The thief of (bed)time: Examination of the daily associations between bedtime procrastination and multidimensional sleep health

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Introduction

Sleep is a multidimensional construct that has a substantial role in maintaining health and well-being (eg.1). Dimensions of sleep including its timing, duration, and efficiency have been previously associated with increased risk for mood and anxiety disorders (eg.2,3), cardiometabolic disease (eg.4,5), and all-cause mortality (eg.6). Despite the risks associated with inadequate sleep, over one-third of American adults report that they do not sleep the recommended minimum 7 hours each night.7 Sleep disorders may contribute to poor sleep, but the prevalence estimates for these disorders cannot account for the widespread sleep insufficiency in the general population.8 Accordingly, additional research is needed to investigate subsyndromal biopsychosocial factors which may contribute to poor sleep health, including exposure to evening light, stress, and sleep-interfering behaviors. One such sleep-interfering behavior is bedtime procrastination. The present study seeks to examine the daily associations between bedtime procrastination and multidimensional sleep health.

Bedtime procrastination and sleep health

Bedtime procrastination refers to the behavioral tendency to delay bedtime in the absence of external obligations. Like general procrastination, bedtime procrastination is considered a consequence of poor self-regulation.11,12 Bedtime procrastinators frequently report doing leisure activities, including consuming media and socializing with friends, before bedtime.12,13 Prevalence rates indicate that this is a common sleep-related behavior, with an estimated 74% of a representative Dutch sample procrastinating their bedtimes at least once per week;12 similar rates have been found in U.S. samples.11 Accordingly, bedtime procrastination is a common behavior which poses a significant risk to sleep health.
Bedtime procrastination likely impacts sleep by limiting sleep opportunity. As individuals delay their bedtimes, total sleep may be shortened by morning obligations or circadian arousal. Consistent with this conceptualization, bedtime procrastination is associated with later sleep timing\(^{13,14}\) and shorter sleep duration.\(^{11,12,15,16}\) Furthermore, bedtime procrastinators also reported increased daytime fatigue,\(^{11,12,14,15}\) and poorer subjective quality of their sleep.\(^{15,17}\) Finally, a cognitive-behavioral treatment designed to diminish bedtime procrastination also improved sleep efficiency, but the direct association between bedtime procrastination and sleep efficiency was not examined.\(^{18}\) However, another investigation found no difference in sleep efficiency between those with high and low bedtime procrastination.\(^{13}\) Although these results provide preliminary support for the association between bedtime procrastination and poor sleep health, there are considerable limitations in this literature.

Prior research investigating the associations between bedtime procrastination and sleep has been fragmented. Differences in sample characteristics, measurement, and statistical methodology across these studies undermine the interpretation of the cumulative impacts of bedtime procrastination on sleep health. Although some prior work has attempted to examine these impacts comprehensively, either via composite sleep measures (ie, the Pittsburgh Sleep Quality Index\(^{19,20}\)) or meta-analysis,\(^{15}\) critical sleep health indices such as sleep regularity and efficiency have not been examined. Using a multidimensional assessment of sleep health would address these gaps. For example, the RU-SATED model of sleep health incorporates dimensions of health most relevant to the development of medical morbidity and mortality.\(^1\) This model includes dimensions whose associations with bedtime procrastination have already been examined, such as sleep duration, sleep timing, and daytime alertness, as well those which have not been established, such as sleep regularity and efficiency.

Utilizing multiple dimensions of sleep health, in addition to providing foundational evidence for future research on antecedents and consequences of bedtime procrastination, can aid in contrasting bedtime procrastination from other constructs related to sleep timing. One such notable construct is chronotype, which refers to individuals’ preferences for sleep and activity timing.\(^{21}\) Previous research has demonstrated that having an evening chronotype is associated with increased bedtime procrastination,\(^{15,22,23}\) and that chronotype may play a “prominent role” in bedtime procrastination.\(^{24}\) Although these studies show that bedtime procrastination and chronotype are related, they differ in terms of their putative mechanisms. For example, bedtime procrastination is conceptualized as a behavioral delay resulting from poor self-regulation,\(^{11,12}\) whereas chronotype is considered a biological tendency toward sleep timing.\(^{25}\) Accordingly, we might expect that these constructs may share similar, yet distinct, associations with multidimensional sleep health.

Finally, prior investigations of the association between bedtime procrastination and sleep health have relied on cross-sectional study design. Although results from cross-sectional studies can demonstrate the co-occurrence of bedtime procrastination and poor sleep in individuals, they are often erroneously interpreted as changes within individuals. In other words, cross-sectional research observes that, at a single time point, one individual may report both high bedtime procrastination and late sleep timing and another individual may report low bedtime procrastination and early sleep timing, but this does not imply that either person will have later sleep after procrastinating their bedtimes (example adapted from\(^{26}\)). Often, theoretical accounts of bedtime procrastination suggest a within-person process (ie, when individuals procrastinate their bedtimes, they have shorter sleep), but only evaluate the between-person level. Investigating the association between bedtime procrastination and sleep health at a within-person level not only is consistent with theory, but it also provides necessary support to establish predictors as putative mechanisms (ie,\(^{27,28}\)). Therefore, the present study sought to evaluate the within-person associations between daily bedtime procrastination and multidimensional sleep health.

