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Failing to plan: Bedtime planning, bedtime procrastination, and objective sleep in university students

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ABSTRACT

Study objectives: Many people go to bed later than intended, yet very little is known about how bedtime plans are formed and followed. This study aimed to characterize bedtime planning, procrastination, and their relationship with objective sleep behavior among university students.

Methods: Participants (N = 119; full-time university students) were monitored for 2–4 weeks during their term time. Day-to-day bedtime planning was reported through a smartphone application, with plan frequency and deviation (actual-planned bedtime) as outcomes. Daily sleep timing and duration were objectively measured through wearable sleep trackers. Prior to monitoring, participants completed sleep-related questionnaires, including the bedtime procrastination scale, measuring the tendency to go to bed later than intended.

Results: Participants (mean age [SD] = 22.66 [1.67] year, 64 females [53.8 %]) planned their bedtime on a minority of nights only (median [IQR] = 0.93 [0.37–2.75] nights/week). Moreover, when they did plan a specific bedtime, they frequently overran their planned time (mean [SD] bedtime deviation = 46.23 [48.99] minutes) which correlated with baseline bedtime procrastination scores. On a day-to-day basis, having a bedtime plan associated with better sleep outcomes (i.e. earlier bedtimes [mean −11.78 min]; longer total sleep time [mean + 11.88 min]), compared to days without a plan. Study/work and e-leisure were the most common reasons for overrunning a bedtime plan.

Conclusions: University students often did not plan bedtime, and when a plan was in place, it was often overrun. Bedtime planning was associated more favorable sleep outcomes and should be considered as a strategy for health behavior change.

1. Introduction

Bedtime procrastination, or "going to bed later than intended without having external reasons for doing so" [1], is a common behavioral phenomenon affecting sleep health [2]. Across different populations, higher bedtime procrastination has been associated with negative sleep outcomes, including shorter sleep duration, poorer sleep quality, and higher levels of daytime sleepiness and fatigue [1,3–7]. While people are often aware of these negative consequences, delaying bedtime for activities such as using smartphones or watching TV shows is often experienced as satisfying and challenging to counteract [8].

Bedtime procrastination can be viewed as a form of self-regulatory failure, where individuals delay their bedtimes for immediate gratification of indulging in nighttime activities [1,4,9,10]. This conceptualization suggests that people with poorer self-regulation are more prone to bedtime procrastination. Subsequent findings have supported this, indicating higher bedtime procrastination was associated with lower trait self-control [1,4] and lower level of self-regulation skills [11,12].

Part of the challenge in self-regulating bedtime behaviors could involve difficulties in establishing and executing a planned bedtime. Bedtime procrastination has been conceptualized as a failure to follow an intention or a plan for a specific bedtime [1,4,10]. However, very little research has been done on how people form and follow bedtime plans. A recent study [13] explored this question by examining how often adolescents planned their bedtimes (and wake-up times) and how well these plans were executed. It found that only a small proportion of adolescent participants (29.9 % on school nights, 3.5 % on non-school nights) planned bedtimes consistently, while some adolescents (19.5 % on school nights, 53.2 % on non-school nights) never planned their bedtime. Moreover, when participants did have a planned bedtime in

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place, these plans were often overrun, resulting in an average bedtime delay of 46–71 min.

While these findings suggest a pattern of infrequent planning of bedtimes and common deviations from these plans, it is unknown whether this pattern generalizes to other non-adolescent populations. Adolescence is marked by a transition from parent-controlled to autonomous sleep self-regulation [13], when complex self-regulation is still under development [14]. The present study aimed to explore bedtime planning and bedtime procrastination in a university sample of young adults. While no clear prior literature is available on bedtime planning in this population, complex self-regulation does not seem to fully mature but continues to develop in early adulthood [14,15]. In addition, university students tend to enjoy a high degree of autonomy over their bedtime routines in combination with a high level of flexibility in their daytime schedules [16,17]. Therefore, it could be expected that a similar or lower frequency of bedtime planning behavior might be observed in this population.

Furthermore, no studies have examined to what extent the observed planning and execution behavior is related to bedtime procrastination. As planning and following through on those plans can be seen as a first step in exercising discipline and self-regulation [18], our study utilized an ecological momentary assessment (EMA) study design to examine the following hypotheses: 1) individuals who score high on the Bedtime Procrastination Scale would less often report a planned bedtime; ii) when a bedtime plan is in place, people who score high on the Bedtime Procrastination Scale would overrun that bedtime plan more often and for longer durations; and iii) having a bedtime plan would benefit actual sleep behaviors (i.e. earlier sleep timing, longer sleep duration).

