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RESEARCH ARTICLE

Symptom dynamics among nightmare sufferers: An intensive longitudinal study

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Summary

Nightmares are considerably prevalent in the general population and are known to be closely associated with a variety of mental disorders. However, not much is known about the immediate antecedents and consequences of nightmares. Therefore, we used intensive longitudinal assessments to investigate the night-to-night within-person associations between nightmares on the one hand and fear of sleep, somatic as well as cognitive pre-sleep arousal, and sleep quality on the other hand. Young women with regular nightmares ($n = 16$) maintained a sleep diary for around 30 days; upon awaking, the participants reported on nightmares and sleep quality during the past night as well as the pre-sleep levels of arousal and fear of sleep (which resulted in 461 observations). Participants also wore an actigraph, which provided objective sleep parameters. Multilevel modeling showed that higher levels of fear of sleep and lower subjective sleep quality were significantly associated with higher levels of nightmare distress. Furthermore, we found individual differences in the strength of these associations, which implies that factors proximate to nightmares may vary across individuals. Pre-sleep arousal, however, did not show expected within-person associations with nightmares or fear of sleep. These findings highlight the crucial role of fear of sleep in the etiology of nightmares and sleep disturbances, while pointing to the importance of pursuing individual, personalised models that explain heterogeneity in the process of triggering nightmares.

KEYWORDS
actigraphy, ambulatory assessment, fear of sleep, hyperarousal, insomnia, sleep diary

1 | INTRODUCTION

Nightmares are highly dysphoric dreams that commonly result in and can be recalled upon awakening (American Psychiatric Association, 2013). It is known that nightmares are considerably prevalent in the general population and are associated with impaired mental and physical health (Gieselmann et al., 2019). Studies have highlighted multiple interrelated factors that potentially trigger nightmares, such as fear of sleep (FoS; Werner et al., 2021), pre-sleep arousal (e.g., Youngren et al., 2020), and daily stress (e.g., Garcia et al., 2021).

There is established evidence for the cross-sectional association between fear of sleep and nightmares among healthy individuals as well as individuals with posttraumatic stress disorder (PTSD; Kanady et al., 2018; Krakow et al., 1995; Neylan et al., 1998; Pruiksma et al., 2011). Furthermore, a prospective study showed that baseline

levels of fear of sleep predict daily nightmares during the following week in a sample of PTSD patients – even after controlling for the symptoms of PTSD (Short et al., 2017). In addition to fear of sleep, daily pre-sleep arousal is known to be a good predictor of nightmares. In a study using daily sleep assessments, pre-sleep arousal was predictive of (posttraumatic) nightmares during the following night (Youngren et al., 2020). Furthermore, bidirectional associations between daily stress and nightmares have been found. Garcia et al. (2021) showed that nightmares were likely to occur after days with increased levels of stress, and that the experience of nightmares was in turn associated with higher levels of stress on the following day. These findings may suggest that nightmares serve as a stressor, resulting in elevated next-day stress, as well as increased fear of sleep and arousal. Thus, beyond fear of sleep, pre-sleep arousal and daily stress, various aspects of insomnia symptoms (e.g., difficulties initiating or maintaining sleep) have been shown to be linked to increased nightmares (e.g., DeViva et al., 2004; Neylan et al., 1998; Short et al., 2017; Youngren et al., 2020).

Although there is growing evidence of the factors that contribute to nightmares, the dynamic interplay between these factors has, so far, remained largely hypothetical and needs further empirical investigation (Gieselmann et al., 2019). Importantly, most evidence investigating this interplay has been derived from cross-sectional studies, which do not allow for establishing the temporal precedence of one factor over the other. Furthermore, the first studies investigating within-person associations limited their focus to a particular factor only, for example, daily stress (Garcia et al., 2021) or pre-sleep (cognitive) arousal (Youngren et al., 2020), and did not investigate multiple factors simultaneously in one model. Expanding on previous literature, we therefore investigated the dynamic interplay of nightmares with fear of sleep, pre-sleep arousal, daily stress, and aspects of sleep disturbances in a sample of regular nightmare sufferers. Intensive, long-term assessments were used, where participants reported nightmares and other factors every day for 30 days. This approach allowed us to estimate the within-person associations between the variables, and to explore the proximate factors that have a unique effect on nightmares after controlling for the other factors.

2 | METHODS

2.1 | Participants

Participants were recruited via flyers primarily among psychology students on the university campus. Inclusion criteria were (1) aged 18–35 and (2) regular nightmares (i.e., at least one nightmare per month). Exclusion criteria were (1) current mental disorder, including (somatic) sleep disorders, (2) current psychological or pharmacological treatment, (3) currently suffering from or receiving treatment for cardiovascular, neurological, or endocrinological disease or diabetes. At the end of the study, the participants received either 38€ or course credits.

