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American Journal of Health Education

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/ujhe20

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To cite this article: Adam P. Knowlden & Shabnam Naher (2023) Time Management Behavior Structural Equation Model Predicts Global Sleep Quality in Traditional Entry University Students, American Journal of Health Education, 54:4, 265-274, DOI: 10.1080/19325037.2023.2209617

To link to this article: https://doi.org/10.1080/19325037.2023.2209617

Published online: 30 May 2023.

AMERICAN JOURNAL OF HEALTH EDUCATION
2023, VOL. 54, NO. 4, 265–274
https://doi.org/10.1080/19325037.2023.2209617

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Time Management Behavior Structural Equation Model Predicts Global Sleep Quality in Traditional Entry University Students

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ABSTRACT

Background: Poor sleep is commonplace among traditional entry university students. Lifestyle modifications, such as time management behaviors, may improve sleep quality by allocating sufficient time for sleep and mitigating stress-associated sleep latency inefficiencies.

Purpose: The purpose of our study was to evaluate time management behaviors as predictors of sleep quality in traditional entry university students. We hypothesized that time management behaviors would predict perceived control of time, which in turn, would predict global sleep quality.

Methods: A cross-sectional convenience sample of university students (n = 302) completed a 73-item instrument comprised the Pittsburgh Sleep Quality Index and the Time Management Behavior scale. Model building procedures included exploratory factor analysis, confirmatory factor analysis, and structural equation modeling.

Results: Our specified model identified significant paths between setting goals and priorities (β = .261; p = .012), mechanics of time management (β = .210; p = .043) and preference for organization (β = .532; $p < .001$) for perceived control of time ($R^2 = .300$ $p < .001$). We further identified a significant path between perceived control of time and global sleep quality ($R^2 = .196$, $p = .022$).

Discussion: Our study suggests that time management behaviors are associated with global sleep quality.

Translation to Health Education Practice: Health education interventions addressing sleep quality of traditional entry university students should consider incorporating time management behaviors.

ARTICLE HISTORY
Received 28 December 2022
Accepted 23 January 2023

Background

Insufficient sleep is common in the United States, with an estimated 35.3% of the adults receive less than 7 hours of sleep per night.[1] Poor sleep is a public health concern as it is bi-directionally linked to numerous chronic diseases.[1] Of particular interest within the health education profession is the relationship between insufficient sleep and obesity.[2] Short sleep leads to a cascade of endocrine system inefficiencies, part of which includes dysregulation of hormones that control hunger and satiation: namely, leptin and ghrelin.[2] Subsequently, chronic short sleepers are more likely to overeat, resulting in an increased risk for obesity. Obesity, in turn, increases the risk for obstructive sleep apnea[1]; a breathing disorder independently associated with deleterious cardiometabolic outcomes including diabetes,[3] hypertension,[4] and stroke.[5]

In addition to increasing risk of chronic disease, insufficient sleep has acute physiological and psychological consequences, ranging from increased inflammatory biomarkers,[6] higher risk of unintentional injuries,[7] and diminished emotional regulation.[8] The prevalence of inadequate sleep in the general population is reflected in the sleep patterns of university students. Hicks et al.[9] found a 1.10-hour decrease (14%) in college students' median hours of sleep between 1969 (7.75 hours) and 2001 (6.65 hours). Lund et al.[10] found that less than 30% of college students received at least 8 hours of sleep per night and 25% received less than 6.5 hours of sleep per night. The same study also noted erratic sleeping patterns in this sample, including restricted weekday sleep, staying up a full 24 hours at least once in the past month (20%), and staying up until 3:00 a.m. at least once per week (35%).[10]

Sleep quality encompasses quantitative components of sleep including sleep duration, latency, and fragmentation in addition to qualitative components such as "depth" and "restfulness" of sleep.[11] In university students, poor sleep quality obstructs higher cognitive functions, impairs psychomotor vigilance, impedes emotional stability, and is associated with overall lower life satisfaction.[12,13] University students are not always aware of the impact sleep restriction has on their ability to maximize cognitive performance.[14] Pilcher and

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Walters[15] found sleep-deprived university students performed considerably worse on a controlled study task compared to non-deprived students, yet the deprived study group reported significantly higher levels of estimated performance on the study task relative to the control group.

