Promoting teenage sleep for improved mental health and school performance: Research plan

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Introduction

Sleep problems are common among young people and there are connections between sleep problems and mental health, concentration problems, and lower grades (Hedin et al., 2020, Sampasa-Kanyinga et al. 2020). Over time (historically since the 80's), teenagers sleep less and less and too little, which affects mental health and school performance in the short term. Long-term lack of sleep increases the risk of leaving school with failed grades and of having long-term health problems. It is therefore important to break this trend.

A challenge in existing preventive sleep programs is to motivate young people to change their sleep habits. Just like adults, teenagers have many activities that demand their time. It can therefore be difficult to balance sleep with schoolwork, exercise, etc. Young people need knowledge about sleep to gain an understanding of how it can affect their mood and ability to cope with school. The reasons for the lack of sleep among young people are multifold: the 24-hour society and easily accessible entertainment/society via technology use, puberty-related changes in the circadian rhythm, and stress about the future (Becker et al., 2015). The school has a clear responsibility for the students' knowledge and understanding of the importance of lifestyle for health as well as for supporting the students in orienting themselves in society. The school is therefore a natural arena to reach out to teenagers because most young people are there, and the school health department can offer health-promotion initiatives.

The overall aim of this project is to evaluate the effectiveness of two school-based programs that have the potential to promote adolescent sleep and prevent future depressive symptoms. The programs will be offered to students aged 13-19 at Swedish high schools and upper secondary schools at the classroom level. The students will be compared to teaching as usual (control group).

Sleep on schedule is a program (5 lessons over 5 weeks) that integrates sleep knowledge and skill training to promote good sleep routines. *Technology restriction (TechRest)* is a program (2 lessons over 2 weeks) that targets mobile phone use at bedtime. Both programs have shown good results (up to 20 minutes more sleep on school days). The current goal was to test the effects of the programs on young people in a Swedish context to investigate if they can affect teenagers' sleep and mental health.

The study design is a cluster-randomized study where schools are randomized to either 1) Sleep on schedule, 2) Technology restriction, or 3) Control group (no intervention). All schools will be informed of the results and receive training in the program that proves to be most effective at the end of the project, if desired. The intervention is aimed at students aged 13-19. The study want to involve large parts of the school's staff and avoid that knowledge and responsibility resting on a few members of staff. The program will be delivered by teachers or school health professionals (e.g., school counsellor, school nurse).

The interventions will directly benefit young people because sleep problems are a risk factor for mental illness and worse school performance. Sleep on schedule and restricting use of technology are important life skills and strategies that can help young people manage their everyday lives both now and in the future. The study offers benefits to the students in the intervention group in that they can learn strategies for preventive purposes regarding sleep before clinical problems arise. The participants will also have their voices heard on the subject.

Area overview

Sleep is important for both physical and mental health as well as for learning. During adolescence, sleep is affected by both biological and psychosocial changes. In teenagers, sleepiness accumulates more slowly than in younger children, which means that they are more alert in the evenings and want to go to bed later (Crowley et al. 2018). In addition, teenagers often spend more time with peers (compared to when they were younger) as well as having higher workloads in school and in leisure activities. All these obligations must fit into the waking hours of the day (Becker et al. 2015). This collectively causes teenagers to frequently go to bed later to make time, but sleep time is reduced because school often starts early. Approximately 20-30% of Swedish adolescents between 13 and 15 years of age report that they have problems with sleep, which include difficulty falling asleep, short sleep time, delayed sleep phase, and daytime fatigue (Norell-Clarke & Hagquist 2017). The problems increase as teenagers get older (Inchley et al., 2020). In addition, there has been a trend in Sweden where more teenagers go to bed late on school days and sleep less than recommended; this has been observed since the late 1980s (Norell-Clarke & Hagquist, 2017).

It is worrying that teenage sleep duration and sleep quality are decreasing, especially given the clear link between sleep and mental health, especially depression (Palmer & Alfano, 2017). Depression is rare in children before puberty, but increases from age 14 (American Psychiatric Association, 2013). Depression is one of the most common causes of disability among teenagers (World Health Organization, 2021). Research shows that poor sleep may actually be a risk factor for the development of depressive symptoms rather than the other way around (Lovato & Gradisar, 2014; Scott et al., 2021). This underscores the need for preventive measures to improve sleep health in early adolescence.