One participant dropped out of the study, reporting discomfort wearing the actigraph during sleep. The final sample size was $n = 16$ (age: mean = 23.06 years, SD = 4.00). Only women signed up to participate in the study. Twelve participants were undergraduate students, two had a bachelor's degree, one had a master's degree, and one had a lower secondary school leaving certificate. For three participants, no actigraphy data were available due to technical problems (battery issue); however, participants were included in the statistical analyses as their diary data were valid. We collected a total of 461 out of 480 (16 participants * 30 days) possible observations for the sleep diary (mean = 28.81, SD = 1.70), and 362 out of 390 (13 participants * 30 days) possible observations for actigraphy (mean = 22.63, SD = 11.17).

2.2 | Measures

2.2.1 | Baseline assessment

Participants completed the German versions of the following measures.

The Insomnia Severity Index (ISI; Gerber et al., 2016) is a 7-item measure of insomnia symptoms (e.g., difficulties falling and staying asleep, waking up too early) in the past month. A sum score is calculated, which ranges from 0 to 28, with higher scores indicating greater symptom severity. A score ≥ 15 indicates a positive screen for clinically significant insomnia (Morin et al., 2011). Internal consistency for the current study was moderate (Cronbach's $\alpha = 0.68$).

The Nightmare Disorder Index (NDI; Dietch et al., 2021) is a 5-item self-report screening tool for nightmare disorder as defined by the DSM-5 (American Psychiatric Association, 2013). Total scores range from 0 to 20, with higher scores indicating higher nightmare severity. A nightmare disorder is considered probable if participants report one or more nightmares per week and experience sometimes or more frequently alertness, distress, and impairment after a nightmare. In the current study, internal consistency was moderate ($\alpha = 0.65$).

The Patient Health Questionnaire (PHQ-9; Kroenke et al., 2001) is a 9-item measure of depressive symptoms. Total scores range from 0 to 27. Scores >10 indicate a positive screening for depression (Fischer et al., 2021). Internal consistency for the current study was excellent ($\alpha = 0.91$).

The PTSD Checklist for DSM-5 (PCL-5; Weathers et al., 2013) is a 20-item measure of PTSD symptoms. Total scores range from 0 to 80, where higher scores indicate greater PTSD symptom severity. A PTSD diagnosis is considered probable if scores are ≥ 33 and if the following criteria are met: participants score at least moderately in all four PTSD-criteria (intrusion ≥1, changes in cognition and mood ≥1, avoidance ≥2, and hyperarousal symptoms ≥2). Internal consistency in the current study was good (Cronbach's $\alpha = 0.88$).

2.2.2 | Daily assessments

Sleep variables, including sleep quality, were assessed following the recommendations of the consensus sleep diary (Carney, 2012; see Appendix 0 for a complete list of daily items and information on

answer formats). Sleep efficiency was calculated from self-reported items as the total sleep time (TST[1]) divided by time in bed (TIB[2]). We decided to use sleep efficiency as a summary index of sleep for each night to prevent multicollinearity due to the moderate to high correlations between the sleep parameters, such as TST and wake after sleep onset (WASO). Nightmare occurrence and nightmare distress were assessed by single items each adapted from the NDI (Dietch et al., 2021). Fear of sleep and pre-sleep arousal were assessed by a short version of each measure to limit participant burden. Items were derived from the Fear of Sleep Inventory – Short Form (FOSI-SF; Drexl et al., 2019) and the Pre-Sleep Arousal Scale (PSAS; Gieselmann et al., 2012). The item choice followed theoretical considerations or previously reported factor loadings. Wording and scoring options were changed for use on the previous night instead of several weeks.

Actigraphy was used to measure objective sleep efficiency (corresponding to SE measured via the sleep diary). The participants were instructed to place an actigraph (GT3X-BT; ActiGraph, Pensacola, FL) on their non-dominant wrist for the 30 day assessment period for the main sleep hours. Physical activity was recorded with a sampling rate of 30 Hz and aggregated for each 1 minute epoch. The sleep–wake cycle was scored using the Cole-Kripke algorithm (Cole et al., 1992). Actigraphy is considered an effective tool for objective sleep measurement, especially when measuring sleep over an extended period in an ecologically valid setting (Ancoli-Israel et al., 2003).

2.3 | Procedure

All study procedures were approved by the local Ethics Committee. The study included two phases: (a) baseline assessment and (b) a 30 day period of daily sleep assessments. After providing written consent, the participants completed online baseline questionnaires including sociodemographic variables (e.g., sex, age, education level), as well as sleep and psychopathology measures. Participants were then provided with an actigraphy device. The sleep diary was completed online, daily after awakening.

2.4 | Statistical analyses

Multilevel modeling was used to explore the within-person associations between the target variables: nightmare distress, sleep quality, sleep efficiency (for both sleep diary and actigraphy), somatic and cognitive pre-sleep arousal, fear of sleep, and stressful events.

