

Sleep Education Improves the Sleep Duration of Adolescents: A Randomized Controlled Pilot Study

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Purpose: To determine the feasibility and pilot a sleep education program in New Zealand high school students.

Methods: A parallel, two-arm randomized controlled pilot trial was conducted. High school students (13 to 16 years) were randomly allocated to either a classroom-based sleep education program intervention (n = 15) or to a usual curriculum control group (n = 14). The sleep education program involved four 50-minute classroom-based education sessions with interactive groups. Students completed a 7-day sleep diary, a sleep questionnaire (including sleep hygiene, knowledge and problems) at baseline, post-intervention (4 weeks) and 10 weeks follow-up.

Results: An overall treatment effect was observed for weekend sleep duration ($F_{1,24} = 5.21$, $p = 0.03$). Participants in the intervention group slept longer during weekend nights at 5 weeks (1:37 h:min, $p = 0.01$) and 10 weeks: (1:32 h:min, $p = 0.03$) compared to those in the control group. No differences were found between groups for sleep duration on weekday nights. No significant differences were observed

between groups for any of the secondary outcomes (sleep hygiene, sleep problems, or sleep knowledge).

Conclusions: A sleep education program appears to increase weekend sleep duration in the short term. Although this program was feasible, most schools are under time and resource pressure, thus alternative methods of delivery should be assessed for feasibility and efficacy. Larger trials of longer duration are needed to confirm these findings and determine the sustained effect of sleep education on sleep behavior and its impact on health and psychosocial outcomes.

Commentary: A commentary on this article appears in this issue on page 793.

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Adolescent sleep problems are common and global.¹ It is estimated up to a third of adolescents experience problems with sleep, and poor sleep is associated with sleepiness, learning problems, mood disorders, increased aggression, substance abuse, cardiovascular disease, and obesity.²⁻⁶ Many adolescents report sleeping poorly and wanting to sleep more, which may explain the high prevalence of daytime sleepiness.^{7,8}

Consensus about the optimal sleep duration for adolescents has not been reached and guidelines for “sufficient” sleep are based on minimal evidence.⁹ According to Carskadon and colleagues, the average adolescent requires approximately nine hours of sleep and this is supported by evidence that adolescents sleep more than 9 hours on school holidays.^{10,11} However others suggest less, despite the vast majority of adolescents reporting daytime sleepiness.^{12,13} If the threshold of nine hours is valid, meta-analysis of 41 surveys of worldwide adolescent sleep patterns estimated that 53% of study participants reported a sleep duration of less than eight hours.¹ The review also showed that bedtimes were later than would be necessary for sufficient sleep prior to waking and getting ready for school. Findings from the meta-analysis also illustrated the existence of a worldwide delayed sleep-wake behavior pattern, which was consistent with symptoms of delayed sleep phase

BRIEF SUMMARY

Current Knowledge/Study Rationale: Poor sleep is associated with a multitude of physical and psychological problems. Adolescence represents a time of disrupted sleep patterns and school-based sleep education programs may be a conduit for better health.

Study Impact: Sleep education may be limited in its ability to improve sleep patterns. This study has highlighted several issues, including long-term cluster randomized trials, which should be considered to effectively determine whether sleep intervention can improve adolescent sleep and influence health outcomes.

disorder (DSPD).¹⁴ DSPD is “characterized by a stable sleep schedule that is substantially later than the conventional or desired time.”¹⁴

A range of behavioral and biological factors have been associated with poor sleep patterns. Screen time, including television (TV) watching, computer and electronic game use, delays bedtimes and encroaches on sleep time.¹⁵ Relaxed parental bedtime monitoring sets up an environment that allow bedtimes to move to later times.¹⁶ Other behavioral factors that could potentially disrupt sleep are after-school work schedules and the stress of academic demands.¹⁷ Biologically, puberty may disrupt sleep onset which can delay bedtimes and in extreme cases develop

clinical delayed sleep phase syndrome.¹⁸ Pubertal “phase-delayed” circadian rhythms coupled with sleep-delaying behaviors, such as TV watching, may work synergistically to generate a self-perpetuating cycle of short sleep duration and low sleep quality.

