



Is gradual sleep extension effective for social jetlag in adolescents and college students?

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Irregular sleep patterns, insufficient sleep, sleep disturbances, and daytime sleepiness are prevalent in adolescents and young adults [1–5], mainly caused by an interaction of biological (e.g. puberty, circadian or homeostatic changes) and environmental factors (e.g. early school start times, social pressure, academic workload) and/or mismatch between social time and the nature of the individual's biological clock [1, 6–9]. Many youths compensate for their insufficient sleep during the week by extending their sleep on the weekends, resulting in irregular sleep patterns and jet lag-like symptoms. Social jetlag (SJL) represents the discrepancy between circadian (internal body) and social clocks.

SJL is increasingly prevalent among youths in today's "24/7" society. Nearly half of adolescents have SJL for at least 1 h and more than 15% for 2 h or more [10, 11]. In a recent study of Korean adolescents, the prevalence rates of $SJL \geq 2$ h was 41.3% [12]. SJL has negative impacts on multiple domains of psychosocial well-being and health, such as sleep disturbances, daytime sleepiness, fatigue, reduced cognitive function, poor academic performance, behavioral and emotional problems, psychiatric disorders, self-harm, metabolic changes, overweight, and risk of cardiovascular diseases [13–15].

SJL can be treated by chronobiological and sleep interventions such as light therapy, exogenous melatonin, cognitive behavioral therapy, sleep hygiene education, lifestyle modification, and gradual sleep extension (GSE) [6, 8, 16]. GSE can shift adolescents' bedtimes and extend their sleep durations on school nights and to prevent bedtime shifts during the weekend. However, no specific clinical trials have

been conducted to demonstrate the effects of GSE on SJL as the primary endpoint.

In the current issue of *Sleep and Biological Rhythms*, Dr. Furihata and coauthors reported their findings of a parallel randomized controlled trial (RCT) to examine the efficacy of gradual sleep extension therapy using a remote support system (SET-R) in 54 colleague students with $SJL \geq 1$ h [17]. The SET-R included an individualized sleep schedule for GSE plus sleep hygiene education, stimulus control therapy, and progressive muscle relaxation for two weeks. The authors found that the mean SJL score was significantly reduced by 27.7 min at 2 weeks post intervention in the intervention group vs control group. The mean sleep duration increased by 12 min on weekdays (albeit not statistically significant). Daytime sleepiness, depression, and sleep knowledge were significantly improved in the intervention group. At 6-month follow-up, the difference in the mean change in SJL between the two groups was no longer statistically significant, but the scores for depression and sleep knowledge remained significant. There were no significant changes in sleep quality, insomnia, sleep efficiency, and sleep onset latency.

This is the first RCT to have shown that GSE plus other nonpharmacological sleep interventions is effective for decreasing SJL and has potential effects on daytime sleepiness and depressive symptoms in college students. Notwithstanding the strengths of the study, such as an RCT, the experimental manipulation in individuals' home environment and use of objective and subjective measures, several limitations should be pointed out. First, this is not a double-blinded RCT due to the nature of the study. The expectations from the sleep intervention and placebo effects could affect the participants' behavior and consequently the outcomes. Second, adherence to sleep interventions is a major challenge [18], but adherence in the study is unknown. Third, all participants were selected from one single university, making the findings from this study lack generalizability to other college students. Fourth, daytime sleepiness and mental

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health outcomes were assessed based on self-reports. Fifth, although the sample size was estimated to be statistically large enough for the primary endpoint and is comparable to other sleep intervention trials [6, 19, 20], only 54 participants were included in the study. Sixth, the study cannot distinguish the effects of GSE from other interventions such as sleep hygiene education and progressive muscle relaxation and cannot ascertain which one was the most contributing factor. Furthermore, the analysis did not adjust for multiple comparisons, which may increase Type 1 error with some significant differences/changes observed by chance.

Regardless of the study limitations, the findings may have significant clinical and public health implications. From a clinical practice standpoint, health professionals should consider GSE as a treatment method to manage SJL and potentially improve depressive symptoms in youths with $SJL \geq 1$ h. From a public health standpoint, GSE plus sleep hygiene education should be considered as intervention programs in the school settings to improve students' sleep patterns and sleep duration. These findings also have implications for the design and implementation of future sleep health interventions targeting adolescents and young adults.

Given the limitations of the study, large RCTs are warranted to replicate the findings. Further research is also needed to answer the following questions.

- What is the optimal time period of sleep intervention: 1 week, 2 weeks, 3 weeks, or ≥ 1 month?
- What is the optimal time of GSE: 5 min, 10 min, or ≥ 20 min/night?
- What is the adherence of participants to sleep interventions?
- Is GSE in combination with other sleep interventions such as sleep hygiene education and light therapy more effective than GSE alone?
- SJL intervention is associated with improvement in depressive symptoms, which is highly relevant for clinical practice. However, the mechanisms between GSE and changes in SJL and depressive symptoms need to be investigated.

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