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RESEARCH ARTICLE

Healthy sleep for healthy schools: A pilot study of a sleep education resource to improve adolescent sleep

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Abstract

Issue addressed: Insufficient sleep and unhealthy sleep practices in adolescents are associated with significant health risks. Sleep education programs in schools aim to improve sleep behaviour. A new eLearning sleep education program, Healthy Sleep for Healthy Schools (HS4HS), was developed focused on these goals and is distinguishable from other sleep education programs because it is delivered by teachers, making it more sustainable and adaptable for schools. We aimed to evaluate if HS4HS would improve student sleep knowledge, healthy sleep practices, sleep duration and reduce sleepiness. We also aimed to understand if this intervention could be successfully implemented by trained teachers.

Methods: Teachers trained in sleep delivered HS4HS to 64 South Australian students in year 9 (aged 13-14 years) over 6 weeks during regular school curriculum. A sleep education survey assessing sleep patterns (such as healthy sleep practices, time in bed and sleepiness), and a sleep knowledge questionnaire was completed pre- and post-HS4HS delivery. Evaluations were also completed by teachers.

Results: Sleep knowledge and healthy sleep practices significantly improved post intervention. Time in bed on both school days and weekends increased slightly and sleepiness decreased slightly, but these changes were not statistically significant. Teachers found the program useful, comprehensive and easy to incorporate into their curricula.

Conclusions: After short training, teachers can deliver sleep education during class and improve sleep practices in their students. This suggests that this program may offer potential as an effective and useful resource for teachers wanting to include sleep health in their curriculum.

So what?: Sleep is the foundation of good health and teachers can promote and integrate sleep education into their curricula for the first time with this online teacher focussed program, which has the potential to be a sustainable sleep health promotion resource.

KEYWORDS
adolescents, adolescent development, health education, online learning, sleep, teacher education

1 | INTRODUCTION

Sleep health is a cornerstone of good health but is under threat from a 24/7 lifestyle, particularly in adolescents.[1,2] Across the globe, adolescents report needing more sleep, experiencing difficulties initiating and maintaining sleep, and excessive daytime sleepiness.[2,3] Indeed, international studies report that adolescents commonly get less than the recommended amount of sleep (between 7 and 9 hours) for their age group.[2,3] Adolescents in Australia report similar issues such as short sleep duration, difficulty falling asleep and increased sleepiness.[4] Short sleep duration negatively impacts adolescents' daily functioning, with reduced sleep duration correlating with a lower probability of completing school homework, and engaging in sports.[5] Adolescents with insufficient sleep display poorer school engagement, higher risk-taking and disruptive behaviour at school, substance abuse, depression, anxiety and suicidal ideation.[6-10]

Shorter sleep duration is particularly the case during the school week as adolescents have a biologically driven delay in sleep onset, yet are unable to sleep in in the morning due to school start times, with a subsequent and consequential reduced sleep duration during the school week.[3,4] Furthermore, catch up sleep on the weekends (to compensate for school week sleep loss) is often indicative of shorter sleep during the week and is common for adolescents.[4] Sleep timing differences between weekdays and weekends can result, which have been shown to be detrimental to physical and mental health.[4,11]

Insufficient sleep can result in sleepiness, which has been associated with increased prevalence of accidents and poor academic performance.[11] Thus, it is important not only to consider sleep duration and weekday/weekend differences but also to consider levels of daytime sleepiness in adolescents.[12]

One way to improve sleep behaviour in adolescents (eg managing later bed and wake times, increasing sleep duration and reducing daytime sleepiness) is to target behaviours within their control. These behaviours are commonly referred to as sleep hygiene, or healthy sleep practices.[13] Healthy sleep practices include factors such as maintaining regular sleep and wake times, reducing caffeine intake before sleep, reducing screen and light exposure activity (especially mobile phone) use at bedtime and maintaining regular sleep-wake rhythms between weekdays and weekends.[14,15] Healthy sleep practices are also associated with reduced daytime sleepiness.[13,16,17] In contrast, unhealthy sleep practices often result in reduced sleep quantity and quality.[14]

Increasing knowledge about healthy sleep practices is considered the first step towards improving sleep behaviours.[18] As healthy sleep practices are generally within the control of adolescents, they are the most logical domain to be included and targeted as interventions in sleep education programs. If healthy sleep practices are increased this should, in turn, increase sleep duration and reduce sleepiness, and improve downstream variables such as academic disengagement, disruptive behaviour and poor academic performance.[19]

1.1 | Sleep education in schools

The consequences of poor sleep and the need to improve sleep has led to the development of school-based sleep education programs because there is a general understanding that increasing knowledge can lead to positive changes in sleep behaviour.[5,20-22] The format of sleep education programs that have been delivered to date include educational leaflets, 2-hour one-off interventions, weekly teaching sessions and month-long programs, and often include resources, activities or workbooks to reinforce classroom learning.[23-25] The effectiveness of such programs is often evaluated by measuring not only a change of knowledge but also a change in sleep-related behaviour (ie healthy sleep practices) and other sleep measures (ie sleep duration and sleepiness) after program participation.

