Does Social Support Buffer the Effects of Occupational Stress on Sleep Quality Among Paramedics?

A Daily Diary Study

Jessie Pow, David B. King, Ellen Stephenson, Anita DeLongis

University of British Columbia

Author Note

Jessie Pow, Department of Psychology, University of British Columbia; David B. King, Department of Psychology, University of British Columbia; Ellen Stephenson, Department of Psychology, University of British Columbia; Anita DeLongis, Department of Psychology, University of British Columbia.

David B. King is now in IRMACS Centre, Simon Fraser University.

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Correspondence regarding this article should be addressed to Anita DeLongis, Department of Psychology, University of British Columbia, 2136 West Mall, Vancouver, British Columbia, Canada, V6T 1Z4. E-mail: adelongis@psych.ubc.ca.

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Abstract

Given evidence suggesting a detrimental effect of occupational stress on sleep, it is important to identify protective factors that may ameliorate this effect. We followed 87 paramedics upon waking and after work over one week using a daily diary methodology. Multilevel modeling was used to examine whether the detrimental effects of daily occupational stress on sleep quality were buffered by perceived social support availability. Paramedics who reported more support availability tended to report better quality sleep over the week. Additionally, perceived support availability buffered post-workday sleep from average occupational stress and days of especially high occupational stress. Perceived support availability also buffered off-workday sleep from the cumulative amount of occupational stress experienced over the previous workweek. Those with low levels of support displayed poor sleep quality in the face of high occupational stress; those high in support did not show significant effects of occupational stress on sleep.

Key words: Sleep, occupational stress, social support, Buffering Hypothesis, shift-workers

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Sleep facilitates recovery from daytime demands and has been found to be strongly related to health across multiple studies (Åkerstedt, 2006). In large-scale cross-sectional epidemiological studies, sleep disturbance has been linked to depression, cardiovascular disease, high blood pressure, migraines, lung disorders, sickness absence from work, burnout, and increased health care consumption (Drake, Roehrs, Richardson, Walsh, & Roth, 2005; Doi, Minowa, & Tango, 2003; Fabsitz, Sholinsky, & Goldberg, 1997; Groeger, Zijlstra, & Dijk, 2004; Grossi, Perski, Evengård, Blomkvist, & Orth-Gomér, 2003; Melamed, Ugarten, Shirom, Kahana, Lerman, & Froom, 1999; Roth & Roehrs, 2003; Taylor, Lichstein, Durrence, Reidel, & Bush, 2003; Urponen, Vuori, Hasan, & Partinen, 1988; van Diest, 1990). Sleep disturbance has also been linked to future cardiovascular disease, diabetes, depression, and fatal occupational accidents in prospective research (Nilsson, Rööst, Engström, Hedblad, & Berglund, 2004; Meisinger, Heier, & Loewel, 2005; Lustberg & Reynolds, 2000; Åkerstedt, Fredlund, Gillberg, & Jansson, 2002). Given its consequential role in facilitating good health and wellbeing, it is important to identify factors that impact sleep.

Research has demonstrated that stress is detrimental for sleep (Åkerstedt, Fredlund, Gillberg, & Jansson, 2002; Åkerstedt, Kecklund, & Axelsson, 2007; Hall, Buysse, Mofzinger, & Reynolds, 2008; Hanson & Chen, 2010; Urponen, Vuori, Hasan, Partinen, 1988; Utsugi et al., 2005). This may be because sleep requires deactivation, which may be incompatible with the activation that arises as a consequence of stress (Åkerstedt, 2006). Consistent with this, exposure to laboratory stressors causes sleep disturbance (for a review, see Kim & Dimsdale, 2007).

Furthermore, findings from prospective studies indicate that stress negatively impacts sleep over the long-term (Vahtera et al., 2007; Van Laethem, Beckers, Krompier, Dijksterhuis, & Geurts, 2013). Indeed, stress may be a more powerful predictor of sleep quality than other factors commonly linked to sleep quality, including exercise, sleep schedules, and consumption of caffeine and alcohol (Lund, Reider, Whiting, & Prichard, 2010). Research suggests that occupational stress in particular can be a significant trigger for sleep-disturbance (Åkerstedt, 2006; Van Laethem et al., 2013). A recent review of prospective studies suggests that stress experienced in the workplace is a strong and consistent predictor of future sleep disturbance (Van Laethem et al., 2013). Recent findings using a daily diary method indicate that occupational stress predicts day-to-day shifts in sleep quality across nights (Vahle-Hinz, Bamberg, Dettmers, Friedrich, & Keller, 2014).

Do some individuals have sleep that is more sensitive to occupational stress than others? It has long been known that there are large individual differences in the effects of stress more generally (DeLongis, Folkman, & Lazarus, 1988; Rabkin & Struening, 1976; Schneiderman, Ironson, & Siegel, 2005), and a key factor found to explain these individual differences is perceived social support availability (DeLongis & Holtzman, 2005; Taylor, 2011). Perceived support has been defined as the experience that one is loved, cared for, esteemed, and part of a social network characterized by mutual assistance and obligations (Wills, 1991). The stress buffering model argues that the perception of support availability protects individuals from the effects of stress by moderating the stress reaction (Cohen & Wills, 1985; Taylor, 2007). Perceived support may reduce the stress reaction by assisting the individual with coping (Thoits, 1986; Uchino, 2009) and by enhancing self-esteem and perceived control over the environment (Pearlin, Lieberman, Menaghan, & Mullan, 1981). In the current study, we assessed whether differences in perceived social support availability explained variations in the relation between daily stressful experiences in the workplace and daily sleep quality. We expected individuals who perceived high social support availability to have sleep that is less sensitive to occupational stress compared to individuals who perceived social support to be lacking.

Previous research suggests that differences in perceived social support availability may partially explain why some individuals have sleep that is more sensitive to stress than others. One population-based cross-sectional study conducted in Finland found that higher perceived support was linked to less fatigue, fewer sleeping difficulties, and longer sleep duration (Sinokki et al., 2010). Other cross-sectional studies have found relations between perceived support and sleep across a variety of samples (Brummett et al., 2006; Nakata et al., 2001; Nordin, Knutsson, & Sundbom, 2008). Additionally, a recent prospective study found that perceived support from both coworkers and those outside of work was important in predicting change in sleep disturbance over more than a decade (Nordin, Westerholm, Alfredsson, & Åkerstedt, 2012).

Although previous research has found evidence that perceived support predicts differences in sleep outcomes, the question remains as to whether these differences are due, at least in part, to the stress buffering effects of support. Perhaps the benefits of perceived support for sleep are present primarily under conditions of stress (House, 1981). To our knowledge, only two studies have examined whether perceived support buffers sleep from occupational stress. In a study of shift-workers, Nakata and colleagues (2001) examined whether perceived support availability from colleagues and supervisors protected sleep from workplace demands. In a later study, Crain and colleagues (2014) examined whether perceived support from supervisors protected sleep from work-family conflict in information technology workers. However, neither of these studies found evidence of stress buffering effects for sleep outcomes. This could be because both studies only examined perceived support availability in the workplace, excluding sources of support from outside work. Support from both the work supervisor and the larger social network outside of work have been found to be key in protecting individuals from occupational stressors (House, 1981).

