Sleep Medicine Reviews 70 (2023) 101807

Contents lists available at ScienceDirect

Sleep Medicine Reviews

journal homepage: www.elsevier.com/locate/smrv

Interventions to increase sleep duration in young people: A systematic review

Sylistah Gadam [a, b, *], Cassandra L. Pattinson [a, b, c], Kalina R. Rossa [a, b], Shamsi Shekari Soleimanloo [a, b], Jane Moore [d], Tahmina Begum [a, b], Arvind Gnani Srinivasan [a, b], Simon S. Smith [a, b, c]

[a] Institute for Social Science Research, The University of Queensland, Australia
[b] The Australian Research Council Centre of Excellence for Children and Families over the Life Course (the Life Course Centre), Australia
[c] The Australian Research Council Centre of Excellence for the Digital Child, Australia
[d] UQ Library, The University of Queensland, Australia

ARTICLE INFO

Article history:
Received 14 June 2022
Received in revised form
20 December 2022
Accepted 12 June 2023
Available online 16 June 2023

Handling Editor: M Vitello

Keywords:
Intervention
Sleep
Sleep duration
Sleep extension
Sleep banking
Young people

SUMMARY

This systematic review explored the outcomes of current interventions to increase sleep duration in healthy young people (14–25 years). Nine databases were systematically searched, and 26 studies were included in this review. Quality assessment of the included studies was evaluated using two tools: the Newcastle-Ottawa scale, and Cochrane Risk of Bias. The interventions incorporated a range of strategies including behavioral (46.2%), educational (26.9%), a combination of behavioral and educational (15.4%), and other strategies such as physical therapy (11.5%). The findings indicate that behavioral and combination interventions were consistently effective in increasing sleep duration in healthy young people. Educational interventions alone were less effective at increasing young people's sleep duration. Of all the included studies, only one randomized control trial but none of the non-randomized trials were rated as good quality. Our findings suggest a combination of strategies with an emphasis on personalization of intervention could possibly maximize the chances of success at improving sleep duration in healthy young people. More high-quality studies with long-term assessments ($\geq$ 6 months) should be conducted to test the efficacy and durability of interventions to increase sleep duration in young people, as well as the clinical implications to mental and physical health.

1. Introduction

Insufficient sleep, defined as having a short sleep duration of <7 h per night [1,2], is experienced by a substantial proportion of young people [3–5]. Young people aged 14–17 y (teenagers) and 18–25 y (young adults) are recommended to sleep for at least 8 h and 7 h per night, respectively [2]. However, almost 70% of teenagers and over 30% of young adults do not achieve these sleep hours [6]. Short sleep duration is associated with a wide range of adverse consequences for young people, including impaired cognitive performance [7], increased risk of a car crash [8], type-2 diabetes and obesity [9,10], mood impairment [11,12], and suicidal ideation [13]. Sleep problems in young people also predict future sleep issues, such as insomnia, in later life [14].

Sleep duration is modifiable [15] through various strategies and interventions. Early evidence focused primarily on behavioral approaches that directly extended the duration of time-in-bed. However, there are a number of interventions including educational, a combination of behavioral and educational, and other strategies, that have been designed to manipulate sleep duration. Behavioral approaches typically prescribe a longer time-in-bed to increase the opportunity for longer nocturnal sleep duration. One example of a behavioral intervention which extended time-in-bed to 10 h for one week, led to an increase in sleep duration of more than 60 min across the week and an improvement in young people's executive functioning [16] and tolerance to subsequent sleep restriction [17]. In contrast, educational approaches typically provide information and knowledge about sleep, based on 'sleep hygiene' or other good sleep health principles. In one study that

* Corresponding author. The University of Queensland, Institute for Social Science Research, 80 Meiers Road, Indooroopilly, Queensland, 4068, Australia.
E-mail address: sylistah.g@gmail.com (S. Gadam).

https://doi.org/10.1016/j.smrv.2023.101807
1087-0792/

Glossary of terms

Actigraphy	A non-invasive, validated, and objective, wearable device used to record activity (movement), including sleep
Sleep hygiene	Education on healthy habits, behaviors, and environmental conditions that can be adjusted to promote sleep
Time-in-bed	Time spent in bed by an individual, whether or not they are sleeping during that period
Sleep duration	Quantity of time that an individual spent sleeping during their main evening sleep period (not including napping during the day)

incorporated education about managing technology use before bed in combination with good sleep hygiene information, sleep duration increased on average 31 min in the week following the intervention [18]. The combination of behavioral and educational approaches blends several predefined behavioral and educational elements. For example, an intervention may have prescribed longer time-in-bed combined with education on the benefits of a consistent sleep schedule. The delivery of sleep hygiene education combined with the implementation of a personalized sleep plan in one combination type intervention study, led to an increase in objective sleep duration of nearly 30 min [19]. Finally, other approaches may include receiving physical therapy (such as massage) or use of bright light therapy.

A growing body of literature indicates promise for sleep extension interventions to improve sleep in young people [20–22]. Indeed, two systematic reviews/meta-analyses have shown strong efficacy of behavioral sleep extension interventions to increase sleep duration in young adults [20,22], with one reporting that on average, these interventions increased sleep duration by 35 min [20]. Similarly, Niu et al. [21] examined the efficacy of 17 at-home sleep extension studies in young people (both clinical, athlete and non-clinical/athlete populations). Overall, this study reported that sleep extension studies, regardless of intervention design were effective at increasing sleep duration measured by actigraphy, by 31 and 55 min, for between and within-subjects studies respectively. Taken together, this work paints a strong picture for the efficacy of behavioral sleep extension interventions to increase sleep duration [20–22]. However, the available evidence does not explicitly distinguish between the different intervention designs aimed at manipulating sleep in healthy young people, nor do they provide robust comparisons of changes in sleep duration related to each approach. Therefore, this review aimed to identify the types of interventions currently being employed to intervene to improve sleep duration in healthy young people (14–25 y), and report on the efficacy of each intervention type for increasing sleep duration.

