



Challenge and hindrance stressors in relation to sleep

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ABSTRACT

Rationale: Research using the challenge-hindrance stressor framework shows hindrance stressors tend to have detrimental affective and work-related outcomes, whereas challenge stressors have relatively more salutary affective and work-related outcomes. The extent to which this pattern extends to health behaviors, such as sleep, is unknown.

Objective: The current study examines challenge and hindrance work stressors in relation to sleep quantity and quality.

Methods: We use survey data from the MIDUS II (Phase 1 and Phase 4) to test the relationship between self-reported challenge and hindrance stressors and assessments of sleep, including cross-sectional and prospective indicators of sleep quantity, sleep quality (sleep onset latency, sleep disturbance), and sleepiness.

Results: Hindrance stressors are associated with prospective sleep quantity, as well as cross-sectional and prospective sleep quality and sleepiness. Further, the pattern of results for sleep quality and sleepiness reflects the expected challenge-hindrance pattern, such that hindrance stressors are more strongly associated with poor sleep quality and sleepiness than are challenge stressors. The same challenge-hindrance pattern was not significant for sleep quantity. Work hours and time lag generally did not moderate associations between work stressors and sleep.

Conclusion: The challenge-hindrance pattern holds for sleep quality and sleepiness, but not sleep quantity. Relationships appear to be consistent across time and differences in work hours. Results have implications for expanding the challenge-hindrance stressor framework and underline the importance of distinguishing between different types of stressors and sleep dimensions.

1. Introduction

Sleep is critical for healthy human functioning. Between 50 and 70 million Americans suffer from sleep problems that hinder their daily functioning and negatively affect their health (Colten and Altevogt, 2006). In an effort to address this major health issue, a flourishing and diverse body of research seeks to understand factors that affect sleep health. Stress has emerged as one of the primary culprits. We define stress as a holistic process in which stressors (events, conditions, or aspects of the environment that instigate psychological or physical change) produce strain (individuals' psychological or physical change in response to stressor exposure).

Work experiences have gained increased attention in the sleep literature due to recognition of work as a significant source of stress, the impact of sleep behavior on workplace experiences, and renewed interest in understanding psychosocial underpinnings of health and health behavior (e.g., American Psychological Association, 2017;

Barnes, 2012; Buysse, 2014; Crain et al., 2017). Work demands, defined as physically or mentally taxing aspects of work, have been identified as a key predictor of sleep behavior (Åkerstedt, 2006; Sonnentag et al., 2016). The relationship between work demands and sleep is typically framed using work stress theories, which position work demands as a stressor that elicit strain reactions, such as impaired sleep. The job demands-control model (Karasek, 1979) and the effort-reward imbalance model (Siegrist et al., 1986) are perhaps the most popular work stress theories used to explain the relationship between work demands and sleep. According to these frameworks, jobs characterized by high work demands and low resources yield poorer attitudinal and health outcomes relative to jobs with less work demands. Work stressors are considered psychologically and physiologically burdensome, making it difficult for individuals to find and maintain a relaxed state that is needed for sleep (Åkerstedt, 2006).

Consistent with theory, empirical reviews conclude that work stressors are negatively associated with sleep using both cross-sectional

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and prospective designs (Åkerstedt, 2006; Linton et al., 2015; Van Laethem et al., 2013). Most studies broadly operationalize work stressors (e.g., Linton et al., 2015; Litwiller et al., 2017; Pow et al., 2017). When multiple workplace stressors are examined, generalized hypotheses are used to propose similar relationships with sleep (e.g., Berkman et al., 2015; Mullins et al., 2014). Yet, not all work stressors are equally distressing. Challenge stressors are defined as stressors that induce strain, but also provide potential for learning and growth, while hindrance stressors induce strain and frustrate achievement and growth. Research on challenge and hindrance stressors show psychological strain reactions differ in that challenges tend to be less detrimental compared to hindrances (Cavanaugh et al., 2000; Crawford et al., 2010). The extent to which this distinction extends to health behaviors is largely unknown (see for an exception French et al., 2018).

The current study examines whether relationships between challenge stressors and sleep health differ from relationships between hindrance stressors and sleep health. Additionally, we test the robustness of challenge hindrance differences over time by examining both cross-sectional and prospective, or lagged, relationships in which sleep dimensions are measured several months after work stressors. Finally, we examine two moderators that may alter work stressor exposure: work hours and time lag.

We contribute to the extant literature on work stressors and sleep in several ways. First, we use the challenge-hindrance framework to organize work stressors into theoretically meaningful categories that may have differential relationships with sleep health. Sorting stressors into challenges and hindrances can help provide the precision needed to pinpoint which stressors are most likely to influence sleep. Second, we focus on three components of sleep: quantity, quality, and sleepiness. Compared to sleep quality, sleep quantity and sleepiness are under-studied particularly in organizational research, despite their theoretical importance for predicting work-related outcomes (Litwiller et al., 2017; Sonnentag et al., 2016). Our study therefore contributes evidence as to the relationship between work demands and sleep as a holistic, multi-faceted construct and provides empirical evidence where little exists. Third, we examine both cross-sectional and prospective relationships across several months. Much of the work stressor and sleep literature is cross-sectional (Linton et al., 2015), and consequentially little is known about whether work stressors have relationships with sleep outcomes over time. Our research serves this aim by testing the association between work stressors and sleep outcomes assessed several months apart. Finally, we examine two indicators of work stressor exposure: work hours and time lag between stressor and sleep measurement. These two factors are typically controlled for statistically or methodologically. For example, Van Laethem et al.'s (2013) review of longitudinal and prospective sleep research found only one study that assessed more than one time point, and several challenge-hindrance studies use exclusively full time workers (e.g., Cavanaugh et al., 2000; Rodell and Judge, 2009). Thus, our study contributes knowledge of whether work stressor exposure (in the form of increased work hours, shorter time lags) affects the relationship between work stressors and sleep.