The present study

Previous findings suggest that limiting assessments to social support from co-workers and work supervisors dismisses key sources of support that may buffer stress. To redress this limitation, we assessed perceived social support availability using the Interpersonal Support Evaluation List (ISEL; Cohen, Mermelstein, Kmack & Hoberman, 1985), a broad-based measure of perceived social support availability that has been well-validated in diverse participant pools (Cohen & Hoberman, 1983; Cohen & Wills, 1985). It has been widely used in health research (Fortmann & Gallo, 2013) and higher scores on the scale have been found to be associated with lower rates of morbidity (Cohen et al., 1985). Additionally, social support measured in this way has been found to have stress-buffering effects on a range of health outcomes (Cohen et al., 1985; Taylor, 2011).

In order to examine whether global perceptions of support availability protect sleep from occupational stress, we used a daily diary methodology. This allowed for the measurement of occupational stress and sleep quality over a seven-day period encompassing approximately four workdays. There has been a recent call in the literature to examine sleep quality over multiple days, because it tends to vary significantly over time within individuals (Mezick et al., 2009). This method allowed us to obtain a more reliable estimate of average sleep quality for each person, while also gaining information about the times when individuals were tending to report better or worse sleep than was typical for them. Furthermore, we were able to examine sleep quality for both workdays and off-workdays.

The buffering hypothesis was tested in three ways. First, we examined whether sleep would be protected from individual differences in occupational stress when support availability was high. We expected that individuals who reported higher occupational stress across the workweek would show poorer sleep quality during that period compared to individuals reporting lower occupational stress, but only if they perceived low social support availability. However, individuals reporting higher occupational stress were expected to maintain similar levels of sleep quality as compared to individuals reporting lower occupational stress if they perceived high social support availability (H1).

Second, we examined the relationship between daily fluctuations in occupational stress and fluctuations in subsequent sleep quality. We expected that individuals who perceived low support availability would have sleep that is more sensitive to day-to-day shifts in occupational stress compared to individuals who perceived higher support (H2). Because of previous research indicating that higher variability in sleep schedules and duration tends to have negative implications for well-being (Fuligni & Hardway, 2006), having sleep that is sensitive to the ups and downs of daily life may also be expected to be detrimental (Mezick et al., 2009). Yet, very little is known about predictors of day-to-day variability in sleep quality.

Third, we examined whether support had stress buffering effects on off-workday sleep. If adequate recovery does not occur during the workweek, occupational stress may accumulate and negatively impact sleep even on subsequent days off. Such an effect is consistent with effort-recovery theory (Meijman & Mulder, 1998). If occupational stress impacts sleep quality even on off-workdays, this could indicate a lack of recovery from the stress of the previous workweek, and could have implications for health over time. Findings regarding the impact of occupational stress on off-workday sleep quality have been mixed (Syrek & Antoni, 2014; Vahle-Hinz et al., 2014; van Hooff, Geurts, Kompier, & Taris, 2007). Based on a social support buffering model, we expected to find the effects of occupational stress on end-of-workweek sleep to be limited to those low in social support, with those high in social support protected (H3).

Paramedics are an appropriate population in which to study the stress-buffering effects of social support because they are a population at-risk for experiencing sleep disturbances given that they engage in shift-work (Åkerstedt, 2003). Indeed, one study found high rates of disturbed sleep in emergency medical technicians (EMTs), a group that includes paramedics (Pirrallo, Loomis, Levine, & Woodson, 2011). It is possible that sleep disturbances commonly arise in paramedics and other EMTs not only because their employment requires them to do shift work, but also because of the high levels of occupational stress that they tend to experience (Regehr, Goldberg, & Hughes, 2002). Therefore, a greater understanding of the stress-sleep relation is needed in this vulnerable population.

Method

Participants

Data were drawn from a larger ongoing longitudinal study of 87 paramedics examining the impact of occupational stress on wellbeing (for additional information about demographics, eligibility criteria, and recruitment procedures, see King & DeLongis, 2014). Participants were licensed as paramedics by the Canadian Medical Association and had been on the job for an average of 15.2 years (*SD* = 7.7, range = 3-35). Participants had a mean age of 42.1 years (*SD* = 8.3, range = 27-62) and most identified as male (*n* = 71). Eighty-two participants identified as Caucasian, four as Asian, and one as Hispanic. The majority had children living with them in the home: fifteen had one child (17%), twenty-three had two children (26%), and sixteen had three or four children (18%), whereas 33 (38%) had no children living with them.

Procedure

Paramedics self-selected into the study in response to online media as well as flyer and brochure advertisements posted at local Emergency Medical Service stations. The advertisements directed interested paramedics to an online website where they were asked to complete an eligibility questionnaire. This questionnaire asked basic information about employment status, relationship status, and schedule information. Eligibility criteria included being employed full-time or working full-time equivalent hours. Additionally, participants had to be scheduled to work four consecutive shifts during the study in order to maintain homogeneity in work schedules. Participants were also required to have a cohabitating romantic partner willing to participate in the larger study to be eligible to participate. However, because of our particular interest in examining factors related to shift workers' sleep, we only examine paramedic data here.

If participants met the eligibility criteria for the study, they were directed to an online questionnaire on a secure server at the University of British Columbia where they were asked to provide informed consent and basic demographic information. Following this, participants were contacted by phone to schedule the diary phase of the study. Once a time was scheduled, participants received an email link to the online diary questionnaires. Participants were asked to complete structured diaries for a seven day period during which days 2-5 were scheduled work days. Because of changing schedules associated with shift work as well as the sensitive nature of the job, we chose to use an event-contingent design whereby paramedics were asked to complete diaries within one hour of waking, at the end of the workday, and before going to bed. For the purposes of the current study, we only examined diaries that were completed upon waking (i.e., assessing sleep quality) and after work (i.e., assessing occupational stress). Figure 1 provides a visual representation of when assessments were made during the diary phase of the study. Participants completed a final online questionnaire battery within two weeks following the diary phase of the study. After the online questionnaire battery, participants were thanked and debriefed. All participants received a $40 (Canadian) gift card. This study was approved by the affiliated institution's Behavioural Research Ethics Board.

Work Schedules

Although days 2-5 were scheduled workdays at study onset, some work schedules changed during the study, with some paramedics working fewer than four shifts and some working more than four shifts. We included all participants who reported working at least one day. There were seven participants who did not report working during the study, and were excluded from analyses. Of the 560 days that were assessed across the remaining participants, there were 291 reported workdays with a mean for each person of 3.6 days (SD = 0.9, range = 1-6). Work days included 137 nightshifts and 154 dayshifts. Participants commonly worked on a forward-rotating shift-schedule (i.e., working a dayshift directly followed by a nightshift; n = 39; 49%); however, one individual worked on a backward-rotating shift schedule (i.e., working a nightshift directly followed by a dayshift; 1%). Some participants worked only dayshifts (n = 13; 16%), some worked only nightshifts (n = 10; 13%), and some worked a combination forward- and backward- rotating shift schedule (n = 17; 21%). For analytic purposes, the one paramedic who worked on a backward-rotating shift schedule was added to the group who worked on a combination forward- and backward-rotating shift schedule. Dummy variables were created reflecting these categories, with those who only worked dayshifts being the comparison group. For a visual representation of the most common work schedule, please see Figure 1.