Despite empirical evidence on the effects of poor sleep on both daytime performance and health,¹⁹⁻²¹ few studies have examined the effectiveness of interventions on sleep outcomes. Clinical and community awareness of this issue also appears to be low, and one solution to address this deficit has been the targeted use of sleep education programs in schools.^{22,23} Previous studies have largely developed their own specific sleep education programs for their respective population. This, and the added differences in design, and varying duration of intervention make it difficult to compare their effectiveness.²⁴⁻²⁹

Two Australian sleep education programs, the Improving Adolescent Well-Being (IAWB): Day and Night program²⁹ and the Australian Centre for Education in Sleep (ACES) program^{27,30} have shown some promise. The IAWB and its subsequent motivational interviewing-modified (IAWB-MI) version²⁸ were classroom-based courses held over four 50-minute education sessions. Both studies were randomized and included year 11 students. Sleep knowledge and behavior was targeted, primarily the differences between week night and weekend night sleep, i.e., discrepant rise times. Despite both studies observing significant increases in sleep knowledge, neither study observed a significant improvement in sleep behavior.

The ACES program was also delivered over four sessions, and two intervention studies reported a significant increase in knowledge in all school students exposed to the sleep education material. In addition, more than 90% of students self-reported a need for ongoing sleep education within the school curriculum. Teachers reported greater student engagement in the learning process; however, sleep duration data were not collected. While it is acknowledged that sleep education alone may not be sufficient to motivate changes in sleep behavior,³¹ an adequately powered randomized control trial (RCT) is required to determine the effectiveness of a sleep education program on sleep duration, sleep quality, sleep knowledge, and other health outcomes such as mental well-being and body weight.

Given the cultural similarity between Australia and New Zealand, the ACES program offers an ideal basis for a sleep education intervention in New Zealand (NZ); however, this program has not been tested outside Australia. Thus the purpose of this study was to adapt the ACES program for use in a NZ context and undertake a pilot trial to determine the short-term effects on sleep duration and highlight feasibility issues prior to conducting a larger randomized controlled trial.

METHODS

Design

A standard two-arm, parallel, randomized controlled pilot trial was conducted with an ethics review provided by the Northern Regional Ethics Committee (NTX/09/07/067). Students in the selected classes received verbal and written information from the researcher about the study and were informed that participation was voluntary. Written student consent and parent/care-giver assent was required from all study participants.

Recruitment targeted 8 NZ secondary schools in the Auckland central region. Researchers used existing contacts and sent letters of invitation to participate in the study. Letters were followed up with a telephone call to the school principal to determine their interest. If schools responded positively, a meeting was held to outline the aims of the study. Initially, 3 schools agreed to participate, and of these one took part in the study.

Participants were randomly allocated to groups using sequentially numbered opaque sealed envelopes. Blocked randomization, stratified by sex and age, was used with random numbers generated in SPlus in block sizes of 2 and 4. The randomization sequence was generated by a statistician using SAS (Statistical Analysis Systems version 9.1.3).

Participants

Twenty-nine students aged 13 to 16 years attending a local high school were recruited from 2 classes (Year 9 and Year 11/12). New Zealand schools are ranked from 1 to 10 (10 being the most affluent and 1 being the most deprived) using Statistics New Zealand meshblocks (50 households with children) in the local school area.³² For this study, the participating school was decile four. Students under 16 years of age were required to provide written individual assent and parental consent. Older students provided their own consent. Participants received a \$20 shopping voucher in acknowledgement of their involvement. Two classes were selected for participation by the school’s Deputy Principal; they included a year 9 Health Education class and a combined year 11 and 12 Gateway class. Gateway classes are for year 11 and 12 students who are likely to be going into the work force the following year.

Procedure

Participants were recruited during the third school term (August 2009) and issued information sheets and consent forms. Those who consented were invited to attend a baseline assessment where they completed a series of questionnaires including demographics and sleep information. Sleep diaries were provided to all participants to provide a subjective measure of sleep over the following 7 days. A face-to-face interview was conducted to provide a previous day’s recall of all time use using a computerized questionnaire. Seven days after baseline, sleep diaries were collected and the participants were randomized. Identical data collection procedures were conducted at post-intervention and follow-up.

MEASURES

Sleep: Self-reported sleep behavior was assessed using a sleep diary, which asked participants to record their “time to bed,” “lights out,” “time fell asleep,” and “time awake” over a 7-day period. “Time fell asleep” and “time awake” were used to calculate average daily sleep hours for week nights only (Sunday to Thursday) and average daily sleep hours for weekend nights only (Friday and Saturday) sleep duration. Sunday was considered a week night, as the next day was a school day. Friday night was considered a weekend night as the next day was considered a weekend day.

