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The interplay between sleep and mood in predicting academic functioning, physical health and psychological health: A longitudinal study

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ABSTRACT

Objectives: Existing studies on sleep and behavioral outcomes are mostly correlational. Longitudinal data is limited. The current longitudinal study assessed how sleep duration and sleep quality may be causally linked to daytime functions, including physical health (physical well-being and daytime sleepiness), psychological health (mood and self-esteem) and academic functioning (school grades and study effort). The mediation role of mood in the relationship between sleep quality, sleep duration and these daytime functions is also assessed.
Methods: A sample of 930 Chinese students (aged 18–25) from Hong Kong/Macau completed self-reported questionnaires online across three academic semesters. Sleep behaviors are assessed by the Sleep Timing Questionnaire (for sleep duration and weekday/weekend sleep discrepancy) and the Pittsburgh Sleep Quality Index (sleep quality); physical health by the World Health Organization Quality of Life Scale—Brief Version (physical well-being) and Epworth Sleepiness Scale (daytime sleepiness); psychological health by the Depression Anxiety Stress Scale (mood) and Rosenberg Self-esteem Scale (self-esteem) and academic functioning by grade-point-average and the College Student Expectation Questionnaire (study effort).
Results: Structural equation modeling with a bootstrap resample of 5000 showed that after controlling for demographics and participants' daytime functions at baseline, academic functions, physical and psychological health were predicted by the duration and quality of sleep. While some sleep behaviors directly predicted daytime functions, others had an indirect effect on daytime functions through negative mood, such as anxiety.
Conclusion: Sleep duration and quality have direct and indirect (via mood) effects on college students' academic function, physical and psychological health. Our findings underscore the importance of healthy sleep patterns for better adjustment in college years.

Introduction

College students face multiple challenges, such as intellectual demands and identity formation. Furthermore, their sleep behaviors have been characterized by sleep deprivation, poor sleep quality and excessive daytime sleepiness [1]. Growing evidence suggests poor sleep patterns are related to impaired academic performance [2], physical health [3] and psychological well-being [4]. Yet, the temporal relationships among sleep and these functional outcomes are unclear.

Sleep and psychological well-being

The relationship between sleep, mood and other psychological functions has lately become a rapidly developing research area. While negative mood, such as depression and anxiety, has long been identified as harming nighttime sleep, recent findings show that the relationship between sleep and mood is bi-directional [5]. Neuropsychological evidences suggest that both quality and quantity of sleep are vital to the optimal functioning of brain activity in regulating our emotions [5]. Fredriksen and coworkers [4] provided longitudinal data to show that among adolescents, sleep loss was a significant predictor of increased depressive feeling and self-esteem. In fact, Walker and Harvey [6] argued that while sleep and mood are unquestionably linked, future studies should assess how exactly they are related and the outcomes of such interaction/relation.

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Sleep, mood and academic functioning

Sleep and mood also affect school performance. Kelly, Kelly and Clanton [7] found a positive correlation between hours of sleep and school grades. Students with ≥8 h of sleep reported an average grade-point-average (GPA) of 3.24 compared to an average GPA of 2.74 for those with <7 h of sleep. Psycho-physiological research indicated that sleep is crucial for the consolidation and reactivation of memory [8]. Sleep-deprived participants have greater difficulty than healthy controls in recalling learned materials [9]. Good sleep quality was also associated with higher learning motivation and school performance. Gomes, Tavares and de Azevedo [10] recently demonstrated that both sleep duration and quality are significant predictors of school grades among undergraduates. While other evidence suggests that mood is related to school grades and motivation [11], how mood mediates the relationship between sleep behaviors and academic functioning remains to be determined.

Sleep, mood and physical health

A healthy sleep pattern has been shown to relate to desirable health conditions. Sleep duration and quality are suggested to closely relate to daytime sleepiness which reflects one's inability to sustain attention [1]. Daytime sleepiness has been used as an indicator of the health status in both patient and healthy population. For instance, excessive daytime sleepiness is seen as a cardinal symptom in sleep apnea and it is correlated with increasing medical problems in an otherwise healthy population [12]. Apart from daytime sleepiness, sufficient sleep is also demonstrated to predict health conditions, such as blood pressure [13] and body mass index (BMI) [3]. Chang and coworkers [14] found that among cancer patients' caregivers, poor self-reported sleep quality predicted dissatisfaction with physical health. While sleep behaviors appear to correlate with physical health, limited studies compared the relative contribution of different sleep behaviors in predicting health conditions.

