# Nightmare frequency predicts worry-related sleep disturbance one month later

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*Summary*. Previous research examining the directionality of the relationship between nightmares and worry-related sleep disturbance has been limited. The current study examines the influences of self-reported nightmare frequency on worry-related sleep disturbance after a one-month duration among a sample of 126 university students. Regression results indicated that nightmare frequency significantly predicted worry-related sleep disturbance longitudinally after accounting for baseline worry-related sleep disturbance, a general tendency to worry, dream recall frequency, and habitual sleep duration. The results are discussed in the context of current research and theory. Future research is needed to replicate the current findings and examine possible mechanisms in the relationship between nightmares and worry-related sleep disturbance.

*Keywords:* Nightmare frequency, worry-related sleep disturbance, dream recall frequency, sleep duration, worry

## 1. Introduction

Frequent nightmares, easily recalled and disturbing dreams that often awaken the sleeper, have been reported by 2–6% of adult community samples (Levin & Nielsen, 2007). Nightmares have been related to a variety of unpleasant experiences and syndromes among clinical and nonclinical samples including anxiety, depression, trauma, and schizotypy (Kelly, 2016; Swart et al., 2013). Many researchers conceptualize nightmare etiology using a disposition-stress model whereby individuals with trait negative affect experience nightmares due to buildups of daily stress (Gieselmann et al., 2019). Other researchers have noted additional dispositional factors to include "thin" psychological boundaries (Hartmann, 1984), heightened sensory sensitivity (Carr & Nielsen, 2017), and a nightmare proneness disposition (Kelly, 2018a).

One relatively established correlate of nightmares is sleep disturbance (Sandman et al., 2015). A straight-forward explanation of this relationship is that nightmares tend to disturb sleep (Ohayon et al., 1997). While this seems reasonable based on the notion that nightmares often create awakening, another explanation is that sleep disturbed individuals more readily recall nightmares (Li et al., 2010). To date, most research has relied on cross-sectional data which does not allow causal inferences.

Another possibility is that a third variable influences both sleep disturbance and nightmares. For instance, both pre-sleep arousal and a general proclivity towards arousability have been related both to sleep disturbance (Arnison et al., 2022; Coren, 1988; Van Someren, 2021) and nightmares

(Coren, 1988; Paul et al., 2019; Sayk et al., 2024). Other cross-sectional research found that nightmares related to sleep disturbance outside of nightmare proneness (Kelly, 2022), which largely encompasses general psychical hyperarousal (Kelly & Mathe, 2019). The latter findings suggest that the relationship may be more complex than nightmares and sleep disturbance simply stemming from arousal. For instance, it could be that nightmares and sleep disturbance influence each other to perturb arousal.

Krakow et al. (1995) suggested that chronic nightmares result in sleep disruption due to fear of having subsequent nightmares. As such, pre-sleep arousal could be a conditioned response maintained by frequent nightmares. Similarly, Harvey's cognitive model (Harvey, 2002; Harvey & Tang, 2012) suggests that sleep disturbance occurs partly as the result of arousal due to hypervigilance to possible sleep-related threats. Anticipation of nightmares likely qualifies as a potential sleep-related threat.

The recently articulated Nightmare Cognitive Arousal Processing Model (NIGHT-CAP; Youngren et al., 2020) provides additional conceptualization of the relationship between cognitive arousal, sleep disturbance, and nightmares. The model proposes that nightmares might result from dysphoric cognitive activity (i.e., worry) occurring during an extended period of arousal-induced sleep latency. Ostensibly, this activity primes the individual to experience dysphoric cognitive arousal during waking states which continues into sleep states producing nightmares. The NIGHT-CAP model was supported by cross-sectional findings involving posttraumatic nightmares (Youngren et al., 2023). However, the model also seems promising for general (i.e., not specified as posttraumatic) nightmares, especially given that nightmares of all sorts might be considered a return of unprocessed disturbed waking thoughts during sleep (Freud, 1900/1996; Malinowski et al., 2019).

Taken together, the above models and findings provide a foundation to understand the relationship between nightmares and sleep associated cognitive arousal. Nevertheless, the directionality for this relationship remains unclear. After analyzing several studies, Sheaves et al. (2023) determined that nightmares might influence later experiences of sleep

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disturbance. It should be noted that these findings involved treatment-seeking samples with posttraumatic nightmares which may not generalize to nonclinical samples with general nightmares. Using a within subjects design, Balch et al. (2024) found that sleep disturbance predicted nightmares the following night. However, when examining between subjects data nightmares predicted sleep disturbance the night after.