2. Methods and materials

2.1. Participants

Two samples of university students from the National University of Singapore were recruited to participate in two studies using near-identical measures. Study 1 took place from March to May 2021, while Study 2 took place from August to October 2022, both during university terms. Seventy-six participants in Study 1 and 63 in Study 2 responded to advertisements posted on the university's learning management system or received from campus housing emails. Four participants in Study 1 and 5 in Study 2 were excluded based on criteria including known neurological, psychiatric or sleep disorders, and moderated to high risk of sleep apnea, clinical anxiety or depression. Eleven students participated in both studies and were excluded from Study 2 data analysis to avoid data redundancy, resulting in 72 students in Study 1 and 47 students in Study 2, for a total sample of 119. Participants in Study 1 were all housed in single-room campus housing. In Study 2, 12 participants were housed on campus, while 35 lived off-campus. All participants were of Chinese ethnicity. The protocols in both studies were approved by the Institutional Review Board of the National University of Singapore, and informed consent was obtained from all participants (see Ref. [19] for protocol details).

2.2. Study protocol

Both studies followed a similar protocol. During the baseline study visit, participants completed a battery of sleep questionnaires and psychological scales, including the Bedtime Procrastination Scale. They were then fitted with a wearable sleep tracker (Oura ring, Oura Health, Oulu, Finland). Participants were then followed in free-living conditions for four (Study 1) or two (Study 2) weeks, during which they provided daily sleep data from the Oura ring and reported on daily bedtime/wake-up time planning and execution of plans on an ecological momentary assessment (EMA) smartphone app (Z4IP, Sleep and Cognition Laboratory, Singapore). This report follows the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guidelines for cohort studies.

2.3. Bedtime/wake-up time planning and execution of plans

Participants completed two daily ecological momentary assessments including questions about their bedtime/waketime planning. The morning sessions were open from 8AM to 2PM while the evening sessions were open from 8PM to 12AM. Participants completed the EMA session at their time of choice within the time windows. Bedtime planning and execution of bedtime plans (if any) were retrospectively assessed using the following questions in the morning session on the next day:

"Last night, did you have any specific time planned for going to bed? (Yes/No)"

"If yes, what time did you plan to go to bed? (hh:mm AM/PM)"

"If you went to bed at a different time than you had planned, what was the reason? (Free text)"

Similarly, wake-up time planning and execution of wake-up time plans (if any) were assessed using the following questions in the same morning session:

"This morning, did you have any specific planned wake up time? (Yes/No)"

"If yes, what time did you plan to wake up? (hh:mm AM/PM)"

"If you woke up at a different time than you had planned, what was the reason? (Free text)"

If a participant missed a morning session, the same questions would appear in the evening session on the same day.

2.4. Sleep tracking using Oura rings

Nocturnal sleep metrics were recorded through electronic diary and the Oura ring. Sleep timing metrics bedtime, wake-up time, and time-in-bed (TIB) were based on diary self-report. Total sleep time (TST), sleep efficiency (SE, calculated as 100*(TST/TIB)), sleep onset latency (SOL), and wake after sleep onset (WASO) were based on Oura's proprietary algorithm using body movement, temperature, heart rate variability and a circadian factor [20–23].

2.5. Bedtime procrastination scale

Person-level bedtime procrastination was measured at baseline using the Bedtime Procrastination Scale [1]. This is a 9-item self-report questionnaire measuring the extent to which respondents engage in bedtime procrastination (Cronbach's $\alpha = .85$). Each item is scored on a 5-point Likert scale resulting in a total score ranging from 9 to 45, with larger scores indicating higher frequency of engaging in bedtime procrastination.

2.6. Data analysis and statistics

The proportion of days a participant planned a specific bedtime over the period of data collection was extracted for each participant to characterize the frequency of bedtime planning in university students. Plan execution (on days they had one) was calculated by the discrepancy between planned bedtime and actual bedtime and overrunning bedtime was defined as actual bedtime later than planned bedtime. From this, the proportion of days a participant overran planned bedtimes and the average duration of delay (actual bedtime – planned bedtime) were used to indicate an individual's pattern of bedtime plan execution. The same measures were derived for wake-up time planning and execution of wake-up time plans. Participants' reasons for overrunning planned bedtimes were provided in free text and, upon analysis, classified into different themes (i.e., study/work, electronic leisure).

Data from both studies were combined for all analyses. Bivariate correlation was used to examine associations between bedtime procrastination score and both the frequency of bedtime planning and measures of (un)timely execution of bedtime plans. Spearman's rank correlation was performed given non-normality of the bedtime planning and execution data, suggested by Shapiro-Wilk test ($ps \leq 0.003$).

