadrant, quotient, and logarithm approaches were all associated with physical and mental health, sickness leave due to back pain, and work-related stress; however, linear explained the highest percentage of variance for health outcomes and sickness leave due to back pain, whereas logarithm was the most effective in explaining the variance for work-related stress only [18]. In Colombian workers, Gomez Ortiz et al. found that the quadrant approach explained more variance in well-being outcomes [19]. From studies in Finland, early atherosclerosis was associated with linear and quotient approaches, but not with quadrant [21]; while the effect of job strain on burnout among Finnish teachers was consistent across quadrant and tertile approaches [22]. In one study in the United States, quadrant, quotient, and linear approaches were significantly related with systolic blood pressure [17]. Notably, the aforementioned studies were based on cross-sectional data. To the best of our knowledge, only one longitudinal study suggested similar predictive power of all the above formulations on psychological distress among workers in Japan [20]. Furthermore, none of these studies examined sleep disturbances, especially in the United States. There remains a gap in the systematic examination of alternative formulations of job strain on sleep disturbances using longitudinal data from Western countries, especially considering cultural differences in work stress research [23].

To summarize, there has been a lack of research examining the longitudinal association of job strain as the combined components of demands and control, with sleep disturbances in the United States. Moreover, no existing research has systematically evaluated different formulations of job strain in predicting sleep outcomes. We aimed to address this gap by investigating 9-year longitudinal associations between six formulations of job strain and sleep disturbances using data from a national sample of workers in the United States. Furthermore, we sought to provide a novel perspective on this association by demonstrating its stability across different operationalizations of job strain, indicating a consistent and robust effect that transcends specific measurement approaches.

2 | Methods

2.1 | Study Sample

Our study used a publicly available data set from Midlife in the United States (MIDUS), a longitudinal study that addresses behavioral, psychological, and social factors related to adult health. The core national sample of MIDUS consisted of non-institutionalized, English-speaking individuals aged 25–74 from the contiguous United States. In total, three waves of data collection were conducted in the MIDUS series study, in 1995–1996 (MIDUS I), 2004–2006 (MIDUS II), and 2013–2017 (MIDUS III), respectively. Additionally, sub-samples of African Americans from Milwaukee were collected as a refinement of the MIDUS project in 2005–2006 and 2016–2017, respectively [24]. More information on the sampling strategy and data information is available at http://www.midus.wisc.edu.

Our study used data from both the MIDUS national study and Milwaukee study, with participants who were working in the MIDUS Wave II (i.e., baseline) and followed up in Wave III. The overall response rate from MIDUS Wave I to Wave II was 69.82%, and 5555 participants were included in Wave II [25–28]. Among them, 2641 participants were working at baseline. To investigate potential selection bias, we compared baseline characteristics between working and nonworking populations. The nonworking populations were more likely to be older, women, separated/divorced/widowed, to possess a high school education or less, in lower self-perceived financial situations, with no or light alcohol consumption, low leisure-time physical activity, and higher levels of sleep disturbances (see Table S1). Participants with missing values on job strain, sleep

disturbances, and sociodemographic characteristics at baseline were further excluded. Out of 2349 working participants with complete data at baseline, 1852 participants completed the follow-up survey, corresponding to a follow-up rate of 78.84%. To investigate potential attrition bias, we compared baseline characteristics between retained and dropped-out participants. The participants lost to follow-up were more likely to be non-white, separated, divorced, or widowed, to possess a high school education or less, in lower self-perceived financial situations, and smokers (Table S2). However, baseline job strain and sleep disturbances were not significantly different. We further excluded those who had missing data for sleep disturbances at follow-up. The final analytical sample was 1721 workers in this study. A detailed sample selection procedure can be found in Figure 1.

This study was approved for exemption by the University of California, Los Angeles Institutional Review Board (IRB#23-001176).