To succeed, traditional entry university students must adjust to a complex interplay of novel social, academic, and lifestyle dynamics.[16] To balance the demands of university life, students may restrict their sleep during the week and then attempt to compensate for their sleep debt over the weekend.[14,17,18] The relevance of time management in relation to sleep is exemplified by exam study behaviors. In this context, students frequently report acute bouts of sleep deprivation ranging from 24 to 48 hours.[15] Such variability in sleep/wake cycle patterns may partially explain the delayed sleep-phase syndrome symptoms in university student populations.[18,19] In addition to lifestyle factors, traditional entry university students undergo developmental changes as they finish transitioning from adolescence to adulthood.[20] These physiological changes are associated with many of this population's sleep problems including a delayed circadian preference, poor sleep quality, and daytime dysfunction due to excessive sleepiness.[20]

The increased vulnerability to sleep difficulties within this population suggests time management may be a correlate of sleep quality. Although there are several genetic, environmental, and behavioral factors believed to influence sleep, there is evidence the sleep quality of university students can be improved through lifestyle modifications. Brown et al.[21] concluded that varying sleep schedules, going to bed thirsty, environmental noise, and worrying while falling asleep contributed to students' poor sleep quality. Taub and Berger[22] discovered that even among students who received 8 hours of sleep per night, those who shifted their sleep schedules by 2 hours or more over the weekend reported greater levels of depression, decreased sociability, and more cognitive difficulties. Vranesh et al.[23] observed that students overly concerned about effectively managing their time to meet academic demands were more likely to report sleep problems.

Time management may play an important role in sleep quality outcomes.[10,24] Claessens et al.[25] define time management as a set of activities aimed at achieving an effective use of time while performing particular goal-related endeavors. Behaviors encompassed in this operational definition include time assessment, planning, and monitoring behaviors.[25] For adults, sleep duration requirements range from 7 to 9 hours per night.[26] In addition, time must be allocated for sleep latency, or the amount of time it takes for sleep onset to occur once an individual begins trying to fall asleep[27] Given a significant block of time must be allocated to achieve sufficient sleep quality, poor time management behaviors may interfere with sleep demands. Furthermore, mismanagement of time may lead to increased stress levels.[28] Indeed, university students frequently cite academic and emotional stress as the primary source of their poor sleep.[10] Stress increases vulnerability to sleep disturbance and hyperarousal, resulting in increased sleep onset latency[10,29] and impairs next-day memory performance.[30]

Lifestyle modifications that mitigate stress, such as time management behaviors, may reduce stress-associated sleep inefficiencies.[10] Improved sleep from proper time management may subsequently improve other sleep quality domains, such as daytime dysfunction from sleepiness and overall sleep quality.[31,32] Time management may be a more relevant predictor of sleep quality in generalized, non-clinical populations, such as the traditional entry university students between 18 and 24 years of age.[33] As a non-clinical population, traditional entry university students may be more likely to engage in self-imposed sleep restriction due to psychosocial reasons, as opposed to experiencing poor sleep quality due to physiologically based sleep disorders, such as sleep apnea,[34] restless leg syndrome,[35] chronic pain,[36] thyroid imbalances,[37] or diabetes mellitus.[38]

Purpose

Given this backdrop, the purpose of our study was to assess the capacity of time management behaviors to predict sleep quality among traditional entry university students. Our primary hypotheses encompassed specifying a theoretical framework that included time management behavior constructs predicting sleep quality. Our primary set of hypotheses posited that the exogenous *setting goals and priorities, mechanics of time management*, and *preference for organization* variables would significantly predict the endogenous variable, *perceived control of time*.[28,39] Concurrently, we hypothesized that *perceived control of time* would significantly predict *global sleep quality*.