Being mentally or physically alert or tense instead of relaxed at bedtime is incompatible with falling asleep. Difficulties falling asleep at bedtime can be caused by worry or disturbing thoughts or by engaging in activities that require attention and quick reaction just before bedtime (for example, playing computer games) or an environment incompatible with sleep (for example, a bright room in the evening). In a comprehensive meta-analysis, good sleep hygiene, defined as both daily routines and an environment that promotes good sleep (Irish et al., 2015), was identified as one of the most powerful protective factors for adolescent sleep. A stressful home environment, on the other hand, was consistently associated with a lack of sleep, while parents having rules for children's bedtimes was beneficial for good sleep among children and adolescents (Bartel et al., 2015).

School-related stress (performance demands, strained relationships with teachers and peers, and perceived high workload) is one of the most common daily stressors in early adolescence (Hörbo et al., 2021). Teenagers may also delay their bedtime due to schoolwork and/or worries about school, thus affecting both sleep duration and sleep quality. When teenagers are interviewed, school-related stress and technology use are among the top causes of poor sleep (Hedin et al., 2020, Gruber et al., 2017, Penayo, 2015). Fortunately, it is possible to teach teenagers healthy sleep habits and strategies to manage both stress and technology use. Involving support from peers is also important at a time when peers are becoming more influential (Hörbo et al., 2021). The school environment is a natural arena for promoting healthy habits (Garmy, 2016) and offers opportunities to reach both families and the peer environment.

There is a need to test the effectiveness of school-based interventions to promote healthy adolescent sleep habits and evaluate their long-term benefits. School-based interventions to prevent physical and mental ill-health have been shown to be cost-effective because most teenagers are in school (Durlak, 2011), and promoting health is a main objective of school health care services (Garmy, 2016).

The associations between lack of sleep and adolescent daily functioning—including physical and mental health and school performance (Shochat et al., 2014)—have led to a series of intervention studies aimed at improving adolescent sleep. In general, school-based universal interventions have been moderately successful because teenagers learn about sleep through sleep education, but that knowledge does not translate into changes in their sleep habits (Cassoff et al. 2013, Blunden, 2017, Blunden & Rigney, 2015). Qualitative studies have shown that teenagers are often aware of the importance of sleep and that many wish to sleep more or better. Based on previous research, it seems important to target stress and technology use (Hedin, et al., 2020, Gruber et al., 2017, Penayo, 2015). In line with this, the few studies that target these barriers have been successful in producing a behavioral change (e.g., longer sleep duration). For example, Bonnar et al. (2015) used motivational interviewing (MI) that created 30 minutes longer sleep duration with reduced depressive symptoms in the participating teenagers. Bartel et al. (2019) aimed to reduce the time with mobile phones in bed and reported 20 minutes more sleep. Further, Bauducco et al. (2020) taught better time planning resulting in long-term effects on sleep duration. These programs have shown promising results and contain effective components that should be tested further (see Table 1).

Theoretical model

Motivational interviewing (MI) (Miller & Rollnick, 2012) is a useful framework when working with young people because it is non-confrontational and respectful of the person's autonomy, which are sensitive areas during this developmental period (Cassoff et al., 2013). MI is based on four important principles including showing empathy for the person, raising ambivalence between current behavior and the person's goals and values, adapting to resistance (i.e., non-confrontational attitude to resistance), and supporting autonomy. Thus, MI aims to resolve the ambivalence created by, for example, the advantages and disadvantages of earlier bedtime (Cain et al., 2011). In other words, individuals need to feel "ready" (i.e., the time must be right for change and commitment), "capable" (i.e., they must feel confident) and "willing" (i.e., they must appreciate that the change is important) to be able to change their behavior.