2.2 | Measures

2.2.1 | Job Strain

Job strain was defined using Karasek's Job-Demand-Control model, which combined high job demands with low job control [10]. Job strain at baseline was measured using self-reported questionnaire items for job demands and job control. Job demands were quantified from 5 items, which included "Work intensively," "Work demands hard to combine," "Too many demands," "Time to get everything done," and "Lot of interruptions." Job control was quantified from 9 items, with 6 assessing decision authority ("Initiate things at job," "Choice how to do work tasks," "Choice what tasks to do at work," "Say in work decisions," "Say in planning work environment," and "Control amount of time at tasks at job") and 3 assessing skill discretion ("Learn new things," "Work demands high skill level," and "Job provides variety interesting things"). Each item was assessed on a five-point Likert scale, each representing:

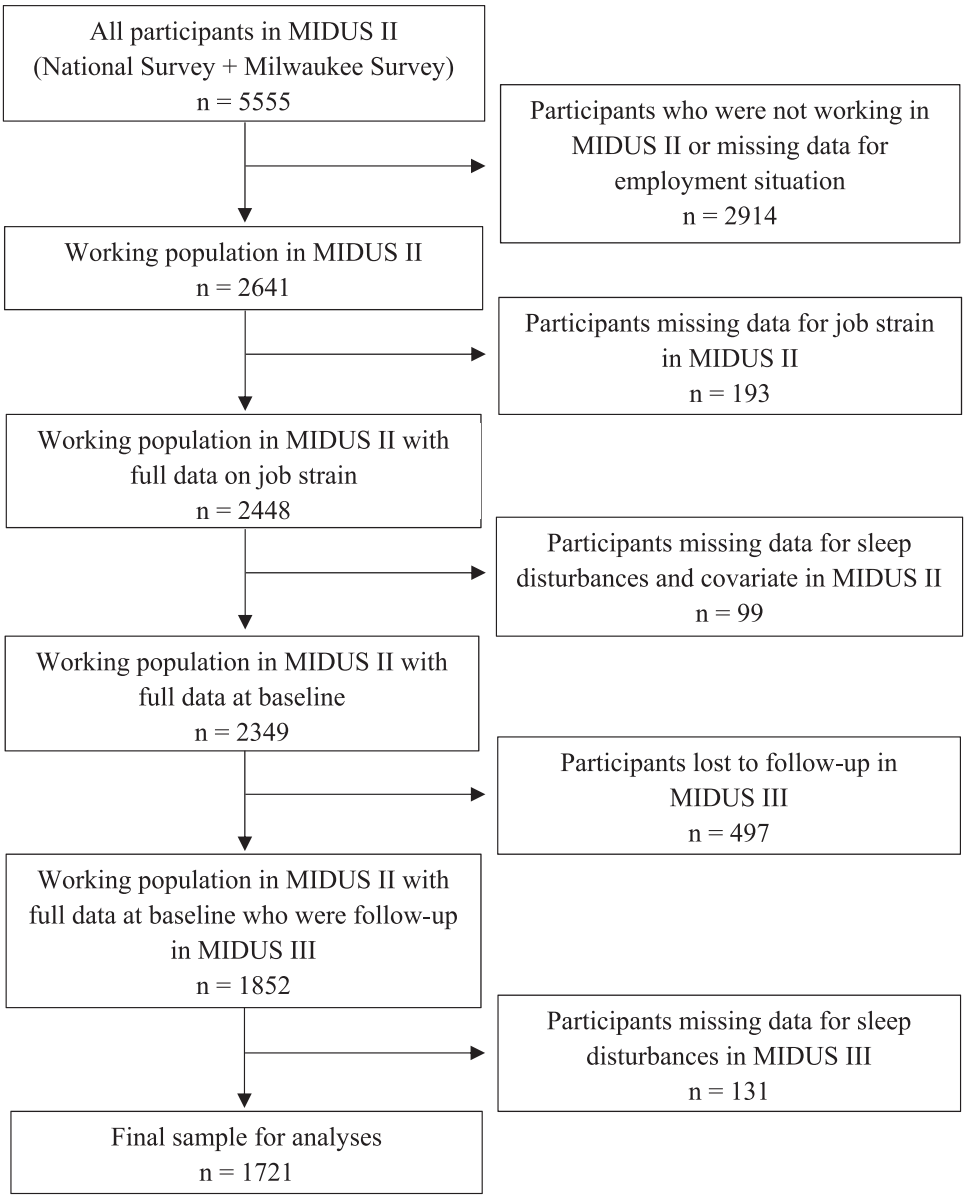

FIGURE 1 | Sample size selection. MIDUS, Midlife in the United States.