Previous studies have shown a difficulty in translating acquired sleep knowledge into behaviour change. Some school-based sleep education programs have shown success in improving sleep knowledge,[24,26-28] while some have not.[23,29] Improvements to sleep practices such as regularity of napping and bedtimes have had varying success.[24,26,28-30] In contrast, both Kira et al[31] and Rigney et al[25] found that despite increases in students' sleep duration after a school sleep education program, there were no significant changes to sleep hygiene or sleep knowledge. These mixed results concerning improvements in sleep knowledge and sleep behaviour after school-based sleep education programs highlight the difficulty in developing a program that equips adolescents to (a) attain sleep knowledge, (b) translate it into behaviour change (ie, healthy sleep practices) and (c) learn practical steps for how to achieve successful outcomes.

Multiple reviews have identified factors that might maximise success in sleep education programs.[18,20,22,32] Factors include motivation to change behaviour, appropriate theoretical underpinnings and integration of sleep into a whole of school approach across curriculum. One factor that has consistently been identified in previous reviews is the need for programs to be delivered by trained teachers rather than sleep researchers or clinicians. This is an important consideration because researchers may not be readily available during school hours, and they are less likely, compared with teachers, to know and understand the student and/or curriculum issues. As such, utilising teachers to deliver school-based sleep education programs promotes a more sustainable sleep education model.

1.2 | Heathy sleep for healthy schools (HS4HS) teacher resource

To maximise the possibility of a sustainable sleep education resource for teachers, that targets both sleep knowledge acquisition and healthy sleep behaviour improvements, the eLearning program Healthy Sleep for Healthy Schools (HS4HS) has been developed.[33] Based on previous published and successful sleep education program content, HS4HS has been developed by researchers and informed by both teachers and current evidence-based literature.[25,31,34] The HS4HS program is an online multi-phased, multi-component program, which presents information utilising diverse domains of learning styles relevant for children and adolescents to achieve optimal results. The first step in the program is to build the teacher's knowledge of sleep so that they can successfully deliver the program to their students. The HS4HS program is designed to have the content delivered by teachers over four sessions, with the primary aim being to increase awareness of the importance of sleep in young people and to help them improve their sleep behaviour, so to optimize their daytime functioning.

To achieve this aim, the HS4HS online program includes the following components: (a) Teacher information – teachers complete four online sessions, which map onto the four student lessons, to attain the background knowledge required to deliver the program (see Table 1 below for summary of content). Teachers can review these sessions at any time and there is a mastery test at the end of each session, so teachers feel confident they have the knowledge to deliver the content to their students. If possible, it is recommended that schools accept this online training as part of the required professional development hours teachers undertake each year; (b) Lesson plans for the four sessions – once mastery has been reached for each session, the teacher has access to the resources developed to help them deliver the sessions to their students. The lesson plans provide a suggested step-by-step guide of how best to deliver the session to their students. Teachers are able to further tailor the plans to their students; (c) PowerPoint presentations to use with students for the four sessions – PowerPoint presentations for each session are accessible to teachers following the completion of mastery testing to aid in delivery of the program. Teachers are able to adapt these to their specific teaching presentation style if desired; (d) Access to a companion adolescent online interactive sleep program called Better Nights Better Days[34] – after each session, the students are able to reinforce what they learned in class by completing interactive and engaging activities in the online interactive program. This student program maps against the four sessions and learning lessons with activities including interactive tools, drag and drop activities, videos, questionnaires, and interactive text; (e) Handouts for parents for each session –teachers will have access to a one-page parent handout for each session that they can share with parents. The goal is to create a "Whole of School" approach in the hope that providing parents with this information will engage them as critical partners in this initiative.

The HS4HS program has been developed with consideration of behaviour change theoretical underpinnings. Evidence suggests that behaviour change theories can help to provide an understanding of how and why behaviour changes may occur, going beyond the dissemination of simple knowledge. An individual's intention to change their behaviour is a key deciding factor in whether or not they actually set goals and make behavioural changes. Importantly, it is thought that if significant others, such as teachers, parents, and peers, expect and support someone to change their behaviour, then a person's intention and motivation to change their behaviour will be stronger. The HS4HS program embraces this perspective, with teachers, parents and peers each being informed about the importance of sleep to encourage students to achieve and maintain the goals they set towards achieving healthy sleep. The program's four sessions run for approximately 45 minutes and are delivered over 6 weeks. The first three sessions are completed weekly. There is a recommended 2-week gap between session three and session four when students implement their goals and teachers monitor their progress. Table 1 presents a description of HS4HS content.