Sleep problems and sleep hygiene were assessed using standardized and validated questions from the school sleep

habits survey (SSHS).³³ The Sleep-Wake Problems Behavior scale (SP) includes 10 items rated on 5-point Likert-type scale ranging from 1 (never occurs) to 5 (every night). Scores can range from 10 to 50, with a high score indicating impaired sleep quality. The scale had acceptable internal consistency at all time points (Cronbach α ranged from $\alpha = 0.72$ to $\alpha = 0.82$). The sleep hygiene index (SHI) included 13 items scored on 5-point Likert-type scale from 1 (never) to 5 (always). Scores range from 13 to 65, with higher scores indicating poorer sleep hygiene. The internal consistency of the scale was acceptable throughout the study ($\alpha = 0.80$ to 0.83).³⁴

The scale of morningness and eveningness from the SSHS was adapted and validated from Smith's evaluation of morningness/eveningness surveys in adults.³⁵ A score is derived from 10 multiple-choice questions; each answer choice has a score allocated that is summed for the total score. Three questions have 5 options (scores 1 to 5), and 7 questions have 4 options (scores 1 to 4). Possible scores range from 10 to 43 with the highest score indicating morning preference ($\alpha = 0.76$).

Sleep knowledge was assessed using the ACES program questionnaire, which included 15 true-false questions. The total of correct answers indicated the level of knowledge regarding sleep. This measure has not been assessed for its psychometric properties.

Acceptability of Program

A brief exit survey was conducted after the initial intervention period, to assess participants' perceptions of acceptability of the intervention. A variety of open and closed questions were used. For example, participants were questioned to determine whether the program was informative, educational, "helpful," "entertaining," or "boring." The participants were also asked if the program was "too long, difficult to understand," "a waste of time," or whether they "needed more information."

Outcomes

The primary outcome was change in sleep duration from baseline to 10 weeks follow-up. Secondary outcomes included change in sleep hygiene, sleep problems, and sleep knowledge.

Intervention

The intervention was an adaptation of the ACES sleep education program 25 and included four 50-minute education sessions that the teacher presented using a Microsoft PowerPoint format during classroom time. The effect of alcohol and drugs on sleep, depression/anxiety and sleep, and a relaxation exercise were omitted, as the delivery of the program ran over time. These sections were omitted only after consultation with the developer of the program, and it was felt that it was unlikely they would adversely impact the results of the program, as these were information sections only.

For the purpose of this study, a health education teacher at the participating school delivered the sleep education program over 5 sessions (5 weeks) to include time for research questionnaires. The health educator had a basic knowledge of sleep and its importance. A "train-the-trainer" approach was taken, whereby the NZ researcher was trained by the developer of the program and then trained the teacher.

The programme was delivered over 5 sessions rather than the 4 of the prescribed program. This was due in part to sessions 1 and 5 being used for research activities (e.g., collecting Actigraphs and diaries). In addition, some students forgot to attend the classroom required for the sleep education program and went to their normal classroom. If a student missed a session, there were no follow-up sessions.

In addition to the standard program described below, there were multiple adaptations for the NZ environment, including interactive group peer-led sessions, reduction in time of teacher presentations, and small changes in text to suit NZ youth. These changes involved spreading the classes over 5 sessions instead of 4, changing some language, and using a less didactic approach—for example, reduced use of PowerPoint presentation and introducing peer-led, small group discussions.

This change was primarily to bring the presentation of the topic in line with common teaching techniques for NZ classrooms and those techniques that the teacher felt were effective for students. Teaching techniques implemented for this topic were cooperative learning—students teaching students, kinesthetic learning, modifying group sizes, and visual learning (use of PowerPoint). Key points from past sessions were persistently repeated.

An accompanying workbook was provided to all students, which included a full copy of all the presentations as well as additional information, for example, the importance of sleep and problems associated with lack of sleep. The sleep education program was supported with a comprehensive teacher training manual, which covered all aspects of the sleep education program, answers to questionnaires, and references for further information. The PowerPoint presentations also included notes, which included elaboration of specific points and answers to frequently asked questions. A workbook was sent home with students to deliver to their parents. The book contained summarized content of the students' workbooks, with additional information about sleep patterns and problems in other age groups.

