Sleep Patterns and Health: How Important Are Sleep Duration and Sleep Variability?

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We live in a modern 24-hour society that never truly sleeps, and around 10 % of the adult population suffers from chronic sleep difficulties defined as insomnia (Pallesen et al., 2001). There is thus a pressing need for knowledge about what characterizes health-promoting sleep patterns.

This article is a popular science summary of the doctoral dissertation: "Sleep patterns and health. Investigating the significance of sleep duration and sleep variability" (2024), Norwegian University of Science and Technology (NTNU), Trondheim.

Background

Sleep duration is one of the most commonly used measures of sleep and has been shown in numerous studies to be strongly associated with both physical and mental health (Chaput et al., 2020; Steptoe, Peacey, & Wardle, 2006). Still, few individual studies have examined the association between sleep duration and a broad spectrum of mental health outcomes. In addition to sleep duration, sleep variability – that is, how stable sleep is from day to day – has gained increasing attention as a potential predictor of health (Bei, Wiley, Trinder, & Manber, 2016). Variability in when and how long one sleeps has been shown to affect health on multiple levels, and irregular sleep patterns are

particularly common among young adults (Dillon et al., 2014). Clinically, stabilizing behaviorally influenced sleep patterns has been a central component of cognitive behavioral therapy for insomnia (CBT-I) (Morin & Espie, 2007), including digital versions (dCBT-I). In dCBT-I, participants are encouraged to follow consistent bedtimes and wake-up times throughout the week. However, research has so far been limited on whether this stabilization actually contributes to treatment effects.

Objective of the doctoral thesis

The thesis investigated the relationship between sleep patterns and health, with particular focus on mental health and the effect of a sleep intervention. The aim was twofold:

1. To examine how sleep duration and variability in sleep duration are associated with mental and physical health in young adult students (Studies I and II).
2. To investigate sleep variability in adults with insomnia symptoms, particularly whether changes in variability during dCBT-I can explain improvements in sleep difficulties and mental health (Studies III and IV).

How were the studies conducted?

The dissertation comprises four studies exploring the link between sleep patterns and health in two different populations: young adult being students and adults with insomnia symptoms. The first two studies are based on large cross-sectional datasets from the student population, while the last two build on a large randomized controlled intervention trial.

Studies I and II used data from the Students' Health and Wellbeing Study (SHoT), a national survey collecting health information from all full-time university and college students in Norway. More than 50,000 students participated in the relevant waves (SHoT2018, SHoT2021, and SHoT2022). Participants completed questionnaires on sleep habits,

mental and physical health, lifestyle, and academic performance. Study I used longitudinal data to examine whether sleep duration predicted mental health problems one year later. Study II analyzed how variability in sleep duration between weekdays and weekends was associated with both health and academic performance. Sleep was self-reported, with average sleep duration on weekdays and weekends assessed separately, allowing for measurement of total sleep time and sleep variability.

Studies III and IV were part of a large randomized controlled trial including 1,720 adults with symptoms of insomnia. Participants were randomly assigned to either receive dCBT-I or a sleep education control intervention. They completed sleep diaries for at least 10 out of 14 days and filled out standardized questionnaires assessing sleep problems, psychological distress, sleep-related thought patterns, and lifestyle factors both at baseline and post-treatment. Sleep diaries were used to calculate intraindividual variability, measuring day-to-day fluctuations in sleep.

Main findings

Study I: Sleep duration and mental health in students (Vestergaard, Skogen, et al., 2024)

Short (<7 h) and long (>9 h) sleep were associated with poorer mental health such as anxiety and depression, as well as lower quality of life one year later. The highest risk was observed with short sleep, consistent across both genders.

Study II: Irregular sleep and health in students (Vestergaard, Simpson, et al., 2024)

Large differences in sleep duration between weekdays and weekends were linked with poorer mental (psychological distress and dissatisfaction with life) and physical health (obesity and somatic burden) and a higher risk of exam failure. Students who consistently slept too little had the highest risk, but those who compensated with

more weekend sleep had somewhat lower risk for adverse health outcomes.

Study III: Sleep variability in adults with insomnia (Bredeli et al., 2022)

High intraindividual day-to-day variability in sleep patterns was associated with greater sleep problems, fatigue, higher BMI, and alcohol consumption – but also with better perceived sleep quality in some sleep variables.

Study IV: Treatment effects on sleep variability (Vestergaard et al., 2021)

Digital Cognitive Behavioral Therapy for Insomnia significantly reduced sleep variability. This reduction partially explained improvements in insomnia symptoms, and even more so reductions in symptoms of psychological distress with symptoms of anxiety and depression.

Summary and implications

Among young adult students, sleep duration appears to be a transdiagnostic risk factor for a wide range of mental health issues one year later. Consistently short sleep throughout the week was clearly linked to the highest risk of psychological distress. Long sleep was also associated with increased risk, though less strongly. The implications of these findings depend on understanding why young adults sleep the way they do—particularly whether their sleep patterns are voluntary or involuntary.

Treatment with dCBT-I led to clear stabilization of sleep patterns compared to the control group. This stabilization partly explained improvements in sleep difficulties and, to a greater extent, symptoms of psychological distress. The analyses showed a stepwise effect: stabilizing behavioral sleep patterns (such as bedtime and time in bed) led to fewer sleep disturbances (like sleep onset latency and awakenings), which in turn led to reduced symptoms of insomnia and

distress. Stabilizing behavioral sleep patterns thus appears to be one of the mechanisms of action in dCBT-I. The findings suggest that stabilization may also be useful for individuals with psychological stress and could potentially be incorporated into treatments for other mental health disorders.

Consistent with previous research linking sleep variability to poor health, this thesis offers further support for that association as variability in sleep duration between weekdays and weekends was associated with negative health and academic outcomes in students. In adults with insomnia, high variability was linked to more severe insomnia and worse physical health. However, some findings suggest that compensatory weekend sleep may be beneficial compared to consistently short sleep. Furthermore, greater variability was linked to better perceived sleep quality in some individuals. These findings suggest that sleep variability may not be universally negative for health. More research is needed to determine for whom and to what extent sleep variability is harmful. In particular, we lack thresholds for what constitutes "healthy" versus "unhealthy" variability across groups. Therefore, future research should include sleep variability alongside sleep duration and aim to standardize how variability is measured and reported.

The overall conclusion of the thesis is that short sleep and high sleep variability are linked to negative health outcomes. At the same time, some variability – like the ability to recover sleep after sleep loss – may be beneficial. This thesis supports continued use of sleep stabilization as a component of dCBT-I for people with insomnia symptoms, and further investigation into its therapeutic potential in other mental health populations.

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