The present study

The present study examined the association between bedtime procrastination and sleep health while addressing conceptual and methodological gaps in previous work. Using experience sampling methods, we evaluated within-person associations across 14 days. Consistent with previous investigations, we expected that bedtime procrastination would be associated with poorer sleep satisfaction, later sleep timing, and shorter sleep duration. However, we also expected that bedtime procrastination would be associated with more irregular sleep and poorer sleep efficiency. Furthermore, we expected that bedtime procrastinators and evening chronotypes would demonstrate unique patterns of associations to sleep health dimensions.

Method

Participants

The sample consisted of 280 undergraduate students who participated for partial course credit. As data were collected for educational purposes as part of a psychology course, this study was granted IRB-approved exemption status for use of deidentified data. Participants were excluded from the study if they reported engaging in shiftwork during study procedures. Participants in the sample identified predominantly as female (79%; 20% male, 1% nonbinary), and White (78%). The sample further identified as Asian (18%), American Indian (3%), Black (4%), and Native Hawaiian/Pacific Islander (2%). In addition, 12% of the sample identified as Latinx. Age for the sample ranged from 18 to 63 years (M = 24.40 years, SD = 6.69 years).

Measures

Bedtime procrastination scale

Participants completed a daily version of the bedtime procrastination scale (BPS)\(^{11,22}\) each morning. The daily BPS utilizes 7 of the 9 original items of the BPS, which were adapted to reflect prior night bedtime procrastination (ie, “Last night, I went to bed later than intended”). BPS scores consist of the daily average of items, each rated using a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Previous investigations have demonstrated good internal consistency\(^{13,14,24}\) and test-retest reliability\(^{29}\) of the BPS. The present sample demonstrated excellent internal consistency of average item score across the 14-day assessment period (\(\alpha = 0.90\)).

SATED sleep health questionnaire

A subsample of participants (\(n = 220\)) completed the SATED as a measure of self-reported sleep health.\(^1\) The SATED is a 5-item scale, with each item representing different dimensions of sleep health (ie, sleep satisfaction, daytime alertness, sleep timing, efficiency, and duration). Participants rate how frequently they experience good sleep health across each item, using 3-point Likert scale from 0 (rarely/never) to 2 (usually/always). Items are summed to create a composite of multidimensional sleep health. The SATED in this study was found to have modest internal consistency (\(\alpha = 0.54\)), consistent with previous studies,\(^{30}\) likely due to the low number of items and the multidimensional nature of sleep health.
Consensus sleep diary

The consensus sleep diary was administered each morning to participants during the 14-day assessment period, and was used to assess sleep health dimensions, including the duration, timing, efficiency, and regularity of sleep. Sleep duration was calculated as the difference between participants’ daily wake and bedtimes, minus their sleep onset latency and wake after sleep onset duration. Sleep timing was captured using the midsleep point for each night, defined as half the time elapsed between bedtime and waketime added to daily bedtime. Sleep efficiency was calculated as the proportion of sleep duration to the time spent in bed. Time in bed was estimated as the time elapsed between when participants first got into bed in the evening and when they got out of bed in the morning. Regularity indices were calculated as the standard deviation of participants’ daily midsleep point. Social jetlag was also included as an index of within-week sleep regularity and was calculated as the absolute difference in average midsleep point for weekends and weekdays.

Restorative sleep questionnaire

The restorative sleep questionnaire (RSQ) was administered each morning. The RSQ is a 9-item measure of perceived sleep restoration with ratings on a 5-point Likert scale ranging from 1 (not at all) to 5 (completely). The RSQ has demonstrated significant associations with previously validated measures of sleep quality and has been shown to distinguish between healthy sleepers and insomnia patients. The RSQ in previous studies has demonstrated good internal consistency ($\alpha = 0.90$) and test-retest reliability ($r = 0.80$). Internal consistency for the daily scale in the present study was calculated based on the average item score across the 14-day assessment period ($\alpha = 0.94$).

Morningness-eveningness questionnaire

The morningness-eveningness questionnaire (MEQ) is a 19-item self-report measure of chronotype. Participants are asked to rate their preferences for wake and sleep timing, their difficulty waking in the morning, and their preferences in timing for activities using both Likert and visual analog scales. Higher scores on the MEQ indicate a preference for morningness, whereas lower scores indicate a preference for eveningness. Internal consistency for this sample was similar to other reports ($\alpha = 0.79$).