Control

The control group continued with their usual health and physical education curriculum, with their usual teacher, during the study. At the end of the pilot study, participants received a condensed version of the intervention from the teacher that facilitated the intervention. Components of the program that were excluded were sleep knowledge testing, physiology, and relaxation. One 50-minute session was devoted to presenting the sleep program.

There was no additional emphasis of sleep in the control health class; however, discussion about the intervention between control and intervention participants was not controlled. Given that this design was to pilot the feasibility of the ACES education program in a New Zealand school environment, control for cross-contamination was not possible.

Sample Size and Statistical Analysis

A total of 22 participants were estimated to provide 90% power with an alpha level of 0.05 to detect a 1-h between-group difference in sleep duration, with a standard deviation of 0.90 h.³⁶ All analyses were performed using SAS (Statistical Analysis Systems) version 9.1.3, and were conducted according to intention-to-treat principles. Outcomes were analyzed with a

repeated measures analysis of variance (ANOVA) with intervention group as a between-subjects factor and each outcome as the within-subjects factor. Sphericity was confirmed by Mauchly's test and Greenhouse-Geisser (ϵ) adjustment applied if sphericity was violated. Between groups effect sizes (η^2) were calculated using Eta squared.

RESULTS

The participant recruitment and flow during the study is presented in **Figure 1**. As can be seen in **Figure 1**, 29 participants were randomized, and 28 participants completed the study. One intervention participant left school and did not participate in data collection at post-intervention or follow-up. Mean attendance at the sessions was 77%. For each session, attendance ranged from 47% to 93%. One student missed 3 sessions, 4 students missed 2 sessions, and 6 students missed 1 session due to illness. Four students attended all sessions.

Baseline characteristics are presented in **Table 1**. The mean age of all participants was 14.7 years (± 1.13), and 55% were

male. Participants were predominantly NZ Maori (indigenous) and NZ European. Baseline results show that control and intervention participants received slightly less than 9 h sleep per evening on week nights and weekend nights (**Table 2**).

Primary Outcome

An overall treatment effect was observed for weekend sleep duration ($F_{1,24} = 5.21, p = 0.03$). Participants in the intervention group slept longer during weekend nights at 5 weeks (1:37 h:min, $p = 0.01$) and 10 weeks (1:32 h:min, $p = 0.03$) compared to those in the control group ($\eta^2 = 0.21$). No differences were found between groups for sleep duration on weekday nights.

Secondary Outcomes

Main effects were observed for weekend wake times ($F_{1,24} = 8.26, p = 0.01$). There were no significant differences between groups for any of the secondary outcomes (sleep problems, sleep knowledge, and sleep hygiene). Trends were noticeable for reduced sleep problems and increased sleep knowledge for those in the intervention group compared to those in the control group.

Program Acceptability

Fourteen of the 15 intervention participants took part in the exit survey. Most of the participants indicated that the program was informative (93%), educational (100%), and helpful (86%).

Figure 1—Flowchart of recruitment and randomization process

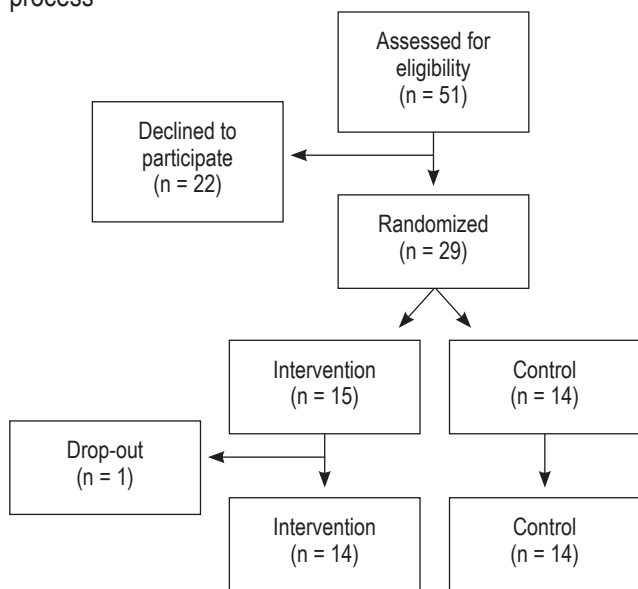


Table 1—Demographic and baseline characteristics of participants

	Intervention (n = 15) n (%)	Control (n = 14) n (%)
Sex (Female)	7 (46.7%)	6 (42.9%)
Ethnicity		
New Zealand European	3 (20.0%)	6 (42.9%)
New Zealand Māori	6 (40.0%)	3 (21.4%)
Pacific Peoples	2 (13.3%)	2 (14.3%)
Other (Asian and Indian)	4 (26.7%)	3 (21.4%)
	Mean ± SD	Mean ± SD
Age (years)	14.8 ± 1.1	14.7 ± 1.2
Morningness/Eveningness	26 ± 5	29 ± 4