2. Methods

We conducted this review using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [23]. We registered the protocol with the PROSPERO international database of the University of York Centre for Reviews (PROSPERO ID: CRD42021249154) which can be accessed at: https://www.crd.york.ac.uk/PROSPERO/display_record.php?RecordID=249154.

2.1. Literature search strategy

We performed a systematic literature search across nine electronic databases: PubMed, Ovid MEDLINE, CENTRAL, Embase, CINAHL (via EBSCOhost), PsycINFO, Scopus, Web of Science and ProQuest Dissertations and Theses. A librarian (JM) with expertise in systematic reviews assisted with creating the search strategies and conducting the initial search on 15 June 2020 to capture any studies involving sleep extension from all countries and regions from 2005 onwards. We further searched for any related thesis or dissertation in Trove, an online discovery tool hosted by the National Library of Australia. The updated searches on 1 April 2021 did not find any additional studies for inclusion. We identified and removed all duplicate records using Bramer and Bain's method [24]. File S1 contains the search strings used in each database.

2.2. Inclusion and exclusion criteria

We assessed the eligibility of papers using the Population, Intervention, Comparison, Outcomes and Study Design (PICOS) framework approach [25] (see Table S1). The population of interest was restricted to human studies of healthy young people aged 14–25 y, regardless of their gender, geographical location, socioeconomic status, ethnic group, regular sleep hours per night or sleep complaints. Studies with young participants outside the age limit of 14–25 y were included if a sub-analysis was provided for the age group of 14–25. We included studies that provided the results of behavioral, educational, combination or other interventions on sleep duration outcomes. Study designs included both randomized and non-randomized control trials. Only studies reporting the primary outcome of interest, sleep duration (e.g., total sleep time), were included. We included studies with objective (via actigraphy or polysomnography) or subjective (via a sleep diary or other sleep questionnaires) measurements of sleep duration and various locations of delivery of the intervention (e.g., at home or in the laboratory). Studies without a baseline sleep duration or sleep duration before exposure to the intervention were excluded. Depending on the study designs, sleep duration in the comparison condition could be derived from a non-intervention control condition, placebo condition, treatment-as-usual (active control intervention group), baseline sleep duration, or pre-intervention sleep duration. Any studies that included a pharmacological intervention to facilitate sleep, including exogenous melatonin, were excluded. Published theses were included, but reviews, commentaries, letters, editorials, conference proceedings or abstracts, case reports, study protocols, notes, and short surveys were excluded. The language of publication was restricted to English only. Any relevant non-English publications without English full text available were excluded.

2.3. Study screening

The search results were uploaded to Covidence [26], an electronic systematic review management system, and deduplicated using the Covidence duplicates removal function. Four reviewers (SG, TB, AGS, SA) were trained to conduct the screening based on the specific inclusion and exclusion criteria. In accordance with PRISMA guidelines, two reviewers independently examined the titles and abstracts and then the full-text versions of relevant studies to determine eligibility. Consensus discussions with the review team (CLP, KR, SS, SS) resolved disagreements between the reviewers. The rationale for excluding potentially relevant studies was documented (see Fig. 1).