1.1. Defining sleep

Sleep health can be defined using multiple dimensions, such as timing, duration, efficiency, satisfaction, and sleepiness (Buysse, 2014). In the present study, we focus on three dimensions of sleep health: sleep quantity, sleep quality, and sleepiness. Sleep quantity is the duration of sleep or number of sleep hours within a 24-h period. Sleep quality is broadly defined as “good” or restful sleep. Sleep quality can be operationalized using different indicators, including sleep inadequacy, sleep problems, sleep onset latency, difficulty waking, sleep disturbance, sleep dissatisfaction, insomnia, or perceptions of overall sleep quality (e.g., Barnes, 2012; Buysse et al., 1989; Krystal and Edinger, 2008). Sleepiness occurs when individuals feel a physiological craving or a

need for sleep, and is typically measured as the probability of falling asleep while awake (Litwiller et al., 2017; Mullins et al., 2014).

Although sleep quantity, quality, and sleepiness are considered related components of sleep health (Buysse, 2014), they are conceptually and empirically distinct (e.g., Crain et al., 2014; Litwiller et al., 2017; Mullins et al., 2014). Research relating work stressors to sleep has predominately focused on sleep quality indicators, rather than on sleep quantity or sleepiness (Barnes, 2012; Sonnentag et al., 2016). When assessing sleep quality, researchers often use composite measures, such as those assessed by the Pittsburgh Sleep Quality Index (Buysse et al., 1989) or the Nottingham Health Profile (Hunt et al., 1985). This is problematic, as relationships between work stressors and strain may differ depending on the sleep indicator of interest (e.g., Åkerstedt, Knutsson, Westerholm, Theorell, Alfredsson and Kecklund, 2002a; Crain et al., 2014).

We focus on sleep quantity (number of sleep hours each night), two indicators of sleep quality (sleep onset latency (the time between going to bed and falling asleep) and sleep disturbance (problems maintaining sleep)), and sleepiness (trouble staying awake). These four indicators reflect key components of sleep health (Buysse et al., 1989; Buysse, 2014). These indicators are also included in composite measures of sleep (e.g., Buysse et al., 1989; Hunt et al., 1985), and are well represented in the larger sleep literature. Further, each indicator measures a distinct aspect of the sleep process, including time in a sleeping state, falling asleep, maintaining sleep, and maintaining an alert, wakeful state post-sleep.

1.2. Challenge-hindrance stressor framework

To clarify the relationship between work stressors and sleep, we use the challenge-hindrance framework (Cavanaugh et al., 2000). Challenge stressors are aspects of work that may be experienced as distressing, but also push individuals to grow, learn, and accomplish work-related goals (Cavanaugh et al., 2000). Examples include workload and time pressure (e.g., Crawford et al., 2010). Hindrance stressors are distressing demands that create excessive or unwanted burden and frustration, thwarting attempts to grow and accomplish work-related goals (Cavanaugh et al., 2000). Examples include interruptions, hassles, and poor supervision (e.g., Crawford et al., 2010). Challenge stressors are positively related to desirable work outcomes, such as motivation, performance (LePine et al., 2005), and engagement (Crawford et al., 2010), whereas hindrance stressors are negatively related to these work outcomes. Patterns for strain-related outcomes are similar. Because challenge stressors foster positive experiences, they have weaker relationships with strains compared to hindrance stressors. This pattern has been found across a variety of strains, including burnout (Crawford et al., 2010), anxiety (Wood and Michaelides, 2016), anger (Rodell and Judge, 2009), emotional exhaustion, and physical symptoms (Webster et al., 2011).

Most studies that examine psychosocial work stressors and sleep quantity only investigate broad work demand measures. For example, studies have associated work stressors (generalized work demands, effort-reward imbalance) and stressful work days with short sleep duration (e.g., Dahlgren et al., 2005; Parkes, 2017; Utsugi et al., 2005). Studies that assess specific psychosocial work stressors often do not assess multiple stressors, or stressors cannot be clearly categorized as challenges or as hindrances. As an exception, Berkman et al. (2015) showed a significant association between work-family conflict (a hindrance) and actigraphy-measured sleep quantity, while no such relationship was found for a combined measure of workload/time pressure (challenges). In contrast, Barber and Santuzzi (2015) found workload and work hassles associated with information and communication technology use were similarly associated with sleep quantity ($r = -0.09$ and -0.05 , respectively).