Another characteristic of MI is that it is person-centered, meaning that it is adaptable to individual needs (Cassoff et al., 2013). MI has been integrated into sleep education in the past and has been successful in improving youth motivation (Bonnar et al., 2015; Cain et al., 2011). From an MI perspective, readiness, ability, and willingness should be promoted in the beginning of an intervention and this naturally makes the intervention longer. This corresponds with universal interventions where only a few might identify a need for change. Interventions on selective or indicated levels might assume that individuals at risk or with symptoms might already be ready for change and therefore a shorter targeted intervention might be justified. The latter is supported by a qualitative study that shows that young people know that sleep is important and wish to get more sleep (Jakobsson et al., 2022).

Scientific question

The purpose of the project is to evaluate the short-term and long-term effectiveness of the two programs on both the students' sleep and mental health as well as to evaluate the implementation in the school.

- Does sleep on the schedule taught in the classroom on five occasions affect sleep duration, perceived sleep quality, and mental health? Will the effects remain 1 year after the end of the program?

- Does Technology restriction before bedtime affect sleep duration, perceived sleep quality, and mental health? Will the effects remain 1 year after the end of the program?

The project will evaluate the programs using the RE-AIM framework. Limitations found with previous studies include short-term evaluations, a limited number of outcomes (effect on sleep but not on mental health), or a technology restriction with only two evaluations among older youth, although those show that technology restriction was associated with promising effects (Bartel, Shereen & Gradisar, 2019).

The questions answered with quantitative data are as follows:

- Does Sleep on the Schedule affect students' sleep duration, sleep habits, daytime symptoms, perceived sleep quality, grades, and physical/mental health versus a control group?
- Does Technology restriction affect students' sleep duration, sleep habits, daytime symptoms, perceived sleep quality, mobile use, grades, and physical/mental health versus a control group?
- To what extent have the respective programs been disseminated in the schools, reached the students, and been implemented as intended?
- What is the health economic aspects of Sleep on Schedule and Technology restriction?

The questions answered with qualitative data are as follows:
- What are the school staff's experiences of taking part in the training on the Sleep on Schedule and Technology restriction interventions?
- What are school staff's experiences of delivering the Sleep on Schedule and Technology restriction interventions?
- What are the students' experiences of participating in Sleep on Schedule?
- What are the students' experiences of participating in Technology restriction.
- What are the guardians' experiences of the young people using mobile phones before bedtime before and after participation in the Technology restriction.
- What are guardians' experiences of their young people's sleep habits and mental health before and after Sleep on Schedule.

Methods

Study design: Cluster-randomized trial.

Schools will be randomized to either 1) Sleep on Schedule, 2) Technology restriction, or 3) Control group (no intervention). All schools will be informed of the results and receive training in the program that proves most effective at the end of the project, if so desired.

The intervention is aimed at students in grades 7 and 8 in high school and grades 1 and 2 at upper secondary school. The project want to involve large parts of the school's staff, so that the responsibility does not lie with individual members of the staff. The program will be delivered in collaboration between teachers and school health care professionals (e.g., school counsellor, school nurse). Teachers who have previously participated in Sleep on Schedule have taught subjects related to sports and health, biology, and social studies.

The principal, the school health care professionals, and interested teachers will receive practical training in the interventions to be tested (this does not apply to the control group who will receive it at the end of the project) and all staff and parents (via the school's communication system) will receive information. The training will be given digitally and is divided into two meetings, two hours each. The first session involves background of the project, adolescent sleep, how the program works, and reviewing the program manual. Session 2 contains data collection instructions and questions (incl. control schools). The research team will be available and supervise the school staff during the programs' implementation and data collection.

Table 1: Description of the two interventions and one control group.