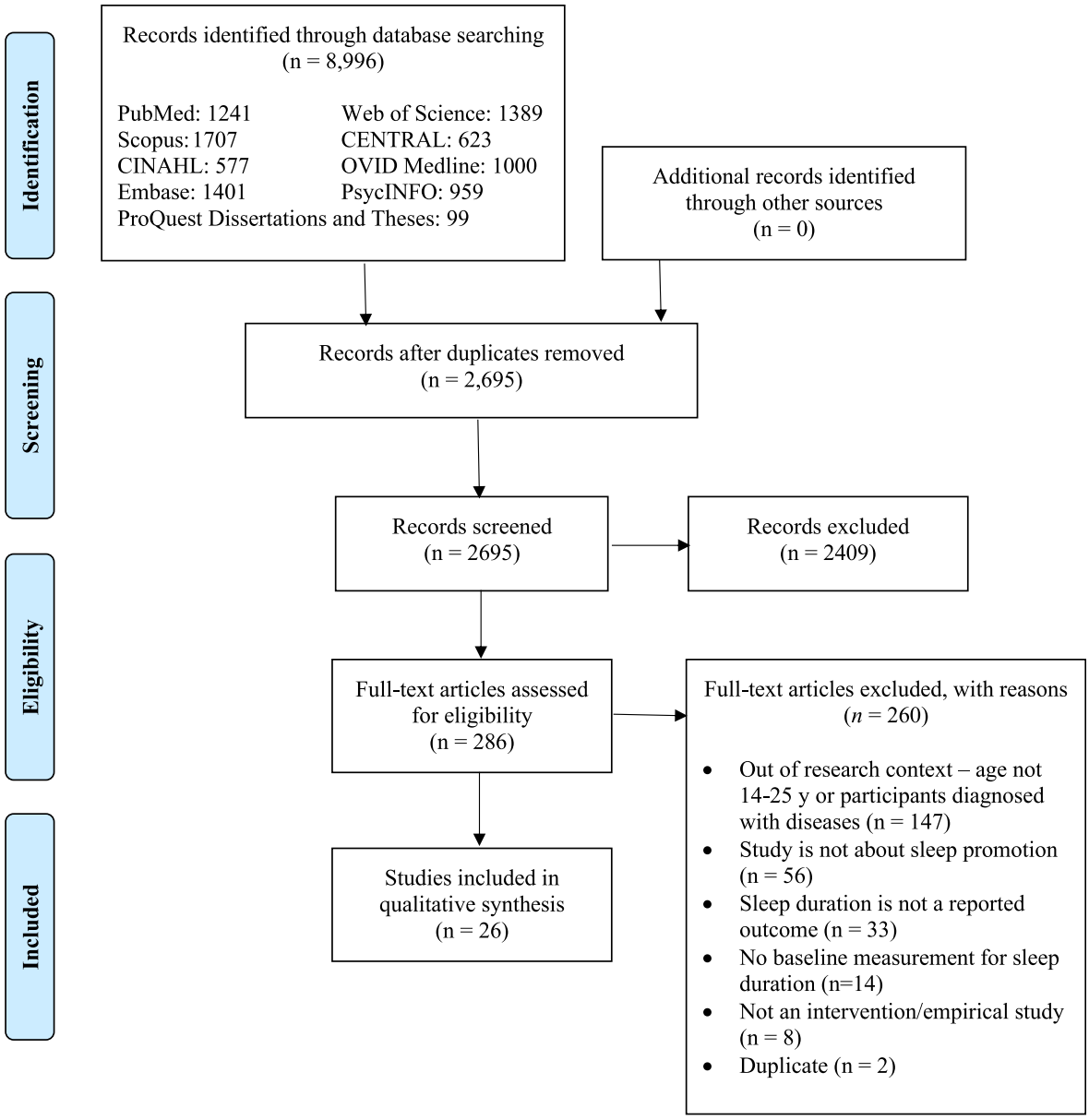

Fig. 1. PRISMA flow diagram.

2.4. Data extraction and synthesis

Three reviewers extracted data independently into a customized excel spreadsheet, which includes the characteristics of publication, participant, study design, outcomes of the study, and the intervention details. Studies using data from the same sample were recorded to avoid duplication of published data. Any discrepancies were resolved via discussion with the review team, and data were summarized into tables. Meta-analysis was not performed due to the heterogeneity of the included studies, in terms of the intervention designs [27]; hence, narrative synthesis was undertaken.

2.5. Study quality and risk of bias assessment

In addition to the PRISMA guidelines, two independent reviewers assessed the quality of studies and risk of bias for each study using two tools: the Cochrane Risk of Bias (CoB) tool [28] for randomized controlled trials (RCTs), and the Newcastle-Ottawa (cohort) scale (NOS) [29] for non-randomized trials (non-RCTs). Any disagreement was resolved via discussion in the review team.

Using the CoB tool (see File S3), we assessed the bias of the relevant studies over seven domains: 1) sequence generation, 2) allocation concealment, 3) blinding of participants and personnel, 4) blinding of outcome assessment, 5) incomplete outcome data, 6) selective outcome reporting, and 7) other issues, such as reporting bias. We used the thresholds for converting the CoB based on the Agency Healthcare Research and Quality (AHRQ) standards to rate the included studies as good, fair, or poor quality (see File S2).

Using the NOS tool (see File S4), the quality of non-randomized trials, including randomized crossover design studies, was assessed over three domains: 1) selection of study groups, 2) comparability of groups, and 3) ascertainment of the outcome of interests. The Newcastle-Ottawa scale assigns points for risk of bias, up to a maximum of nine points (least risk). We followed previously reported thresholds [30] to rate the non-randomized studies as good

(7–9 points), fair (4–6 points), or poor quality (0–3 points), and resolved any discrepancies by a discussion with the review team.

3. Results

3.1. Study selection

The study selection process is illustrated in Fig. 1. Database searches identified a total of 8996 initial records. After duplicate removal, we screened the title and abstract of the remaining 2695 records and excluded a further 2409 records. The screening process left 286 studies for the full-text review. Upon completion of the full-text screening, 26 studies met the eligibility criteria and were included in the data extraction.

3.2. Descriptive characteristics of the included study

The 26 retained studies (see Table 1) comprised 23 peer-reviewed journal articles and three theses or dissertations. While most studies ($n = 14$, 53.8%) were conducted in the United States, the remaining studies were conducted in Australia ($n = 5$, 19.2%), Asia ($n = 4$, 15.4%), and Europe ($n = 3$, 11.5%). Most studies were non-randomized controlled trials ($n = 16$, 61.5%), as opposed to the randomized controlled trials ($n = 10$, 38.5%). The total sample size was 1682, ranging from 8 to 210 participants. The mean age ranged from 14 to 24 y, with 11 studies conducted among adolescents and 15 among young adults. The majority of studies ($n = 19$, 73.1%) utilized actigraphy as an objective measure of sleep duration. Of these 19 studies, 15 were accompanied by subjective measures of sleep duration (sleep diaries or self-developed questionnaires), one study combined actigraphy with polysomnography. In contrast, another study used a subjective measure (sleep diary), alongside actigraphy, polysomnography, and the Multiple Sleep Latency Test. The remaining studies ($n = 7$, 16.9%) used subjective questionnaires only.

3.3. Types of interventions to increase sleep duration and their effectiveness

The 26 included studies employed a number of different intervention types. These interventions were assigned to one of four categories (see Table 2 for definition of each category): 1) behavioral, 2) educational, 3) combination of behavioral and educational, and 4) other. The majority of studies (46.2%) implemented behavioral interventions [31–42], seven (26.9%) studies adopted an educational intervention [18,43–48], four (15.4%) studies used a combination of behavioral and educational interventions [19,49–51], and three (11.5%) studies implemented other types of interventions [52–54]. The results of each of these studies by intervention sleep on sleep duration is shown in Table 3.