1 – *Never*; 2 – *Rarely*; 3 – *Sometimes*; 4 – *Often*; 5 – *Almost always*. Cronbach's alpha coefficients for job demands and control in this study were 0.77 and 0.85, respectively. Job demands and job control were then categorized into low and high levels based on the sample median values, 15 and 34 respectively.

Consistent with the previous study [20], we formulated job strain in six approaches: standard quadrant, simplified quadrant, linear, quotient, logarithm quotient, and quartile.

a. Standard quadrant job strain was categorized into four levels using categorical job demand and job control. It included low strain (low job demand and high job control), active strain (high job demand and high job control), passive strain (low job demand and low job control), and high strain (high job demand and low job control).

b. Simplified quadrant job strain was a simplified version of standard quadrant job strain. It combined the first three levels of standard quadrant job strain (low, active, and passive strain) into low strain, and kept the remaining level as high strain.

c. Linear job strain was generated using continuous job demand and job control. It subtracted job control from job demand, with weighting based on the different numbers of items, i.e., $[(9 \times \text{Job demand}) - (5 \times \text{Job control})]$.

d. Quotient job strain was also generated using continuous job demand and job control. It divided job demand by job control, with item weighting, i.e., $[(9 \times \text{Job demand})/(5 \times \text{Job control})]$.

e. Logarithm quotient job strain was then generated by applying log transformation on quotient job strain.

f. Quartile job strain was categorized based on four quartiles of quotient job strain, including low quartile (0%–25%), medium-low quartile (26%–50%), medium-high quartile (51%–75%), and high quartile (76%–100%).

2.2.2 | Sleep Disturbances

Sleep disturbances were quantified from 4 self-report items ("Trouble falling asleep," "Waking up during the night and having difficulty going back to sleep," "Waking up too early in the morning and being unable to get back to sleep," and "Feeling unrested during the day no matter how many hours of sleep you had"). Each item was assessed on the five-point Likert scale ranging from 1 (*Never*) to 5 (*Almost always*). In line with previous studies [29–31], answers of "sometimes", "often", or "almost always" in the four items were considered as indicators of sleep disturbances. Then sleep disturbances were generated by the sum of four indicator indexes, ranging from 0 to 4.

2.2.3 | Social-Demographic Characteristics

Socio-demographic characteristics in this study included age, race (White, Black, or others), sex (men or women), marital status (married, never married, or separated/divorced/widowed), education (high school or less, some college, or university degree or more), self-perceived financial situation (poor, fair, or good), smoking (yes or no), alcohol consumption (no/light, moderate/heavy), and leisure-time physical activity (low or high). The selection of covariates was aligned with previous analyses of MIDUS studies [16, 32]. We identified participants' race based on their response to the main racial origin, consistent with other MIDUS studies [33]. Definitions of alcohol consumption and leisure-time physical activity were also applied and validated by other MIDUS studies [34, 35].