Measures

Occupational stress. During the diary phase of the study, paramedics were asked to complete an 11-item checklist for problems or events experienced "while at work" at the end of each workday. Checklist items were chosen based on cited job responsibilities by major services in Canada, reviewed by a paramedic consultant on the project, and included items such as high call volume, illegitimate calls, experiencing a threat to crew safety, or responding to a call for a multiple casualty incident (see Table 1). One of the 11 checklist items was "other problem" and participants were given the opportunity to give a brief description of this problem if they endorsed this item. These open-ended responses were most often in regard to issues associated with patient care (32%; e.g., "pulseless patient with return of pulse", "road rage incident directed at elderly disabled person", "cardiac arrest"), with coworkers (24%; e.g., "my partner drives like Stevie Wonder", "my partner was incompetent", "working de-paired"), and with working conditions (17%; e.g., "lack of resources", "missed lunch break", "scheduling issues"). The number of stressors was summed for each workday to create an index of the workday's occupational stress; therefore, the possible range of scores was zero to eleven.

Sleep quality. Sleep quality was assessed during the seven-day daily diary phase of the study with a key item that makes up the score for the first component of the Pittsburgh Sleep Quality Index (PSQI; Buysse, Reynolds, Monk, Berman, & Kupfer, 1989). This item was chosen for the diary component of this study because it is the most representative of the global PSQI score, with the highest correlation with the total score compared to other subscales (Buysse et al., 1989). Additionally, this item has been used in previous daily diary research to measure self-reported sleep quality (Rutledge et al., 2009). Paramedics were asked to report their sleep quality on all days of the study and with reference to the “previous day or night’s sleep” within one hour of waking. The question read, “How would you rate your sleep quality overall?” and responses included “very good (= 3)”, “fairly good (= 2)”, “fairly bad (= 1)”, and “very bad (= 0)”.

Perceived social support availability. Participants completed the Interpersonal Support Evaluation List (ISEL; Cohen et al., 1985) during the final online questionnaire battery. The ISEL is a 40-item measure of perceived social support availability and asks respondents to report whether a series of statements are “definitely true (= 3)”, “probably true (= 2)”, “probably false (= 1)” or “definitely false (= 0)” in general, without reference to a specific timeframe. Example items include, “there are several people who I trust to help solve my problems” and, “I feel like there is no one I can share my most private worries and fears with” (reverse scored). The scores for each item were summed and possible scores ranged from 0- 120. Cronbach’s alpha for the scale was .94, indicating excellent internal consistency.

Covariates. Covariates at the person-level were considered in both workday and off-workday analyses. These person-level covariates included demographic variables (i.e., gender, age, time on the job, years of post-secondary education, household income, number of children in the home), the overall shift pattern completed during the study (forward-rotating, dayshift only, nightshift only, or other schedule type), average sleep duration, average bedtime, and average time out of bed. Some covariates at the day-level were considered in both workday and off-workday analyses and included the concurrent sleeping session’s bedtime, time out of bed, and sleep duration. For workday analyses only, we also considered the type of day directly prior to the sleeping session (i.e., nightshift or dayshift) and the type of day directly following the sleeping session (i.e., nightshift, dayshift, or off-workday). This was controlled in off-workday analyses because this analysis focused on sleep that occurred after a day off, and both the day prior to and day following the sleeping sessions were off-work days. The effect of each covariate on sleep quality was tested separately, and only covariates that were significantly related to sleep quality were included in final analyses presented here.[1] The only covariates that were significantly related to workday sleep quality were concurrent sleep duration and whether a dayshift was worked directly following the sleeping session (compared to working either a nightshift or having the day off). The only covariates that were significantly related to off-workday sleep quality were concurrent sleep duration and time out of bed.

Statistical analysis

Workday analyses. Due to the multilevel structure of the data in which days were nested within individuals, we used hierarchical linear modelling (HLM) software (v6.0; Raudenbush, Bryk, Cheong, & Congdon, 2004). Following recommendations (Woltman, Feldstain, MacKay, & Rocchi, 2012), we tested two unconditional means models to examine whether the intercept variance for sleep quality was significantly different from zero and to calculate intra-class correlations (ICCs) for sleep quality and occupational stress. The null model for sleep quality indicated that there was significant variability in sleep quality across individuals (*variance* = 0.10, χ^2 (76) = 133.24, $p < .001$). The ICC1 for sleep quality was .17 and the ICC2 was .39. The ICC1 for occupational stress was .38 and the ICC2 was .68. Overall, results from the null models confirmed that a multilevel approach was necessary in order to account for the dependency in the data due to repeated measures. We tested our first two hypotheses using a series of two-level models: within-person effects were modeled at Level 1 and between-person effects were modeled at Level 2. Following the test of the null model for sleep quality, covariates and predictor variables were entered as sets in a step-wise sequence, and the model fit, based on a chi-square statistic using maximum likelihood, was used to evaluate whether the addition of variables as a set significantly improved the amount of variance accounted for (Raudenbush & Bryk, 2002). The first step included concurrent sleep duration and whether the day directly following the sleeping session was a dayshift or not. Along with these covariates, the previous day's sleep quality was included in order to decrease the chance that any observed effects of occupational stress on subsequent sleep quality were due to reverse causation. The second step of the model included daily within-person fluctuations in occupational stress and each person's average occupational stress. In the third step, we added perceived social support availability into the model, testing both main and interactive effects with daily and average occupational stress. Restricted maximum likelihood and robust standard errors were used in estimation of effect sizes and standard errors.[2] To aid interpretation, the change in percent variance accounted for in sleep quality was calculated using the formula for modelled proportion of variance at the within- and between- person levels (pseudo-R^2; Snijders & Bosker, 1999).

All Level 1 continuous variables, including concurrent sleep duration, the previous day's sleep quality, and daily fluctuations in occupational stress were centered on each individual's own mean, providing a within-person comparison. The categorical Level 1 variable representing whether a dayshift was worked directly following the sleeping session was dummy coded (dayshift = 1, non-dayshift = 0) and remained uncentered. All Level 2 between-person continuous variables, including each person's average occupational stress and each person's perceived social support availability, were centered on the mean of all of the participants, providing a between-person comparison. According to recommendations, participants were only excluded if they had insufficient data for analyses (Raudenbush & Bryk, 2002, p.199). This resulted in a total of 77 participants across 546 diary entries included in workday analyses.

Reverse Causation Analysis. We tested the possibility for reverse causation in our workday analysis. In order to test this hypothesis, we ran a multilevel model to test whether there is a main effect of fluctuations in sleep quality on subsequent occupational stress, controlling for the previous day's occupational stress rating. In a second model, we tested for an interaction between fluctuations in sleep quality and perceived social support availability to predict subsequent occupational stress.