Methods

Participants and recruitment

We collected cross-sectional convenience samples from a subject pool of students enrolled in an introductory human development course at a southwestern university during the fall of 2019. We operationally defined traditional entry university students in accordance with

Trueman and Hartley's[33] criteria to include (a) full time, (b) undergraduate university students, (c) between 18 and 24 years of age. As we sought to investigate the relationship between sleep and time management behaviors in university students free of sleep disorders, respondents who self-reported being diagnosed with a medical sleep disorder and respondents who self-reported being pregnant were ineligible to participate in our study. We sought a minimum of 300 participants to meet conventional sample size requirements of 200[40] for structural equation modeling and 300 for factor analysis.[41] In association with course instructors, respondents were eligible to receive extra credit for their participation. Permission to recruit participants was obtained from the University of Alabama Institutional Review Board (IRB) prior to initiating data collection.

Instrumentation

We collected the data for this study using a 73-item electronic instrument consisting of two questionnaires and a demographic section. We made available a hyperlink to the electronic instrument to the subject pool through course websites. The first questionnaire measured sleep quality through the Pittsburgh Sleep Quality Index (PSQI), while the second questionnaire measured time management using the Time Management Behavior (TMB) scale. The final component of the instrument included demographic items to assess the characteristics of the sample. We included two attention filter items in the instrument as quality check indicators and excluded data from any respondents that did not answer the filter items correctly. To increase response quality, we excluded data from any respondents that finished the instrument in 5 min or less. The last page of the questionnaire included a "proof of completion form" which participants could print and submit to their instructor to receive a nominal bonus point incentive. In this way, we were unable to link the data back to any of the participants.

Sleep quality

We measured sleep quality using the Pittsburgh Sleep Quality Index (PSQI).[11] The PSQI is a 19-item, self-report, recall questionnaire designed to evaluate sleep quality over the past 30 days. The PSQI is comprised of a series of sub-scales that generate seven component scores: *sleep duration, sleep latency, daytime dysfunction due to sleepiness, sleep disturbances, sleep efficacy, overall sleep quality*, and *use of sleep medication*. For each component, a score of 0 indicates no difficulty, whereas a score of 3 indicates severe difficulty. The sum of the seven components provides a *global sleep quality* score that has been validated against polysomnography, the clinical gold standard for evaluating sleep. Sensitivity (90%) and specificity (87%) of *global sleep quality* scores, distinguish poor and good quality sleepers, with scores >5 indicating poor sleep quality and scores of ≤5 indicating good sleep quality.[11] The developers of the PSQI reported accepted levels of internal reliability (Cronbach's α = .830), test–retest reliability (r = .850, p < .001), and discriminant validity against controls (*Hotelling's* T^2 = 2.62, p < .001).[11]

Time management

We measured time management with the TMB scale.[28,39] The TMB scale is a 46-item instrument that uses 5-point, Likert-type scales (1 = Seldom True; 5 = Very Often True) to measure four time management behavior constructs. The first construct, *setting goals and priorities*, refers to the goals an individual must accomplish and the prioritization of various tasks to achieve said goals. The second construct, *mechanics of time management*, refers to tasks normally associated with managing time, such as creating lists and planning. The third construct, *preference for organization*, refers to a general preference for organization in the individual's workplace and approach to projects. The final construct, *perceived control of time*, evaluates the individuals' self-efficacy for control of their time. According to Macan,[39] *setting goals and priorities, mechanics of time management*, and *preference for organization* constructs are predictors of the model's outcome variable, *perceived control of time*. The TMB instrument also asks participants, "have you ever read books on time management or stress management" and "have you ever attended stress or time management seminars/workshops"? The developers of the TMB scale reported moderate levels of internal reliability (Cronbach's α = .680) as well as acceptable convergent (F-values between .18 and .29, p < .01) and discriminant validity (F-values between .18 and .26, p < .01).[39]