Sleep quality research provides relatively more preliminary support consistent with the challenge-hindrance pattern. For example,

hindrance stressors such as role overload, role conflict, and repetitive work are associated with poor sleep quality (e.g., sleep onset latency and disturbed sleep), whereas challenge stressors such as time pressure are weakly or not significantly associated with sleep quality (e.g., Åkerstedt et al., 2004; Eriksen et al., 2008; Knudsen et al., 2007; Syrek et al., 2017). In line with challenge-hindrance tenets, Sonnentag et al. (2016) concluded effect sizes for social stressors such as interpersonal conflict and incivility (which conceptually align with hindrance stressors) are largest because, “these stressors threaten employees’ well-being in a fundamental way” (p. 81). Finally, meta-analytic evidence yields challenge-hindrance patterns, such that interpersonal conflict and organizational constraints are stronger predictors of sleep disturbances ($r = 0.22$, $r = 0.17$, respectively), compared to workload ($r = 0.11$) (Nixon et al., 2011). Similarly, Litwiller et al. (2017) found significantly stronger associations between work-family conflict and sleep quality compared to workload and sleep quality.

Like sleep quantity, sleepiness has primarily been studied in relation to general psychosocial work demands. This research shows psychosocial work demands are positively associated with sleepiness (Åkerstedt, Knutsson, Westerholm, Theorell, Alfredsson and Kecklund, 2002b; Cotrim et al., 2017; Lamb and Kwok, 2016). Specific workplace stressors have yet to be examined. However, the challenge-hindrance pattern has been supported for conceptually similar psychological outcomes, such as exhaustion (LePine et al., 2004; Van den Broeck et al., 2010) and burnout (Crawford et al., 2010).

We propose hindrance stressors will demonstrate stronger negative relationships with dimensions of sleep compared to challenge stressors. We test this hypothesis across subjective measures of sleep quantity (number of hours asleep), sleep quality (sleep onset latency, sleep disturbance), and sleepiness, as well as cross-sectional and prospective designs.

Hypothesis 1. Hindrance stressors have a stronger negative relationship with a) sleep quantity and a stronger positive relationship with b) sleep onset latency, c) sleep disturbance, and d) sleepiness compared to challenge stressors.

1.3. The moderating effect of work hours

Many studies examining work demands restrict their samples to full-time workers, or workers that report a certain minimum number of working hours. This criteria is imposed because work hours are assumed to be an indicator of work stressor exposure. Consequently, samples are often limited to those who work a minimum number of hours per week (e.g., 20, 37). We put this assumption to the test by examining work hours as a moderator of the association between challenge and hindrance stressors and sleep dimensions. In line with the exposure assumption, we posit that as work hours increase, there will be stronger associations between challenge and hindrance work stressors and sleep dimensions.

Hypothesis 2. The relationship between hindrance and challenge stressors and cross sectional and prospective a) sleep quantity, b) sleep onset latency, c) sleep disturbance, and d) sleepiness is moderated by work hours. Specifically, the relationship between hindrance and challenge stressors and each indicator of sleep health becomes stronger as work hours increase.

1.4. The moderating effect of time lag

The majority of studies examining work stressors in relation to sleep dimensions are cross-sectional in design (Åkerstedt, 2006; Van Laethem et al., 2013). Although informative, such designs limit causal and directional inferences. More recent studies have investigated longitudinal and prospective effects. Reviews on cross-sectional and longitudinal studies both reach similar conclusions, namely that work stressors are

associated with poor sleep (Åkerstedt, 2006; Sonnentag et al., 2016; Van Laethem et al., 2013). However, these reviews treat time lags as equivalent, and primary studies typically only examine two time points (Van Laethem et al., 2013). It is therefore difficult to discern the degree to which effects might wane over time. Bivariate associations may diminish over time due to increasing likelihood that the dependent variable is influenced by alternative, more proximal factors as the time lag increases (e.g., a more recent demand or a vacation; Mitchell and James, 2001). It might also be that cross-sectional correlations are inflated by spurious correlates, such as mood. Examining the correlation patterns in longitudinal primary studies yields some support for waning over time, such that correlations between cross-sectional work stressors and sleep dimensions appear stronger than do prospective correlations between work stressors and sleep dimensions (e.g., de Lange et al., 2009; Elovainio et al., 2015; Hanson et al., 2011). We therefore propose the association between work stressors and prospective indicators of sleep health decrease over time.

Hypothesis 3. The relationship between hindrance and challenge stressors and prospective a) sleep quantity, b) sleep onset latency, c) sleep disturbance, and d) sleepiness is moderated by time lag. Specifically, the relationship between hindrance and challenge stressors and each indicator of sleep health becomes weaker as time lag increases.

2. Method

2.1. Participants

We used data from the second wave of the National Survey of Midlife Development in the United States Study (MIDUS II, collected 2004–2006) (Ryff et al., 2012). This study examined social and behavioral determinants of health in the aging U.S. population. The MIDUS II main study (Phase 1) included a phone survey and a mail-in self-administered survey. After completing Phase 1, participants could opt into several sub-studies. We use data from Phase 1, the national survey phase, and Phase 4, the biomarker phase (Ryff et al., 2013). Participants in our sample completed the biomarker phase between 0 and 62 months after the Phase 1 self-administered survey ($Mean = 26.87$ months, $Median = 25.00$ months, $SD = 15.03$ months). The biomarker phase aimed to identify psychosocial pathways to biological health, and included a two day, one night visit to a local clinic. On the first night, participants completed an additional self-administered survey.