Linear mixed-effects models were used to evaluate the day-level associations of having a bedtime plan with sleep timing and duration, using day-level bedtime planning status (yes/no) and person-level bedtime procrastination score as predictors of bedtime, wake-up time, total sleep time (TST), sleep efficiency, sleep onset latency (SOL) and wakefulness after sleep onset (WASO). Random intercepts random slopes models allowed the associations of daily bedtime planning status to vary across different participants. Age, sex, daily wake-up time planning status (yes/no), and day type (weekday/weekend) were added as control variables. For days with a bedtime plan, a similar LMM analysis was run to test the day-level associations of overrunning the bedtime plan (actual-planned bedtime) and sleep outcomes. As data collection periods partly overlapped with exam (preparation) periods, a control analysis coding for term time (regular days, exam days) and study number (Study 1, Study 2) was performed. All statistical tests were performed in SPSS, version 29.0 (IBM Corporation).

3. Results

3.1. Sample demographics and objective sleep parameters

A combined sample of 119 participants (mean age [SD] = 22.66 [1.67] years, 64 females [53.8 %]) was included for data analysis (Table 1). Students scored an average of 28.21 on the Bedtime Procrastination Scale (total possible scores range from 9 to 45), indicating moderate bedtime procrastination tendencies among university students (Table 1). Table 1 also shows the average sleep parameters of the combined sample throughout the data collection. Participants in Study 1 had slightly higher Bedtime Procrastination Score and shorter Sleep Onset Latency than those in Study 2, but no differences in sleep timing, duration, and bedtime planning (see Supplementary Materials, Table S1).

3.2. Bedtime/wake-up time planning and execution of plans

A total of 2538 EMA sessions were recorded (94.91 % of study days). Of all completed EMA sessions, participants indicated they had a planned bedtime on only 23.80 % of days (days with plan = 604; days without plan = 1934; See Fig. 1A). On a per-person basis, most participants planned their bedtimes on less than one day per week (Median [IQR] = 0.93 [0.37–2.75] days/week). For wake-up times, participants more often indicated having plans (54.65 % of days; days with plan = 1387; days without plan = 1151). Median [IQR] per-person planning frequency was 4.00 [2.66–5.38] days/week.

Table 1
Demographics and sleep parameters in the combined sample (N = 119).

	Mean (SD) or N (%)
Age	22.66 (1.67)
Sex, female	64 (53.78 %)
Bedtime Procrastination Scale	28.21 (6.39)
Sleep	
EMA Bedtime	01:29 (1:04)
EMA Wake-up Time	08:40 (0:50)
EMA Time-in-Bed (hr)	7.17 (0.75)
Oura Total Sleep Time (hr)	6.10 (0.68)
Oura Sleep Efficiency (%)	83.98 (4.97)
Oura Sleep Onset Latency (min)	11.51 (4.32)
Oura Wake after Sleep Onset (min)	66.38 (22.44)

When a bedtime plan was in place, participants frequently overran this plan (Fig. 1B). Based on EMA self-reported bedtimes and wake-up times, mean [SD] bedtime plan deviation (actual-planned time) was +46.23 [48.99] minutes. Almost all participants (82.83 %) overran their bedtime plans (n = 82 out of 99 who ever had a bedtime plan), 58 (58.60 %) of which overran their bedtime plans by at least 30 min on average. In contrast, wake-up time plans were followed more strictly. The average wake-up time plan deviation was +11.05 [25.94] minutes. While most people woke up later than their planned wake-up time, only 13.9 % of participants overran their planned wake-up time by more than 30 min on average (n = 16 out of 115 who ever had a wake-up time plan).

Free-text entries of reasons participants gave for overrunning planned bedtimes were reviewed by one author (single rater) and manually coded into seven broad categories (see Fig. 1C). Categorisation was based on identification of common themes resulting from discussion among the first and last author: Study/work (26.63 %; e.g., "studying", "work to finish") and electronic leisure (26.04 %; e.g., "play video games", "watch movies") were the two most frequent categories. Another frequently reported category was not tired/can't sleep (17.16 %; e.g. "not very sleepy", "couldn't fall asleep"), followed by social activities (13.02 %; e.g., "replying to messages", "talking to a friend"), leisure (other, 7.69 %; e.g., "reading fiction", "football"), and personal care (5.33 %; e.g., "needed more time to shower", "reflecting and journaling"). Interestingly, "procrastination" was explicitly cited as a reason on a few occasions (4.14 %) by students without specifying the activities involved (e.g., "procrastination", "loss track of time").