Model building procedures

We followed the protocol outlined by Macan[39] to evaluate the reliability and validity of the TMB theoretical model. First, we conducted an exploratory factor analysis using the maximum likelihood method with promax rotation and Kaiser Normalization to determine the factor structure of the data. We selected promax rotation to allow the factors to correlate.[42] We applied the Kaiser criterion for eigenvalues greater than 1.00 as the basis for factor extraction.[43] Next, we used confirmatory factor analysis to determine the construct validity. We assessed convergent validity through factor loadings, construct reliability (CR), and average variance extracted (AVE). We set AVE≥.50 and CR≥.70.[44,45] For discriminant validity, we required maximum shared variance (MSV) <AVE and the square root of AVE> inter-construct correlations.[44]

We use a totally disaggregated approach to build our models.[46] Fit indices for both our measurement and structural models included relative Chi-square ($\chi^2/d.f.$), goodness-of-fit index (GFI), adjusted goodness-of-fit index (AGFI), incremental fit index (IFI), normed fit index (NFI), comparative fit index (CFI), and root mean square error of approximation (RMSEA) values. Goodness-of-fit indices were set *a priori* with $\chi^2/d.f.<5$, GFI, AGF, IFI, NFI, and CFI>.80, and RMSEA< .80.[47,48] We used IBM SPSS and AMOS version 28.0 software to build our models and Microsoft Excel 2019 to calculate CR, AVE, and MSV based on the formulas developed by Fornell and Larcker.[49] To enhance reporting transparency, we reported our study findings following the recommended guidelines outlined in the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE)[50] criteria.

Results

Descriptive statistics

A total of 336 respondents enrolled in the study. We excluded the responses of those participants that did not provide consent (n = 21), failed to meet inclusion criteria (n = 1, diagnosed sleep disorder; n = 1 pregnant), failed to meet quality check filter standards (n = 1, time filter standard; n = 3, attention filter items), or those considered multivariate outliers (n = 2; Mahalanobis' distance chi-square distribution values at the .001 level). We further excluded six cases due to missing data, which resulted in a final sample size for analysis of 301, satisfying our sample size requirements. Prior to building the model, we reviewed the cleaned data set for missing data, normality, homoscedasticity, linearity, and multicollinearity. There were no major violations of modeling assumptions. We conducted Harman's single-factor test to detect for the presence of common method variance.[51] No dominant factor emerged, suggesting the data were free from significant common method bias effects.[52]

Study participants were primarily female (n = 255; 84.7%), non-Hispanic (n = 290; 96.3%) Caucasian (n = 240; 79.7%), or African American (n = 45; 15.0%). The mean age of the participants was 19.48 (SD = 1.95) years, with most being first (n = 165; 54.8%) or second year (n = 58; 19.3%) university students. The means (M) and standard deviations (SD) for the observed ranges (OR) of the *setting goals and priorities* (OR = 10–50; M = 33.32; SD = 8.90), *mechanics of time management* (OR = 11–55; M = 30.97; SD = 9.04), *preference for organization* (OR = 12–40; M = 30.35; SD = 6.62), and *perceived control of time* (OR = 7–25; M = 15.90; SD = 3.90) constructs were all within the possible score ranges (10–50; 11–55; 8–40; 5–25, respectively). Among the sample, only 78 (25.9%) had ever read books on time or stress management and only 55 (18.3%) had ever attended time or stress management seminars/workshops. The mean global PSQI score of the sample was 6.76 (SD = 2.76) and ranged from 0.00 to 16.00. Applying standard *global sleep quality* score cut points (≤5.00, good sleep quality; >5.00, poor sleep quality) for the PSQI, we classified 198 (65.8%) of participants as poor quality sleepers and 103 (34.2%) as good quality sleepers.

Model building specification

Based on the pattern matrix, we removed two items from the *setting goals and priorities*, seven items from the *mechanics of time management*, and two items from the *preference for organization* scales due to low factor loadings (<.40).[53] The final iteration of our exploratory factor analysis resulted in a three-factor solution representing the constructs of *setting goals and priorities, mechanics of time management*, and *preference for organization*. The three extracted factors with Eigen values greater than 1.0 accounted for 61.32% of the cumulative variance. All items are loaded according to hypothesized construct groupings.