Additional study is needed to examine possible influences of general nightmares on sleep disturbance associated with cognitive arousal. One concept which encapsulates a combination of cognitive arousal and sleep disturbance and might allow efficient study on this phenomenon is worry-related sleep disturbance (WRSD).

WRSD can be described as difficulties with sleep initiation, maintenance, and sleep loss attributed to worry (Dregan et al., 2013; Kelly, 2002a, 2003a). Dregan et al. (2013) reported that about 40% of a large community sample attributed sleep difficulties to worry. Given the description of WRSD, it should not be surprising that WRSD has been related both to general worry and sleep disturbance, as well as decreased life satisfaction, lower self-esteem, less production of humor, more negative affect, and perceptions of stress (Kelly, 2002b, 2003a).

Though, to some degree, the concept appears to be a conflation of worry and insomnia, it should be noted that WRSD, general sleep disturbance, and a general tendency to worry appear statistically separable (Kelly, 2003a). This suggests the concept can be examined in its own right and may have its own correlates. After a meta-analysis, Bartel et al. (2015) posited that WRSD may disturb sleep both directly and indirectly by increasing levels of somatic arousal. This was supported by findings that WRSD related to a general tendency toward arousability as well as pre-sleep cognitive activity (Marques et al., 2016). Wang et al. (2020) found that among a large student sample in Southeast Asia, WRSD was consistently linked to experiences of being bullied and feeling lonely. Importantly for the current research, WRSD has been cross-sectionally related to nightmare frequency (Kelly, 2018b).

Taking together the notion that nightmares might heighten subsequent pre-sleep arousal (Krakow et al., 1995; Sheaves et al., 2023) and the NIGHT-CAP model (Youngren et al., 2020), it is possible that nightmares not only correlate with WRSD (Kelly, 2018b) but perhaps even precede WRSD which is then associated with additional nightmares. The purpose of the current study was to examine one aspect of this supposition: that is, if nightmares longitudinally predict subsequent WRSD. The study design did not include the reverse relationship—whether WRSD predicts later nightmares—since prior research has shown that while maladjustment and nightmares covary over time, maladjustment does not longitudinally predict nightmares when controlling for concurrent levels of maladjustment (Schredl & Göritz, 2021; Schredl et al., 2019)

To examine if nightmares predict WRSD, it was deemed important to account for other variables which may influence their relationship. For instance, both WRSD and nightmares have been related to general experiences of worry (Kelly, 2018b; Rek et al., 2017). Moreover, McGowan et al. (2016) found that a general tendency to worry longitudinally predicted sleep disturbance, but not the other way around. Similarly, WRSD and nightmares both have been related to sleep duration (Ginsberg, 2006; Kelly, 2002a; Lin et al.,

2021; Rek et al., 2017). Finally, while no previous studies were located examining dream recall frequency and WRSD, dream recall has consistently been associated with nightmare frequency and may share similar mechanisms (Schredl et al., 2014; Yu, 2012). Given the review presented above, it was hypothesized that 1) nightmares would be significantly, positively correlated with WRSD and 2) nightmares would predict later WRSD after controlling for baseline WRSD, a general tendency to worry, habitual sleep duration, and dream recall frequency.

## 2. Method

### 2.1. Participants and Procedure

Participants included 126 (99 females, 27 males) students enrolled in undergraduate psychology courses at a small university in the United States. The average age of the sample was 24.34 years (SD=6.82), Mdn=21.50, ranging from 18–53. Most of the sample self-identified their race/ethnicity as White/Caucasian (n=102; 81.0%), followed by Black/African American (n=19; 15.0%), Latinx (n=1; 0.8%), Native American (n=3; 2.4%), and "other" (n=1; 0.8%).

Participants were recruited before regular class lectures. Care was taken not to survey participants on weeks with exams or quizzes as exams have been found to influence levels of current worry (Kelly, 2002c). After obtaining informed consent, participants completed "paper and pencil" surveys in small group settings. There were no time limits for survey completion and no exclusionary criteria were used for participation. Participants received nominal course credit in exchange for participation. Participants were assessed at Time 1 ($t_1$) and one month later at Time 2 ($t_2$). Given that this study focused on whether nightmares predicted WRSD rather than the other way around, nightmare frequency was only assessed only at $t_1$ whereas WRSD scores were measured at $t_1$ and $t_2$. Sociodemographics, a tendency to worry, and habitual sleep duration also were assessed only at $t_1$ given the goals of the study. Dream recall frequency was only assessed at $t_1$ to control its contemporaneous relationship with nightmare frequency.