	Sleep on the Schedule	TechRest	Control
Length	1 lesson per week for 5 weeks	2 lessons with 2-week interval	School as usual
Conducted by	School staff (teachers, school health care professionals)	School staff (teachers, school health care professionals)	School staff (teachers, school health care professionals)
Integrated in the school curriculum	Yes. Homework and attendance	Yes. Homework and attendance	School as usual
Components	Sleep education + practical skills training (time management, healthy sleep habits, problem solving) + involvement of parents and peers	Limiting screen use in the evening one hour before bedtime	School as usual
Theory/ rationale	Motivating interviewing (MI): The lessons were developed based on Cain et al. (2011) but were adapted to fit into the motivational interviewing (MI) framework which promotes readiness, willingness, and ability by providing knowledge and tools for change. Cognitive and behavioral therapeutic principles underlie the content of the techniques that are being taught.	The motivational interviewing (MI) framework: Promoting ability by removing barriers. The perfect storm model, which includes screen use in its latter adaptation.	
Previous results	The length of sleep increases by about 20 minutes, and leads to improvements in depressive symptoms.	The length of sleep increases by about 20 minutes.	

Time schedule

The plan is to train school staff and start the program in April 2024. Data will be collected 2024 - 2027. At the end of the project (after the last data collection), schools will receive training in the sleep program that demonstrates the best results, if desired. There will also be an offer to give a lecture on sleep and to report back the results from the study.

Data collection

Students will complete digital questionnaires during regular lessons at school. Data collection takes place for all schools (regardless of intervention) before the start of the program (baseline), at the end of the program, and one year after completion. Data is de-identified and sent to the researchers in a secure manner. One week before the Technology restriction intervention, students will be asked to fill in a sleep form and indicate when they usually stop using their screens for the night to adapt the Technology restriction time to each individual student. Students will also complete an accompanying form (background questions, sleep knowledge, sleep hygiene, sleep habits, insomnia symptoms, physical and mental health, and motivation). A sample (about 80) of the students from both intervention and control groups will be asked to wear an actigraph to validate self-estimation of sleep.

The baseline period will be approximately the same regardless of intervention and will be at the beginning of the semester. Post-test after the end of the interventions. The schools/classes will be matched to interventions again one year after the end of the intervention.

Interim analysis (Kumar & Chakraborty, 2016) will be applied meaning that an analysis of the primary outcome measures will be performed when 50% of the planned data have been collected. If the result is significant, then the remaining data collection will be interrupted. This can save time and resources, but also not expose the study participants to "unnecessary" data collection. Adjustments for normal routines may need to be made in the case of repeated significance tests on data that are being collected.

Material

All materials for teaching (e.g., PowerPoint slides, manuals, sleep diaries) and for data collection (the questionnaires) are ready to use and have been developed in collaboration with other schools to adapt to the school's digital communication platform.

The questionnaires that will be used have been used in several previous studies, and no problems have been reported due to the nature of the questions. School healthcare service is informed that the study is ongoing, and students are encouraged to seek help from school healthcare service if needed. Students will be requested to answer the following questionnaires in order to answer the research questions about sleep duration, sleep habits, daytime symptoms, perceived sleep quality, mobile phone use, grades, physical and mental health, and motivation.

- Background data (age, sex, country of birth, socioeconomic status, academic success)
- Adolescent Sleep Hygiene Scale (ASHS) - Sleep
- (Modified) School Sleep Habits Survey (SSHS) - Sleep and mobile phone use in the evening
- Insomnia Severity Index (ISI) - Sleep
- EQ VAS – Physical and mental health
- CHU9D - Measuring health and calculating QALYs for children and adolescents
- Hospital Anxiety and Depression Scale (HADS) – Mental health
- Sleep knowledge – Sleep
- Metacognitions Questionnaire – Adolescents (MCQ-A)- Metacognitions

- Academic Self-Regulation Questionnaire (SRQ-A) – Intrinsic motivation subscale Why I do things - Motivation

Process evaluation will test motivation (3 MI questions in the survey), attendance, program fidelity, and homework completion. The students' experiences of participating in a school-based sleep intervention, student health staff's experiences of providing the sleep intervention, and teachers' views on student participation and integration of sleep education will be evaluated.

Sleep on Schedule

The sleep training includes five lessons during school hours, and will be held by school staff (teachers, school nurses and school counsellors). The teaching consists of sleep education (sleep knowledge and good sleep routines), time management (e.g., planning homework without distraction, planning other activities, quiet time before bedtime), information to guardians, and discussions with peers in the classroom (e.g., rules regarding evening interaction via electronic media). Homework/exercises and behavioral experiments are also included. Data collection takes place in connection with the first and last lesson of Sleep on Schedule.