3.3.1. Behavioral intervention designs effectiveness on increasing sleep duration

Of the 12 studies that incorporated a behavioral intervention, six prescribed an extended time-in-bed, with the times being extended by 60 min [34,38], 90 min [32,33,40], or by 20% of the participants' habitual sleep duration [31]. The time-in-bed extension regimes lasted from 4 to 14 days. In each of these studies, sleep duration measured by actigraphy increased significantly (range: 31–45 min).

Four studies focused more on prescribing a set number of hours of sleep per night, ranging from 9 to 12 h [36,37,41,42]. The sleep extension regime in these studies lasted from 3 to 9 days. Each of these studies reported a significant increase in objective (range: 62–102 min [36,37,41,42]) and subjective sleep duration (by 103 min [37]).

One study allowed participants a 10 h sleep opportunity and encouraged participants to sleep as much as possible, including daily naps, to reach the 10 h target [39]. In this study, sleep duration (measured via actigraphy) increased by 111 min across 24 h. In another study, mobile phone usage was restricted by 30 min prior to bedtime through an app blocking function [35]. This study reported a significantly longer sleep duration (around 18 min) in the intervention group compared to the control group. None of the 12 behavioral-intervention studies conducted a follow-up assessment of sleep duration after the intervention periods.

3.3.2. Educational intervention designs effectiveness on increasing sleep duration

Seven studies implemented an educational intervention to increase sleep duration; however, these studies varied in the content, frequency, and delivery method of educational information. Of these, three studies prescribed the educational content in a brief single-session model of intervention [18,43,46]. Barber and Cucalon [18] presented undergraduate students with educational information about general sleep hygiene and pre-bedtime digital device management via an electronic platform. In a novel interactive approach, Perucho et al. [46] presented educational materials about sleep health and utilized a web-based platform to show participants digitally edited photographs of their own faces experiencing varying degrees of hypothetical sleep restriction. Shepherd [43] utilized a message framing approach in which either the benefits of sufficient sleep or the risks of insufficient sleep were presented on pamphlets to two groups of participants. Of these three studies, only one [18] found an increase in sleep duration (31 min measured by actigraphy).

Four of the seven studies delivered the educational interventions across multiple sessions [44,45,47,48]. Fucito et al. [48] used a web-based platform to deliver four modules of sleep health information to a group of college students over four weeks. The modules covered general sleep physiology and circadian rhythms, sleep disruptive behaviors, sleep environments, and some tips on sleep hygiene and management of sleep disruptions and stress [48]. Moseley et al. [45] delivered secondary students four in-person classes (50 min) of controlled and interactive sleep education over four weeks. The sleep education was embedded within a broader cognitive behavior therapy framework addressing general wellbeing. Similarly, Van Rijn et al. [47] delivered secondary students a 60 min interactive sleep education session each week for four weeks, targeting sleep physiology, sleep hygiene and time management. A more individualized 6-week program of sleep education was provided by Van Ryswyk et al. [44] to a group of elite athletes. The program began with a 60 min session with a qualified sleep physician providing general sleep hygiene advice alongside targeted information on improving sleep for optimal athletic performance. Then, weekly individualized feedback was provided by research assistants via electronic messages on athletes' sleep progress during this 6-week program. Further, the same sleep physician provided a 60 min group sleep education session mid-program and offered face-to-face personalized feedback to the selected participants. Of all these studies, one found the educational intervention effective in increasing self-reported sleep duration by around 20 min [44], whilst the three other educational studies found no improvements in sleep duration [45,47,48].

3.3.3. Combination-intervention designs effectiveness on increasing sleep duration

Four studies implemented a combination of behavioral and educational interventions [19,49–51]. Dewald-Kaufmann et al. [51]

Table 1
Descriptive characteristics of included studies.