We configured a multilevel vector-autoregressive (VAR) model following Bringmann et al.'s (2013) two-step approach. At Level 1 (i.e., within-person level), we assumed the autoregressive and contemporaneous effects, for example:

$$FOSI_{ij} = \beta_{0j} + \beta_{1j} FOSI_{i-1j} + \beta_{2j} Efficiency_{ij} + \beta_{3j} NDI_{ij} \ldots + r_{ij},$$

where $FOSI_{ij}$ is the FoS level at the *i*-th night (with i > 1) of the *j*-th participant, and the residual is denoted as r_{ij}. This univariate model was estimated sequentially with each target variable as the outcome, which provided estimates of the directional associations for each pair of variables. An exception was that we did not estimate the models with fear of sleep, pre-sleep arousal (cognitive and somatic), and stressful event as the outcome variable, as these variables were specified for the pre-sleep moment and therefore cannot follow variables (e.g., sleep quality) assessed for the in-sleep period.

The auto-regression term controls for the level of the outcome at the previous night and serves as an instrumental variable to make the directional effects identifiable. We also estimated a standard multilevel VAR model with the lag-1 predictors (e.g., $NDI_{i\text{-}1j}$ instead of NDI_{ij}); however, none of these showed a statistically significant effect. Therefore, we did not consider the lagged effects in the analyses reported here. The slopes (e.g., β_{1j}) were assumed to vary across individuals, and the Level 2 (between-person) structure was specified for each variable (*k*) as follows:

$$\beta_{kj} = \gamma_{k0} + u_{kj},$$

where the fixed effect (γ_{kj}) represents an average effect, for example, of fear of sleep on the daily nightmare distress, across all individuals. The fixed effects can be seen as an adjacency matrix of a weighted network (e.g., Epskamp et al., 2018), which helps to visualise the bivariate, directional associations within an assessment occasion (here: night). The random effect ($u_{kj} \sim N[0, \sigma^2_k]$) reflects individual differences in each β estimate, which allowed for computing a person-specific effect. We estimated the variance for each random effect, but their covariance was fixed to be zero. As we performed multiple tests on the fixed effects, the false discovery rate was controlled for at $\alpha = 0.05$ with Benjamini-Hochberg (BH) correction. Each variable was person-mean centred and *z*-standardised for ease of interpretation. The model estimation (restricted maximum likelihood) was performed with R lmer4 package (Bates et al., 2014).

3 | RESULTS

3.1 | Descriptives and demographics

At baseline, seven participants showed subclinically or clinically significant levels of insomnia symptoms (ISI >7; mean = 9.17, SD = 4.00), four met the criterion for moderate or severe depressive symptoms (PHQ-9 ≥ 10; mean = 7.75, SD = 5.43), and three exhibited symptoms reflecting a provisional PTSD diagnosis (PCL-5 ≥ 33; mean = 20.19, SD = 12.65). All participants reported >0 nightmares in the previous 4 weeks and 68.7% scored above the threshold for clinically relevant nightmare frequency (item 1) on the NDI with nightmares either "1–3 times per week" ($n = 9$) or "4–6 nights per week" ($n = 2$). Four participants fulfilled the full criteria for a probable nightmare disorder (i.e., experience one or more nightmares per week and indicated a frequency of "sometimes" or higher for the questions regarding alertness, distress, and impairment). The remaining 12 participants reported subthreshold nightmare disorder

TABLE 1 Descriptive statistics and bivariate correlations of the diary and actigraphy variables

Diary variables		Mean (SD)[a]	ICC	Reliability R_C	Reliability R_{KF}	No. observations[b]	Correlation 1	2	3	4	5	6	7	8
1	Sleep efficiency (diary)	0.90 (0.05)	0.12			459		0.51	0.51	−0.17	−0.47	−0.40	−0.34	−0.16
2	Sleep efficiency (actigraphy)	0.88 (0.33)	0.12			362			0.37	−0.07	−0.29	−0.28	−0.22	−0.14
3	Sleep quality	3.39 (0.45)	0.23			446				−0.32	−0.51	−0.44	−0.26	−0.28
4	Nightmare distress	0.58 (0.33)	0.04			460					0.18	0.14	0.49	0.25
5	Cognitive pre-sleep arousal	2.17 (0.81)	0.57	0.90	1.00	459						0.42	0.21	0.26
6	Somatic pre-sleep arousal	1.48 (0.59)	0.75	0.57	1.00	459							0.28	0.18
7	Fear of sleep	0.50 (0.61)	0.41	0.63	0.98	460								0.14
8	Stressful event the day before	4.62 (2.83)	0.04			457								

Note: >Reliability coefficients were calculated as proposed by Cranford et al. (2006) and Shrout and Lane (2012). The within-person reliability coefficient, R_C, reflects whether there are reliable within-person differences in change over time. The between-person reliability coefficient, R_{KF}, reflects the reliability of the between-person diary average, calculated across persons and times. As the values are averaged across all assessments ($K = 30$), high values of >0.9 are common. Displayed correlations refer to person-mean-centred variables on the within-person level.