TechRest

This intervention has been tested in Australia with a small sample of teenagers, and it was associated with promising effects (Bartel, Shereen & Gradisar, 2019). The data collection consists of a digital questionnaire regarding sleep habits, insomnia, motivation, physical and mental health, and electronic media use; a selection of students will use the actigraph for a week. After the first week, the participants will be instructed to stop using screens 1 hour before their usual bedtime. After one week has passed, participants in the Technology restriction intervention will be asked to complete the previously mentioned questionnaires as well as questions about the intervention itself: its applicability, compliance, and whether or not they will continue to limit their screen time before bedtime. One year after the intervention, they will be asked to complete the same questionnaire as at baseline. A selection of students will also wear a wrist actigraph.

All classes in schools that agreed to participate will be randomized to intervention or control, i.e., so-called cluster randomization. Conclusions about differences and effects are drawn at the cluster level and not at the individual level. All students are asked to participate in the study. Written informed consent will be obtained from students under and over the age of 15 and from all guardians of students under the age of 15.

Power calculation

Sample size calculations were used to estimate the number of clusters in a three-arm randomized cluster trial with a continuous outcome at 80% power and an alpha of 0.05.

In this calculation, the following assumptions are made:

- Power 80%
- Alpha 0.05
- 3 arms

- 60 students in each cluster (ca. 2 classes)
- Variance within cluster: 30 min => SD 42 min
- Variance between cluster: 15 min => SD 30 min

Mean values:

- Control: 8 hours
- Sleep on Schedule: 8 hours and 6 minutes
- TechRest: 8 hours and 21 minutes

85 clusters are needed meaning a total number of students 85*60 = 5100 students. However, the plan is to initially do a feasibility test of the interventions with a lower number of participants to investigate the feasibility.

For interview studies with students, leaders and guardians, approx. 30 participants are calculated per study. This is will help reach a variety of experiences.

Management of research data

Survey responses are answered digitally via Kristianstad University's web tool Evasys. Collected data will be stored securely so that no unauthorized person can access it and in accordance with the GDPR legislations. The informants will be named with a code written on a code list; each person will get a number. The code list is kept separately from information about the informants in a safe, and only those responsible for the present study will have access to the code list. During the course of the study, consent forms, code list, audio files, and transcribed interviews will be kept locked in a safe. Research data must be handed over to HKR's archives when the project is finished, i.e., when the results of the research project have been reported and published or otherwise made public.

Ethical considerations

The research will be carried out in school environments. Most of the activities performed within the school is compulsory. Participating in Sleep on Schedule and Technology restriction takes place during school hours, but the research steps (filling in questionnaires and participating in interviews) are voluntary. There is a risk that students do not perceive that they have the option to refrain from participating in the research. This risk is taken into account by thoroughly informing school staff who will ask students to participate. It is particularly important to make it clear to students and guardians that participation in research is voluntary and that it does not affect the students' other assessments of school performance.

Answering questionnaires and interview guides about mental and physical health could be experienced as unpleasant. However, all questionnaires and interview questions have been used without reported problems in previous studies, and no negative experiences have emerged. However, the school health care services are prepared to handle problems if the need arises.

Regarding the young people's participation in the evaluation, consent will be collected after they have been informed in writing and orally about what participation entails. It will be clear that their participation in the study does not affect the grade for the course and that they can end their participation at any time without giving a reason. It will be emphasized that it will not impact their school results (grades).

The study has the potential to produce new knowledge about sleep problems and mental health in young people and to investigate the effects of a cost-effective universal prevention program integrated into regular school education that deals with sleep skills. Our goal is to find an effective way to prevent the development of sleep problems and promote mental health through better sleep among young people in a resource-efficient way because this could lead to better sleep habits, better mental health, and better school performance. These benefits will all positively impact society.

The interventions (Sleep on Schedule and Technology restriction) have been carried out in similar versions among young people in the past without any negative effects reported. This is information that they can otherwise access through student health.

Training the school staff to provide support to young people with sleep problems can also lead to benefits for future students who are not part of the research project.

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