Author, year, reference	Country	Age in years, *M* (*SD*)	Sample size, *N*	Gender, (% female)	Sample description
Non-randomized Trials (*n* = 16)					
Boergers et al., 2014 [52]	USA	15.6 (−)	197	59%	High school students
Britton et al., 2010 [49]	USA	16.4 (1.3)	18	50%	Adolescent outpatients who had completed substance abuse treatments
Duffield et al., 2014 [53]	Australia	20.9 (3.6)	8	0%	Trained, professional tennis players
Garner et al., 2017 [40]	USA	16.8 (0.8)	38	63%	Short-sleeping adolescents
Irish et al., 2020 [19]	USA	18.7 (1.2)	60	54%	Young adults (poor sleepers)
Klerman and Dijik, 2005 [41]	UK	21.8 (3.7)	17	59%	Healthy volunteers without clinical sleep disorders
Mah et al., 2011 [39]	USA	19.4 (1.4)	11	0%	Undergraduate students (varsity basketball players)
Motomura et al., 2017 [42]	Japan	23.3 (2.1)	15	0%	Young adults
Paavonen et al., 2016 [50]	Finland	[a]16-18	36	83%	Adolescents with subjective sleeping difficulties
Rossa, K., 2018 [31]	Australia	21.4 (2.6)	21	47%	Short-sleeping young adults, university students
Schwartz and Simon, 2015 [37]	USA	20.2 (−)	12	58%	Tennis players
Shepherd, M., 2016 [43]	USA	19 (−)	156	83% for *N* = 170, no information for 156 retained in final analysis	Undergraduate students
Stock et al., 2020 [38]	USA	20.5 (1.1)	53	70%	Undergraduate students
Van Dyk et al., 2017 [33]	USA	15.1 (−)	18	67%	Short-sleeping adolescents
Van Dyk et al., 2018 [32]	USA	[a]14-18	76	62%	Short-sleeping high school students
Van Ryswyk et al., 2017 [44]	Australia	23.7 (2.0)	25	0%	Football club athletes
Randomized Controlled Trials (*n* = 10)					
Barber and Cucalon, 2017 [18]	USA	20 (4.8)	78	60%	Undergraduate students
Bonnar et al., 2015 [54]	Australia	16.3 (0.4)	193	79%	Students
Dewald-Kaufmann et al., 2013 [51]	Netherland	15.4 (−)	55	86%	Adolescents with chronic sleep reduction
Fucito et al., 2017 [48]	USA	[b]Intervention: 20.7 (1.4) Active control: 20.3 (1.2)	42	48%	College students (heavy drinkers with sleep concerns)
Hasler, 2008 [34]	USA	16.5 (−)	56	61%	Adolescents with complaints of daytime sleepiness and insufficient sleep
He et al., 2020 [35]	China	[b]Intervention: 21 (2.1) Control: 21 (2.6)	38	[b]Intervention: 36.8% Control: 26.3%	College students with poor sleep and habit of mobile phone use during bedtime
Moseley and Gradisar, 2009 [45]	Australia	15.6 (0.6)	81	77%	Secondary school students
Perucho et al., 2019 [46]	Singapore	[b]Intervention: 22.1 (2.1) Active control: 0.7 (1.9)	70	[b]Intervention: 58% Active control: 78%	Short sleeping young adults
Ritland et al., 2019 [36]	USA	[b]Intervention: 20.1 (2) Control: 19.8 (1.1)	50	[b]Intervention: 52% Control: 48%	Young adults
Van Rijn et al., 2020 [47]	Singapore	14 (0.3)	210	0%	Secondary school students

Note.
[a] Age range is reported since mean and/or standard deviation are not provided in the original report. (−) information is not provided in the original report.
[b] Information for both intervention and control groups are reported if been provided in the original report.

Table 2
Detailed descriptions of intervention categorization.

Category	Descriptions
1. Behavioral	Interventions that target sleep behaviors (e.g., timing, habits, and environment)
2. Educational	Interventions that provide information about sleep (e.g., knowledge, literacy, and beliefs)
3. Combination	Interventions involving a combination of both behavioral (refer 1) and educational (refer 2) strategies to impact sleep.
4. Other	Interventions using strategies other than behavioral or educational, or a combination of 'Other' with either behavioral (refer 1) or educational (refer 2)

combined a gradual advancement of habitual bedtimes by 5 min per night and sleep hygiene information. This study found a significant increase in sleep duration in the intervention group (by 13 min measured by actigraphy) compared to the control group.

In the study of Paavonen et al. [50], sleep consultants provided a semi-structured intervention during two brief sessions to extend the time-in-bed by 1 h. The session consisted of education on the psychology of sleep health, routines and rhythms, and sleep hygiene, alongside a behavioral sleep consultation and prescription of additional time-in-bed. The prescription was based on estimates of habitual sleep acquired from sleep diaries and questionnaires at baseline. This study found improvements in self-reported (46 min) and actigraphy-measured sleep duration (18 min).

In Britton et al. [49], six small group sessions (90 min weekly) were presented to adolescents face-to-face. The first session consisted of sleep education only. The remaining five sessions were divided equally between two training components, including cognitive-behavioral therapy and a modified Mindfulness-Based Stress Reduction (MBSR) training followed by a formal mindfulness meditation homework (10 min/day for six days a week). The

Table 3
Means and standard deviations of sleep duration.