The current study

Although increasing evidence suggests that sleep behaviors are closely linked with mood and functional outcomes (including academic functioning, physical and psychological health), causal relationships cannot be established without longitudinal or experimental evidence [2]. The current study aims primarily to explore the temporal relationships from sleep behaviors to the aforementioned functional outcomes. We also intend to explore if sleep affects daytime functions through inducing negative mood. In other words, we plan to test the mediating role of mood between sleep behaviors and daytime functions. While some sleep behaviors were shown to have differential roles in predicting daytime functions in previous cross-sectional studies, we aim to compare the relative contribution of interdependent sleep behaviors in predicting the outcome measures with a longitudinal structural equation modeling (SEM) approach. With the use of SEM, all regression pathways can be tested at once and comparisons of strengths of pathways can be made accordingly.

Methods

Participants

Chinese undergraduates, aged 18–25 from 16 universities and colleges in Hong Kong and Macau were recruited through campus flyers, emails and online platforms. Of the 1195 participants who completed the measurements in Time 1, 1006 (84.2%) continued in Time 2 and 930 (77.8% of Time 1) in Time 3.

Procedures

The current investigation was a sub-study of a large-scale longitudinal research program on the formation and transformation of beliefs, lifestyle, and well-being in Chinese. Ethics approval was obtained from the University of Hong Kong prior to data collection. The study was conducted across three consecutive academic semesters from September, 2010 to December, 2011. Participants filled out online questionnaires in Chinese to report their demographic information, sleep behaviors, academic functioning (GPA and study effort), physical health (physical well-being and daytime sleepiness) and psychological health (mood and self-esteem). For each timepoint, participants first provided informed consent. After completing the measurements, participants could either enter a lucky draw for cash coupons (HK$100/100 participants) or have us make a donation (HK$20) to a designated charity for poverty relief.

Measurements

Demographics

Participants' demographic information (age, sex, BMI, family income, parents' education level and hours of part-time work) were used as covariates in the SEM model. Participants report their family income on a 6-point scale (from 1: <$10,000; 2: $10,000–$19,999 to 6: ≥$50,000). Parents' education level is calculated by the mean score of education level between the two parents on a 6-point scale (1 = pre-primary education; 2 = primary education; 6 = post-graduate education).

Sleep duration and quality. Sleep duration, weekday/weekend sleep discrepancy and various dimensions of sleep quality are included as predictors in the SEM model. The Sleep Timing Questionnaire (STQ) [15] and Pittsburgh Sleep Quality Index (PSQI) [16] were used to examine an individual's sleep duration and weekday/weekend sleep discrepancy, and sleep quality respectively. In lieu of a sleep diary, the STQ consisted of 14 items in assessing an individual's habitual sleep–wake patterns in a recent normal week (when the participant is not sick or on vacation). Sleep duration on school-days and holidays are separately assessed. Weekday/weekend sleep discrepancy is calculated by subtracting the hours of sleep in school-days from holidays. The PSQI assesses seven dimensions of sleep quality: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication and daytime dysfunction, over the past month. With the objective to probe into the potentially different roles of each sleep behavior in predicting the outcome measures, we decided to present sleep quality as five individual dimensions (subjective sleep quality, sleep latency, habitual sleep efficiency, sleep disturbances and daytime dysfunctions). Of note, sleep medication is not used in the current study, as only 3.9% of the student sample has used medicine to aid sleep; sleep duration is captured in STQ more specifically.

Academic functioning

Participants' academic functioning, namely school grades (GPA) and study effort in the previous semester are set as outcome variables in the SEM model. GPA is measured on an 11-point scale (1 = F or ≤1.00; 11 = A/A+ or ≥4.00). Study effort is measured by the College Student Expectations Questionnaire, CSEQ) [17]. We conducted a factor analysis of this measurement of diverse aspects of college experiences (Supplement 1 for details) and extracted three items relevant to study habits. They were “completed readings for class”, “attended to teachers' lecturing” and “jotted detailed notes in class”. Study effort is operationalized by aggregating answers to these three items.

Physical health

Participants' physical health, measured by their physical well-being and daytime sleepiness, is another outcome variable in the SEM model. The domain of physical well-being in the World Health Organization Quality of Life Measures (WHOQOL-BREF, HK) [18] includes seven