Abbreviations: SD, standard deviation; ICC, intraclass correlation.

[a]The mean and SD reported here were calculated by first calculating an intraindividual mean of a variable (e.g., sleep quality) across the 30 day assessment for each participant, and then calculating the descriptive statistics (e.g., mean, SD) of these intraindividual means.

[b]Maximum number of observations = 480 (30 days × 16 participants).

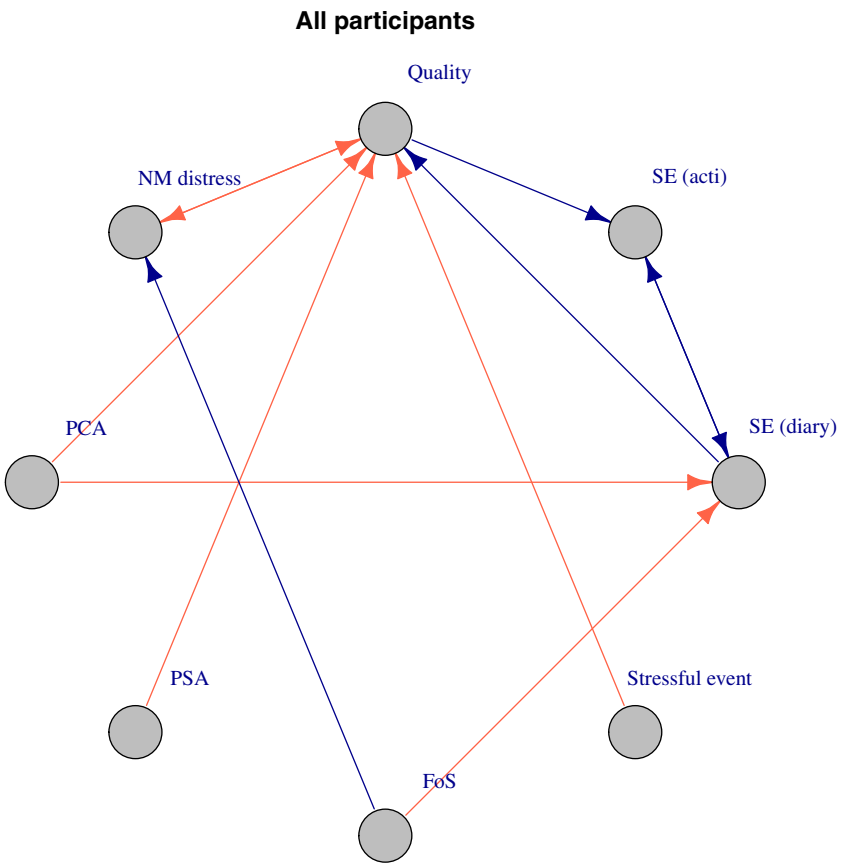

FIGURE 1 Within-person associations for all participants ($n = 16$). Nodes represent target variables: SE (diary), sleep efficiency measured via sleep diary; SE (acti), sleep efficiency measured via actigraphy; quality, sleep quality; PSA, somatic pre-sleep arousal; PCA, cognitive pre-sleep arousal; NM distress, nightmare distress; FoS, fear of sleep. Arrows indicate significant predictive relationships ($p < 0.05$) between two target variables after Benjamini-Hochberg correction. Blue arrows represent positive, orange arrows represent negative relationships.

TABLE 2 Fixed effects of significant associations between target variables

DV	IV	Fixed effects	*p*	CI
Sleep efficiency (diary)	Sleep efficiency (acti)	0.468	0.044	0.15–0.79
Sleep efficiency (diary)	Fear of sleep	−0.145	0.033	(−0.24) – (−0.04)
Sleep efficiency (diary)	Cognitive pre-sleep arousal	−0.273	0.033	(−0.43) – (−0.11)
Sleep efficiency (acti)	Sleep efficiency (diary)	0.209	0.033	0.12–0.29
Sleep efficiency (acti)	Sleep quality	0.117	0.033	0.45–0.19
Nightmare distress	Fear of sleep	0.697	0.038	0.28–1.12
Nightmare distress	Sleep quality	−0.205	0.044	(−0.35) – (−0.06)
Sleep quality	Sleep efficiency (diary)	0.206	0.044	0.06–0.35
Sleep quality	Stressful event	−0.116	0.033	(−0.20) – (−0.03)
Sleep quality	Nightmare distress	−0.292	0.033	(−0.45) – (−0.13)
Sleep quality	Cognitive pre-sleep arousal	−0.263	0.038	(−0.43) – (−0.09)
Sleep quality	Somatic pre-sleep arousal	−0.213	0.033	(−0.33) – (−0.09)

Abbreviations: DV, dependent variable; IV, independent variable. $p < 0.05$, CI = 95% confidence interval.

symptoms (Dietch et al., 2021) with 74.9% reporting being at least "somewhat" disturbed by their nightmares in the previous 4 weeks.