2.3 | Statistical Analysis

First, descriptive statistics on baseline characteristics and sleep disturbances across follow-up were generated. Means and standard deviations (SDs) were calculated for continuous variables, and frequencies and percentages were calculated for categorical variables. Second, the longitudinal associations of job strain at baseline (Wave II) with changes in sleep disturbances between baseline (Wave II) and follow-up (Wave III) were estimated using Generalized Estimating Equations (GEE). To account for within-subject variability due to repeated measures, exchangeable correlation structure was used [36]. The mean and variance of sleep disturbances at baseline were 1.69 and 1.99, respectively, and at follow-up were 1.79 and 2.01, respectively; aggregately, the mean and variance were 1.74 and 2.01, respectively. Considering the count nature of sleep disturbances and reasonably close mean and variance, a Poisson distribution was applied in the GEE model [37]. The results were reported as risk ratios (RRs) with 95% confidence intervals (CIs). Analyses were adjusted in 3 steps: Model I was adjusted by age, sex, race, and marital status at baseline; Model II included additional adjustments for education and financial situation at baseline; Model III included additional adjustments for smoking, alcohol consumption, and leisure-time physical activity at baseline.

To evaluate the robustness of such associations for different formulations of job strain, analyses were repeated for all six job strain approaches. For continuous job strain (linear, quotient, logarithm quotient), standardizations were applied and RRs were reported by one unit increase per SD. Evaluation of Quasi-likelihood Information Criterion (QIC) was performed to confirm the selection of correlation structure and Corrected Quasi-likelihood Information Criterion (QICu) was reported to assess the goodness of fit for each model. Lower QIC indicates a better choice of correlation structure and lower QICu indicates a better model fit [38]. All tests were two-sided and a p-value < 0.05 was considered statistically significant. SAS 9.4 was used for all statistical analyses.

3 | Results

Table 1 shows the characteristics of the sample. At baseline, participants had a mean age of 51 years (SD = 9.17). The sample was slightly more than half female (52.47%), and the

TABLE 1 | Characteristics of the study sample.

Variables	*N* (%)
Age at baseline	
mean ± SD	51.08 ± 9.17
Race at baseline	
White	1491 (86.64)
Black	166 (9.65)
Others	64 (3.72)
Sex at baseline	
Men	818 (47.53)
Women	903 (52.47)
Marital status at baseline	
Married	1218 (70.77)
Never married	187 (10.87)
Separated/divorced/widowed	316 (18.36)
Education at baseline	
High school or less	437 (25.39)
Some college	497 (28.88)
University degree or more	787 (45.73)
Financial situation at baseline	
Poor	476 (27.66)
Fair	694 (40.33)
Good	551 (32.02)
Smoking at baseline	
Yes	236 (13.71)
No	1485 (86.29)
Alcohol consumption at baseline	
No/light	1026 (59.62)
Moderate/heavy	695 (40.38)
Leisure-time physical activity at baseline	
Low	840 (48.81)
High	881 (51.19)
Job strain: Standard quadrant at baseline	
Low strain	381 (22.14)
Active strain	504 (29.29)
Passive strain	417 (24.23)
High strain	419 (24.35)
Job strain: Simplified quadrant at baseline	
Low strain	1302 (75.65)
High strain	419 (24.35)
Job strain: Linear at baseline	
mean ± SD	−31.70 ± 38.86
Job strain: Quotient at baseline	
mean ± SD	0.84 ± 0.24
Job strain: Logarithm quotient at baseline	
mean ± SD	−0.22 ± 0.28
Job strain: Quartile (based on quotient) at baseline	
Low quartile	445 (25.86)
Medium-low quartile	435 (25.28)
Medium-high quartile	417 (24.23)
High quartile	424 (24.64)
Sleep disturbances at baseline	
median (range)	1.00 (0–4.00)
Sleep disturbances at follow-up	
median (range)	1.00 (0–4.00)

SD, standard deviation.

majority were White (86.64%), married (70.77%), and non-smokers (86.29%). The sample had high educational attainment with 45.73% having a university degree or more, a fair financial situation (40.33%), no or light alcohol consumption (59.62%), and high leisure-time physical activity (51.19%). For baseline descriptive statistics of job strain, the standard and simplified quadrant approaches indicated that 24.35% of participants were experiencing high strain. Linear, quotient, and logarithm quotient approaches showed mean values of −31.70 (SD = 38.86), 0.84 (SD = 0.24), and −0.22 (SD = 0.28), respectively. The quartile approach indicated that 24.64% of participants fell into the high job strain quartile.