We limited our sample to participants who completed Phase 1 and Phase 4 ($N = 1054$), those who were working at the time of the Phase I surveys or who reported more than zero work hours (382 participants removed), and completed items for the variables of interest (24 participants removed). After using these exclusion criteria, we had no variables or participants with missing data. The final sample included 648 participants. Approximately half of the sample was male (50.6%) and mostly White (93.9%) with a mean age of 51.79 years ($SD = 9.67$). Participants worked full time on average ($Mean = 38.83$ h/week, $SD = 14.37$) in a variety of occupations, including professional (26.5%), executive, administrative, and managerial (24.3%), or administrative support occupations (12.0%). Most participants had a 4 or 5 year college degree (25.5%) or higher (26.9%). Average household income was \$88,952/year ($SD = \$64,322$ /year). Participants in the sample were younger ($t(1024) = 9.73$, $p < .01$), more educated ($t(876) = -7.54$, $p < .01$), had longer time lags ($t(683) = -3.28$, $p < .01$), greater challenge stressors ($t(2700) = -2.18$, $p = .03$), reported fewer hours of prospective sleep ($t(1297) = 5.42$, $p < .01$), had quicker sleep onset latency (cross-sectional $t(1297) = 5.42$, $p < .01$; prospective $t(578) = 2.39$, $p = .02$), and less sleep disturbance (cross-sectional $t(984) = 2.73$, $p < .01$; prospective $t(961) = 3.27$, $p < .01$) than their excluded counterparts.

Table 1
Means, standard deviations, and bivariate correlations among study variables.

	Mean	SD	1	2	3	4	5	6	7	8	9
1. Hindrance stressors	2.07	0.65									
2. Challenge stressors	3.74	0.65	.15*								
3. CS sleep quantity	7.07	0.99	-.06	-.06							
4. L sleep quantity	6.88	1.06	-.11*	.01	.55*						
5. CS sleep onset latency	22.07	25.95	.08*	.02	-.20*	-.22*					
6. L sleep onset latency	17.35	18.80	.01	-.13*	-.10*	-.23*	.55*				
7. CS sleep disturbance	2.48	1.03	.12*	.05	-.21*	-.20*	.36*	.27*			
8. L sleep disturbance	1.80	0.49	.21*	.00	-.01	-.10*	.26*	.30*	.38*		
9. CS sleepiness	2.52	1.00	.26*	.02	-.18*	-.21*	.27*	.18*	.36*	.34*	
10. L sleepiness	1.29	0.61	.13*	-.02	-.15*	-.16*	.06	-.04	.05	.17*	.21*

CS = Cross-sectional. L = Prospective. * $p < .05$.

^aSleep time presented in hours to allow for easy comparison across sleep quantity measures.

2.2. Measures

Work Stressors. *Challenge stressors* were measured using three items in the Phase 1 self-administered survey. Items reflected time pressure and high levels of responsibility. Participants responded using a five-point frequency scale that ranged from 1, *never*, to 5, *all of the time* ($\alpha = 0.59$; minimum corrected item-total correlation = 0.25). *Hindrance stressors* were measured using eight items from the Phase 1 self-administered survey. Items reflected hindrances such as work overload and unfair treatment. Two of the item rating scales ranged from 1, *never*, to 5, *all of the time*, and the remaining six item rating scales ranged from 1, *never*, to 5, *once a week or more* ($\alpha = 0.78$). Items were evaluated for content, psychometric, convergent, and discriminant validity using subject matter expert ratings and a cross-sectional sample of Mturk workers ($N = 123$; see Appendix A for items and validation details).

Sleep quantity. *Cross-sectional sleep quantity* was assessed using two items from the Phase 1 self-administered survey, “How much sleep do you usually get at night (or in your main sleep period) on weekdays or workdays?” and “How much sleep do you get at night (or in your main sleep period) on weekends or your non-workdays?” The two items were averaged to create a cross-sectional sleep quantity composite. *Lagged sleep quantity* was assessed using a single item on the Phase 4 self-administered survey, “During the past month, how many hours of actual sleep did you get at night (This may be different than the number of hours you spend in bed).” Participants indicated the number of hours. Higher values indicate greater sleep quantity.

Sleep onset latency. *Cross-sectional sleep onset latency* was assessed with a single item from the Phase 1 self-administered survey, “How long does it usually take you to fall asleep at bedtime?” Participants indicated time in minutes. *Prospective sleep onset latency* was assessed with a single item from the Phase 4 self-administered survey, “During the past month, how long (in minutes) has it taken you to fall asleep at night?” Participants indicated time in minutes.

Sleep disturbance. *Cross-sectional sleep disturbance* was assessed with a single item from the Phase 1 self-administered survey, “Please indicate how often you wake up during the night and have difficulty going back to sleep.” Response options ranged from 1, *never (0 times)*, to 5, *almost always (4 or more times per week)*. *Prospective sleep disturbance* was assessed using nine items ($\alpha = 0.69$) from the Phase 4 self-administered survey. A sample item is, “During the past month, how often have you had trouble sleeping because you woke up in the middle of the night or early in the morning.” Response options ranged from 1, *not during the past month*, to 4, *three or more times per week*.

Sleepiness. *Cross-sectional sleepiness* was assessed using one item from the Phase 1 self-administered survey, “Please indicate how often you feel unrested during the day, no matter how many hours of sleep you had.” Response options ranged from 1, *never (0 times)*, to 5, *almost always (4 or more times per week)*. *Prospective sleepiness* was assessed using one item from the self-administered survey, “During the past

month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?” Response options ranged from 1, *not during the past month*, to 4, *three or more times a week*.