TABLE 1 Content of healthy sleep for healthy schools (HS4HS)

Week	Name of session	Content
One	All About Sleep	Introduces basic sleep principles and knowledge, and includes information about the functions of sleep, how humans sleep and the importance of sleep quantity and quality
Two	Adolescents, Sleep and Its Measurement	Covers information about how adolescents sleep, how much sleep adolescents should be getting, the effects of poor sleep and how to measure sleep
Three	Healthy Sleep Practices	Informs students about the levels of interventions for sleep problems, where teachers lead students to set and implement sleep goals for healthy sleep
Four	Real-World Impact of Sleep Disorders	Covers clinical sleep disorders and mental and physical health disorders associated with sleep disorders

This pilot study was the first step in the validation of the HS4HS program without a focus on the Better Nights Better Days component. The primary aim of this study was to evaluate whether the HS4HS program had any observable effect on sleep knowledge, healthy sleep practices, sleep duration or sleepiness. It was hypothesised that participation in the HS4HS sleep education program would result in (a) increased sleep knowledge, (b) improved healthy sleep practices, such as (c) increased time in bed and (d) decreased sleepiness. As this was the first time teachers were to deliver this program, a secondary aim of this pilot study was to understand teacher perspectives on implementation and feasibility of the HS4HS program and to gain feedback and opinions of their experience.

2 | METHODS

A new, state-of-the-art public high school in Adelaide, South Australia, which had a pre-existing relationship with the researchers, agreed to trial HS4HS in a pilot program. The school also agreed to evaluate the efficacy of the program in changing sleep practices with a pre-post sleep education survey developed by the researchers. Data were collected through the school data system and accessed, with permission, post program as archival data.

Ethics approval to access the archival data from the relevant school was granted by both the Central Queensland University Ethics committee (Approval Number: 22131), and the South Australian Department of Education.

2.1 | Participants

In term one (February–April) 2020, all year nine students (n = 207, ages 13-14 years, 50% male) undertook the program as part of the usual school health curriculum. Due to the archival and de-identified nature of the data, no other specific demographic data were available.

Only a subset of students gave permission for their data to be used for the research project. This consent was obtained through an opt-out approach: if students completed the research surveys, that was considered as consent for researchers to access their data. The "opt-out" approach is commonly used in school-based sleep education studies.[35,36] This approach to recruitment allows teachers to implement the education program to all students in their class as part of normal school health activities, without requiring consent from each student to participate in the research study. While at the outset, research evaluation needs and milestones (eg suggested timeframes for survey completion) were given to the school, the actual delivery and execution were undertaken by the teachers independently. Many students only completed the research surveys at one time point (pre-program delivery). The program was delivered by five teachers; these included two home group teachers, with expertise in science and physical education, one physical education teacher, a well-being coordinator and a teacher of psychology who was also coordinator of year 9 classes. Teachers started delivering the lectures face-to-face (for the first session) then students transferred to delivery online via the school system due to the COVID-19 pandemic, which caused mass stay-at-home orders in South Australia. The rapid management of online teaching of all curriculum content (including the sleep education program) challenged teaching capacity and workload during this time and further disrupted survey completion.

2.2 | Materials

2.2.1 | Procedure

Teachers (n = 5) at the school undertook the 4-hour online training, comprising approximately one hour for each of the four sessions. At the end of each training session, teachers were required to complete a mastery test to ensure that they have a working knowledge of the sleep education material. Teachers are required to achieve 80% in each of the mastery quizzes before they gain access to the relevant teaching materials for that particular session. The HS4HS program allows teachers flexibility in their sleep education training, allowing them to choose whether they complete the training in one-sitting, or at different times (eg weekly) that is convenient for them. Lesson plans and resources were available to download once mastery for each session had been achieved. As noted, the HS4HS program was delivered by the teacher to students in their class through four sessions of 45 minutes per session over 6 weeks. A 2-week break between sessions three and four enabled students to set sleep goals and teachers to monitor goal achievement and motivation.

Measurements were collected before (pre: 1-3 weeks prior) and after (post: 2-4 weeks after) program participation. As measures were completed online during class time, via school systems, the researchers had no control over the exact timing of when the measures were completed. Measurements were not compulsory for students to complete whilst participating in the sleep education program.

2.2.2 | Measures

For this pilot study, students were asked to complete the two measures of focus – the Sleep Knowledge Questionnaire and the Sleep Education Survey pre and postdelivery.