Off-workday analysis. We conducted a multiple regression using SPSS 17.0 to test for main and buffering effects of perceived social support availability (H3). In these analyses, the outcome variable was sleep quality as rated one day removed from the last day of work observed in the study. This is because we were interested in predicting sleep quality for sleeping sessions following days off work. For example, if the participant's last day of work was on the fifth day of the study, then the sleep quality rating measured on the seventh day of the study was the outcome, which was the case for most of the participants included in this analysis ($n = 52$). The rest of the participants included in this analysis had their last day of work on the fourth day of the study, so the sleep quality rating taken on the sixth and seventh days of the study were averaged and included in this analysis ($n = 12$). Thus, we were examining whether cumulative occupational stress experienced during the workweek could spill over to the off-workday, impacting sleep even after a full day off of work, and whether perceived social support availability buffered this effect.

These effects were tested in a three-step regression model. The first step of the model included concurrent off-workday sleep duration, time out of bed, and the number of shifts that participants worked. We also controlled for their sleep quality for all days prior to the workweek observed in this study in order to decrease the chance that findings were due to stable person or environmental factors. The second step of the model included the main effects for their perceived social support availability rating and cumulative occupational stress experienced that week. The third step of the model included an interaction term for perceived social support availability by cumulative occupational stress. All predictor variables were centered on the grand mean to facilitate interpretation of main unstandardized effects. The same analyses were also run with the standardized variables in order to obtain accurate standardized effects. These analyses only included individuals who provided a sleep quality rating prior to their first day of work, worked during the study, and provided a sleep quality rating one day removed from the last workday observed in the study. This resulted in a sample of 64 individuals and a total of 371 diary entries for off-workday analyses.

For all analyses, alpha was set at the 0.05 level and hypotheses were tested using two-tailed tests. Assumptions were tested for workday and weekend analyses. These analyses did not give any evidence that there were model misspecifications, heteroscedasticity, or non-normal residuals for final models. In the entire dataset, there were 1321 completed diary entries including 549 waking diary entries, 291 after work diary entries, and 481 before bed diary entries. Across both workday and off-workday analyses, 141 waking diary entries, 15 after work diary entries, and all 481before bed diary entries were excluded from analyses. Thus, a total of 637 (48.22%) of the completed diary entries were excluded.

Results

Preliminary Analyses

Means, standard deviations, and ranges for all study variables are presented in Table 1. The mean sleep quality rating over the workweek was 1.94, the mean sleep quality rating for off-workdays prior to the workweek was 1.89, and the mean sleep quality rating for off-workdays subsequent to the workweek was 1.95, indicating that participants tended to rate their sleep as just worse than "fairly good". Paired samples *t*-tests revealed no significant differences between these sleep quality values (*p*s ranged from .637 - .914). These average sleep quality values are consistent with mean sleep quality ratings in nurses and physicians in a previous daily diary study who gave an average sleep quality rating of 1.9 during the workweek (Rutledge et al., 2009). The mean number of occupational stressors experienced each day was 1.68. The most frequent stressor reported was "a lot of work demands/high call volume", and the second most common stressor was "receiving an illegitimate call". Participants reported stressors involving "death, threatened death, threatened or serious injury" (American Psychiatric Association, 2013) on a frequent basis. For example, they reported experiencing violence or a threat to crew safety on 46 days (16% of workdays; 8% of all study days), going to a suicide call on 23 days (8% of workdays, 4% of all study days), experiencing the death of a patient under care on 16 days (5% of workdays, 3% of all study days), and responding to a multiple casualty incident on 9 days (3% of workdays, 2% of all study days). These findings are consistent with previous research indicating that paramedics tend to experience high levels of occupational stress, and that between one fourth to one third tend to show traumatic stress symptoms in the high or severe range (Alexander & Klein, 2001; Regehr, Goldberg, & Hughes, 2002; Regehr & Millar, 2007).

We examined whether protocol compliance was related to study variables. Of the 291 reported workdays, participants completed the occupational stressors checklist on 290 days; therefore, we did not test differences between completers and the non-completer of the occupational stress measure. Across the 560 days of daily diaries for the 80 participants who worked during the study, the sleep quality rating was completed for 506 days in total, which represents a 90.4% completion rate overall. Thus, the sleep quality rating was completed a mean of 6.3 days (*SD* = 1.0, range = 3-7). There were no significant associations between the number of days that individuals completed their sleep quality rating and the value of their mean sleep quality rating over the workweek, their sleep quality ratings during the prior off-workdays or the subsequent off-workdays, the amount of occupational stress reported over the week, their social support availability ratings, or any of the covariates examined in this study (ps > .05). On the perceived social support availability measure used in this study, there was a 99.6% completion rate, with a minority of participants missing a single item on the 40-item measure (n = 10). There were no significant differences between those who provided fully complete data on the social support availability measure compared to those who did not on the number of days that individuals completed their sleep quality rating, the value of their sleep quality rating over the workweek, their sleep quality rating during the prior off-workdays or the subsequent off-workdays, the amount of occupational stress reported over the week, their social support availability ratings (following linear interpolation),[3] or any of the covariates examined in this study (ps > .05).

Bivariate correlations between variables of interest are displayed in Table 2.[4] At the within-person level of analysis, none of the correlations between pre-workday sleep quality, post-workday sleep quality, or daily occupational stress were significant. However, between-person correlations indicated that individuals who reported higher levels of perceived support availability or lower occupational stress tended to report better quality sleep on workdays and non-workdays compared to individuals who reported lower perceived support availability or higher occupational stress (their relations with the subsequent off-workday's sleep quality were a marginally significant effect). Mean occupational stress and perceived support availability were not significantly related.

Workday effects

Tests of workday stress buffering effects of perceived support availability are shown in Table 3. Model 1 shows that of the three covariates, concurrent sleep duration uniquely predicted sleep quality over and above prior sleep quality and whether a dayshift was worked directly following the sleeping session.[5] Model 2 shows that individuals who reported more occupational stress tended to report poorer sleep quality compared to individuals who reported less occupational stress. Results from this model indicate that for the average participant, days of occupational stress that exceeded participants' own typical levels were not significantly related to subsequently reporting poorer quality sleep.[6] However, the variability across individuals in their occupational stress-sleep relation was significant, suggesting that individuals varied in the way that occupational stress was related to subsequent sleep quality. Model 3 shows that the addition of perceived social support availability to the model led to a decrease in the unexplained variability in how daily occupational stress and sleep quality were related across individuals. Consistent with our first hypothesis, there was a significant interaction between each person's average occupational stress and perceived social support availability. Consistent with our second hypothesis, there was a significant interaction between perceived social support availability and daily occupational stress.[7]

The moderating effect of perceived social support availability on the relation between average occupational stress and average post-workday sleep quality is displayed graphically in panel A of Figure 2. Examination of this interaction revealed that for participants at relatively low levels of perceived social support availability at one standard deviation below the mean, experiencing greater average occupational stress across the workweek was related to experiencing poorer average post-workday sleep quality, $b = -0.40$, $SE = .09$, $t(70) = -4.28$, $p < .001$. For participants at mean levels of perceived social support availability, the negative relation between average occupational stress and average post-workday sleep quality was weaker but still significant, $b = -0.22$, $SE = .06$, $t(70) = -3.96$, $p < .001$. However, for participants at relatively high levels of perceived social support availability at one standard deviation above the mean, the relation between the average occupational stress and average post-workday sleep quality was not significant, $b = -0.04$, $SE = .07$, $t(70) = 0.63$, $p = .529$. Together, this indicates that as individuals reported higher levels of perceived social support availability, the negative relation between their average occupational stress and average sleep quality became weaker. This test of the buffering hypothesis suggests that social support protects average workday sleep from the otherwise detrimental effects of high stress workweeks.