Next, we tested the three-factor solution with confirmatory factor analysis to determine the degree of convergent and discriminant validity of the measurement model, which comprised three latent variables and 18 observed variables. Our model yielded adequate fit ($\chi^2/d.f.$ = 3.136, GFI = .860, AGFI = .819, NFI = .849, CFI = .891, and RMSEA = .084). All regression paths were significant ($p < .001$). Construct reliability values were adequate, ranging from .798 to .896. Based on average variance extracted, maximum shared variance, and maximum reliability values, we confirmed convergent and discriminant validity among the time management behavior constructs. Table 1 summarizes factor loadings of the three-factor solution as well as the reliability and validity measures of the time management behaviors measurement model.

Fitting of our structural equation model required removal of one indicator from the *setting goals and priorities* construct, one indicator from the *mechanics of time management* construct, and one indicator from the *perceived control of time* construct due to low factor loading. Fit for our final model met *a priori* thresholds ($\chi^2/d.f.$ = 1.762, GFI = .918, AGFI = .885, IFI = .955, NFI =.902, CFI = .954, RMSEA = .050). In terms of the PSQI, the scale was internally consistent (α = .627), and each sub-scale was significantly correlated with *global sleep quality* at the .001 level. Regarding *perceived control of time*, the construct was internally consistent (α = .728) and significantly correlated with *setting goals and priorities* (r = .178), *mechanics of time management* (r = .163), *preference for organization* (r = .532) and *global sleep quality* (r = .273) at the .001 level.

Significant direct paths for the final model were identified between *setting goals and priorities* (β = .261; p = .012), *mechanics of time management* (β = .210; p = .043) and *preference for organization* (β = .532; p < .001) on the *perceived control of time* construct (R^2 = .300; p < .001). A significant direct path was also identified between *perceived control of time* and the *global sleep quality* construct (R^2 = .196; p = .022). Table 2 summarizes the parameter estimates for the final structural model predicting *global sleep quality* from the time management behaviors of the sample. Figure 1 illustrates the final structural model with standardized regression weights.

Discussion

Our study hypotheses were rooted in the premise that achieving adequate sleep requires allocation of sufficient time for sleep and that time management behaviors may influence stress-associated sleep quality inefficiencies (e.g., sleep latency, daytime dysfunction due to sleepiness). The results of our study found that the TMB[39] theoretical framework significantly predicted *perceived control of time*, which, in turn, accounted for significant variance in the *global sleep quality* of the sample. In our sample, *preference for*

Table 1. Exploratory factor analysis factor loadings and confirmatory factor analysis convergent and discriminant validity values for time management behavior scale constructs (N = 301).

	Exploratory Factor Analysis[a]			Confirmatory Factor Analysis[e]		
Construct	Factor 1	Factor 2	Factor 3	CR[f]	AVE[g]	MSV[h]
Setting Goals and Priorities[b]				.896	.520	.473
Item 3	.688					
Item 4	.730					
Item 5	.769					
Item 6	.804					
Item 7	.658					
Item 8	.624					
Item 9	.735					
Item 10	.751					
Mechanics of Time Management[c]				.798	.509	.473
Item 2			.515			
Item 5			.806			
Item 6			.880			
Item 7			.597			
Preference for Organization[d]				.856	.501	.063
Item 3		.641				
Item 4		.704				
Item 5		.614				
Item 6		.788				
Item 7		.819				
Item 8		.656				

[a]Exploratory Factor Analysis Notes. Kaiser-Meyer-Olkin measure of sampling adequacy (KMO) = .878; cumulative variance = 61.32%. Following items were removed due to loading values <.40.
[b]Setting Goals and Priorities: Items 1 and 2 removed.
[c]Mechanics of Time Management: Items 1, 3, 4, 8, 9, 10, 11 removed.
[d]Preference for Organization: Items 1 and 2 removed.
[e]Confirmatory Factor Analysis Notes. Fit statistics for the time management behavior measurement model: χ^2 = 413.909, df = 132, p < .001; CMIN/DF = 3.136, GFI = .860, AGFI = .819, NFI = .849, CFI = .891, and RMSEA = .084.
[f]CR = construct reliability.
[g]AVE = average variance extracted.
[h]MSV = maximum shared variance.