Sleep knowledge questionnaire

The Sleep Knowledge Questionnaire consisted of 15 true or false questions about the content delivered in HS4HS. Participants received one mark for each correct response and incomplete or incorrect responses were scored as 0. The total sum of all the correct responses gave the student a mark ranging from 0-15, with higher scores indicating better sleep knowledge. This Sleep Knowledge Questionnaire has been utilised in previous studies, shows sensitivity to sleep knowledge changes in children and offers a degree of discriminant validity.[26,31]

Sleep education survey

The Sleep Education Survey was based on a questionnaire utilised in the United States in a larger study of school start times, performance and sleep in adolescents (Meltzer et al, 2019). The questionnaire grouped together some standardised sleep questionnaires (eg Sleep Hygiene Index) and additional questions (eg relevant to school engagement, school grades, extracurricular activities, sleepiness and sleep patterns). All questions were written in a way that would enhance readability for the target audience of adolescents.[37] From a total of 61 questions, only specific questions from the Sleep Education Survey that were deemed relevant to the variables of interest for the present study (healthy sleep practices and sleepiness) were used. Psychometrics of the questionnaire were not available. The two sub-scales used in the current study were as follows:

Healthy sleep practices

Five questions based on the Sleep Hygiene Index were scored on a Likert scale question: *never (= 1)*, *almost never (= 2)*, *sometimes (= 3)*, *almost always (= 4)* and *always (= 5)*, with a total score of 25 indicating the most unhealthy sleep hygiene behaviours.[15] The five questions were as follows: "I take daytime naps lasting two or more hours"; "I go to bed at different times from day to day"; I get up at different times from day to day"; I go to bed feeling stressed, angry, upset, or nervous"; "I do something that may wake me up before bedtime (eg play video games, use the internet or clean)".

Sleepiness

Five questions included in the sleepiness scale were as follows: "I had a hard time concentrating because I was sleepy," "When I woke up I felt ready to start the day," "Being tired made it hard for me to keep up with my schoolwork," "How often did you feel alert during your first session?" and "In the past 7 days, have you struggled to stay awake (fought sleep) or fallen asleep while doing extra school time and/or homework?" The first four questions listed above had five options for responding. They were scored 1-5 depending on the question; some items were reverse scored. The last question "In the past 7 days, have you struggled to stay awake (fought sleep) or fallen asleep while doing extra school time and/or homework?" had only four response options: *no (= 1)*, *struggled to stay awake (= 2)*, *fell asleep (= 3)* and *both struggled to stay awake and fell asleep (= 4)*. Overall, sleepiness was scored from one to 24 with 24 indicating the highest level of sleepiness.

Sleep patterns

Also included within the Sleep Education Survey were four questions adapted from the Sleep Timing Questionnaire, for example, "What time do you usually go to bed/wake up on school days/weekends?".[38] The Sleep Timing Questionnaire is a single item administration replacement for standard sleep diaries that can yield information equivalent to a week of actigraphy or a 2-week sleep diary and has been validated in adolescents.[39] Subtracting wake times from bedtimes allowed calculation of Time in Bed for both school days and weekends.

2.3 | Teacher feedback survey

Given that this resource was for teachers, it was important to evaluate teacher feedback and opinion. All five teachers who delivered the program were asked to complete a short hard copy program evaluation. Opinions were sought with three questions each on usefulness, credibility and value. Responses were gathered on a Likert scale from *1 = Strongly agree* to *5 = Strongly disagree*. Open-ended questions offered the option for further comment. Follow-up conversations with the school leadership group (principal, assistant principal and year 9 coordinator) discussed the hard copy findings regarding feasibility and areas for improvement.

2.4 | Data cleaning

Initially, there were 200 students in the sample who completed the Sleep Education Survey. Students who only had a pre or a post entry in the survey were removed (n = 130). Six entries with unclear or blank IDs were removed. After the exclusion of these participants, there were 64 participants in the sample, used for healthy sleep practices, time in bed school days and weekends and sleepiness.

Adolescent sleep patterns often have high variability, so the two outliers (one who reported 4 hours of sleep and another who reported 13 hours) were not removed from the data set, as they were considered to be likely reflections of sleep patterns. As a result only pre and post sleep hygiene ($W(65) = 0.98$, $P = .21$; $W(65) = 0.97$, $P = .11$) and pre- and postsleepiness were normally distributed ($W(65) = 0.97$, $P = .17$; $W(65) = 0.97$, $P = .15$) Data transformations attempting to normalise the data included log, square root, reciprocal, reverse score and Box Cox. None of these transformations improved the normality of the data. As a result, it was not possible to use MANOVA. Hence, t-tests with bootstrapped confidence intervals (sample of 1000) and Bonferroni adjusted p-values were used.

When calculating time in bed variables (wake time – bedtime), if participants provided a range for bed/wake time, the difference between the two times was used to create an average time. For school days, this was done for 29 cases. For weekends, this was done for 33 cases.

Of 179 initial entries, on The Sleep Knowledge Questionnaire, 126 did not have post entries and were removed. Three entries had more than two entries at either time point, and two entries without IDs were removed. This resulted in a sample size of 48.

2.5 | Statistical analyses

Descriptive statistics were performed on all variables of interest: sleep knowledge, healthy sleep practices, time in bed school days, time in bed weekends and sleepiness.