Table 2—Primary and secondary outcomes across all three timepoints by intervention group

	Baseline		4-weeks		10-weeks		F-test	Sig.
	Intervention (n = 15)	Control (n = 14)	Intervention (n = 15)	Control (n = 14)	Intervention (n = 15)	Control (n = 14)		
Week night bedtime	22:38 ± 0:42	22:36 ± 0:33	22:25 ± 0:50	22:20 ± 0:39	22:18 ± 1:14	22:26 ± 0:36	0.03	0.88
Weekend bedtime	00:43 ± 2:25	23:40 ± 1:30	23:25 ± 1:22	00:08 ± 2:03	00:02 ± 1:47	23:34 ± 1:51	0.16	0.69
Week night wake time	07:31 ± 0:33	07:25 ± 0:58	07:30 ± 0:48	06:54 ± 1:21	07:15 ± 0:23	07:10 ± 0:44	0.80	0.38
Weekend wake time	09:12 ± 2:24	08:12 ± 1:10	08:53 ± 1:10	08:00 ± 1:22	09:44 ± 1:00	07:59 ± 2:03	8.26	0.01*
Week night total sleep time (h:min)	8:53 ± 0:43	8:48 ± 0:48	9:05 ± 0:53	8:35 ± 1:19	9:01 ± 1:07	8:44 ± 0:49	0.96	0.32
Weekend total sleep time (h:min)	8:29 ± 1:53	8:53 ± 1:23	9:28 ± 1:18	7:51 ± 1:41	9:48 ± 1:31	8:16 ± 1:40	5.21	0.03*
Sleep knowledge	10.4 ± 2.0	10.5 ± 1.6	11.1 ± 2.0	10.4 ± 1.8	10.9 ± 1.6	10.1 ± 1.5	0.72	0.40
Sleep hygiene	32.9 ± 8.4	28.9 ± 8.4	33.3 ± 9.2	31.2 ± 7.9	30.4 ± 8.6	31.4 ± 8.2	0.35	0.56
Sleep problems	23.5 ± 5.8	20.7 ± 6.1	21.5 ± 6.9	21.1 ± 7.4	20.5 ± 5.2	21.0 ± 7.4	0.17	0.69

Data are presented as mean ± SD. * Significantly different $p < 0.05$.

Most (71%) participants felt the program was not too long (71%) or a waste of time (79%); however, 29% found the program boring, and 43% did not think the program was entertaining. Most (79%) found the intervention was easy to understand.

DISCUSSION

The overall aim of this study was to adapt the ACES program for use in a New Zealand context and conduct a pilot trial to determine the short-term effects on sleep duration. An additional aim was to highlight feasibility issues prior to conducting a larger randomized controlled trial. Overall, our findings showed a positive effect on weekend sleep duration but not for weekday sleep. Adaptations to the intervention ensured its applicability for NZ youth and the intervention was shown to be feasible to implement on a larger scale.

This is the first study to show a positive effect on sleep duration using the ACES education program. Previous evaluation of the ACES program did not involve an RCT design, nor did they include measures of sleep duration. Our pilot data suggest that sleep education provision can influence sleep behavior in adolescents; however, a much larger trial is needed to confirm these effects.

Unlike previous studies conducted in Australia,²⁷ our intervention did not have a noticeable effect on sleep knowledge. In our study we used the quantitative but not the qualitative component of the ACES sleep knowledge questionnaire, which may have contributed to the null effect on sleep knowledge; however, based on the exit interview findings, participants stated that the ACES program was their only formal source of sleep information. Future studies need to incorporate more robust measures of sleep knowledge.