### 2.2. Measures

*Nightmare Frequency*. To obtain an estimate of nightmare frequency, participants responded to the item "About how many nightmares do you recall in the past six months?" Response options were 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 15, 20, 30, 40, 50, more than 50. The measure has been used previously (Kelly, 2018c). Nightmares were not defined for participants and the waking criteria was not specified in attempts to reduce conflation of WRSD and waking from nightmares. To compare estimates in the current sample to previous findings, nightmare scores were converted to estimated nightmares per week by dividing individual responses by 24 (6 months x 4 weeks). This item was reported previously to have adequate validity (Kelly, 2018c). No reliability estimates were located using this measure. However, retest reliabilities of other single-item nightmare estimates without the waking criterion were estimated between 0.75–0.86 over two to four weeks (Krakow et al., 2002; Stumbrys et al., 2013).

*Worry-Related Sleep Disturbance*. WRSD was measured using the five-item Sleep Disturbance Ascribed to Worry Scale (Kelly, 2002a). Participants responded to each item using a 0 (*never*) to 10 (*very often*) scale. Total scores indi-

cate more worry-related sleep disturbance. Validity of the measure has been supported (Kelly, 2002a, 2003a). Retest reliability was estimated at 0.83 (one month; Kelly & Forbes, 2004).

*Sleep Duration*. Habitual sleep duration was self-reported using the item "In general, what is the average amount of sleep you get per 24-hour period?" Participants responded by providing hours and minutes, which were converted into a continuous score indicating hours of sleep (e.g., 7 hours and 30 minutes was converted to 7.50 hours). This sleep duration measure has been reported to have adequate validity (Kelly, 2009a). Retest reliability was estimated at 0.80 (one month; Kelly, 2009b).

*Dream Recall Frequency*. Dream recall frequency was measured with the item "About how many dreams do you recall in the past six months?" Like the nightmare measure, responses options were 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 15, 20, 30, 40, 50, more than 50. As done with the nightmare measure, reports were converted to estimated dreams per week by dividing individual responses by 24. A similar single item dream recall measure with an ordinal response scale had adequate validity and an estimated retest reliability of 0.76 (two weeks; Schredl et al., 2014).

*Worry*. Worry was measured using the Three-Item Worry Index (Kelly, 2004). Participants responded using a 0 (*not at all*) to 10 (*very much*) scale. Higher scores indicated more general tendency to worry. Previous findings indicated adequate validity of the measure (Churchill et al., 2015; Kelly, 2004). Reliability has been supported through coefficient alphas ranging from 0.92–0.94 (Kelly, 2004; Ragozzino & Kelly, 2011). Retest reliability of a similar worry measure was found to be 0.87 (one month; Stöber, 1998).

## 2.3. Statistical Analysis

Pearson correlation coefficients were used to examine relationships between continuous variables. Correlations involving nightmare frequency and dream recall were calculated using Spearman's rank correlation, as these variables were deemed ordinal due to gaps in the possible response options. Cohen's (1988) criteria were used to delineate correlation size: correlations of 0.10, 0.30, and 0.50 indicated small, medium, and large correlations, respectively. To examine nightmare frequency as a predictor of WRSD after 30 days, a cross-lagged panel linear regression was used. This design controls contemporaneous relationships of predictors and baseline values of outcome variables (Kearney, 2017). The outcome variable was WRSD at $t_2$. Age, gender, race/ethnicity, sleep duration, dream recall frequency, worry,

WRSD at $t_1$, and nightmare frequency were entered simultaneously as predictors. An alpha level of $p < 0.05$ (two-tailed) was set for statistical significance.

## 3. Results

As shown in Table 1, the average number of nightmares per week for the sample was 0.28. An inspection of the frequency counts revealed that 23 (18.3%) participants reported no nightmares over the past six months while 10 (8.0%) averaged at least one nightmare per week. The median number of reported nightmares over the past six months was 3. Participants reported recalling an average of 0.65 dreams per week. No participants indicated recalling no dreams while 11 (8.7%) reported between 1–2 dreams and 15 (11.9%) recalled an average of more than 2 dreams per week over the past six months. The median number of dreams recalled over the past six months was 10.