Paired samples t-tests (after performing relevant normality tests) were performed with bootstrapped confidence intervals to assess the mean difference in the scores on sleep knowledge, healthy sleep

practices, time in bed school days, time in bed weekends and sleepiness before and after program participation. Cohen's *d* was used to estimate effect sizes. The significance value was strictly set at *P* = .01, two tailed for all analyses using a Bonferroni adjustment. All statistical analyses were performed with SPSS 27.0 for Apple Macintosh.

3 | RESULTS

3.1 | Descriptive statistics

After program participation, students entered bed at slightly later times than prior to program participation. They also had a wider range of times that they entered bed. The same trend is also seen in the school day wake times. Times students entered bed on weekends also appears to trend slightly later than before program participation. While weekend wake times appeared to also have a slightly larger spread, there was an increase of 9 students who woke between 8 AM and 8:59 AM. See Figures 1-4 below for clustered bar count representations of bed times and wake times, for school days and weekends.

Mean (SD) bed and wake times, healthy sleep practices scores, sleep knowledge and sleepiness scores are presented in Table 2. Descriptive analyses revealed that, average time in bed on school days increased by 12.14 minutes, and time in bed weekends decreased by 4.15 minutes. Sleep knowledge, heathy sleep practices and sleepiness mean scores improved post participation.

3.2 | Pre-post within-subject analysis

Paired-sample t-tests were performed pre- and post-sleep education delivery on the five key variables to assess any change. Due to the number of t-tests being performed, Bonferroni adjustments were made to the significance value, so significance was set at *P* = .01. The results are detailed in Table 2.

As seen, sleep knowledge scores significantly increased between pre (M = 9.39, *SE* -= 0.38) and post (M = 10.50, *SE* = 0.38) completion (*P* = .003) with a medium effect size (*d* = 0.41). This indicates that student's sleep knowledge improved after program participation.

Pre-healthy sleep practice scores (M = 13.23, *SE* = 0.40) significantly decreased after program participation (M = 12.09, *SE* = 0.42; *P* = .005) and represented a small to medium effect size, *d* = 0.36. This indicated that healthy sleep practices improved after program participation.

The increase in time in bed on school days from pre (M = 514.47, *SE* = 7.99) to post-program participation (M = 526.61, *SE* = 7.90), was not statistically significant (*P* = .144), with a small effect size (*d* = 0.18). The decrease in time in bed on weekends from pre (M = 553.45, *SE* = 13.07) to post (M = 549.30, *SE* = 10.17) was not significant (*P* = .697) and had a small effect size (*d* = 0.05). The decrease in pre sleepiness scores (M = 13.38, *SE* = 0.45) post program participation (M = 12.81, *SE* = 0.43), was not significant (*P* = .166) with a small effect size (*d* = 0.18).

3.3 | Teacher feedback

Post-delivery, three of the five teachers completed an evaluation form to offer their opinions on the program. Few comments were recorded. In terms of the training and the mastery test, teachers reported that training took them approximately 1 hour per lesson (4 hours in total) and that the learning components were understandable and not arduous. Teachers also commented that the teacher lesson plans and activity ideas were helpful and saved time, but assistance to adapt content to different age groups in future would be beneficial. Teachers reported that the HS4HS program