3.3. Associations among bedtime procrastination, bedtime planning and execution of plans, and objective sleep

Bivariate correlation analyses combining data from both studies (Table 2) suggested that bedtime procrastination score was not significantly correlated with the proportion of days university students planned a specific bedtime (also see Fig. 1D). However, more frequent bedtime planning was associated with longer total sleep time (Table 2). In addition, a higher bedtime procrastination score was significantly correlated with both measures of untimely execution of bedtime plans, namely a higher proportion of days students overran planned bedtime and longer duration of delay (Table 2, Fig. 1E). These measures of untimely execution of bedtime plans were also correlated with later average bedtimes (Table 2). Longer duration of bedtime delay was also correlated with later wake-up times (Table 2).

3.4. Day-by-day bedtime planning and sleep outcomes

Linear mixed effects models, controlled for age, sex, and weekday/weekend, showed that on nights with a specific bedtime plan, bedtimes were earlier by 11.78 min, and TST was longer by 11.88 min compared to nights without a bedtime plan (Table 3, also see Fig. 2). Days with a wake-up time plan were associated with earlier bedtimes by 18.04 min, earlier wake-up times by 53.59 min, and shorter TST by 28.58 min (Table 3, Fig. 2). Higher bedtime procrastination scores were associated with later bedtime and shorter total sleep time (Table 3). Specifically, an increase of one standard deviation on the Bedtime Procrastination Scale (i.e. 6.39 points on a scale from 9 to 45) was associated with a later bedtime by 19.7 min and a shorter TST by 7.8 min. These effects remained present after controlling for Study number and exam periods (with the exception of Bedtime Procrastination Scale on TST; see Supplementary Materials Table S2). Random intercepts were significant for all models ($ps < 0.03$), while random slopes were significant only for wake-up time ($p < .001$, but not for bedtime and TST ($ps > 0.23$). This indicates that only the effect of having a bedtime plan on next-day wake-up time varied significantly between subjects.

For sleep continuity metrics, having a bedtime plan was associated with an increase in SOL (+0.97 min, see Table 4), and having a wake-up