Procedure

Data collection procedures for this study were approved by the University of Utah Institutional Review Board with an exemption for use of deidentified data. A questionnaire battery was first presented to participants, in which they completed the MEQ and SATED. Participants were asked to complete sleep diary, RSQ, and bedtime procrastination ratings each morning within an hour of waking over a 14-day experience sampling period. Most participants completed each daily assessment within 1 hour of their reported wake time (Median = 58 minutes). Each participant began the daily assessments on Monday mornings. Participants completed the study procedures between October 2020 and October 2021.

Analytic plan

Multilevel models (MLMs) were used to examine the daily associations between bedtime procrastination and sleep health dimensions. MLMs adjust for nonindependence of daily observations measured for each individual and allow for nonbalanced data. MLM analyses were completed in HLM 7.00 using restricted maximum likelihood estimation with robust standard errors to estimate model parameters.

To investigate the associations between bedtime procrastination and sleep health indices at both the level of individual differences and daily variation, we used centering procedures which separated within- and between-person associations. Prior to being re-pressed onto sleep health indices, bedtime procrastination was person-mean centered (PC) in level-1 equations, and grand-mean centered (GC) in level-2 equations. Significant associations between bedtime procrastination and sleep health indices at the within-person level would support the mechanistic role of bedtime procrastination in poor sleep health. Each model included random effects on the level-1 slopes, as they were sufficiently reliable ($\lambda > 0.05$) and improved model fit via likelihood ratio test. The following equation depicts the models evaluated in HLM, with $j$ representing daily assessment occasions and $i$ representing individuals in the models:

Level 1: Sleep Health Dimension $= \beta_{0ij} + \beta_{1ij}(PC\ BPS)_{ij} + r_{ij}$

Level 2: $\beta_{0ij} = \gamma_{00} + \gamma_{01}(GC\ BPS) + u_{0i}$

These models were evaluated using sleep diary estimates of daily sleep timing, sleep efficiency, sleep duration, and RSQ scores as indices of sleep health. Cross-sectional analyses (ie, bivariate correlations) were conducted to examine the associations between bedtime procrastination, regularity metrics, and SATED scores. To support the validity of the relevant findings, additional MLMs were constructed including sex, age, and chronotype as between-person covariates.

Results

Descriptive statistics

Participants completed on average 11.77 daily measures during the sampling period $(SD = 2.78)$. Descriptive statistics for study
variables are presented in Table 1, along with their intercorrelations. As demonstrated by the sleep health indices, this sample was generally healthy with respect to sleep, with participants on average sleeping 7.35 (SD = 0.98) hours each night with average efficiency of 82.13% (SD = 8.77). Average MEQ scores (M = 49.75, SD = 9.17) characterize this sample as intermediate chronotype, with scores that range from definitive evening types (minimum = 27) to definitive morning type (maximum = 74).

Bivariate correlations

Bivariate correlations between BPS and sleep health indices provide preliminary support for their associations. These correlations indicate that higher bedtime procrastination was associated with lower SATED scores, poorer reported sleep restoration and efficiency, shorter sleep duration, and later sleep timing. However, there were no significant correlations between BPS scores and sleep regularity indices, contrary to expectations. Consistent with prior studies, later chronotype was significantly correlated with higher BPS scores. Examining the pattern of correlations among chronotype, bedtime procrastination, and sleep health dimensions yields similarities and dissimilarities for these sleep-delaying constructs. Both bedtime procrastination and chronotype were associated with later sleep timing and poorer sleep restoration and efficiency. However, bedtime procrastination was associated with shorter sleep duration, whereas evening chronotype was not. In contrast, evening chronotype was associated with more irregular sleep timing. Together, these findings provide preliminary support for the separability of the constructs of bedtime procrastination and chronotype.

Multilevel analyses

MLM analyses indicated that bedtime procrastination was associated with poor sleep health across each daily index (see Table 2). As expected, higher daily BPS scores were significantly associated with reports of nonrestorative sleep quality, later sleep timing, poorer sleep efficiency, and shorter sleep duration. These associations were significant for both person-mean and grand-mean-centered BPS scores. Accordingly, increased bedtime procrastination was associated with both poorer daily sleep health, as well as individual differences in sleep health across indices. For example, a one-unit increase in daily-rated BPS score was associated with a reduction in nightly sleep duration by 0.74 hour (44 minutes). In contrast, a one-unit increase in individual’s average BPS scores across the 14-day assessment period was associated with a 0.37 hour (22-minute) decrease in average sleep duration across this period. As demonstrated in Table 3, the associations between bedtime procrastination and each sleep health dimension remained significantly at both the within- and between-person level when statistically adjusting for individual sex, age, and chronotype. These results provide additional evidence of the separability and incremental validity of bedtime procrastination over chronotype.