Author, year, reference	Study design	Sleep promotion intervention			Sleep duration *(hours)*			
					Objective		Subjective	
		Description	Duration "dose" *(days)*	Assessment of sleep	Baseline, *M (SD)*	Extended, *M (SD)*	Baseline, *M (SD)*	Extended, *M (SD)*
Behavioral Interventions								
Garner et al., 2017 [40]	RCT	Extended time-in-bed by 1.5 h	14	During the 2 weeks intervention periods (focus on weeknights)	6.23 (0.43)	7.41 (0.53)*	–	–
Klerman and Djik, 2005 [41]	Pre-post	Extension of sleep opportunity for 16 h (12 h/night and 4 h/midday)	3	Each day during the 3 days intervention period	8.50 (1.10)	10.2 (1.60)*	–	–
Mah et al., 2011 [39]	Pre-post	Sleep as much as possible with a minimum goal of 10 h in bed per night.	35–49	During the 5-7 weeks intervention period	6.68 (1.03)	8.46 (1.31)*	7.83 (1.10)	10.40 (1.14)*
Motomura et al., 2017 [42]	Pre-post	Extension of time-in-bed for 12 h/night	9	During the 9 days intervention period	7.37 (0.18)	8.41 (0.18)*	–	–
Rossa, K., 2018 [31]	RXT	Extended time-in-bed (≈20% of the habitual night sleep)	7	During the 1 week intervention period	5.58 (1.27)	6.10 (1.18)*	7.20 (0.88)	8.23 (0.80)*
Schwartz and Simon, 2015 [37]	Pre-post	Extension of sleep opportunity for at least 9 h/night	7	During the 1 week intervention period	–	–	7.14 (0.87)	8.85 (0.60)*
Stock et al., 2020 [38]	Pre-post	Extended time-in-bed by 1 h/night	7	During the 1 week intervention period	7.31 (0.67)	8.04 (0.66)*	–	–
Van Dyk et al., 2017 [33]	RCT	Extended time-in-bed by 1.5 h/night	14	During the 2 weeks intervention period	6.16 (–)	7.33 (–)*	–	–
Van Dyk et al., 2018 [32]	RCT	Extended time-in-bed by 1.5 h/night	14	During the 2 weeks intervention period	6.40 (0.68)	7.37 (0.08)*	–	–
Hasler, 2008 [34]	RCT	Extended time-in-bed by 1 h/night	4	During the 3 nights intervention period	6.01 (1.26)	6.75 (1.12)*	6.64 (1.26)	7.98 (0.89)*
He et al., 2020 [35]	RCT	Restriction of mobile phone use before bedtime	28	1 week after the intervention period	–	–	6.20 (0.58)	6.56 (0.71)*
Ritland et al., 2019 [36]	RCT	Extended time-in-bed of 10 h/night	5	During the 4 nights intervention period	6.16 (0.67)	7.52 (–)*	–	–
Educational Interventions								
Shepherd, M., 2016 [43]	Pre-post	Sleep education via message framing (benefits of sufficient sleep or costs of insufficient sleep)	1	A week after the intervention period	–	–	PSQIgain: .79 (.94) PSQIloss: .50 (.68)	PSQIgain: .54 (.71) PSQIloss: .37 (.65)
Van Ryswyk et al., 2017 [44]	Pre-post	Sleep education and optimization program	42	During week 1 and at the end of the 6 weeks intervention period	7.11 (0.92)	7.27 (1.07)	8.31 (0.90)	8.65 (0.57)*
Barber and Cucalon, 2017 [18]	RCT	Sleep promotion education presentation (sleep hygiene and technology boundary management)	1	Sleep assessed for a period of 1 week immediately after the one session intervention	Done but value not stated	6.44 (1.23)*	Done but value not stated	7.20 (0.23)
Moseley and Gradisar, 2009 [45]	RCT	Sleep education, based on a cognitive-behavior therapy framework, to promote and maintain a healthy lifestyle.	28	At week 4 and week 6 following the intervention period	–	–	6.89 (0.80)	7.30 (1.00)
Perucho et al., 2019 [46]	RCT	Sleep education containing digitally edited photographs of participant's faces after varying amounts of sleep	1	At week 1 and week 4 following the one session intervention	W/day: 5.77 (–) W/end: 6.70 (–)	W/day: 6.38 (–) W/end: 6.28 (–)	–	–
Van Rijn et al., 2020 [47]	RCT	School-based interactive sleep education program on the importance of sleep and time management skills to make more time for sleep	28	Immediately after the 4 weeks intervention and 1 month following intervention period	W/day: 6.16 (0.82) W/end: 7.80 (1.21)	W/day: 5.96 (0.88) W/end: 7.94 (1.01)	–	–
Fucito et al., 2017 [48]	RCT	An experimental web-based intervention (4-module) that focused primarily on sleep and included evidence-based content for improving sleep and drinking in young adults - "Call it a Night"	28	At week 4 following intervention period	6.47 (0.21)	6.70 (0.15)	–	–
Combination Interventions								
Britton et al., 2010 [49]	Pre-post	Sleep education, cognitive-behavioral and modified Mindfulness-Based Stress Reduction therapies.	42	Assessed for 9 weeks, from baseline through to posttreatment week, at 3 months and 12 months following intervention period	–	–	7.27 (1.09)	Increased 1.23 (1.47)*
Irish et al., 2020 [19]	Pre-post	Implementation of a self-personalized sleep health improvement plan based on sleep health	7	During the 1 week intervention period	6.20 (1.38)	6.43 (1.47)*	6.81 (0.80)	7.26 (0.86)*

		recommendation on a website developed by researcher						
Paavonen et al., 2016 [50]	Pre-post	Personalized sleep consultation to extend average sleep by 1 h	1	At week 2 and week 3 following the intervention session	6.98 (0.67)	7.28 (0.63)*	W/day: 6.71 (1.00) W/end: 8.53 (1.92) Average^{+}: 7.23 (1.17)	W/day: 7.48 (1.05)* W/end: 8.93 (1.35) Average^{+}: 7.90 (1.02)*
Dewald- Kaufmann et al., 2013 [51]	RCT	Personalized sleep extension schedule (gradual advancement of bedtimes by 5 min/night) with sleep hygiene information.	14	During the 2 weeks intervention period	6.93 (0.53)	7.15 (0.60)*	–	–
Other Interventions								
Boergers et al., 2014 [52]	Pre-post	25 min delay in school start time	School winter term – duration not specified	At the end of school winter term, and spring term	–	–	W/day: 7.02 (1.00) W/end:9.07 (1.27)	W/day: 7.50 (1.20)* W/end: 9.10 (1.25)
Duffield et al., 2014 [53]	RXT	15 min cold water immersion, 3 h of wearing full-body compression gear, and light manipulation	1	Night after the intervention session during the day	~6.67 (–)	~7.67 (–)*	–	–
Bonnar et al., 2015 [54]	RCT	Three intervention conditions: i. Sleep education and bright light therapy ii. Sleep education and parental involvement iii. Sleep education, bright light therapy, and parental involvement	28	At postintervention and 6 weeks follow-up	–	–	W/day: Done but value not stated	W/day: Increased 0.45*

Note: RCT = randomized control trial; RXT = randomized crossover. *Sleep duration significantly increased following exposure to interventions. $^{+}$Average of sleep duration across one week. ~Approximate value of sleep quantity based on information in study (bar graph).

cognitive-behavioral therapy component included stimulus control instructions, regularization of sleep-wake schedules, bright light, and cognitive therapy. Results post-intervention indicate that self-reported sleep duration increased by 74 min in participants who regularly meditated, compared to participants who were less adherent to the meditation schedule.