Correlations between variables are presented in Table 1. As presented in the table, nightmare frequency and dream recall frequency had a strong, significant correlation. Nightmare frequency had medium, significant correlations with a general tendency to worry, and WRSD at $t_1$ and $t_2$. Correlations between $t_1$ and $t_2$ of WRSD were large and significant. A tendency to worry also had large, significant correlations with $t_1$ and $t_2$ WRSD. Dream recall had small, significant correlations with general worry tendencies but not WRSD at $t_1$ or $t_2$. Sleep duration was not significantly related to any variables.

Due to high correlations between some predictors, multicollinearity was examined before interpreting the regression. Variable inflation factors ranged between 1.0 and 2.1, indicating collinearity was not a problem (Hair et al., 2014). Results of the cross-lagged regression predicting WRSD at $t_2$ is presented in Table 2. The model was able to account for 64.9% of the variance in WRSD at $t_2$. The beta weights shown in the table indicate that most of the variance in WRSD at $t_2$ was accounted for by WRSD at $t_1$ and a general tendency to worry. After accounting for other factors, WRSD at $t_1$, a general tendency to worry, and nightmare frequency independently predicted more WRSD at $t_2$. After accounting for other variables, dream recall negatively predicted WRSD at $t_2$.

## 4. Discussion

The hypotheses that nightmares would relate to WRSD and predict WRSD symptoms over time were supported. These results replicate and clarify the previously reported relation-

*Table 1*. Descriptive statistics and correlations between variables.

| Categories | 1 | 2 | 3 | 4 | 5 | M | SD | α |
|---|---|---|---|---|---|---|---|---|
| 1. Nightmare Frequency | | | | | | 0.28 | 0.46 | -- |
| 2. Sleep Duration | -0.06 | | | | | 7.03 | 1.45 | -- |
| 3. Dream Recall | 0.54** | 0.01 | | | | 0.65 | 0.64 | -- |
| 4. Worry | 0.41** | 0.02 | 0.25** | | | 17.67 | 9.03 | 0.96 |
| 5. WRSD $t_1$ | 0.38** | 0.04 | 0.14 | 0.70** | | 20.01 | 13.03 | 0.89 |
| 6. WRSD $t_2$ | 0.40** | -0.05 | 0.05 | 0.69** | 0.77** | 17.41 | 11.32 | 0.90 |

Note: N=126. *p<0.05 **p<0.01. Correlations for nightmare frequency and dream recall are Spearman Rank. All other correlations are Pearson. WRSD=Worry-related sleep disturbance; $t_1$=administered at time 1, $t_2$=administered at time 2.

Table 2. Linear Regression Predicting Worry Related Sleep Disturbance at $t_2$.

| Variable | WRSD $t_2$ | | |
| --- | --- | --- | --- |
| | β | t | p |
| Age | 0.01 | 0.26 | 0.797 |
| Gender (1=male, 2=female) | -0.00 | 0.05 | 0.962 |
| Race (1=white, 0=nonwhite) | 0.01 | 0.12 | 0.909 |
| Sleep duration | -0.07 | 1.30 | 0.198 |
| Dream recall frequency | -0.20 | 2.84 | 0.005 |
| Worry | 0.31 | 4.06 | <0.001 |
| WRSD $t_1$ | 0.50 | 6.47 | <0.001 |
| Nightmare frequency | 0.22 | 2.96 | 0.004 |
| $R^2_{(adj.)} = 0.649$, F = 29.86, p < 0.001 | | | |

Note: WRSD=Worry-related sleep disturbance; $t_1$=administered at time 1; $t_2$=administered at time 2

ship between WRSD and nightmares (Kelly, 2018a) indicating that more frequent nightmares predict later WRSD. While no definite causal effect can be determined given the methodology used (i.e., no random assignment to groups or manipulation of variables), a causal influence of frequent nightmares on subsequent levels of WRSD does appear plausible.

The finding that nightmares were related with WRSD is consistent with previous research (Kelly, 2018b; Youngren et al., 2023) and Youngren et al.'s (2020) NITE-CAP model. More generally, the current findings also support speculation from previous cross-sectional findings (Kelly, 2022; Ohayon et al., 1997) that nightmares may influence later general sleep disturbance. The current study extends previous findings that posttraumatic nightmares were found to influence subsequent general sleep disturbance (Sheaves et al., 2023) by indicating that such findings may apply to general nightmares.