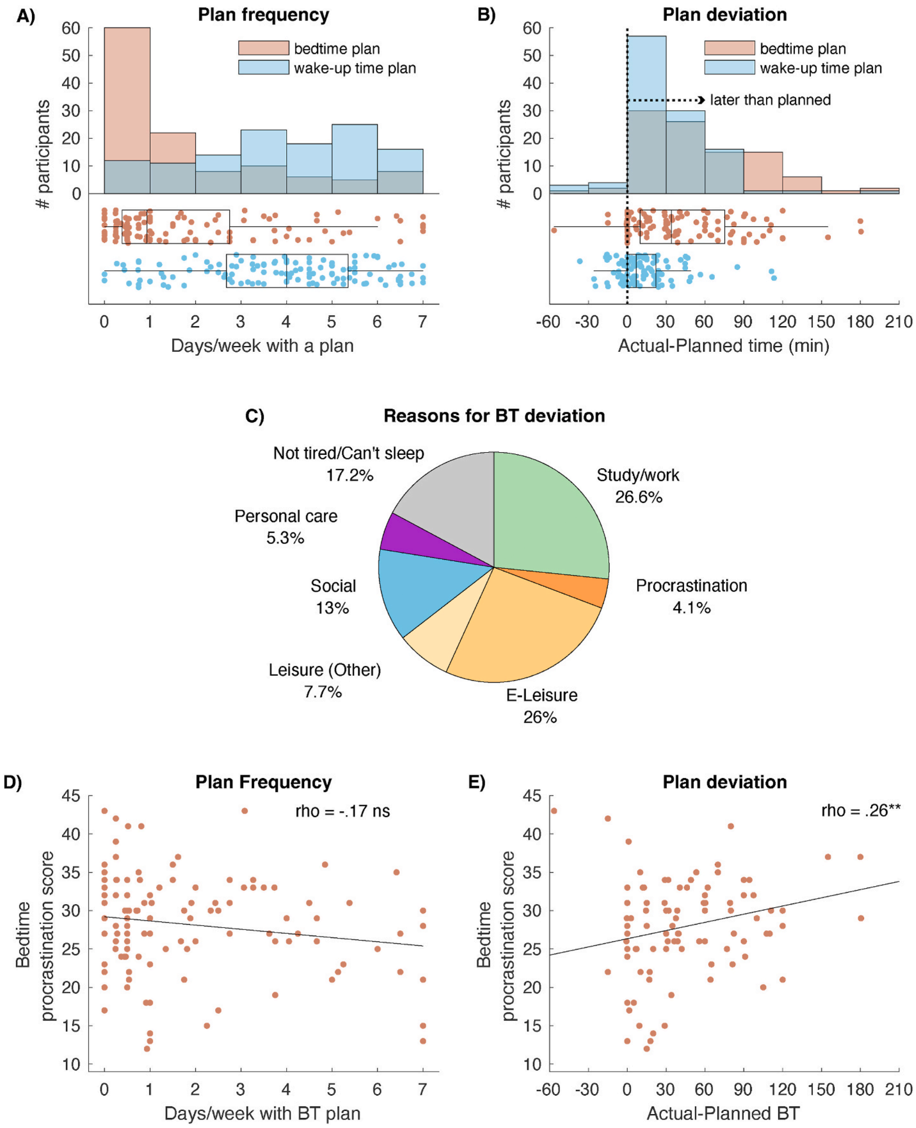

Fig. 1. A) Plan frequency: the percentage of days individuals indicated to have planned bed and wake times, B) Plan deviation: difference scores of planned versus actual bed and wake times, C) Reasons given for overrunning bedtime plans, D) Correlation between bedtime-plan frequency and bedtime procrastination scores, E) Correlation between bedtime-plan deviation and bedtime procrastination scores.

Table 2
Non-parametric correlations among bedtime procrastination, bedtime planning and execution of plans, and sleep parameters in the combined sample.

Spearman's Rho	Days planned a bedtime (%)	Days overran planned bedtime (%)	Average duration of bedtime delay (min)
Bedtime Procrastination Scale	−0.14	**0.28****	**0.26****
EMA Bedtime	−0.07	**0.26****	**0.40*****
EMA Wake-up Time	−0.03	0.19	**0.32****
Oura Total Sleep Time	**0.19***	−0.10	−0.11

Bolded values indicate statistically significant associations (*P < .05, **P < .01, ***P < .001).

time plan was associated with an increase in sleep efficiency (+0.48 %) and a decrease in WASO (−7.47 min). These effects, however, did not survive correction for Study number and exam period (with the exception of WASO; see Supplementary Materials Table S3). Random intercepts were significant for all models (ps < 0.001), but random slopes were significant only for SE (p = .04) and not for WASO (p = .16), indicating that having a bedtime plan had a variable impact across participants on SE only. Convergence was not reached in model for SOL, therefore random slopes were taken out of the model. Results are based on a random intercept, fixed slope model for SOL.

3.5. Control analyses

Control analyses showed that results were largely the same when Oura-derived bed and wake-up times were used as outcome variables (instead of diary-based), with earlier bedtimes on days with a bedtime plan, earlier bed and wake-up times on days with a wake-up time plan, and later bedtimes for participants with higher BPS scores (Supplementary Materials Table S4). Using the duration of bedtime plan deviation as the predictor variable (on days with a bedtime plan) further showed significant day-level associations of longer duration of bedtime delay (actual-planned bedtime) with significantly later bedtime, and shorter TST (see Supplementary materials Table S5).

Table 3
Summary of the linear mixed-effects models predicting day-to-day objective bedtime, wake-up time and total sleep time using daily bedtime planning in the combined sample.

Dependent variable	Bedtime Estimate [95 % CI]	Wake-up Time Estimate [95 % CI]	Total Sleep Time Estimate [95 % CI]
Intercept	**78.22** *** [59.71, 96.74]	**509.89** *** [492.64, 527.14]	**373.78** *** [361.99, 385.57]
Age	−5.06 [-11.97, 1.84]	−5.72 [-12.12, 0.67]	2.15 [-2.18, 6.48]
Sex (female)	0.62 [-22.50, 23.75]	3.16 [-18.24, 24.55]	**27.35*** [12.83, 41.86]**
Day type (weekday)	−6.48 [-13.94, 0.99]	**−20.85*** [-27.70, −14.01]**	**−15.40*** [-21.27, −9.53]**
Day with bedtime plan (yes)	**−11.78* [-22.86, −0.71]**	−6.51 [-17.43, 4.41]	**11.88** [3.43, 20.34]**
Day with wake-up time plan (yes)	**−18.04*** [-26.18, −9.90]**	**−53.59*** [-61.08, −46.11]**	**−28.58*** [-34.94, −22.22]**
Bedtime Procrastination Scale	**3.09*** [1.31, 4.88]**	1.57 [-0.09, 3.22]	**−1.22* [-2.35, −0.10]**

Dependent variables were entered in minutes. Unstandardized coefficients with 95 % confidence intervals were reported. Bolded values indicate statistically significant effects (*P < .05, **P < .01, ***P < .001).