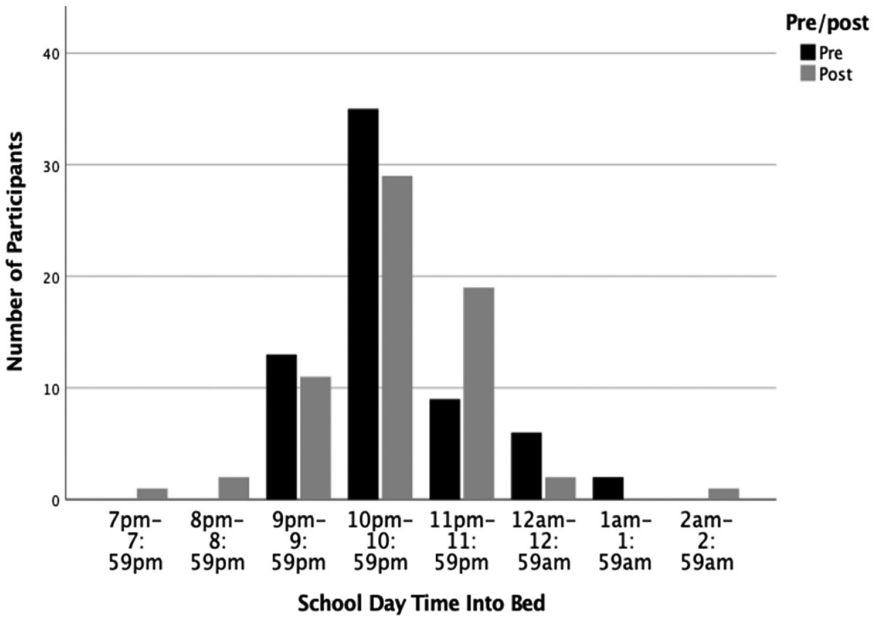


FIGURE 1 Clustered bar count of school day bedtime by pre/post

FIGURE 2 Clustered bar count of school day wake time by pre/post

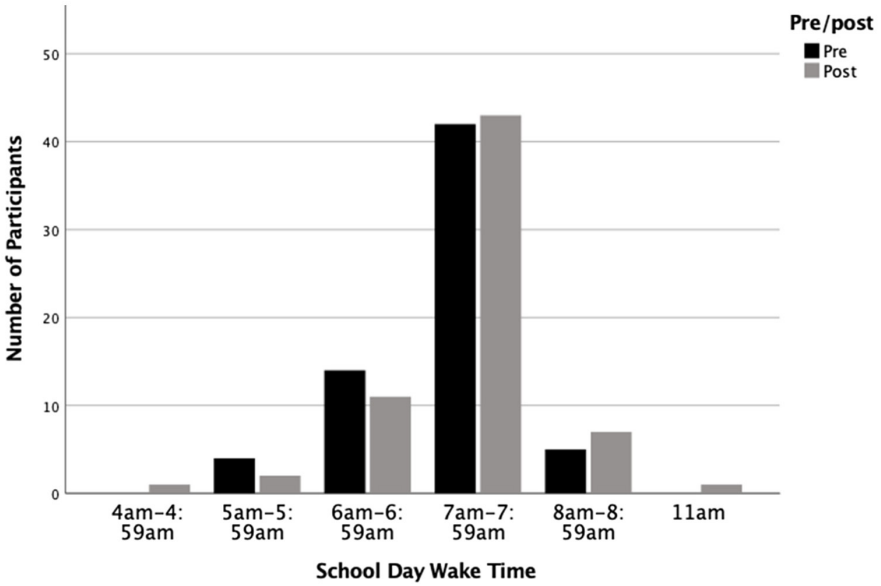
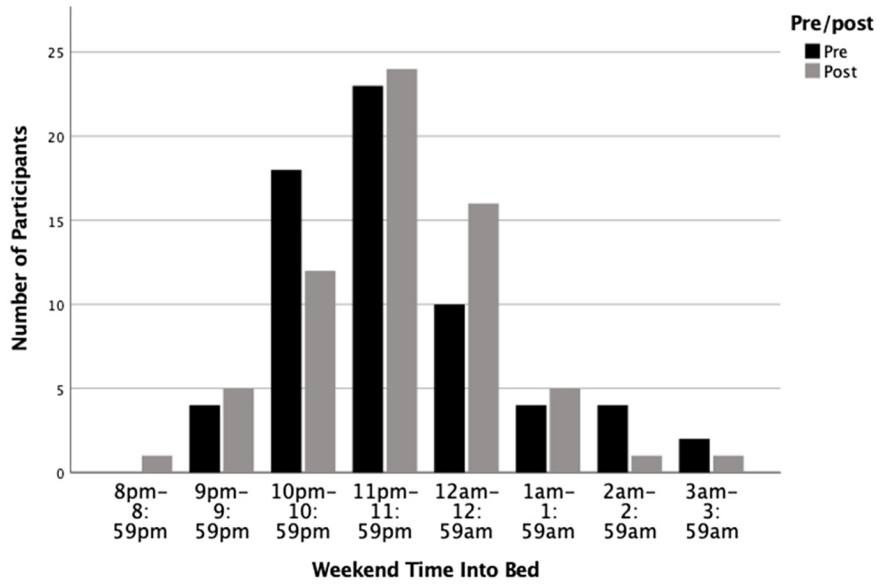


FIGURE 3 Clustered bar count of weekend bedtime by pre/post



gave not only structure but also flexibility to adapt and change activities as needed. This flexibility was noted as very beneficial and teachers reported developing their own sleep goal setting sheet using sleep data analysis during class discussions. Overall, teachers reported that the program was comprehensive and informative. Specifically, Teacher 1 commented that HS4HS "Was useful for the students to learn about the aspects of sleep and how to treat sleep problems." Teacher 2 reported that "a lot of our students researched and analysed sleep and the benefits that a healthy sleep habit can have on their overall health." Teacher 3 reported that "Students learnt or deepened their knowledge of sleep problems but whether they could implement their goals long term to 'treat' their problem is another matter – more time is probably needed." Teacher 3 further suggested that longer-term follow-up is necessary.

Although not the focus of this study, teachers also commented on the Better Nights Better Days program. The adolescent online accompanying activities were seen to be useful; however, teachers reported having technical difficulties with this part of the program. The main feedback was to make it easier for teachers to be able to monitor each student's progress in the adolescent companion program, so that they could assist in answering questions that arise for that student. Parental feedback was not monitored by the school during this trial.