Control Variable. Trait neuroticism was measured using a four item composite on the MIDUS II Phase 1 self-administered survey ($\alpha = 0.75$). Participants indicated how much they described themselves as *moody*, *worrying*, *nervous*, and *calm* (reversed) using a four-point scale that ranged from 1, *not at all*, to 4, *a lot*.

3. Results

We tested the hypotheses using bivariate correlations between challenge and hindrance stressors and each sleep dimension. Correlations were compared using formulas outlined in Steiger (1980) using Hoerger’s (2013) online calculator. We used a Bonferroni-corrected p -value to interpret statistical significance of dependent correlations in order to control for inflated type I error associated with multiple comparisons. Correlations are displayed in Table 1.

Table 2 contains the dependent correlation comparison results for challenge and hindrance stressors. Hypotheses 1a-1d stated hindrance stressors have a stronger negative relationship with a) sleep quantity, and a stronger positive relationship with b) sleep onset latency, c) sleep disturbance, and d) sleepiness compared to challenge stressors. Regarding sleep quantity, hindrance stressors were more strongly associated with prospective sleep quantity ($z = -2.34$, $p = .02$) than were challenge stressors. Hindrance and challenge relationships with cross-

Table 2
Dependent correlation comparison results for hindrance versus challenge stressors.

Sleep Variables	Hindrance r	Challenge r	N	Z	p
Sleep Quantity					
Cross-Sectional	-.06	-.06	648	0.00	1.00
Prospective	-.11*	.01	648	-2.34*	.02
Sleep Onset Latency					
Cross-Sectional	.08*	.02	648	1.17	.24
Prospective	.01	-.13*	648	2.74*	< .01
Sleep Disturbance					
Cross-Sectional	.12*	.05	648	1.37	.17
Prospective	.21*	.00	648	4.14*	< .01
Sleepiness					
Cross-Sectional	.26*	.02	648	4.77*	< .01
Prospective	.13*	-.02	648	2.93*	< .01
Average Sleep Composite	-.13	.00	648	-2.54*	.01
Sleep quantity	-.09	-.03	648	-1.17	.24
Poor sleep quality	.11	-.02	648	2.54*	.01
Sleepiness	.20	.00	648	3.94*	< .01

Note. * $p < .05$. Bolded values are significant using the Bonferroni-adjusted p -value of .025. N = sample size. All average composites computed by averaging relevant individual correlations. Average sleep composite includes sleep quantity, poor sleep quality (reversed), and sleepiness (reversed).

sectional sleep quantity did not differ ($z = 0.00$, $p = 1.00$). Regarding sleep onset latency, challenge stressors were more negatively associated with prospective sleep onset latency, compared to hindrance stressors ($z = 2.74$, $p < .01$). Although the bivariate association for challenge stressors was negative, we interpret the contrast as support that hindrance stressors were relatively more positively associated with prospective sleep onset latency, compared to challenge stressors. No significant differences were found for cross-sectional sleep onset latency ($z = 1.17$, $p = .24$). Regarding sleep disturbance, hindrance stressors were more strongly associated with prospective sleep disturbance compared to challenge stressors ($z = 4.14$, $p < .01$); the correlations were not significant different for cross-sectional sleep disturbance ($z = 1.37$, $p = .17$). Regarding sleepiness, hindrances were more strongly associated with cross-sectional and with prospective sleepiness compared to challenges ($z = 4.77$, $p < .01$; $z = 2.93$, $p < .01$, respectively). Challenge-hindrance differences consistent with the hypotheses emerged for composites of sleep quality ($z = 2.54$, $p = .01$), sleepiness ($z = 3.94$, $p < .01$), and average sleep ($z = -2.54$, $p = .01$), but not sleep quantity ($z = -1.17$, $p = .24$). In sum, Hypotheses 1a, 1b, and 1c received partial support, and Hypothesis 1d received partial support.

Tables 3 and 4 show moderated regression results by work hours for hindrance stressors and challenge stressors. Hypothesis 2a-2d stated challenge and hindrance stressor associations with a) sleep quantity, b) sleep onset latency, c) sleep disturbance, and d) sleepiness become stronger as work hours increase. Again, a Bonferroni adjusted p value of .025 was used to determine statistical significance. Only one of the 16 moderator terms was significant. Specifically, work hours moderated the relationship between challenge stressors and prospective sleep onset latency ($b = 1.96$, $p < .01$, see Fig. 1). This pattern suggests moderate exposure to challenge stressors is associated with better sleep quality in the form of less time before sleep onset latency, while more extreme levels of exposure are detrimental for sleep onset latency. Overall, there was minimal support for Hypotheses 2a-2d.

Table 5 shows moderated regression results by time lag. Hypotheses 3a-3d stated challenge and hindrance stressor associations with prospective a) sleep quantity, b) sleep onset latency, c) sleep disturbance, and d) sleepiness weaken over time. We explored linear and quadratic time lag as a moderator. One significant quadratic result emerged for the relationship between hindrance stressors and sleep disturbance ($b = -0.20$, $p = .01$, see Fig. 2). The relationship between hindrances and prospective sleep disturbance becomes more positive as time lag increases. Overall, there is minimal evidence that the relationships between work stressors and sleep dimensions change systematically over time.