Irish et al. [19] implemented a combination educational and behavioral intervention on healthy young adults with habitual short sleep. In a single session, participants read a website containing a list of sleep health recommendations (i.e., sleep hygiene, stimulus control, and sleep restriction) and developed their own sleep health plan. Participants implemented their personalized sleep improvement plan for one week. On self-reported measures of sleep and actigraphy, sleep durations were increased by 14 min and 27 min, respectively. Overall, all four studies implementing interventions using a combination of educational and behavioral strategies successfully increased objective sleep duration.

3.3.4. Other intervention designs effectiveness on increasing sleep duration

Three studies implemented 'other' intervention strategies to manipulate sleep duration. Boergers et al. [52] conducted a school-policy change intervention by delaying high school start times by 25 min. This delay significantly increased the self-reported sleep duration of school students on weekdays by 29 min but not on weekends. However, this increase in sleep duration was not maintained following the reinstitution of the school start time to the original schedule.

In Duffield et al. [53] randomized crossover study, a recovery intervention was implemented for professional tennis players that combined physical therapy (including cold-water immersion and wearing full-body compression gear) and manipulation of sleeping conditions (low-light, earlier bedtime, cool room, sleep with eye masks). This study found a 60 min increase in actigraphy-measured sleep duration compared to the control condition (15 min of passive stretching).

Bonnar et al. [54] administered a novel school-based intervention to adolescents from six high schools (matched on socioeconomic status) by randomly allocating them to four groups: 1) sleep education (4 × 50 min classes) and bright light therapy (portable green light LED glasses), 2) sleep education with parental support (4 × videos aligning with adolescent sleep education modules), 3) sleep education, bright light therapy, and parental support, or 4) control group with no intervention (class as usual and monitoring sleep). All three intervention groups demonstrated an increase in subjective sleep duration (27 min on average) during school nights post-intervention relative to the control group. A 6 week post-intervention follow-up showed a slight improvement for sleep duration in group 1 (sleep education and bright light therapy), but no significant changes in the other groups ('sleep education with parental support' and 'sleep education, bright light therapy, and parental support') compared to the control group.

3.4. Study quality and risk of bias

The quality of the 16 non-randomized controlled trials was assessed using The Newcastle-Ottawa scale. The most common sources of bias were observed within the two subdomains of selection of study groups: representatives of the exposed cohort and selection of the non-exposed cohort, and within the subdomain of the ascertainment of the outcome of interests: adequacy of follow up of cohorts. Overall, none of the non-randomized control trial studies was rated as good quality (see Table S2). Instead, fourteen and two studies were rated as fair quality and poor quality, respectively.

The assessment of the quality of 10 randomized controlled trials (RCT) using the Cochrane risk of bias tool showed some sources of bias observed related to random sequence generation ($n = 8$), allocation concealment ($n = 8$), blinding of participants and personnel ($n = 7$), blinding of outcome assessment ($n = 9$). All the RCT studies had a low risk of incomplete outcome data and selective reporting. Similarly, the risk of other sources of bias was low for all except for one study with a high risk of bias (see Table S3). Altogether, one RCT was rated as good quality, another was rated as fair quality with some concern, and the remaining eight studies were rated as poor.

4. Discussion

This systematic review explored the outcomes of interventions to increase sleep duration in healthy young people aged 14–25. We identified 26 studies utilizing a range of different intervention strategies. These strategies were categorized into behavioral, educational, combination of behavioral and educational, and other. The vast majority (46.2%) of the interventions identified were behavioral. Overall, the behavioral interventions consistently increased sleep duration in healthy young people, either measured objectively (average of 31–111 min) or subjectively (average of 62–154 min). This is consistent with prior meta-analyses, which exclusively focused on behavioral interventions [20,22]. Nearly all of the behavioral studies identified in this review (11 of 12), implemented behavioral strategies to directly manipulate sleep duration (i.e., prescribing extended time-in-bed, or in one study; 'sleep as much as you can'). One study [35] used an indirect behavioral approach (i.e., restricting mobile phone use before bedtime) and demonstrated a significant improvement in self-reported sleep duration for the intervention group compared to the control group (no restriction of phone use). The durability of these behavioral interventions is uncertain, as only acute or short-term impacts on sleep duration have been reported. Furthermore, many of the studies classified as behavioral in this review were conducted as in-lab experimental studies. Therefore, further work to validate the strategies used, outside of the lab, to ensure translatability in the real-world is still to be done.

Our results indicate that educational interventions had inconsistent success in improving sleep duration, with only two of six papers having a statistically significant impact on increasing sleep duration, self-reported [44] and actigraphically recorded [18]. These mixed findings echo a previous review by Blunden et al. [55] which surmised that educational interventions have shown limited efficacy in changing sleep behavior. This may be due to methodological variations in the educational content and delivery (e.g., frequency and length of classes, the deliverers' skills, target group [individual vs general], delivery mode [in-person vs on-line]), and/or due to a lack of theory-based strategies for behavior change [56]. Some of the studies reported improvement of sleep knowledge through educational interventions [45–47] that did not translate to increased sleep duration, suggesting that sleep knowledge acquisition did not necessarily equate to a change in sleep behavior [55]. Therefore, educational strategies alone may be insufficient to increase sleep duration. However, they could have an adjunctive role in promoting overall good sleep health. Tailoring educational content such that it is relevant, personalized, and addressing the specific needs of young people may be a critical factor in delivering sleep health interventions that lead to significant changes not only in knowledge but also behavior [56].