The moderating effect of perceived social support availability on the relation between daily fluctuations in occupational stress and fluctuations in subsequent sleep quality is displayed graphically in panel B of Figure 2. Examination of the nature of this interaction revealed that for participants at relatively low levels of perceived social support availability at one standard deviation below the mean, the effect of experiencing higher occupational stress compared to their own typical levels was related to experiencing poorer subsequent sleep quality, $b = -0.21$, $SE = .08$, $t(72) = -2.54$, $p = .014$. For participants at mean levels of perceived social support availability, experiencing higher occupational stress compared to their own typical levels was not significantly related to poorer subsequent sleep quality, $b = -0.08$, $SE = .05$, $t(72) = -1.65$, $p = .103$. Additionally, for participants at relatively high levels of perceived social support availability at one standard deviation above the mean, the effect of experiencing higher occupational stress compared to their own typical levels was not significantly related to subsequent sleep quality, $b = 0.05$, $SE = .06$, $t(72) = 0.85$, $p = .399$. Overall, this indicates that as individuals reported higher levels of perceived social support availability, the negative relation between within-person fluctuations in occupational stress and subsequent sleep quality became weaker. This test of the buffering hypothesis suggests that social support protects workday sleep from the otherwise detrimental effects of especially high stress workdays.

Reverse Causation

We tested whether sleep quality could predict the next day's occupational stress, holding constant each person's average sleep quality, and the occupational stress that had been experienced the day before. Results of this model indicated that sleep quality was not a significant predictor of the next day's occupational stress, $b = 0.16$, $SE = .11$, $t(71) = 1.44$, $p = .153$. The results also indicated that there was no significant variability across people in their relation between sleep quality and subsequent occupational stress, *variance* = .03, $\chi^2(24) = 33.99$, $p = .085$. Additionally, there was no significant interaction between the night's sleep quality and perceived support availability to predict the next day's occupational stress, $b = 0.01$, $SE = .01$, $t(70) = 1.13$, $p = .267$. Overall, we did not find evidence the sleep quality predicts future occupational stress.

Off-Workday Effects

Table 4 presents analyses testing our third hypothesis that perceived support availability would buffer off-workday sleep quality from the cumulative amount of occupational stress experienced over the prior workweek. This was tested by examining whether perceived support availability moderated the relation between the cumulative amount of occupational stress and the subsequent off-workday's sleep quality, even when controlling for concurrent sleep duration, time out of bed, the number of days worked, and the off-workday's sleep quality rating for days prior to the workweek observed in this study. Results revealed a significant interaction between cumulative occupational stress and perceived support availability, $b = 0.01$, $t(58) = 2.16$, $p = .035$. Participants who reported relatively low levels of perceived support availability at one standard deviation below the mean showed a significant relation between cumulative occupational stress and off-workday sleep quality, $b = -.13$, $t(58) = -2.30$, $p = .025$. However, at average levels of perceived support availability, the relation between cumlative occupational stress and sleep quality was not significant, $b = -0.06$, $t(58) = -1.78$, $p = .080$. Additionally, participants with relatively high levels of perceived support availability at one standard deviation above the mean had off-workday sleep quality that was not significantly associated with cumulative occupational stress, $b = -0.02$, $t(58) = -.63$, $p = .530$. This interaction is displayed graphically in panel C of Figure 2. Taken together, perceived support availability moderated the occupational stress-off-workday sleep quality relation. Participants who perceived low levels of support availability showed a stronger negative relation between cumulative occupational stress and off-workday sleep quality compared to individuals who were higher in support availability.[8] This third test of the buffering hypothesis suggests that social support protects off-workday sleep from the otherwise detrimental effects of stress experienced during the previous workweek.

Discussion

Findings from the present study indicate that social support buffers sleep from the potentially detrimental effects of occupational stress. More specifically, among those paramedics who perceived higher levels of support, sleep quality tended to be unrelated to occupational stress. Conversely, among those who perceived lower levels of support, sleep quality tended to be lower as a function of higher occupational stress. Buffering effects were robust across three different tests of the occupational stress-sleep relation: 1) comparing paramedics high and low on stress across the workweek in terms of their average sleep across that workweek; 2) examining how fluctuations in stress levels within the workweek were related to fluctuations in sleep across that same period; and 3) examining the effects of cumulative occupational stress across the workweek on end-of-week sleep quality. Each of these findings is discussed below.

First, we found evidence indicating that overall levels of post-workday sleep are protected in individuals experiencing high occupational stress if support availability is high. That is, paramedics who perceived relatively high support tended to have sleep that was of high quality regardless of the occupational stress that they typically experienced across the workweek. On the other hand, paramedics who perceived lower support only tended to report high quality sleep if their workweek was relatively stress-free. This finding suggests the perceived support may be protective for individuals who tend to experience occupational stress that is chronically high over one workweek.

Second, we found evidence for the stress buffering hypothesis when examining the effect of fluctuations in occupational stress on subsequent sleep quality. Consistent with our hypothesis, findings indicate that those paramedics who perceive low support are vulnerable to poor sleep following days of higher occupational stress. Among paramedics who perceive high support availability, sleep may be protected from days of higher occupational stress. This finding is important because it helps to establish the causal ordering of occupational stress and sleep quality in a real–life setting. This effect was time-lagged, with occupational stress predicting sleep quality for the subsequent sleeping session, controlling for the previous day's sleep quality. Furthermore, this finding is important because it suggests that, *over and above* the buffering effects that support has on *overall* experiences of occupational stress, it may also have buffering effects on day-to-day *shifts* in occupational stress. Thus, social support may keep sleep relatively stable despite the ups and downs of everyday life.

Third, we found evidence for the stress buffering hypothesis in examining the effect of cumulative occupational stress on sleep that occurred following the workweek. Findings indicate that occupational stress experienced during the workweek impacts subsequent off-workday sleep for those who perceive lower levels of support availability. For those who perceive higher levels of support availability, off-workday sleep may be protected from cumulative occupational stress experienced during the previous week. This buffering effect was found even though we controlled for sleep quality before the workweek began and the number of days of work. Thus, support may allow for better recovery on off-workdays following workweeks of high occupational stress.

Consistent with findings from previous longitudinal research (Nordin et al., 2012), our findings suggest that perceived social support availability is important in facilitating high sleep quality. However, previous research has failed to find a stress buffering effect for co-worker and supervisor support on sleep (Crain et al., 2014; Nakata et al., 2001). It is possible that we observed buffering effects of perceived support availability from the larger social network because support from outside of work may compensate for a lack of support in the workplace. Another potential interpretation of the findings is that support providers outside of those at work (e.g., the spouse) may be particularly important for protecting sleep from stress. Indeed, research suggests that support gained from close others in personal life, and specifically from one's spouse, may be especially important in reducing reactivity to stress (DeLongis & Holtzman, 2005). Support gained from other sources may be qualitatively different from support from the spouse (Coyne & DeLongis, 1986). Future studies will be needed to tease out which sources of support are most protective of sleep for those under occupational stress. If support specifically from a source outside of work is the important factor for protecting sleep from occupational stress, then practitioners can focus on creating interventions that facilitate support from that particular source.