4 | DISCUSSION AND INTERPRETATION

This pilot study was the first step of a larger project aiming to evaluate the HS4HS program in Australian high school students. The primary aim of this study was to evaluate whether the HS4HS program had any observable effect on sleep outcomes. Findings showed a statistically significant increase in sleep knowledge and healthy sleep practices following participation in the HS4HS program. Changes to time in bed and sleepiness were not found to be

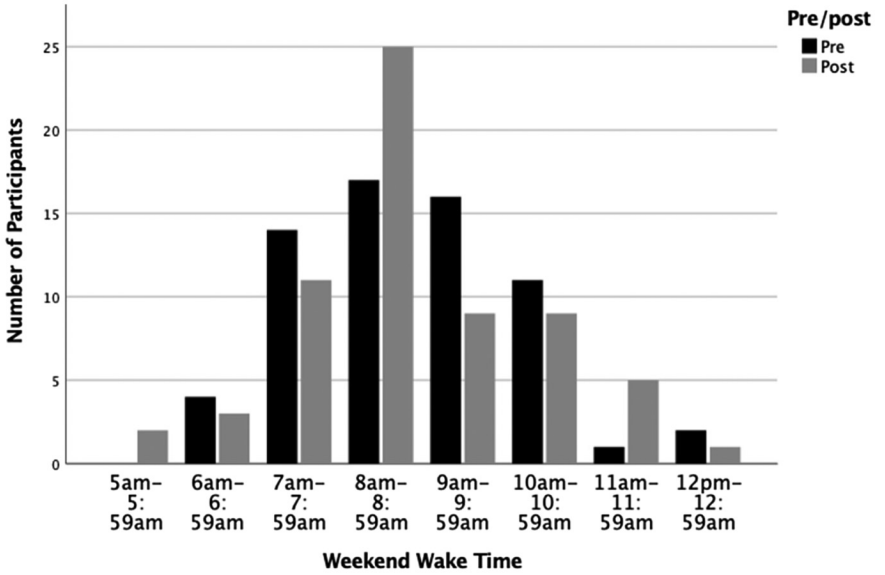


FIGURE 4 Clustered bar count of weekend wake time by pre/post

TABLE 2 Between group differences for sleep variables

Variable	n	M (SD)		T	df	p	95% CI [a]	Cohen's d
		Pre	Post					
Sleep knowledge[b]	48	9.40 (2.65)	10.50 (2.67)	−3.18	47	0.003	[−1.77, −0.38]	0.41
Healthy sleep practices[c]	64	13.23(3.19)	12.09 (3.35)	2.9	63	0.005	[0.39, 1.89]	0.36
Time in bed school days[d]	64	514.47 (63.91)	526.61 (63.16)	−1.42	63	0.144	[−28.37, 4.16]	0.18
Time in bed weekends[d]	64	553.45 (104.52)	549.30 (81.33)	0.391	63	0.697	[−15.52, 23.62]	0.05
Sleepiness[e]	64	13.38 (3.61)	12.81 (3.45)	1.40	63	0.166	[−0.04, 1.34]	0.18

[a]Bootstrapped 95% CI.

[b]Sleep knowledge scores ranged from 0 to 15, with 15 indicating highest sleep knowledge.

[c]Healthy Sleep Practice scores ranged from 1 to 25, with higher scores indicating worse sleep hygiene.

[d]Time in bed in minutes.

[e]Sleepiness scores ranged from 1 to 29, with higher scores indicating higher levels of sleepiness.

statistically significant. The secondary aim of this study was to assess teacher opinion and feedback on the HS4HS program overall. Teachers gave generally positive reviews of the program. These preliminary but positive findings bode well for the future of eLearning teacher led school-based sleep education programs.

The main finding of interest was a significant improvement in healthy sleep practices suggesting participants changed their sleep behaviours to optimise sleep health. Findings are consistent with some previous studies showing improved sleep hygiene measures post program participation.[29,30,40] Sleep knowledge was also found to significantly improve following the HS4HS program, which promisingly has been a common finding across the majority of school-based sleep education studies conducted to date.[20] Significant commentary has been undertaken on the need for an increase in sleep knowledge if healthy sleep practices are to be improved.[20,22,32] In other words, adolescents need to know about sleep and how to improve it before they can change their behaviour. Although this has not always been the case in previous work,[25,31] in this study, we showed that increased sleep knowledge did result in improved healthy sleep practices.

Although participants seemed to make some changes to behaviours associated with healthy sleep practices, changes to Time in Bed were not significant. Participants are thought to have more volitional control over time in bed compared with sleep duration, which makes it an important variable in evaluating school-based sleep education programs. A recent review identified that similarly, approximately half of the studies published to date have seen no significant changes to subjectively measured sleep behaviours.[20] Given that changes to sleep timing on both school days and weekends did not significantly change, it is perhaps expected that the current study also did not find any significant changes in self-reported sleepiness. Potentially, other factors consistent for the duration of the study outside of adolescents' control such as homework and long commutes to school may have interfered with changing sleep behaviours to ultimately improve sleep duration. Questions concerning these factors were not included and may be of importance in future studies.