Participants showed an extremely good compliance to the daily sleep assessments: 28.81 diary reports (SD = 1.70; range: 24–30) and 27.85 days of valid actigraphy data (SD = 2.85; range: 20–30) over the 30 day period. They experienced a mean of 5.38 (SD = 2.87; range: 2–11) nightmares throughout the assessment period, at a rate of 0.81 nightmares (SD = 0.51; range = 0.0–1.75) per week. One participant reported no nightmares for the entire assessment period. Ten participants reported ≥0.75 nightmares per week. During the assessment period, participants reported to be at least "somewhat" disturbed by nightmares in 79.1% of nights with a nightmare. Descriptive statistics for the diary measures (including intraclass correlations and reliability indices for composite measures) are shown in Table 1. On average, sleep efficiency, measured both by diary and actigraphy, was high and sleep quality was reported as medium to good.

3.2 | Associations between nightmares and other variables

Figure 1 shows significant fixed effects after Benjamini-Hochberg correction. Increased fear of sleep was associated with enhanced nightmare distress. Further, enhanced nightmare distress was only significantly associated with poor sleep quality. The overall sleep measures, sleep quality and sleep efficiency, were not within the focus of this study. Both showed expected associations among each other and, overall, with pre-sleep arousal. Sleep quality showed the largest number of significant associations (i.e., pre-sleep arousal, stressful event the day before, and sleep efficiency; see Table 2 for further details on significant within-person associations). Neither cognitive nor somatic pre-sleep arousal showed significant associations with nightmare distress. Fear of sleep was the only variable of interest that showed no direct significant association with sleep quality.

The estimated random effects showed the largest individual differences in the association between FoS and nightmare distress ($\sigma^2 = 0.71$; Figure 2). All other associations, by comparison, showed relatively low individual differences in the estimated effects with the second largest individual difference for the association between sleep efficiency measured via actigraphy and sleep efficiency measured via the sleep diary ($\sigma^2 = 0.49$), and the third largest individual difference between sleep efficiency (actigraphy) and sleep quality ($\sigma^2 = 0.34$). [*Insert* Figure 2 *about here*]. Therefore, Figure 3 shows how individual estimates of the largest individual effects (FoS on nightmare distress) were distributed across participants *[Insert* Figure 3 *about here]*.

4 | DISCUSSION

The aim of the study was to explore the dynamic associations between nightmares and potential antecedents and consequences. We used ecologically valid assessments of sleep and nightmares for a period of a full month (30 days), which allowed us to investigate the night-to-night within-person associations. We aimed to cover candidate processes associated with nightmares as comprehensively as possible. Our analysis revealed that both higher levels of fear of sleep and poor sleep quality are associated with higher levels of nightmare distress; however, neither pre-sleep arousal nor stressors the day before showed the expected associations with nightmares.

Fear of sleep stood out as the most informative predictor of nightmare distress in our model. The following related findings are worth highlighting. First, our results suggest that fear of sleep paves the way for higher nightmare distress. This association could be due to a self-fulfilling prophecy on both physiological and psychological levels. On the one hand, the expectation of a stressful nightmare and maladaptive safety behaviours – both components of fear of sleep – might lead to delayed sleep. Further, delaying sleep could have equivalent effects as restricted/deprived sleep, which is known to increase and alter REM sleep (Carskadon & Dement, 2005) and, in turn, is prone to nightmares (Cappadona et al., 2021). On the other hand, nightmare distress has recently been revisited in line with Lazarus' transactional model of stress (Gieselmann et al., 2020). Following this