Results from GEE are presented in Table 2. All formulations of job strain showed significant associations with sleep disturbances. After adjusting for demographic, socioeconomic, and health-related characteristics at baseline, such associations were slightly attenuated across all formulations. In the standard quadrant job strain, only high strain consistently demonstrated significant associations, with RRs of 1.27 (95% CI: 1.15, 1.40) in the fully adjusted Models III ($p < 0.001$). In the simplified quadrant job strain, high strain had significant associations across all models, with RRs of 1.19 (95% CI: 1.11, 1.28) in Models III ($p < 0.001$). All three continuous measures of job strain approaches showed significant associations with sleep disturbances. The results were similar in linear and quotient job strains, with RRs of 1.10 in Models III ($p < 0.001$); the logarithm quotient job strain showed RRs of 1.11 (95% CI: 1.07, 1.15) in Models III ($p < 0.001$). In the quartile job strain, both medium-high quartile and high quartile showed significant associations: Medium-high quartile showed RRs of 1.11 in Models III ($p < 0.05$); high quartile showed RRs of 1.26 in Models III ($p < 0.001$).

Among the different formulations of job strain, the logarithm quotient approach consistently showed the lowest QICu

TABLE 2 | Regression coefficients and model fit for longitudinal associations of job strain at baseline with sleep disturbances across follow-up.

Job strain approaches	Model I RR and 95% CI	QICu	Model II RR and 95% CI	QICu	Model III RR and 95% CI	QICu
Standard quadrant		4615.36		4620.31		4610.78
Low strain	1.00		1.00		1.00	
Passive strain	1.11 (1.00, 1.23)		1.08 (0.98, 1.20)		1.09 (0.98, 1.21)	
Active strain	1.10 (0.99, 1.22)		1.10 (0.99, 1.22)		1.09 (0.99, 1.21)	
High strain	1.30 (1.17, 1.43)***		1.27 (1.15, 1.40)***		1.27 (1.15, 1.40)***	
Simplified quadrant		4617.41		4620.69		4611.13
Low strain	1.00		1.00		1.00	
High strain	1.21 (1.12, 1.30)***		1.19 (1.11, 1.28)***		1.19 (1.11, 1.28)***	
Linear		4605.21		4611.14		4602.66
Increase per SD	1.11 (1.07, 1.15)***		1.10 (1.06, 1.14)***		1.10 (1.07, 1.14)***	
Quotient		4606.17		4612.13		4604.28
Increase per SD	1.11 (1.08, 1.14)***		1.10 (1.07, 1.13)***		1.10 (1.07, 1.14)***	
Logarithm quotient		4603.37		4610.05		4601.99
Increase per SD	1.12 (1.08, 1.15)***		1.11 (1.07, 1.15)***		1.11 (1.07, 1.15)***	
Quartile (based on quotient)		4609.76		4616.97		4608.02
Low quartile	1.00		1.00		1.00	
Medium-low quartile	1.03 (0.93, 1.14)		1.03 (0.93, 1.14)		1.02 (0.92, 1.13)	
Medium-high quartile	1.12 (1.01, 1.23)*		1.11 (1.01, 1.22)*		1.11 (1.01, 1.22)*	
High quartile	1.28 (1.17, 1.41)***		1.26 (1.14, 1.38)***		1.26 (1.15, 1.38)***	

Note: Generalized estimating equations with Poisson distribution.
Model I: adjustment for age, sex, race, and marital status at baseline.
Model II: Model I + additional adjustment for education and financial situation at baseline.
Model III: Model II + additional adjustment for smoking, alcohol consumption, and leisure-time physical activity at baseline.
Abbreviations: CI, confidence interval; QICu, corrected Quasi-likelihood Information Criterion; RR, risk ratio; SD, standard deviation.
*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

values across all models (Model I: 4603.37, Model II: 4610.05, Model III: 4601.99). This approach was followed closely by the linear and quotient approaches, which showed relatively lower QICu values. The quartile approach had slightly higher QICu, followed by the standard and simplified quadrant approaches. The simplified approach had the highest QICu values across all models. Across all formulations of job strains, fully adjusted models showed the lowest QICu.