Table 3
Hindrance stressors work hours moderated regression results.

	Sleep Quantity		Sleep Onset Latency		Sleep Disturbance		Sleepiness	
	Cross-Sectional	Prospective	Cross-Sectional	Prospective	Cross-Sectional	Prospective	Cross-Sectional	Prospective
	<i>b</i>	<i>b</i>	<i>b</i>	<i>b</i>	<i>b</i>	<i>b</i>	<i>b</i>	<i>b</i>
Intercept	7.06*	6.86*	22.32*	17.51*	2.48*	1.80*	2.52*	1.30*
Hindrance Stressors	−0.03	−0.09*	2.83*	0.80	0.15*	0.12*	0.28*	0.07*
Work Hours	−0.07	−0.05	−3.45*	−2.97*	−0.08	−0.06*	−0.09*	−0.01
Hindrance Stressors x Work Hours	0.06	0.07	−0.95	−0.63	−0.02	−0.01	−0.01	−0.03
ΔF^a	3.40*	2.81	4.99*	7.07*	1.77	4.79*	2.35	0.90
ΔR^{2a}	.01	.01	.02	.02	.01	.01	.01	.00

* $p < .05$.

b = unstandardized beta weight.

All independent variables were standardized before entering into the regression equation.

^a Compared to a model with only hindrance stressors.

3.1. Supplementary analyses

Detailed supplementary analyses and results are in Appendix A. We re-ran all analyses controlling for trait neuroticism. After controlling for neuroticism, three challenge-hindrance comparisons became non-significant (prospective sleep quantity ($p = .05$), average sleep composite ($p = .08$), poor sleep quality composite ($p = .12$)). No differences emerged for moderation analyses. Our supplementary analyses also provide moderation regression models that control for demographic factors and personality. The moderation results remained the same after entering controls. We also compared challenge and hindrance associations with daily self-report and actigraphy sleep diary data completed for a subset of participants ($N = 192$). The challenge-hindrance distinction was supported when examining self-report daily sleep onset latency ($z = 2.55$, $p < .01$) and self-report daily sleepiness ($z = 2.46$, $p = .01$). Although none of the remaining comparisons were significant, nearly all were in the direction consistent with the challenge-hindrance Hypothesis. Finally, three of our sleep variables (cross-sectional sleep onset latency, prospective sleep onset latency, sleepiness) had substantial positive skew (skewness greater than |2|). We log transformed each variable and re-ran correlations and correlation comparisons to ensure our results held with normally distributed sleep variables. All correlations were the same or within |.01| of the original correlation coefficients. Challenge-hindrance conclusions remained the same.

4. Discussion

The current study contributes to the literature on the relationship between stressors and sleep. We examined relationships between workplace challenge and hindrance stressors and multiple operationalizations of sleep. The pattern of findings showed hindrance stressors were more strongly associated with poor sleep quality and sleepiness compared to challenge stressors. However, this pattern was not significant for sleep quantity. We found limited evidence that work hours and time lag moderate the association between work stressors and sleep.

Our results generally support the challenge-hindrance pattern, suggesting hindrances, such as interruptions and unfair treatment, are more detrimental to sleep quality and sleepiness compared to challenge stressors, such as time pressure and high levels of responsibility. As reported hindrance stressors increased, individuals also reported greater sleep onset latency, sleep disturbance, and sleepiness at the same time point. On the other hand, challenge stressors showed weak and non-significant cross-sectional associations with sleep quality and sleepiness. Although not all contrasts were significant, the pattern hypothesized challenge-hindrance contrasts suggests hindrances are more strongly associated with poor sleep quality and sleepiness, compared to challenges. The robustness of this pattern is supported by our averaged

Table 4
Challenge stressors work hours moderated regression results.

	Sleep Quantity		Sleep Onset Latency		Sleep Disturbance		Sleepiness	
	Cross-Sectional	Prospective	Cross-Sectional	Prospective	Cross-Sectional	Prospective	Cross-Sectional	Prospective
	<i>b</i>	<i>b</i>	<i>b</i>	<i>b</i>	<i>b</i>	<i>b</i>	<i>b</i>	<i>b</i>
Intercept	7.08*	6.89*	21.73*	16.90*	2.47*	1.79*	2.52*	1.30*
Challenge Stressors	−0.04	0.03	1.32	−1.61*	0.07	0.01	0.03	−0.02
Work Hours	−0.09*	−0.11*	−2.53*	−1.94*	−0.05	−0.03	−0.02	0.03
Challenge Stressors x Work Hours	−0.03	−0.04	1.47	1.96*	0.04	0.03	0.01	−0.01
ΔF^a	2.49	3.55*	4.31*	7.77*	1.19	2.80*	0.15	0.69
ΔR^{2a}	.01	.01	.01	.02	.00	.01	.00	.00

* $p < .05$.

b = unstandardized beta weight.

All independent variables were standardized before entering into the regression equation.

^a Compared to a model with only challenge stressors.