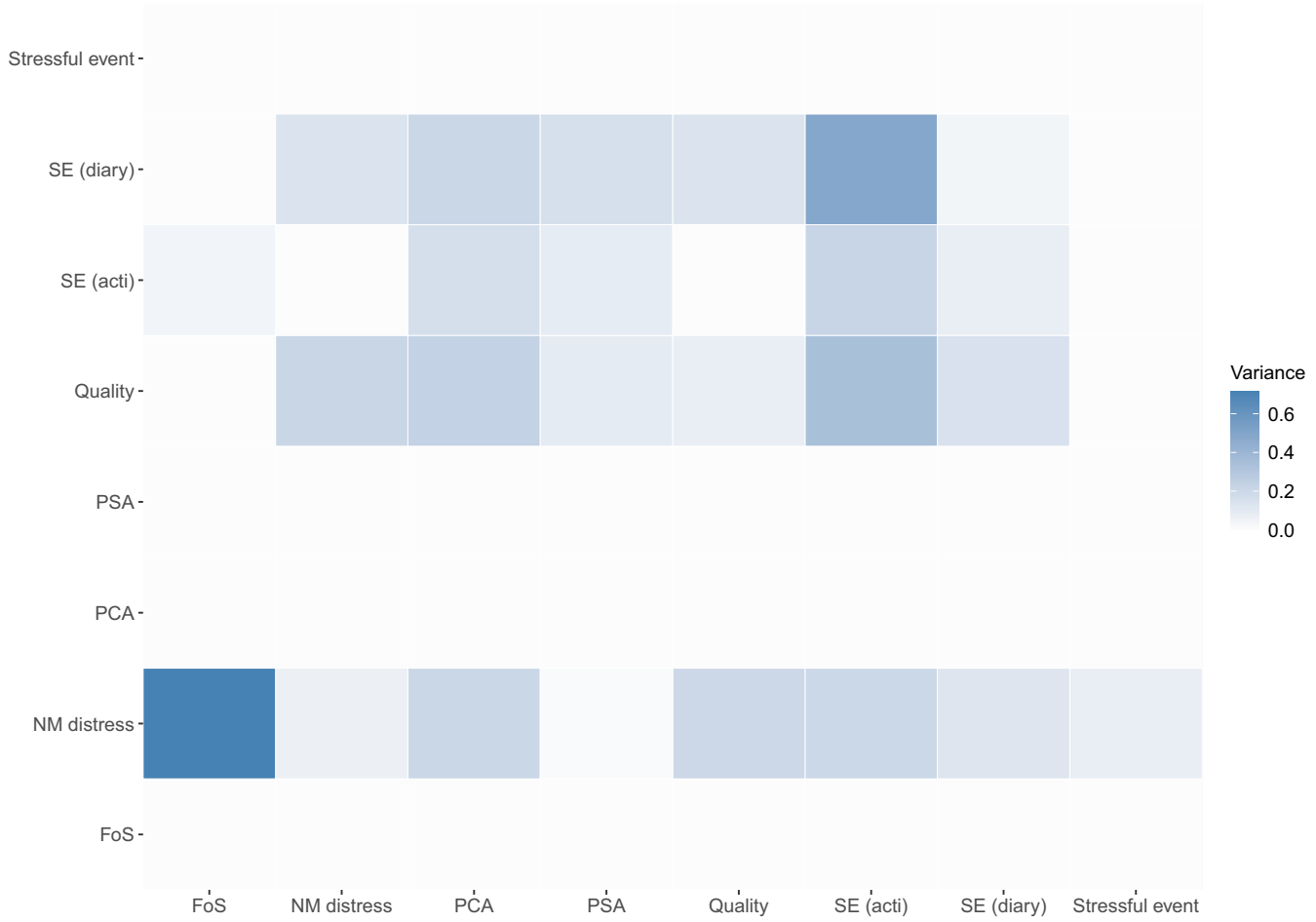

FIGURE 2 Heatmap of between-person variance (random effects) in relationships between the target variables across the 30 day assessment. SE (diary), sleep efficiency measured via sleep diary; SE (acti), sleep efficiency measured via actigraphy; quality, sleep quality; PSA, somatic pre-sleep arousal; PCA, cognitive pre-sleep arousal; NM distress, nightmare distress; FoS, fear of sleep.

approach, fear of sleep may constitute a form of both maladaptive primary appraisal (i.e., on potential harm and threat of nightmares) and maladaptive secondary appraisal (i.e., triggering coping behaviours to deal with nightmares). The present study therefore contributes to this approach with results suggesting that fear of sleep ultimately results in elevated levels of nightmare distress.

Second, the association between fear of sleep and nightmare distress showed high heterogeneity across individuals despite its statistical significance as an average effect. In other words, fear of sleep can be a prominent factor underlying nightmares for some individuals, but this may not apply to other individuals. Cross-sectional research similarly found that only a smaller subgroup of trauma-exposed individuals experiencing nightmare distress was characterised by high levels of fear of sleep (Werner et al., 2020). Our results therefore hint at an important role of individual differences regarding fear of sleep and its association with nightmare distress. The characteristics and causes of these differences need to be explored in future research; however, it is conceivable that levels of trauma exposure or PTSD could play a role here as most previous research on fear of sleep has studied trauma-exposed samples. If replicated in future research, the unique effect of fear of sleep on nightmare distress found in this study may suggest that targeting fear of sleep in psychological interventions is promising (see also King et al., 2021; Werner et al., 2021), and may also reduce nightmare distress. Future research is necessary to detect possible moderators of this association and inform individualised treatment.

Sleep quality was the second variable showing a significant (positive and bi-directional) association with nightmare distress as we would have expected from the literature (Krakow et al., 1995; Lancee et al., 2010; Paul et al., 2015). Despite its significant association with all other variables (except for FoS) and being a rather broad concept, associations with sleep quality could clearly be differentiated from the associations with sleep efficiency (measured by the sleep diary and actigraphy). The associations found with sleep efficiency, in turn, reflected previous research on insomnia (Riemann et al., 2010).