The findings that dream recall frequency correlated with general worry and that greater dream recall longitudinally predicted less WRSD are noteworthy. Regarding the former, increased worry may reflect heightened cognitive activity that extends into sleep in the form of increased dream activity. This possibility would align with the continuity hypothesis of dreaming (Schredl, 2017). As for the regression results, nightmares may function as a suppressor variable in the relationship between dream recall and WRSD. Consistent with previous hypotheses (Freud, 1900/1996; Hartmann, 2014), greater overall dream activity may help process negative cognitive experiences, thereby reducing sleep disruption. However, this interpretation requires further replication and investigation.

Findings in the current study are somewhat strengthened in that general tendencies to worry, sleep duration, dream recall frequency, sociodemographic variables, and baseline WRSD concurrent with the nightmare frequency measure were accounted for in the regression. Hence, it seems less likely that these variables influenced the results. Further, the generalizability of the findings is supported by findings that about 8.0% of the current sample reported nightmares at least weekly. This is on par with findings from community samples (Levin & Nielsen, 2007). The average WRSD scores were also similar with those in previously reported college student samples (Ginsberg, 2006; Kelly, 2002a).

Despite attempts to account for several possible confounding variables and examine longitudinal changes which may have causal inferences, this study has several limitations making clear, generalizable causal statements unjustified. In addition to the lack of experimental manipulation noted previously, other limitations include the use of a relatively small, homogenous sample of university students. Additionally, negative emotions, stress, and hyperarousal, which have been related to both WRSD (Kelly, 2003a) and nightmares (Levin & Nielsen, 2007), were not measured leaving possible mechanisms unaccounted for.

In terms of explaining the current results, as noted previously, it could be that more frequent nightmares heighten cognitive arousal in the form of worry about having further nightmares (Harvey, 2002; Krakow et al., 1995). Other explanations might also be posited. For instance, previous research suggested that individuals with more nightmares and disturbed sleep tend to have increased limbic system activity, associated with stronger emotions, and lower activity in the prefrontal cortex, which is associated with mediating and suppressing emotional reactions (Killgore, 2013; Levin & Nielsen, 2007; Shen et al., 2016; Simor et al., 2012; Marquis et al., 2019). As such, it is possible that individuals with more WRSD have less prefrontal cortical activity before and during sleep which is needed to manage dysphoric cognitive material and prevent subsequent nightmares.

These above explanations for the results cannot be determined from the current data. The WRSD measure used did not allow collecting specific information about the type of worries experienced (e.g., worry about nightmares or waking concerns). Further, it could not be determined if the WRSD experienced was during a pre-sleep phase, such as that described by Youngren et al.'s (2020) NIGHT-CAP model that might signify worry threats to sleep (Harvey, 2002) or during awakenings during the night which might be the result of stirrings from nightmares as suggested by Ohayon et al. (1997). Similarly, it cannot be determined if the WRSD was also associated with general arousability which might have disrupted sleep (Coren, 1988).

The limitations noted above provide several opportunities for future research. For instance, the inclusion of a larger, more diverse sample of adults along with clinical samples with both posttraumatic and idiopathic nightmares would extend these findings. Future research should also include

measures of negative affect or state distress to examine their possible influences. Future studies might also attempt to determine types of worries which might be more related to WRSD and nightmares. Kelly (2003b) reported that worries about relationships were most associated with decreased sleep length. Similarly, Kelly and Kim (2024) noted that many young adults' nightmares were oriented towards relationships. Given the hypothesized continuity of cognitive activity from waking to sleep states (Youngren et al., 2020), it seems possible that one type of pre-sleep worry could be relational and might result in relational nightmares. Though previous research did not find maladjustment longitudinally predicted nightmares after controlling current levels (Schredl & Göritz, 2021; Schredl et al., 2019), future research should include a measure of nightmares at $t_2$ in addition to $t_1$ to observe if WRSD and nightmares have a bidirectional influence. Similarly, it might be useful to include a measure of dream recall frequency at $t_2$ as well. Finally, it might also be useful to compare nightmares with and without the waking criterion.

In conclusion, the current study found that more frequent nightmares influence future WRSD after accounting for sociodemographics, baseline WRSD, general tendencies to worry, habitual sleep duration, and dream recall frequency. Additional study is needed to correct for limitations of the current study and to examine possible mechanisms of nightmares' influence on WRSD.

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