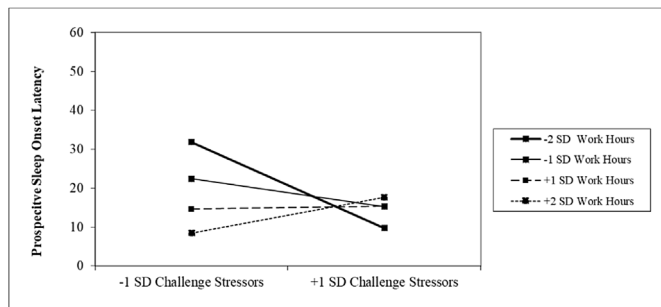


Fig. 1. The relationship between challenge stressors and prospective sleep onset latency as moderated by work hours. *SD* = Standard deviation.

analyses, which show significant differences in sleep quality and sleepiness in line with our hypotheses. Our findings align with Sonnentag et al.'s (2016) conclusions that threatening work stressors tend to have stronger and more consistent associations with sleep health dimensions compared to those that are less threatening.

We found limited evidence that work hours magnifies the relationship between challenge and hindrance stressors and sleep health dimensions. The one emergent moderation effect showed a curvilinear pattern, such that moderate levels of challenge stressors were negatively associated with prospective sleep onset latency, while high levels of challenge stressors had increasingly detrimental associations with prospective sleep onset latency. One other study found curvilinear

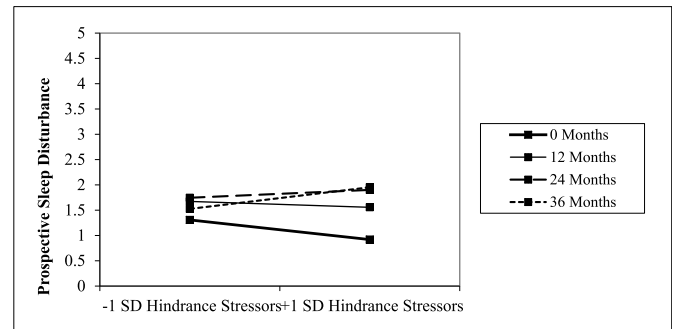


Fig. 2. The relationship between hindrance stressors and prospective sleep disturbance over time. *SD* = Standard deviation.

relationships between challenges and well-being, including emotional exhaustion and job satisfaction (Podsakoff, 2007). Our finding provides some preliminary support that curvilinear associations might also be present for associations between challenges and sleep. Overall our finding suggests work stressors are not exposure-dependent in that the sleep of employees who work even a limited number of hours may be affected by challenge and hindrance stressors.

Hindrances showed significant associations with both cross-sectional and prospective indicators of sleep quality, although follow-up analyses showed cross-sectional associations with sleep quality may be somewhat confounded by neuroticism. Overall, these results indicate

Table 5
Time lag moderated regression results.

	Prospective Sleep Quantity		Prospective Sleep Onset Latency		Prospective Sleep Disturbance		Prospective Sleepiness	
	Hindrance Stressors	Challenge Stressors	Hindrance Stressors	Challenge Stressors	Hindrance Stressors	Challenge Stressors	Hindrance Stressors	Challenge Stressors
	<i>b</i>	<i>b</i>	<i>b</i>	<i>b</i>	<i>b</i>	<i>b</i>	<i>b</i>	<i>b</i>
Intercept	6.80*	6.80*	17.19*	17.21*	1.83*	1.83*	1.30*	1.30*
Work Stressor	−0.12*	0.01	0.18	−2.41*	0.11*	−0.00	0.08*	−0.01
Lag	0.01	0.01	0.69	0.53	−0.01	−0.02	−0.03	−0.04
Lag Squared	0.08	0.07	0.18	0.16	−0.03	−0.03	−0.01	−0.01
Work Stressor x Lag	−0.10	−0.17	0.92	0.13	0.17*	0.16	0.09	−0.02
Work Stressor x Lag Squared	0.11	0.16	−1.55	0.23	−0.20*	−0.15	−0.13	−0.01
ΔF^a	1.16	1.18	0.47	0.22	3.35*	1.90	2.01	1.05
ΔR^{2a}	.01	.01	.00	.00	.02	.01	.01	.01

* $p < .05$.

b = unstandardized beta weight.

All independent variables were standardized before entering into the regression equation.

^a Compared to a model with only work stressor entered as a predictor.

hindrances may have both short-term and long-term effects. Challenge stressors also showed some evidence of long-term effects, such that challenges were associated with shorter sleep onset latency after several months, despite no cross-sectional relationship. The consistent patterns of significance across cross-sectional and prospective results suggest there may be consistency in relationships between work stressors and sleep dimensions over time. Our moderation analyses support this conclusion, as we found only one significant moderated relationship. These findings are important for addressing calls to explore prospective and longitudinal relationships between workplace factors and sleep dimensions (e.g., Åkerstedt, 2006). The patterns show challenge-hindrance differences emerge when looking at prospective relationships, and suggest work demands may have lingering implications for sleep. Researchers or practitioners who want to address long-term sleep problems might focus first and foremost on improving sleep quality by reducing chronic exposure to hindrances. Such interventions may have more short-lived effects for sleepiness.

The one significant moderation effect for time lag was consistent with our hypotheses, showing that the relationship between hindrances and sleep disturbance becomes more positive over time. This pattern might reflect work stressor accumulation over time. Several theories posit such accumulation results in cumulative loss spirals or depletion, such that individuals become overwhelmed and have difficulty replenishing resources (Hobfoll, 1989) or returning to healthy functioning behaviors (McEwen and Seeman, 1999). Perhaps sleep disturbance is most susceptible to such accumulation.