Pre-sleep arousal and stressful events on the previous day had no additional, unique significant effect on nightmare distress beyond the above-mentioned factors in a model combining multiple factors on a within-person level. These findings are in contrast to previous research and certainly require further research. The current findings

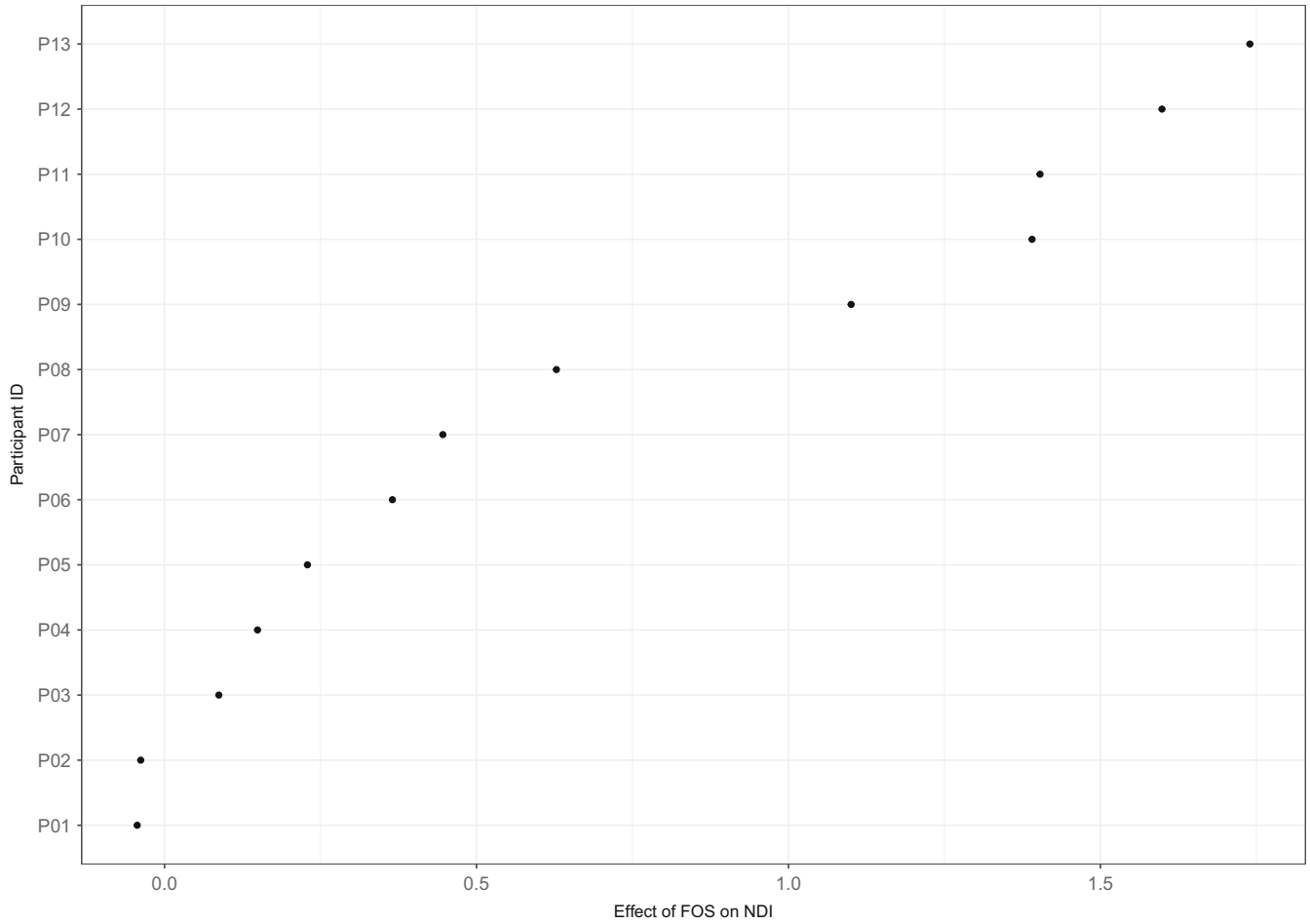

FIGURE 3 Individual estimates for the effect of FoS (= fear of sleep) on NM distress (= nightmare distress) for all participants.

do not rule out that both factors might still contribute to nightmare distress indirectly, that is, on a between-person level, or in more specific samples (e.g., individuals fulfilling the criteria of nightmare disorder or PTSD-patients; see Youngren et al., 2020).