4. Discussion

The present study found that a majority of participants often did not plan a specific time to go to bed. Fifty percent of participants had a planned bedtime on less than one day per week. When they did have a planned bedtime, they executed these plans poorly and often overran their plan. The frequency of bedtime planning was not significantly correlated with bedtime procrastination score, but the frequency and duration of overrunning bedtime plans were. Importantly, planning a specific bedtime predicted an earlier bedtime and longer total sleep time on the same night.

This pattern of infrequent bedtime planning and poor execution of plans in university students is similar to that found in high school students [13]. While university students might be expected to have stronger self-control capacity than adolescents, they often also enjoy greater autonomy over their bedtimes with little to no parental control [16]. In addition, many social and study activities may be scheduled in the evenings and late at night when attending university. This might lead students to forgo planning a specific bedtime or to abandon their plan if these activities are not yet completed [24]. This pattern of behavior might be amplified by the fact that university students often have flexible daytime schedules [17], which may reduce the need for strict bedtime planning.

In contrast, participants frequently had wake-up time plans and followed through on their wake-up time plans more strictly. This likely reflects that overrunning a planned wake-up time might have more acute consequences (e.g., missing a class or an assignment deadline) than overrunning bedtime plans. These findings are consistent with those from Maskevich and colleagues [13] in high-school students, suggesting that infrequent bedtime planning and more frequent wake-up time planning are common across adolescent and university student populations.

While the frequency of having a bedtime plan was not correlated with bedtime procrastination score, the likelihood and duration of overrunning a bedtime plan when a plan was in place did show a

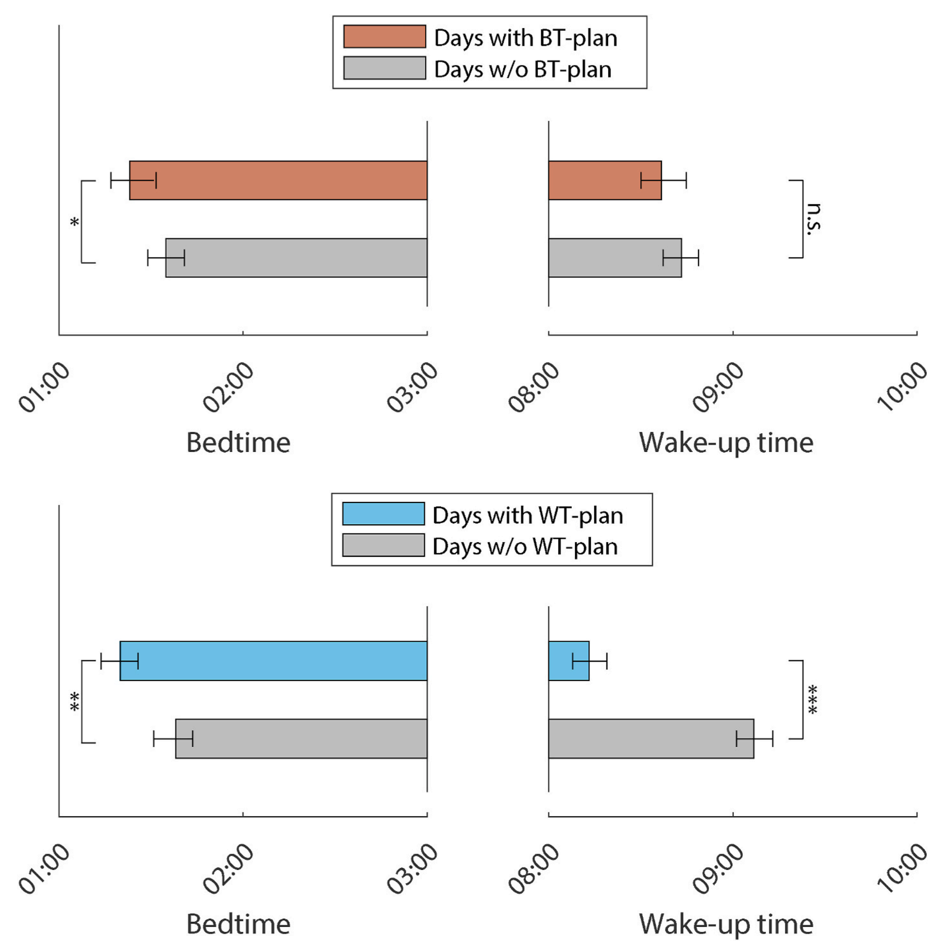

Fig. 2. Day-by-day effects of bedtime and wake-up time planning on sleep timing. *p < .05, **p < .01, ***p < .001.