There is growing interest in understanding how the protective effects of perceived social support availability come about (Bolger, Stadler, Paprocki, & DeLongis, 2009; Bolger, Zuckerman, & Kessler, 2000). Studies suggest that receiving support, as opposed to simply seeing it as available should you need it, may have costs for the recipient and may lead to later increases in state distress (McClure et al., 2014; Uchino, 2009). It has been posited that receiving social support may be distressing because it leads to momentary decreases in state self-efficacy (Bolger & Amarel, 2007), or to violations of relationship equity (Gleason, Iida, Bolger, & Shrout, 2003; Gleason, Iida, Shrout & Bolger, 2008). Indeed, research findings have been mixed with regard to the effects of received support on health outcomes (for a review, see Uchino, 2009). Therefore, it is possible that perceptions of support availability are protective for health in ways that go beyond support experienced by the recipient.

One possibility is that support deemed to be available is comforting in and of itself (Wethington & Kessler, 1986). Indeed, research suggests that individuals who perceive more support to be available report seeking support less often (Brown, 1978). Furthermore, some evidence suggests that just thinking about supportive others can lead to decreased reactivity to stressors, even if the supportive others are not present and when no support exchange has actively occurred (Broadwell & Light, 1999; Taylor, 2007). This has particular implications for shift-workers, given that they work at socially inconvenient times and may not have the opportunity to seek out support after particularly stressful workdays (Costa, 1996). It could be that perceiving support to be available functions like having money in a savings account- having it may be comforting because of the knowledge that resources are available if they were needed. However, "withdrawing from the account" may have momentary costs because the individual may believe that fewer resources are available if they were to be needed at a future date. The theoretical and clinical implications of these issues suggest that more research is needed in order to fully understand how perceived support availability acts as a stress buffering factor.

One way that perceived support availability could decrease the stress reaction is by facilitating more adaptive coping responses (DeLongis, Holtzman, Puterman, & Lam, 2010). Rumination is thought to be a mediator in the relation between occupational stress and sleep (Brosschot, Pieper, & Thayer, 2005). Previous research has found that social support both decreases rumination and decreases the otherwise detrimental effects of rumination on wellbeing (Nolen-Hoeksema & Davis, 1999; Puterman, DeLongis, & Pomaki, 2010). Future research should examine whether rumination is a mediator of the positive effects of perceived support.

Previous long-term prospective research indicates bidirectionality in the relations of sleep with social support and occupational stress (e.g., Hanson et al., 2011; Nordin et al., 2012). Given this, one potential alternative interpretation of the findings is that poor sleep quality leads to increased occupational stress. However, in the current study, for individuals perceiving low support availability, days of especially high occupational stress predicted *subsequent* sleep quality, even while holding the sleep quality of the previous sleeping session constant. Additionally, sleep quality did not predict subsequent occupational stress in reverse causation analysis. Furthermore, the non-significant slope variance for the effect of sleep quality predicting future occupational stress indicates that this effect did not differ across the individuals. However, the number of individuals who had sufficient data to examine variability in slopes was small (*n* = 25); as such, power may have been too low to detect differences between individuals in whether sleep quality predicted subsequent occupational stress.

Another alternative explanation for our findings is that having sleep that is sensitive to occupational stress may decrease perceptions of support availability. Although our findings are consistent with other research pointing to perceived social support availability as having robust stress buffering effects on other health-related outcomes (Cohen & Wills, 1985; Taylor, 2011; Uchino, Cacioppo, & Kiecolt-Glaser, 1996; Umberson & Montez, 2011; Viswesvaran, Sanchez, & Fisher, 1999), further research is needed to examine this possibility.

There could be third variables involved that could have led to certain levels of occupational stress, perceived support, and sleep quality. Although we controlled for many potential third variables, including overall shift schedules, age, gender, and number of children in the home, we did not assess Body Mass Index (BMI) or the age of children in the home, and both are factors known to impact sleep (Troxel, Buysee, Hall, & Matthews, 2009; Vahtera et al., 2007). However, these factors were not expected to impact other variables in our model (e.g., exposure to occupational stressors or perceptions of support availability). Further, both BMI and the presence of young children are likely to be stable factors across the week assessed. Given this, it's unlikely that these factors accounted for our findings regarding social support as a moderator of the within-person effects of occupational stress on sleep found here.

One limitation of this study is in the measurement of sleep quality. Sleep quality was self-reported with a single item in the current study. However, self-reported sleep quality has been associated with health and quality of life (Byles, Mishra, Harris, & Nair, 2003; Wade, 2011) and there is evidence to suggest it is a stronger predictor of health than other measures of sleep in at least one study (Pilcher, Ginter, & Sadowsky, 1997). Poor sleep quality is the most common reason for a person to seek medical attention for sleep problems (Åkerstedt, Kecklund, & Gillberg, 2007). Indeed, it is atypical that an anomalous indicator as assessed on a physiological sleep measure would lead to seeking medical help (Åkerstedt & Wright, 2009). Additionally, it is important that questionnaires be brief in daily diary research in order to limit the burden on participants (Bolger, Davis, & Rafaeli, 2003) and previous daily research has used single items to measure sleep quality (e.g., Rutledge et al., 2009; Vahle-Hinz et al., 2014). The sleep quality rating across workdays and days off work were not significantly different, which deviates from some studies indicating that individuals tend to report better quality sleep and less sleepiness on weekends compared to during the workweek (e.g., Kunz-Ebrecht, Kirschbaum, Marmot, & Steptoe, 2004; Söderström, Ekstedt, Åkerstedt, Nilsson, & Axelsson, 2004). However, there were no differences in sleep quality on weekdays and weekends in at least one study (Hubalek, Brink & Schierz, 2010). Other research suggests that whether sleep quality differs on workdays and days off may depend upon other factors, including burnout scores (Söderström et al., 2004) and chronotype (Vitale et al., 2015). Future research is needed to find out why there were no differences in sleep quality for workdays and days off work in this sample.

Occupational stress was measured using an 11-item stressor checklist. This way of measuring occupational stress may be limited because it may not capture perceptions of the severity of the stressors being experienced. Additionally, it may not capture the full range of stressors experienced during a typical workday. However, the measure was designed to be specific to the common workplace demands that paramedics tend to experience and was developed in consultation with paramedics. Findings here are consistent with studies using previous measures of daily stress and hassles (Bolger, DeLongis, Kessler, & Schilling, 1989;

DeLongis, Folkman, & Lazarus, 1988). Sleep duration was also self-reported in this study. Previous research suggests that individuals tend to overestimate sleep duration (Lauderdale, Knutson, Yan, Liu, & Rathouz, 2008). Future research should examine whether perceived support availability protects sleep from occupational stress using other measures of occupational stress and sleep, and while controlling for sleep duration using observational or physiological assessments.