Additionally, the single effects of job demands and job control were examined. Both job demands and job control at baseline were significantly associated with sleep disturbances across follow-up (for details, see Table S3).

4 | Discussion

The aim of this study was to examine longitudinal associations between alternative formulations of job strain and sleep disturbances using data from a national sample of workers in the United States. All approaches indicate significant associations between job strain at baseline and sleep disturbances across follow-up, with continuous measures having a better model performance than segmented and dichotomized measures.

Six approaches of job strain commonly used in previous studies were implemented: standard quadrant, simplified quadrant, linear, quotient, logarithm quotient, and quartile. Each approach interpreted various combinations of job demands and job control in various distinct dimensions. The quadrant approaches were more equivalent to Karasek's original suggestion [19, 39]. The linear, quotient, and logarithmic quotient approaches provided continuous scales of job strain, which accurately captured gradual variations in the balance between demands and control [18]. The quartile approach segmented the continuous scale into four levels based on distribution, enhanced the identification of thresholds [22]. Given that different approaches can generate various assessments of job strain, our study aimed to longitudinally evaluate the formulations of job strain in association with sleep disturbances.

The longitudinal findings of this study were similar to those of a few studies that utilized a sole formulation of job strain with sleep outcomes in other national contexts. For example, two cross-sectional studies on male workers in Japan found significant associations between job strain and insomnia: Nomura et al. used dichotomized approach with upper quartile, while Yoshioka et al. used quartile approach with three levels [40, 41]. A cross-sectional study of nurses in Brazil and a

longitudinal study of Dutch employees reported significant associations both using the standard quadrant approach [12, 42]. Our findings were aligned with these studies across different populations and study designs, both cross-sectional and longitudinal. However, in contrast to the 4-year follow-up in the Dutch longitudinal study, our study highlighted that job strain had a prolonged negative effect on sleep health over an extended period of 9 years. More importantly, our findings revealed that such effect was consistent across various formulations of job strain, suggesting a robust association that does not depend on a particular operationalization.

Our results indicate that continuous measures of job strain (linear, quotient, logarithm quotient) had better model performance than other approaches, with logarithm quotient as the best fit. Corresponding with suggestions from a previous study [19], our evaluation of these three continuous operationalizations of job strain demonstrated better model performance compared to the categorical job strain formulations. The most common definitions of job strain, quadrant approaches (standard quadrant, simplified quadrant), showed weaker model performance. Quadrant approaches, which lack information on participants with extreme values, may fail to capture as much variance as other approaches. In contrast, the quartile approach, categorizing by distribution, addressed more variance across groups, hence demonstrating slightly better performance than quadrant approaches.

Furthermore, since no existing literature has examined alternative job strain formulations in relation to sleep health, our results are comparable with studies investigating different health outcomes. A longitudinal study in Japan reported that all six approaches of job strain were robustly associated with psychological distress [20]. Likewise, our study demonstrated relatively stable model performance across each formulation. Variations in the statistical significance of these formulations were evident in other contexts. For example, Hintsanen et al. only found significant associations between intima-media thickness and job strain with linear and quotient approaches, but not with quadrant [21]. This variability and our findings emphasized the importance of properly choosing and implementing job strain formulations based on the particular health outcomes of interest.