Neither challenge nor hindrance stressors were related to sleep quantity. With the exception of shiftwork and night work (Åkerstedt, 2003), previous research also indicates weak evidence for the relationship between sleep quantity and work stressors. It may be that sleep quantity is more highly dependent on the timing of work and disruption of circadian rhythms than psychosocial stressors like those assessed in the current study. Work stressors would only influence sleep quantity to the extent that they require workers to be awake for extended periods of time during the evening. It might also be that work stressors are only detrimental to sleep quantity if they trigger rumination or worry that delays sleep (Sonnentag et al., 2016). Future research might consider testing the timing of work and sleep as mechanisms linking work stressors to sleep quantity outcomes on a chronic or daily basis.

4.1. Theoretical and practical implications

The current study contributes to the theoretical study of work stressors and sleep health in several ways. First, our results build support for the challenge-hindrance framework when applied to sleep quality and sleepiness. Previous research has established unique relationships between challenge and hindrance stressors with work-related and psychological strain outcomes (e.g., Crawford et al., 2010; LePine et al., 2005). We extend this framework, showing that challenge-hindrance patterns also emerge for chronic sleep quality and sleepiness. Second, our study builds on the cross-sectional challenge-hindrance and sleep literature by demonstrating that relationships hold for cross-sectional and prospective relationships. Our work also demonstrates a possible boundary condition of the challenge-hindrance framework in that it was not supported for sleep quantity. Alternative theoretical perspectives incorporating sleep physiology or daily variations may need to be incorporated to better understand these relationships.

Workers suffering from sleep problems may consider steps to reducing hindrance demands emanating from the workplace. For example, workers might create temporal or spatial boundaries that reduce the chances of being interrupted at work, for example by turning off email when it is not in use or working from a quiet, private space. Workplace leadership could also design work in a way that minimizes hassles and frustrating demands. For example, organizational policies in combination with leadership training can be used to reduce the

likelihood of harassment and unfair treatment (Dupré and Barling, 2006; Hietapakka et al., 2013). Research shows such factors have the potential to improve worker psychological well-being (Skakon et al., 2010); our results suggest they also have the potential to improve workers' sleep quality and reduce sleepiness.

4.2. Limitations and future directions

The limitations in our study provide avenues for future research. First, our stressor measures do not include all possible challenge and hindrance stressors encountered at work. Moreover, our challenges measure had lower reliability than our hindrances measure, likely due to the smaller number of items. Despite these limitations, we remained true to the conceptual definitions of challenge and hindrance stressors used in the literature (e.g., Crawford et al., 2010; LePine et al., 2005). It is therefore unlikely our results were produced solely due to our specific challenge and hindrance items. Additionally, differences in scale content and item instructions precluded direct comparison of cross-sectional and prospective sleep items. Future research should seek to replicate our findings using alternative measures.

We also were not able to test for reverse causal effects. Several studies, including those using the MIDUS data set, have found evidence for reversed effects to those we hypothesize, such that disturbed sleep or sleepiness increases perceptions of stressors or negative reactions to stressors (e.g., Dinges et al., 1997; Minkel et al., 2012; Van Laethem, Beckers, Kompier, Kecklund, van den Bossche and Geurts, 2015). Future work might continue this line of research in the context of challenges and hindrances. For example, it might be that poor sleep dampens the performance benefits of challenges, and exacerbates negative reactions to hindrances.

Research that manipulates challenge and hindrance stressors would also help to strengthen the link between challenge and hindrance stressors and sleep, adding needed causation evidence to a largely correlational literature. For example, participants could complete a lab task that is either challenging or hindering, and participant sleep health could be tracked the following evening using objective and subjective sleep dimension measures. Natural experiments that center around challenging or hindering times of work could also be conducted. For example, tax accountants might be assessed during and after tax season as an increased period of elevated challenge stressors. Similarly, workers could be surveyed during the implementation of new procedures or softwares as a period of potentially elevated hindrance stressors. We also did not assess mechanisms that link challenge-hindrance stressors with sleep, such as stressor appraisals (Webster et al., 2011), rumination (e.g., Syrek and Antoni, 2014), or emotions (Rodell and Judge, 2009). Overall, there is a paucity of research that directly tests such mechanisms. Moving forward, research is needed to extend our work by delineating and testing theoretical mechanisms to better understand why challenge and hindrance stressors differentially relate to sleep quality. Such research could help to identify individual-level intervention points in the event that it is difficult or impossible to alter organizational work stressors.

Finally, the objective challenge-hindrance distinction has been limited to workplace settings, focusing on workplace stressors. However, stressors may be experienced in a variety of domains, such as in home or leisure time. It is possible that stressors outside of work have similarly differential associations with sleep dimensions depending on the degree to which they thwart versus facilitate personal goals and achievement. Future research might investigate whether objective challenges and hindrances can be extended to non-work demands. For example, it may be that domestic activities such as washing the dishes and grocery shopping are typically viewed as hindrances to personal achievements during off-work time, while other activities such as caring for children are viewed as a challenge and an opportunity for meaningful growth. This extension could help to further specify the degree to which everyday psychosocial stressors are associated with sleep.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.socscimed.2019.01.009>.

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