Our sample was relatively small and homogeneous in nature, with all participants employed as paramedics. Additionally, all participants were in cohabitating romantic relationships, reflecting the population of paramedics we drew from, and a majority were male and white. Thus the generalizability of the findings may be limited to these groups[9]. Additionally, the small number of females in the sample may have rendered the study underpowered to find gender effects. Furthermore, the sample size was reduced for weekend analysis and future research could examine weekend effects in a larger sample. Despite these limitations, knowledge about factors that impact sleep in this population is of particular importance. Shift work may be a chronic stressor that negatively impacts sleep and other aspects of health (Åkerstedt, 2003; Saksvik, Bjorvatn, Hetland, Sandal, & Pallesen, 2011) and paramedics may be especially vulnerable to sleep problems given both their high occupational stress and their shiftwork (Pirrallo et al., 2011; Regehr, Goldberg, & Hughes, 2002). Much of the research on shift workers has focused on scheduling factors and personality variables in predicting shift-work tolerance (Åkerstedt, Kecklund, & Gillberg, 2007; Saksvik, et al., 2011), and this study adds to this literature by examining the synergistic effects of perceived social support availability and occupational stress in predicting sleep quality.

In conclusion, our results provide strong support for the stress buffering model of social support. They suggest that perceptions of available social support protect workers from the detrimental effects of occupational stress on sleep. Given this, clinical interventions aimed at improving sleep quality should include an assessment of both occupational stress and social support availability. It is often difficult to significantly reduce occupational stress, particularly in high stress occupations such as emergency medical personnel and other first responders. However, our findings suggest that even under high levels of occupational stress, interventions that focus on increasing support availability could be an effective means to improve sleep quality.

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Table 1. Descriptive statistics for study variables

Variable	n days (%)[a]	Mean	*SD*	Range
Dayshifts	154 (28)			
Nightshifts	137 (24)			
Non workdays	269 (48)			
Workday time to bed		13:30	9:55	0:00-23:59
Off-workday time to bed		10:18	10:02	0:00-23:59
Workday time out of bed		7:41	3:27	3:00-17:00
Off-workday time out of bed		8:30	2:40	5:00-17:00
Workday sleep duration (hours)[b]		6.54	2.09	0.25-14.00
Off-workday sleep duration (hours)[c]		6.55	1.70	2.00-12.00
Workday sleep quality[b]		1.94	0.75	0-3
Off-workday sleep quality[c]		1.89	0.78	0-3
Perceived social support availability		85.51	18.44	26-117
Occupational stress (# of endorsed items)		1.68	1.29	0-5
A lot of work demands	90 (16)			
Illegitimate call	81 (14)			
Family/ relationship demands	67 (12)			
Significant off-load delay[e]	55 (10)			
Violence/ threat to crew safety	46 (8)			
Suicide call	23 (4)			
Pediatric call	22 (4)			
Personal health problem	19 (3)			
Death of a patient under care	16 (3)			
Multiple casualty incident	9 (2)			
Other problem	59 (11)			

Note. Means, SDs, and ranges are across all person-days and based on data from 80-87 persons across 268-290 diary entries for variables measured repeatedly.

[a]Percentage is calculated out of 560 total diary days

[b]Ratings after workdays

[c]Ratings after off-work days

[d] An off-load delay occurs when a paramedic spends too much time (typically greater than 30 minutes) at the emergency department of a hospital with a patient.

Table 2. Bivariate correlations for variables of interest

	1	2	3	4	5	6
1. Occupational Stress	-	-.29*	-.25*	-.31*	-.22^{+}	-.09
2. Pre-workday sleep quality	.01	-	.79**	.65**	.09	.42**
3. Post-workday sleep quality	-.09	-.10	-	.42**	.20	.41**
4. Sleep quality for prior off-workday				-	.14	.33**
5. Sleep quality for following off-workday					-	.23^{+}
6. Social Support						-

Note. Between-person correlations are presented above the diagonal and within-person correlations are presented below the diagonal for variables that were repeatedly measured. N= 64-80 for between- person correlations and N = 253- 420 for within-person correlations. Within-person correlations were calculated across all person-days using person-centered scores.

$^{+}p < .10$, $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.

Table 3. Predicting sleep quality from occupational stress and perceived social support

	Null Model		Model 1		Model 2		Model 3	
Fixed effects	*b* (SE)	*t*	*b* (*SE*)	*t*	*b* (*SE*)	*t*	*b* (*SE*)	*t*
Intercept	1.94 (.06)	51.79***	2.02 (.07)	44.21***	2.01 (.06)	46.92***	2.01 (.06)	49.92***
Concurrent sleep duration			0.13 (.03)	3.85***	0.12 (.03)	4.23***	0.12 (.03)	4.57***
Dayshift[a]			-0.16 (.11)	-1.54	-0.16 (.10)	-1.70[+]	-0.13 (.09)	-1.41
Prior sleep quality[b]			-0.003 (.06)	-0.01	-0.04 (.06)	-0.67	-0.02 (.05)	-0.38
Support							0.01 (.002)	6.09***
Daily stress					-0.08 (.05)	-1.54	-0.08 (.05)	-1.65
Daily stress X support							0.01 (.003)	2.50*
Average stress					-0.20 (.06)	-3.36**	-0.22 (.06)	-3.96***
Average stress X support							0.01 (.003)	2.99**
Random effects	Variance	χ^2	Variance	χ^2	Variance	χ^2	Variance	χ^2
Intercept	.10	97.35***	.12	63.80**	.12	55.31**	.08	50.15**
Level 1	.46		.34		.30		.30	
Concurrent sleep duration			.02	69.19**	.02	31.99	.01	32.32
Prior sleep quality			.01	31.67	.01	20.08	.01	20.07
Daily Stress					.05	44.67*	.04	39.54
Model Fit								
-2 * Log	571.78		497.07		473.32		449.19	
χ^2 for differences of -2 X Log			68.96***		23.75**		24.13**	
Δ *df*			8		6		3	
Δ % Variance								
Within-person[c]			19%		7%		6%	
Between-person[d]			0%		4%		23%	

Note. Analyses are based off of 74- 77 persons including 253-309 waking diary entries and 237 after work diary entries; *df* for *t* values ranged from 70-76. *df* for χ^2 values ranged from 35-76.

[a]Dayshift = 1, non-dayshift = 0

[b]Sleep quality rating for the prior sleeping session

[c]Change in within-person variance accounted for in sleep quality by additional set of predictor variables compared to previous model

[d]Change in between-person variance accounted for in sleep quality by additional set of predictor variables compared to previous model

$^{+}p < .10$, $*p < .05$, $**p < .01$, $***p < .001$, two-tailed.

Table 4. Predicting sleep quality during the off-workday from the cumulative number of occupational stressors experienced across the prior workweek, perceived social support availability, and their interaction.

Variable	*b* (*SE*)	*β*	*t*
Step 1			
Intercept	1.94 (.09)		32.24***
Prior sleep quality[a]	0.18 (.16)	0.14	1.09
Number of work days	0.02 (.13)	0.02	0.13
Sleep duration[b]	0.25 (.08)	0.50	3.25**
Time out of bed[b]	0.02 (.05)	0.04	0.31
ΔR^2	.25		
ΔF	4.80**		
df	4, 59		
Step 2			
Support	0.01 (.01)	0.26	1.89+
Number of work stressors	-0.02 (.03)	-0.10	-0.82
ΔR^2	.06		
ΔF	2.32		
df	6, 57		
Step 3			
Work stressors X support	-.01 (.002)	0.35	2.16*
ΔR^2	.05		
ΔF	4.65*		
df	7, 56		

Note. Analyses are based off of 64 individuals using data from 371 days (67 sleep quality ratings completed upon waking prior to the workweek; 228 occupational stress ratings following workdays; 76 sleep quality ratings completed upon waking following the workweek).