Table 4
Summary of the linear mixed-effects models predicting day-to-day objective sleep efficiency, sleep onset latency (SOL) and wakefulness after sleep onset (WASO) using daily bedtime planning in the combined sample.

Dependent variable	Sleep Efficiency (%) Estimate [95 % CI]	SOL (min) Estimate [95 % CI]	WASO (min) Estimate [95 % CI]
Intercept	**86.94***** [85.64, 88.23]	**10.74** *** [9.34, 12.15]	**43.43** *** [36.89, 49.97]
Age	0.11 [-0.40, 0.61]	0.43 [-0.05, 0.90]	0.22 [-2.26, 2.70]
Sex (female)	**3.45***** [1.78, 5.13]	−1.13 [-2.72, 0.45]	**−8.54*** [-16.82, −0.25]
Day type (weekday)	−0.16 [-0.60, 0.28]	−0.56 [-1.28, 0.15]	−1.85 [-4.29, 0.59]
Day with bedtime plan (yes)	0.32 [-0.43, 1.06]	**0.97*** [-0.01, 1.94]	−0.30 [-4.20, 3.60]
Day with wake-up time plan (yes)	**0.48*** [0.003, 0.96]	−0.14 [-0.91, 0.63]	**−7.47***** [-10.14, −4.79]
Bedtime Procrastination Scale	0.05 [-0.08, 0.18]	−0.05 [-0.17, 0.07]	−0.59 [-1.23, 0.05]

Unstandardized coefficients with 95 % confidence intervals were reported. Bolded values indicate statistically significant effects (*P < .05, **P < .01, ***P < .001).
Convergence was not reached in model for SOL. Results are based a random intercept, fixed slope model for SOL.

positive correlation with bedtime procrastination score. These findings indicate that the Bedtime Procrastination Scale [1] meaningfully captures relevant aspects of day-to-day behavioral manifestations of bedtime procrastination [25]. Furthermore, days with a planned bedtime were associated with an earlier bedtime and a longer total sleep time (by approximately 12 min). This shows that having a bedtime plan alone might potentially benefit university students' sleep duration. While having a bedtime plan was associated with a 0.97-min increase in SOL, this association was relatively modest and might be because that on nights with a bedtime plan students went to bed earlier and therefore might be slightly less tired compared to nights without a bedtime plan. In addition, having a bedtime was not associated with change in sleep efficiency or WASO, suggesting that having a bedtime plan might benefit sleep duration without necessarily affecting sleep continuity.

While having a bedtime plan does not guarantee that this plan will be followed, it might be a first step towards a conscious strategy to manage night-time routines and regulate one's procrastination tendencies [18,26]. Existing theories on behavioral change, e.g. the Theory of Planned Behavior [27], emphasize the importance of behavioural intention when executing a desired behaviour. Accordingly, having a specific bedtime plan might strengthen students' intention to go to bed earlier by providing a concrete and viable behavioral target. Other implementation theories such as the COM-B model [28] proposes the core components of a behaviour: capability, opportunity, and motivation. Behavioral planning is often reflected in the reflective motivation component of the COM-B model, where conscious intentions and planning can increase motivation to implement a certain behaviour.

It should be noted that having a planned bedtime alone may not be sufficient to establish healthy sleep routines. Behavior change depends on other factors such as capacity/controllability to implement the behavior and on existing social norms [27,28]. This may be reflected in the frequency at which bedtime plans were overrun in our data. Even if a planned time is in place, external factors, such as late-night social activities and peer expectations, may hamper the previously formed intention and prevent earlier bedtimes [24,29].

Existing intervention studies for bedtime procrastination hinge on techniques from these behavior change theories [30–32]. One study emphasized the importance of planning not only a bedtime, but also anticipating obstacles and formulating contingency plans when these obstacles occur [32]. Another intervention study focused on understanding the needs fulfilled by bedtime procrastination, and finding alternative times or means to address the identified needs [30,31]. Accordingly, these interventions help individuals make concrete if-then plans to overcome anticipated obstacles to going to bed on time [32] or help them discover motivation for behavior change and replace bedtime procrastination with healthier alternative behaviors that meet their needs [30,31].

It should be noted that bedtime procrastination may manifest as either mindless or deliberate, each with distinct implications for the effectiveness of bedtime planning and contingency strategies [33,34]. Mindless procrastination occurs when individuals become absorbed in an engaging activity and unintendedly overshoot their intended bed time, for example, while doom scrolling an endless stream of online content. In contrast, deliberate procrastination indicates a more conscious choice to carve out time for activities at the expense of sleep. In such cases, a planned bedtime might exist, yet it might not support the goal of achieving sufficient sleep. Thus, mindless and deliberate forms of bedtime procrastination may relate differently to how a bedtime plan and associated contingency strategies could be helpful to mitigate their effects.