Table 2. Parameter estimates for the time management behavior structural equation model predicting global sleep quality (n = 301).

Variables	B	*SE B*	CR	β	*p*	Hypothesis Supported Yes/No
Perceived Control of Time ← Setting Goals and Priorities	.196	.078	2.514	.261	.012	Yes
Perceived Control of Time ← Mechanics of Time Management	.183	.091	2.020	.210	.043	Yes
Perceived Control of Time ← Preference for Organization	.422	.088	4.822	.532	<.001	Yes
Global Sleep Quality ← Perceived Control of Time	1.173	.512	2.290	.232	.022	Yes

Structural model fit statistics: $\chi^2/d.f.$ = 1.762, GFI = .918, AGFI = .885, IFI = .955, NFI = .902, CFI = .954, RMSEA = .050.

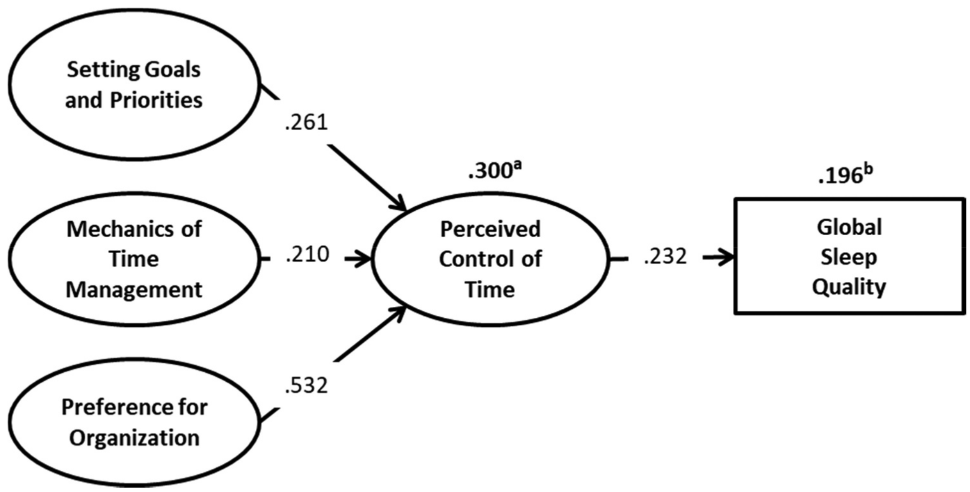

Figure 1. Time management behavior structural equation model predicting perceived control of time and global sleep quality with standardized regression weights (n = 301). Filled-in lines represent significant pathways; dotted lines represent non-significant pathways ($p > .05$). Model pathways reported as standardized regression weights; squared multiple correlations presented in bold text.
[a]Variance explained for perceived control of time.
[b]Variance explained for global sleep quality.

organization was the most significant predictor of *perceived control of time* (β = .532; $p < .001$). Macan's[39] study using the TMB framework also identified *preference for organization* as explaining the most variance in perceived control of time (β = .043; $p < .001$). Macan et al.[28] also found *perceived control of time* to be the most significantly related correlate of performance and affective measures of stress.

The content of this construct included items such as: "at the end of the workday I leave a clear, well-organized work space," "the time I spend scheduling and organizing my workday is time wasted (reverse coded)," and "when I am somewhat disorganized I am better able to adjust to unexpected events (reverse coded)." Of note, the TMB model does not directly measure how effective participants are at organizing their workspace or scheduling tasks.[39] Instead, it measures how an individual's time management behaviors influence their perceived control of time. It is possible that an increased preference for organization creates a sense of control over one's productivity and academic performance. This could result in a greater sense of control over time, independent of how effective an individual is at organizational efficiency, which may partially explain why *preference for organization* is *perceived control of time*'s strongest predictor. Subsequently, *preference for organization*'s influence on *perceived control of time* could lead to mitigated stress-related sleep problems.