To date, only one other study has shown a positive effect of sleep education on sleep duration. In contrast to our study, differences were observed in weekday but not weekend sleep duration.²⁵ Adolescent sleep is partly characterized by longer weekend sleep duration compared to weekdays.³⁷ However in our study, intervention participants had a longer total sleep time on weeknights than weekend nights at baseline. Weekend total sleep time during the study increased due to later waking times. Cross-sectional evidence demonstrates that adolescents tend to increase weekend sleep to compensate for short weekday sleep,³⁸ which is consistent with our findings. Weekends may offer greater flexibility in modifying time use to accommodate greater sleep duration; however, an improvement in weekday sleep duration and a reduction in the disparity between week and weekend night bedtimes may be preferable from a health perspective. Future sleep intervention programs may need to impress the importance of focusing on strategies for earlier week day bedtimes rather than catch-up sleep over the weekend.

For this pilot trial, we adapted the ACES program for use in New Zealand as detailed in the methods section. These differences may have also contributed to the differences in results of the present study to those previously conducted with the ACES program in Australia. Overall, the content and structure of the ACES and Sleep Smart programs are similar, involving four weekly sessions of 50 minutes, but differ in their application of behavior change models. The ACES program does not explicitly specify a theoretical framework in its development, whereas

the Sleep Smart program incorporated a social learning model to encourage behavior change.

Most sleep education programs have been implemented on the premise that knowledge guides behavior and points behavior to a desired result.^{39,40} Social cognitive models, such as the theory of planned behavior, state that knowledge will not elicit behavior change on its own.³⁹ Theory-driven behavior change strategies aim to take full advantage of the potential effect of sleep education. For example, in our study, some participants found the ACES program difficult to understand, boring, and not entertaining. Aspects of the sleep program such as background knowledge and physiology may be less important to initiate behavior change. Reducing non-instructional content and providing practical strategies or providing contingency management skills may assist efficacy of sleep behavior change. By modifying the program to diminish inessential information and enhancing the enjoyment of the learning process, greater sleep knowledge and a higher motivation to make changes to sleep behavior are more likely to follow.

There were a number of feasibility issues that warrant discussion. Participant and program facilitator enthusiasm about the sleep education program may be an influential factor on participant sleep behavior. Students required constant reminders to complete their sleep diaries; thus, future studies should consider more objective measures of sleep duration such as accelerometry. Additionally, the schools' perception of resources (for example, time and staff) was an important consideration for their involvement and affected recruitment. Most of the school principals considered the program to be beneficial but did not feel they had the resources to implement the program. Furthermore, some were skeptical that improving sleep would translate into useful outcomes such as improved academic performance or fewer disciplinary incidents, despite research evidence to the contrary.⁴¹ Identifying and training a teacher to deliver the sleep education program was more difficult than expected, primarily due to time commitments and attendance of training sessions. Inadequate knowledge of sleep benefits by school staff, existing curriculum delivery requirements, limited staffing resources, and availability of teachers for training are all important issues to overcome with schools before such an intervention can be scaled up.

Limitations of this pilot study need to be considered. First, the age range (13 to 16 years) and decile rating of the school restrict generalizing to similar populations only. Second, sleep duration was assessed using a self-report diary and is limited by the biases associated with this method; however protocols that promote adherence to objective measures of sleep duration will help to overcome this issue. Third, a valid measure of sleep knowledge would be useful to analyze the effect of education on sleep behavior. Fourth, the duration of the trial was limited to 10 weeks, and longer duration trials are required to determine the sustained effect of the intervention. Finally, the data presented are from a small pilot study within one school. Even though participants were separated to deliver the intervention, contamination may have existed. A larger cluster randomized design trial would help to address this issue.

Future studies might also consider the effects of improved sleep on health outcomes such as overweight and obesity, and explore potential mechanisms of change. Most recently, poor sleep duration has been linked with overweight and obesity,

and several mechanisms that lead to weight gain have been proposed, including appetite dysregulation and low total energy expenditure.⁴² Measures of sleep knowledge are needed to confirm the relationship between sleep education and sleep behavior. Feasibility issues with implementing sleep education programs on a large scale in schools mean that alternative delivery platforms or approaches be considered, such as Internet-based or family-based interventions.

In conclusion, a sleep education program increased weekend sleep duration in adolescents. Implementing a sleep education program within an existing school curriculum requires commitment from the school to invest adequate staff resources. A classroom-based approach appears to be acceptable to adolescents. A larger randomized controlled trial of longer duration is required to determine the sustained effects of the intervention on sleep behavior and health outcomes.

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