In other cases, a delay in bedtime might be perceived as procrastination, but might belie other underlying reasons. In our sample, some participants reported staying up past their planned bedtime because they did not feel tired at the planned time. This might reflect a mismatch between a participant's chronotype and their scheduled obligations [7,12,35]. In addition, individuals with insomnia, which has been conceptualized as a phase angle disorder, may try to sleep closer to their dim light melatonin onset (DLMO), which may result in prolonged sleep onset latency. Thus, their planned bedtimes may reflect a misalignment between an individual's internal circadian rhythm and their desired sleep schedule [36]. While not explored in our study, such forms of bedtime delay may be more strategic in nature (i.e. to avoid lying awake for long before being able to fall asleep), and would not strictly constitute a form of procrastination [33,34].

Finally, a large portion of participants indicated that the reason for overrunning their bedtime was due to work/study activities. As these cases would imply the presence of an external obligation, these would also not strictly be viewed as procrastination. However, it should be noted that professional and academic pressures are a highly common antecedent of late bedtimes and insufficient sleep, particularly in highly competitive societies [37,38]. While lack of planning and procrastination might contribute to the felt need to work past a bedtime, broader and more structural countermeasures might be needed to reduce the effects of such pressures.

5. Strengths & limitations

This study has several strengths. First, daily sampling of bedtime planning provided a detailed indication of time-varying bedtime behavior. Most prior studies on bedtime procrastination have provided a more static trait-like assessment, while recent studies increasingly demonstrate the day-by-day variance of bedtime procrastination behaviors [11,25,35,39]. Moreover, the diary-based measures of occurrence and duration of overrunning bedtime plans were corrobortaed by objective, wearable-based sleep tracking methods, over a longer period (2–4 weeks). Combined with high compliance rates, these metrics provide a reliable reflection of habitual sleep behaviors [40]. This presents a further advancement as most literature was based exclusively on self-report sleep data [2].

On the flip side, there is a chance that participants' daily behavioral patterns may be influenced by the explicit questioning of bed and wake-up time planning (e.g., by actively bringing planning to mind every morning). Planning questions, however, were embedded in more comprehensive daily surveys, including questions about sleep quality and well-being [19]. Furthermore, having a bedtime (and wake-up time) plan was narrowly defined in this study as having a “specific planned time" for going to bed and waking up. In reality, a bedtime plan or intention may not always rely on a specific time, but rather on a time window or period within which a bedtime would be acceptable [41]. This may have led to an underreporting of plan frequency in our study.

Finally, the issues of lack of planning and failure to follow through might be particularly prevalent in university students who enjoy a relatively high degree of flexibility in their schedules and a high level of autonomy to decide on their night time routines [16,17]. In addition, social influences, like roommates, can often present distractions and cause someone to deviate from their original plans [24]. Furthermore, this study included an ethnically homogeneous sample. It is therefore possible that our findings are specific to the institutional and cultural context of the university population under study. While prior studies in different age groups and different countries have demonstrated that issues of bedtime procrastination, lack of planning, and late bedtimes are also prevalent in other populations such as adolescents and working adults [2,6,7,13,37], replication beyond the current population could further scope out developmental and cultural applicability of our findings.

6. Conclusion

University students did not often plan specific bedtimes despite evidence that doing so might lead to earlier bedtimes and longer sleep durations. Bedtime procrastination was common among university students and predicted later bedtimes and shorter sleep duration, suggesting a need for interventions. Future studies should consider targeting bedtime planning and bedtime procrastination when designing sleep interventions for this population.

CRediT authorship contribution statement

Zhenghao Pu: Writing – original draft, Visualization, Project administration, Methodology, Formal analysis, Data curation, Conceptualization. **Alyssa S.C. Ng:** Writing – review & editing, Project administration, Investigation, Data curation. **Sooyeon Suh:** Writing – review & editing, Supervision. **Michael W.L. Chee:** Writing – review & editing, Supervision, Funding acquisition. **Stijn A.A. Massar:** Writing – review & editing, Visualization, Supervision, Methodology, Formal analysis, Data curation, Conceptualization.

Data availability

The data in this article are available upon reasonable request from the authors.

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Declaration of competing interest

Dr Michael WL Chee is on the Medical Advisory Board of Oura Health, but this work was independent of any commercial interest. He also partially supported the development of the Z4IP Ecological Momentary Assessment App. All other authors declare no conflict of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.sleep.2025.106556.

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