Both *setting goals and priorities* (β = .261; $p = .012$) as well as *mechanics of time management* (β = .210; $p = .043$) explained similar variance in the *perceived control of time* construct. It should be noted that many items from the *mechanics of time management* scale had to be removed due to low factor loadings. However, this should be not necessarily be considered an inherent flaw of the model. Having used convenience sampling, it is impossible to rule out that our study participants were unique, which lead to lower factor loadings; however, a review of the items comprising this construct suggests that conventional time management methods have evolved since the conception of the TMB framework. For example, items such as "I use an in-basked and out-basket for organizing paperwork," "I carry a notebook to jot down notes and ideas," "I carry an appointment book with me," and "when I find that I am frequently contacting someone, I record that person's name address, and phone number in a special file," should be revised to reflect updates in technology.

Revision of this scale's items to include time management tools such as electronic calendars with automatic due date reminders, smart phone contact cards, employment-oriented social media, cloud services for organizing and sharing electronic files, smart devices and apps, virtual assistant technology with time trackers, wearable devices synced with smart calendars, and even group chat rooms may lead to greater retainment of this construct's indicators. On its face, the *mechanics of time management* construct appears valid; however, given changes in the mechanics of time management, it could be argued there are concerns with the construct's content validity. Additionally, this construct was not a significant predictor of *perceived control of time* in

Macan's[39] study, which they partially attributed to potential differences in monochronic (those that focus on one task at a time) and polychronic (that engage in more than one activity at a time) individuals.[54] We agree that the mechanics of time management construct is theoretically consistent within the model, yet it may need additional formative research to improve its validity.

An interesting distinction between mechanics of time management and setting goals and priorities is their relative frames of reference in relation to time. Our assessment of the construct's items suggested that *setting goals and priorities* encompassed a more forward thinking, strategic approach to time management (e.g., "I break complex, difficult projects down into smaller manageable tasks" and "I look for ways to increase the efficiency with which I perform work activities"); whereas, *mechanics of time management* construct items were more present-focused approaches to time management (e.g., "I make a list of things to do each day and check off each task as it is completed"). Given that only a small proportion of the sample ever "read books on time or stress management" (25.9%) or "attended stress or time management seminars/workshops" (18.3%), it is possible our sample lacked these more advanced time management skills and thus their role in *perceived control of time* may not have been as explanatory. Goal setting and reducing complex tasks into smaller steps has been demonstrated to improve task performance.[55] Locke et al.'s goal setting theory[56] contends that goals must be specific and challenging and that goal mediators (e.g., strategies and effort) and moderators (e.g., commitment, feedback, and self-efficacy) influence the capacity for goals to improve performance.[57] Future research should seek to evaluate interventions, which increase goal setting theory constructs for time management behaviors such as *setting goals and priories* to test this construct's potential for improving *perceived control of time*.

Limitations and future directions

This study is unique in that, to the best of our knowledge, no previous study has examined time management as a predictor of sleep quality.

Nonetheless, there were inherent limitations with our study that should be considered when interpreting our findings. The self-report nature of our data is a noted limitation. Beyond issues inherent to self-report such as recall, acquiescence, and social desirability bias, objective measures of sleep (e.g., actigraphy) could have strengthened our study findings. We attempted to minimize these limitations by increasing participant confidentiality and using a standardized, self-report measure of sleep quality.

We did not measure important hypothesized correlates of time management, such as stress, substance use and misuse, or social determinants of health (e.g., housing and finances). While we sought to keep participant burden to a minimum, collecting these measures could have provided more support for our hypotheses and strengthened our model. We used Macan et al. TMB model to assess time management in our sample as studies using this instrument have reported adequate validity and reliability.[58] Our study also supported the hypothesized TMB framework. However, there is limited research exploring time management processing, and the TMB theoretical framework has not been extensively tested. The PSQI, however, has been utilized in clinical and non-clinical populations for assessing sleep quality.[59]

Given the cross-sectional nature of our study, we were unable to ascertain the potential of causal connections between the variables we analyzed. Additionally, since our data were derived from convenience samples, we could not make generalizable inferences to our priority population. As our sample was rather homogenous in nature, the predictive capacity of the time management constructs may be of limited utility when applied to more diverse demographics.