Our study had several notable strengths. First, the six previously mentioned studies on alternative formulations of job strain were predominantly cross-sectional studies or confined to one longitudinal study in Japan [17–22], while our study contributed evidence of longitudinal data from the United States. Previous cross-sectional designs were limited by potential "reverse association," which made the direction of effect unclear. For example, individuals with poor sleep may perceive a worse work environment, and workers with better sleep health may be chosen for certain types of professions [43]. Hence, a longitudinal design that monitored changes over time supports the interpretation of a temporal relationship between exposure and outcome. Simultaneously, our study allowed for a contextual examination of job strain within Western working conditions and employment settings. Second, we examined six formulations of job strain widely used and validated in international work stress research [10, 17–21, 44–46], which provided reliability and validity of our study, allowing for potential comparisons with other studies. Furthermore, our study filled the gap in existing literature as the first to examine alternative formulations of job strain with sleep health. Our study provides a new piece of evidence on more robust formulations to consider for quantifying associations between job strain and sleep health-related factors.

However, our study also faced some limitations. First, due to the self-reported nature of our data, our study was subject to potential self-report bias. As noted by Taber, Spector, and Taylor, using self-report measures in an objective work environment can lead to an overestimation of the effects [47]. However, when considering self-report measures as perceptions of objective situations, Elsass and Veiga suggested that self-report measures can reflect a person's perception of the environment in job stress research better than objective measures [48]. Also, according to Karacan et al., self-reported sleep quality can capture individual variation that is necessary for subjective reporting [49]. Second, differences in socioeconomic status between working participants in our analytical sample and those who were lost during follow-up may limit the generalizability of our findings to the broader labor market. However, given that baseline exposures to job strain and distribution of sleep disturbances were similar, potential bias from drop-out was minimized. Third, our data, although spanning a 9-year follow-up period, was collected at only two time points. The extended intervals between data collection waves may introduce bias due to potential loss of interim information. Given that our study was constrained by the nature of secondary analysis, we recommend that future studies include more frequent follow-ups. Lastly, our study only collected job strain at baseline, without accounting for changes in job strain over time. Therefore our findings are at risk of exposure misclassification, as job strain levels may fluctuate. Future studies should incorporate multiple time points for job strain measurement to provide a more robust analysis.

In conclusion, our study showed that six formulations of job strain at baseline showed significant longitudinal associations with sleep disturbances. The continuous approaches were more consistent and robust, outperforming other approaches in model fit. Our findings highlighted the practical advantages of using specific strategies on job strain formulations, providing suggestions for future workplace health research. More broadly from a preventative standpoint, our results imply the critical need for early workplace interventions aimed at reducing job strain. Implementing regulations to monitor and redesign workload, as well as promote workers' autonomy, may help improve sleep health, therefore potentially reducing the burden on both individual and healthcare system levels.

Author Contributions

Study concept: Jian Li. Study design: Jian Li and Yijia Sun. Acquisition of data: Megan Guardiano and Jian Li. Statistical analysis: Yijia Sun and Jian Li. Interpretation of data: Yijia Sun, Megan Guardiano, Mayumi Saiki, and Jian Li. Drafting of the manuscript: Yijia Sun. Critical revision of the manuscript for important intellectual content: Yijia Sun, Megan Guardiano, Mayumi Saiki, and Jian Li. Administrative, technical, and material support: Jian Li. Obtaining funding and study

supervision: Jian Li. Final approval: Yijia Sun, Megan Guardiano, Mayumi Saiki, and Jian Li.

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Disclosure by *AJIM* Editor of Record

John Meyer declares that he has no conflicts of interest in the review and publication decision regarding this article.

Ethics Statement

This analytic project was approved as exempt research by the University of California, Los Angeles Institutional Review Board (IRB#23-001176). All MIDUS participants provided written informed consent for data collection through that study.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available in National Archive of Computerized Data on Aging (NACDA) at https://www.icpsr.umich.edu/web/pages/NACDA/index.html, reference number 203. These data were derived from the following resources available in the public domain: - Midlife in the United States (MIDUS) Series, https://www.icpsr.umich.edu/web/NACDA/series/203.

Publicly available data from the MIDUS study were used for this research (https://www.icpsr.umich.edu/web/NACDA/series/203). The program code and scripts for statistical packages used to conduct the research are available from the corresponding author upon request.

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Supporting Information

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