As the HS4HS program is still in the evaluation stage, teacher feedback on each of the components of the program and how to deliver it was of utmost importance. According to teacher feedback,

the program provided them with adequate background knowledge to successfully deliver the program content to the students, and for the students to subsequently improve sleep behaviours. Teachers reported the teaching resources to be helpful and the program to be useful, comprehensive and not arduous for them, yet beneficial for students. With teacher training completed in approximately 1-hour per session, this component was reported to be reasonable, and they appreciated that those hours could be included as part of their professional development. It is important to again note that the timing of this study coincided with the COVID-19 global pandemic and that even under those COVID-19-related pressures to adapt curricula to online teaching, teachers still did not find the sleep training arduous. Given that HS4HS is an online program, this was beneficial as it meant teachers could undertake the training at a time that was suitable for them, and the training was not impacted or delayed by not being able to meet with researchers. The online adolescent companion program Better Nights Better Days was also seen to be useful for the teachers during online learning, however teachers reported having technical difficulties with this part of the program. Teachers suggested enabling easier access to student activities to better monitor student progress in the adolescent companion program, so teachers could better assist in answering questions that arise for any particular student.

The HS4HS program is novel compared with previously published school-based sleep education programs as it allows for a more sustainable delivery, through training the teachers about sleep using an eLearning program. The time they take to complete this online training can be included as part of their professional development. A strength of the program is that teachers can decide on the schedule of their training (either completing it in one or multiple sittings), to work in with their availability and teaching style. Promisingly, the HS4HS program was considered flexible and adaptable enough to be tailored to the specific requirements of the students, even during the COVID-19 pandemic upheavals, which included teaching in both face-to-face and online conditions throughout the completion of this study. One of the reported strengths of the HS4HS program was therefore its adaptability to differing conditions.

One of the biggest shortfalls of the program as it was delivered in this study was technical challenges in regard to the integration of the companion online program, Better Nights, Better Days-Youth. This program was designed to help students reinforce what they learned in class by completing interactive and engaging activities in our online student sleep education program. Better Nights, Better Days-Youth also includes four sessions, and these map onto the learning lessons. However, feedback from teachers was that they want to utilise the student online program during the classroom lessons. We aim to integrate these programs together through suggesting where the online activities may best correspond to content in the teaching resources and have been working on resolving the technical issues identified for future trials that plan to be conducted in both Australia and Canada. Additionally, the research team aim to update the teaching resources to better support teachers who want to deliver the program across multiple grades throughout their schooling, rather than in one specific grade. To do this, we are going to provide suggestions on how the content can be scaffolded to build student understanding across each grade.

Although findings from this pilot study are encouraging, they need to be viewed with some caveats. Despite HS4HS being an eLearning program for teachers, the sleep education program is designed to be delivered by teachers to students in a face-to-face classroom setting. However, given the timing of the program coinciding with the COVID-19 pandemic, the program was delivered largely online. It is unknown how much of an impact this had on the some of the variables of interest. However, there was a marked impact on data collection which reduced usable data and the overall sample size and therefore reduced the capacity to rigorously evaluate efficacy and compliance. Such limitations often occur in community research where it is impossible to regulate study delivery and variable conceptualization. Regardless of this, community-based research is still important.[41] In addition, this study was purposely flexible in its delivery to understand the basic feasibility of a program such as this to be conducted independently.

The use of adapted measures while adapted to be user friendly, especially in terms of participant burden, may have inadvertently impacted results, as they may be less valid than the original measures and make comparison to other studies more problematic. Future research should use the full Sleep Hygiene Index or the Epworth Sleepiness Scale for Children and Adolescents[15,42] and a sleep diary across a minimum of 7 days to increase sensitivity. The generalisability of the current findings needs to be considered, given that the current study was conducted with just the one public school, and therefore levels of engagement may be different for other schools. Finally, due to the self-selective nature and anonymity of completing the surveys, it is impossible to know the exact demographics of the small sample, and, thus, whether it is representative making generalisation difficult. This exploratory study should be replicated on a larger representative sample.

5 | CONCLUSION

Despite these limitations, findings from this first step in validating the HS4HS program concur with previous studies indicating that school-based sleep education can improve healthy sleep behaviours and other downstream variables. Future evaluative research of the HS4HS program, aims to incorporate teacher feedback from this study and assess the companion adolescent program and the parental components on a larger scale, potentially in wait list controlled circumstances, in both Australian and Canadian schools. If HS4HS is found to be successful, it holds promise for a more sustainable future of evidence-based sleep education program delivery in schools around the world.

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CONFLICT OF INTEREST

None of the authors have any conflicts of interest in regards to this manuscript or publication in this journal.

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