However, a noted strength of the TMB model is its inclusion of *perceived control of time* as an endogenous variable within its framework.[39] *Perceived control of time* is conceptually similar to *perceived behavioral control* in that perceptions of behavioral control can account for significant variance in actual behavior when behavioral intentions are held constant; particularly in situations that are not completely under a person's volitional control, such as a university setting.[60] *Perceived behavioral control* as a significant, and highly practical, correlate of sleep behaviors falls in line with previous behavior-intention model-based sleep research, which helps to bolster the potential of the TMB model to accurately predict variance in a variety of sleep outcomes.[61–63]

Future research examining these themes should seek to test longitudinal studies that collect pre- and posttest measures of time management, sleep, goal-setting mediators and moderators, stress, academic performance, environmental and organizational factors, as well as social determinants of health. Ideally, an experimental design would be implemented in which the treatment arm would receive a time and stress management theory-based intervention and the control arm a waitlist or standard care control. Such a design could advance our understanding of causal relationships between important variables relevant to the sleep health of traditional entry university students. Study results could be strengthened by collecting objective measures of sleep (e.g., actigraphy and genetic testing for morning/evening chronotype), stress (e.g., salivary cortisol), and time management (e.g., standardized time and goal-setting logs and task trackers) over the course of the study, in diverse university student populations.

Translation to Health Education Practice

The findings of this study may present implications for health education and promotion practice. According to the National Commission on Health Education Credentialing Inc. (NCHEC) (www.nhec.org), the role of the health education specialist is to promote and support the health and wellness of individuals and communities in developing, implementing, and evaluating strategies to improve health outcomes.[64] In light of NCHEC's mission, the findings of our study may present opportunities for health education specialists to promote sleep health.

Sleep health has become a more prominent public health concern; particularly as sleep relates to risk factors connected to overweight and obesity. Poor sleep is commonplace, with over one-third of US adults receiving less than the recommended 7 hours of sleep per night (Area 1, Competency 1.2, Sub-Competency 1.2.1).[1] Of interest to health education specialists is the development of modalities for improving lifestyle factors relevant to sleep health. Time management is one such factor that is relevant to traditional entry student populations. Health education specialists may consider using a variety of modalities for educating the public on improving time management and sleep health behaviors (Area 6, Competency 6.5).

The instruments used to develop our research model included the PSQI and the TMB scales (Area 1, Competency 1.2, Sub-Competency 1.2.7). Our data were collected from a sample of traditional entry university students. As such, health educators working in university wellness and health promotion offices may find our study directly relevant to the needs of the populations they serve. However, these instruments have been used in a variety of populations with adequate reliability and validity[59]; hence, health education researchers and practitioners could replicate our study to evaluate the importance of time management for sleep quality in other populations at risk for insufficient sleep (Area 4, Competency 4.1, Sub-Competency 4.1.8). Furthermore, health education practitioners working in community settings could use these instruments to measure and evaluate health education and promotion interventions aimed at improving sleep behaviors in diverse populations (Area 2, Competency 2.3, Sub-Competency 2.3.4; Area 4, Competency 4.3, Sub-Competency 4.3.2).

In summary, the primary purpose of our study was to assess the capacity of time management behaviors to predict sleep quality in a sample of traditional-entry university students. Within this sample, time management was a relevant factor for sleep quality (Area 1, Competency 1.3, Sub-Competency 1.3.2). Given the prevalence of poor sleep quality in the general population, health education specialists targeting sleep outcomes may wish to consider expanding our efforts by evaluating these factors in a variety of diverse communities (Area 8, Competency 8.1, Sub-Competency 8.1.4). Health education specialists may also incorporate the instruments used in our study to evaluate the sleep health interventions they design and implement to assess the impact of their intervention efforts on improving time management and sleep behaviors in the populations they prioritize.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This work was supported by the National Heart, Lung, & Blood Institute, National Institutes of Health, Bethesda, MD, under Grant [1K01HL145128]; National Institutes of Health Loan Repayment Program, Division of Loan Repayment, National Institutes of Health, Bethesda, MD, under Grant [L30HL15969].

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