5 | LIMITATIONS AND FUTURE DIRECTIONS

Due to several limitations, a cautious interpretation of the results is indicated. First, data were only derived from 16 individuals limiting the generalisability of our findings. However, the intensive length of the assessment phase aimed to secure as many observations as possible to detect within-person phenomena and resulted in > 400 observations across participants. This number exceeds prior research by far (Youngren et al., 2020), resulting in a more reliable estimation of within-person effects. We believe that targeting specific samples and even *N*-of-1 research can be highly informative to the scientific process (Fisher, 2015); nevertheless, replication in larger and more diverse samples is needed. Second, all self-report variables were assessed retrospectively in the morning. Therefore, the assessment of pre-sleep phenomena (pre-sleep arousal; fear of sleep) might be prone to memory bias. The single assessment timepoint reduced the methodological challenge of potentially directing participants' focus to their fear of sleep or pre-sleep arousal before going to sleep and, therefore, artificially inflating both phenomena. It also was used to minimise participant burden, which led to a high compliance rate. However, we encourage future research to improve the temporal resolution of the assessment, especially for fear of sleep, to disentangle the temporal (and even the causal) relationships with nightmares (and sleep). A higher temporal resolution might also improve testing of whether there are longer-term effects or whether these are only short-lived as suggested by the results of the lagged model in this study. Third, although recruiting individuals with "regular nightmares" who had reported a considerable amount of nightmares at baseline, the sample displayed a relatively low burden of nightmares throughout the assessment period. The discrepancy between retrospective and daily assessment in our study reflects a typically found overestimation of clinical symptoms in recall compared with EMA assessments (Shiffman et al., 2008). It is further worth noting that there is preliminary evidence on individuals with regular posttraumatic nightmares showing reduced nightmare frequency when using ambulatory polysomnography (Spoormaker et al., 2006). This finding may imply that sleep monitoring (actigraphy in our case) per se has some positive

psychological effects, for example, reducing anxiety and enhancing a feeling of safety, which then prevent nightmare occurrences. Future studies are needed to explore whether results might differ in samples with a higher nightmare burden.

6 | CONCLUSIONS

Our results suggest that fear of sleep constitutes an important antecedent of nightmare distress and impaired sleep in nightmare sufferers. Therefore, targeting fear of sleep might augment future treatment options. At the same time, our results highlight the important role of individual differences in the dynamic interplay of nightmares and related factors, for example fear of sleep. We therefore encourage future within-person research on more specific samples (i.e., patients with diagnosed PTSD vs. insomnia vs. depression vs. non-clinical samples, thus incorporating information on idiographic vs. posttraumatic nightmares) to disentangle these individual differences, identifying possible moderators and subgroups suffering from nightmare distress and fear of sleep.

AUTHOR CONTRIBUTIONS

All authors were involved in the design of the study and the acquisition of data, contributed to the statistical analysis and interpretation of data, drafted the manuscript, and have read and approved the manuscript.

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CONFLICT OF INTEREST

Britta Dumser, Gabriela G. Werner, Thomas Ehring, and Keisuke Takano have no conflicts of interest to disclose.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are openly available in the Open Science Framework (OSF) repository: https://osf.io/2seha/?view_only=467f13d5ff354a5da047a71d85ab159e. Due to data protection regulations, demographic information was removed from the dataset.

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ENDNOTES

[1] TST = total sleep time (item 17) - sleep onset latency (item 18) - wake after sleep onset (item 20).

[2] TIB = in-bed time (item 13) - out-bed time (item 16).

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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APPENDIX A: Daily assessment

Section	N°	Item wording	Answer format
Somatic pre-sleep arousal	1	Heart racing, pounding, or beating irregularly	0 (not at all) – 4 (extraordinary)
	2	A jittery, nervous feeling in your body	
	3	Shortness of breath or laboured breathing	
	4	A tight, tense feeling in your muscles	
	5	Cold feeling in your hands, feet or body in general	
	6	Have stomach upset (knot or nervous feeling in stomach, heartburn, nausea, gas etc.)	
Cognitive pre-sleep arousal	7	Worry about falling asleep	0 (not at all) – 4 (extraordinary)
	8	Review or ponder events of the day	
	9	Depressing or anxious thoughts	
	10	Worry about problems other than sleep	
	11	Being mentally alert, active	
	12	Cannot shut off thoughts	
Sleep	13	What time did you get into bed?	____:_____
	14	What time did you try to go to sleep?	____:_____
	15	What time was your final awakening?	____:_____
	16	What time did you get out of bed for the day?	____:_____
	17	In total, how long did you sleep?	_____minutes
	18	How long did it take you to fall asleep?	_____minutes
	19	How many times did you wake up, not counting your final awakening?	_____
	20	In total, how long did these awakenings last?	_____minutes
	21	How would you rate the quality of your sleep?	0 (very poor) – 4 (very good)
Nightmares	22	Did you experience a nightmare last night (that woke you up)?	Yes/ No
	24	To what extent have nightmares troubled/ distressed you last night?	0 (not at all) – 4 (very much)
Fear of sleep	25	I was fearful of the loss of control that I experience during sleep	0 (not at all) – 10 (very)
	26	I awoke in the middle of the night from a nightmare, and avoided returning to sleep because I might go back into the nightmare	
	27	I was afraid to close my eyes	
	28	I tried to stay as alert as I could while lying in bed	
	29	I stayed up late to avoid sleeping	
	30	I slept with a light on to feel safer	
Stressful events	31	Did anything exciting, or distressing happen to you yesterday that could have influenced your sleep last night?	Yes/No
	32	If yes, what was it?	Open