Discussion

The current study examined bedtime procrastination as a potential risk factor for poor sleep health. We demonstrated that individuals who procrastinated their bedtime had poorer sleep health 1 This pattern of significant findings was replicated using an alternative measure of bedtime procrastination, the time elapsed between when participants’ intended bedtime and when they reported actually going to bed. 2 The cross-level and between-person interactions between bedtime procrastination and chronotype were additionally examined for each sleep health outcome, but no significant interactions were found (ps > .05).
The association between bedtime procrastination and later sleep timing was expected, given that this type of procrastination is defined by delayed bedtime. Similarly, shorter sleep duration likely arises from sleep being truncated by morning obligations. However, the association between bedtime procrastination and sleep efficiency may be more complicated. Bedtime procrastinators may experience greater presleep arousal or sleep-related anxiety, and accordingly have difficulty falling asleep or staying asleep. Alternatively, people who procrastinate their bedtime might do so while in their bed, increasing their time in bed relative to their sleep duration. In either case, bedtime procrastinators may experience similar sleep-related anxieties or stimulus control issues found in those with insomnia. Finally, bedtime procrastinators also reported poorer restoration of their sleep. Although this may be partially explained by impairments in sleep described above (ie, shorter and less efficient sleep), it may also be the consequence of associated sleep or sleep-related disorders. Unexpectedly, bedtime procrastination was not associated with irregular sleep timing. Thus, while bedtime procrastination may be a risk for delayed sleep phase, it may not destabilize the entrainment of sleep.

Finally, the results of this study support the distinguishability of bedtime procrastination from the related construct of chronotype. Although this study, consistent with previous research, found a significant association between late chronotype and bedtime procrastination, we also demonstrated different patterns of sleep health risk for those who procrastinate their bedtimes and those who report an evening chronotype. Furthermore, bedtime procrastination remained significantly associated with poor sleep health after statistically adjusting for chronotype. Together, the results of this study suggest that bedtime procrastination is a risk factor for poor sleep health independent of preference for sleep timing and can be distinguished from chronotype.

**Strengths, limitations, and future directions**

This study had several strengths. Experience sampling procedures allowed us to examine the associations between bedtime procrastination and sleep health at the daily level. Establishing the within-person association offers necessary, although insufficient, evidence to establish the mechanistic role of bedtime procrastination in poor sleep health (ie, 27, 28). Additionally, this investigation included multidimensional assessment of sleep health, allowing us to examine previously unstudied associations among bedtime procrastination, sleep efficiency, and regularity of sleep. Using multiple sleep dimensions additionally served as a nomological network to empirically determine the construct validity, and separability, of bedtime procrastination and chronotype.

However, this study also had several limitations. First, this sample was composed of undergraduate students. It is unclear whether these results would be consistent in working adults, or in more racially or ethnically diverse populations. Furthermore, we operationalized sleep variables using self-reported sleep behaviors. Sleep diaries, compared to more objective sleep measures (ie, actigraphy), overestimate sleep duration and sleep onset latency and underestimate wakefulness during the sleep episode (eqs. 19, 40).
Consequently, the associations among bedtime procrastination, sleep duration, and sleep efficiency could be at least partly driven by measurement method. Finally, additional research is needed to fully assess the validity of the BPS. Although the results of this study provide convergent and discriminant validity of this scale, it is unclear whether this scale reflects intentional and needless delays in sleep. To address these limitations, future research should determine the associations between sleep and bedtime procrastination using objective sleep assessment methods, and further refine assessment of bedtime procrastination.

Given the substantive findings in this study, future research should investigate the role of bedtime procrastination in sleep disorders. The association between bedtime procrastination, short sleep duration, and poor sleep efficiency in this sample suggests that those who procrastinate their sleep are at risk for developing insomnia. Research should examine the associations between bedtime procrastination and insomnia-related cognitive-behavioral processes, such as poor sleep control and cognitive distortions. Alternatively, individuals may procrastinate their bedtime in response to disordered sleep. Qualitative reports suggest that individuals with insomnia may strategically procrastinate their bedtime to both improve sleep and avoid presleep anxiety. Furthermore, future research should investigate the social context in which bedtime procrastination occurs. For example, bedtime procrastination may serve a regulatory function in managing presleep arousal in individuals who are burdened by social obligations, such as those who work long hours or perform caregiving duties.

Conclusion

We demonstrated that individuals who procrastinated their bedtimes had poorer same-night sleep health, including shorter sleep duration, later sleep timing, poorer sleep efficiency, and lower self-reported sleep restoration. Moreover, these associations could not be explained by, nor did they vary across, levels of individual chronotype. Comprehensive evaluation of the sleep-health correlates of bedtime procrastination suggests novel hypotheses regarding the development and health impacts of this type of sleep-related behavior.

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Declaration of conflict of interest

None.

References