[a]Sleep quality rating for the prior off-workday

[b]Sleep duration and time out of bed are for the sleeping session for which sleep quality is being predicted.

$^{+}p < .10$, $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$, two-tailed.

Study Day	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Type of day	off-work	dayshift	dayshift	nightshift	nightshift	off-work	off-work
Upon waking assessment	sleep quality	sleep quality	sleep quality	sleep quality	sleep quality	sleep quality	sleep quality
After work assessment	-	work stress	work stress	work stress	work stress	-	-

Figure 1. Typical participant work and assessment schedule

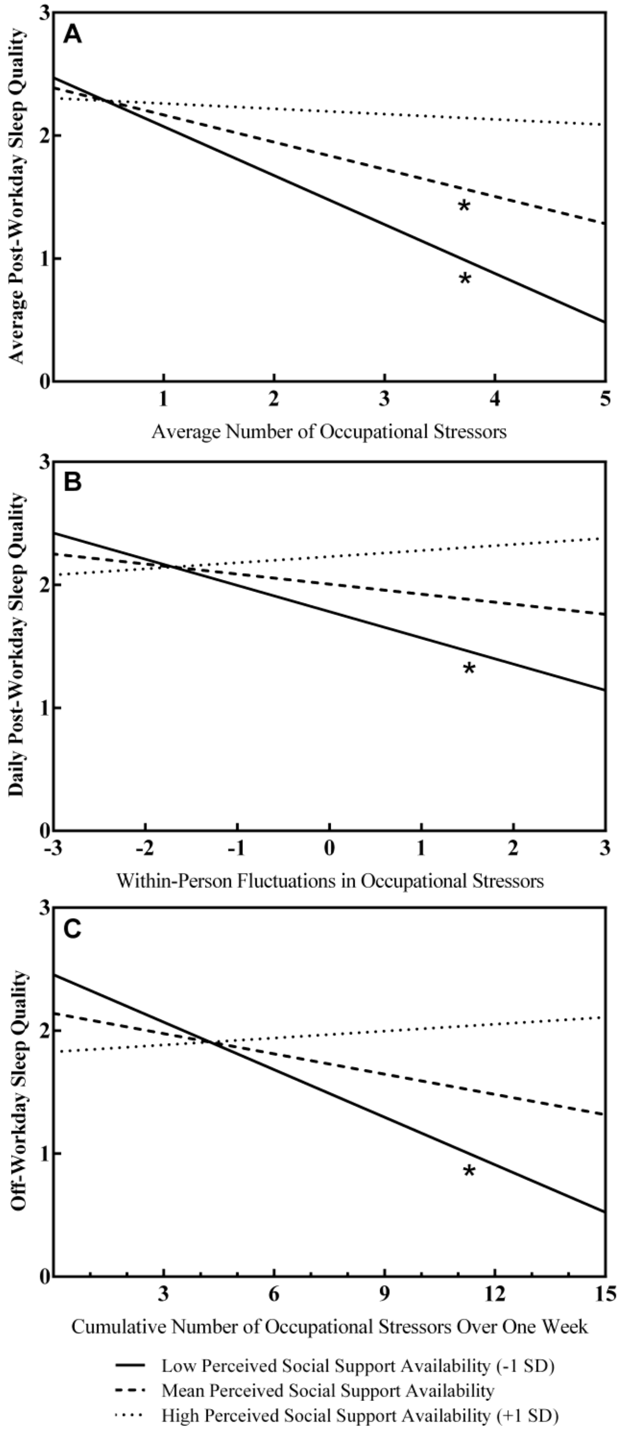

Figure 2. The occupational stress buffering effects of perceived social support availability on average post-workday sleep quality (panel A), fluctuations in post-workday sleep quality (panel B), and sleep quality for off-workdays (panel C). *$p < .05$

Footnotes

[1]All hypotheses were tested controlling for each covariate in turn as well as without any covariates in the models. Effect sizes and significance levels were not substantively changed with the inclusion (or exclusion) of any of the covariates examined in this study.

[2]As often recommended, we attempted to run the models allowing for random intercepts and slopes (Bolger & Laurenceau, 2013). However, convergence could not be met when allowing for random slopes for all Level 1 predictors. We chose to model the categorical variable representing whether the participants worked a dayshift as fixed because its slope variance was low and non-significant (*variance* = .004, $\chi^2(50) = 32.65$, $p > .500$). This allowed for model convergence.

[3]HLM excludes any participants with missing data at level 2 (i.e., between-persons). Because there was a small amount of missing data on the perceived social support availability measure, linear interpolation was used to avoid excluding participants from analyses altogether. However, when we did exclude participants with missing items on this measure, this did not substantively change effect sizes or significance levels of hypothesized relations.

[4]Between-person correlations were computed by averaging scores for each person over days for variables that were repeatedly measured. As recommended by Shrout, Herman, and Bolger (2006), within-person correlations were derived by subtracting the averages for each participant from their daily reports and then computing correlations across days.

[5]In the current study, there was a significant negative relation between sleep quality ratings for subsequent sleeping sessions when tested alone in a multilevel model. This effect was robust when including scheduling variables in the model, including overall schedule type, day type between the two sleeping sessions, and transitioning from one type of day to another type of day (e.g., transitioning from day-shifts to night-shifts). It is possible that homeostatic sleep mechanisms were involved in these effects: one night of poor quality sleep may precede a night of better quality sleep because of a build-up of “sleep pressure” (Åkerstedt, Kecklund, & Gillberg, 2007; Perlis, McCall, Jungquist, Pigeon, & Matteson, 2005). Importantly, this negative association diminished when sleep duration was controlled. This could indicate

that sleep duration mediated the relation of sleep quality between subsequent sleeping sessions in this study.

[6]Even when testing the effect of fluctuations in occupational stress on subsequent sleep quality without also including the effect of average occupational stress on sleep quality, the effect was still not significant (b = -.08, SE = .05, t(73) = -1.40, p = .172).

[7]We considered the possibility that the main and interactive effects of occupational stressors with perceived social support availability were being driven primarily by any one of the occupational stressor checklist items. To determine whether each checklist item was driving the effects, we performed sequential analyses excluding one checklist item from the occupational stressors variable at a time. These analyses did not point to any particular checklist item as driving the results.

[8]The same pattern of results was found when examining the main and interactive effects of each person's average occupational stress experienced across the week to predict off-workday sleep quality rather than their cumulative amount of occupational stress.

[9]Most adults are in a cohabiting relationship at some point in their lives (The World Family Map, 2013). Because romantic relationships represent an important source of support, individuals who are in cohabitating romantic relationships may have more support available than individuals who are single (Pinquart, 2003). Therefore, range restriction could have led to smaller effects than would have been found had we examined buffering effects in the general population (Bobko, Toth, & Bobko, 2001).