Four papers met the inclusion criteria of combination intervention, including both educational and behavioral components. Consistent with previous work [20–22], we found that interventions that combine behavioral and educational strategies provide robust increases in sleep duration, measured objectively (between an average of 13 and 19 min) and subjectively (between an average of 17 and 74 min). Educational interventions as standalone have previously been deemed ineffective and behavioral interventions as a standalone are effective; however, we are unable to assess what components (i.e., just behavioral, or the combination of both behavior and education, or education alone) of these interventions were effective at producing changes in sleep behavior. What is evident, is that each of the combination interventions shared an element of personalization (e.g., personalized sleep consultation [50], or an individual sleep health improvement plan [19]). As such, a personalized approach to sleep extension may be a key driver of sleep behavior change that bolsters both the education and behavior components. However, further investigations are warranted to explore this theory.

There were three interventions which were classified as 'other'. Each of these interventions, which used varying methodology (delayed school start time, thermal and light manipulation, and bright light therapy) did report increases in sleep duration. However, due to the heterogeneity of the methods used, the effect of 'other' interventions was unable to be assessed.

5. Limitations

The findings of this review are subject to several limitations. First, the limited number of studies for the combination of educational interventions and behavioral interventions or 'other' interventions hampers a definite conclusion on the efficacy of these methods for improving sleep duration. Second, the effectiveness of these different approaches over long periods of time is unclear. Previous literature suggests a follow-up measurement period of 6 months is the 'gold standard' in assessing whether a behavior change has become permanent [57]. No studies examined in this review reported follow-up data; thus, the durability of these different intervention types, warrants further investigation. It is also noted that developmental changes in sleep and circadian regulation from childhood to adolescence, and adolescence to young adulthood may require a more nuanced approach to assessing sleep behavior change over these periods of transition. Therefore, regular and extended follow-up of participants post-intervention is vitally needed to bolster our understanding of the effectiveness of these interventions at extending sleep across time. Third, although the reviewed papers were not limited to specific locations, the inclusion of studies published in English might have limited our understanding of these interventions in other settings. Finally, this review focused on the effects of different intervention types on sleep duration only, which resulted in the exclusion of papers examining the impact of interventions on other sleep parameters such as sleep efficiency or sleep quality. Indeed, some of the included studies reported changes in sleep parameters other than sleep duration, but these outcomes are not reported in this review and as such remain open to subsequent investigations.

6. Conclusion and future directions

This systematic review indicates that behavioral and combination interventions show robust effects in increasing sleep duration in healthy young people (aged 14–24 y). A vast majority of the behavioral interventions included in this review are in-lab experimental studies and as such, further work to ensure that the strategies used, in particular, directly prescribing longer time-in-bed and/or increased sleep opportunity is effective in the real-life community context in which young people operate. However, given the robust effects shown by these studies, in-lab, at-home, and the combination approaches, early indications suggest that this

is feasible, particularly in the short term for participants to adhere to. Indeed, including a combination of approaches, and ensuring that educational components are relevant and personalized, to increase sleep and circadian knowledge may be key to longer-term success, however, that is yet to be demonstrated. There may not be a one-size-fits-all intervention to increase sleep duration; however, a combination of strategies with an emphasis on personalization has the potential to maximize sleep duration in healthy young people. For example, tailoring sleep education and healthy sleep behavior promotion that is both evidence-based but responsive and considerate of individual lifestyles and sleep histories (i.e., different individual lived experiences of sleep) whilst incorporating realistic goal setting, may support an increase in motivation to change sleep behavior in the long term.

Practice points

1. Behavioral interventions that directly schedule longer sleep duration seem to be the most effective at increasing sleep duration in young people.
2. The combination of behavioral and educational interventions appears to be the second most effective approach to improving sleep duration,
3. Educational interventions alone are less effective at increasing sleep duration but may positively benefit overall sleep promotion.

Research agenda

1. Further high-quality research is needed to elucidate the effectiveness of single-modality and combination interventions.
2. Future interventions need to ensure that elements are personalized and relevant to the individual or group of individuals to promote sleep behavior change.
3. Follow-up periods should be selected that are longer term ($\geq$ 6 months) and consider developmental changes occurring in sleep and circadian systems.

Declaration of competing interest and acknowledgements

The authors have no conflicts of interests to disclose. This research was supported by the Australian Government through a National Health and Medical Research Council grant (Project ID GNT1163614). This research was supported partially by the Australian Government through the Australian Research Council's Centre of Excellence for Children and Families over the Life Course (Project ID CE200100025). Sylistah Gadam was supported by the University of Queensland Research Training Program Scholarship. The authors wish to thank Ms S. Austerberry for assistance in article screening and assessment for this manuscript.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.smrv.2023.101807.

References

[1] Watson NF, Badr MS, Belenky G, Bliwise DL, Buxton OM, Buysse D, et al. Recommended amount of sleep for a healthy adult: a joint consensus statement of the American Academy of Sleep Medicine and Sleep Research Society. Sleep 2015;38:843–4. https://doi.org/10.5665/sleep.4716.
[2] Hirshkowitz M, Whiton K, Albert SM, Alessi C, Bruni O, DonCarlos L, et al. National sleep foundation's sleep time duration recommendations: methodology and results summary. Sleep Health 2015;1:40–3. https://doi.org/10.1016/j.sleh.2014.12.010.
[3] Liu Y, Wheaton AG, Chapman DP, Cunningham TJ, Lu H, Croft JB. Prevalence of healthy sleep duration among adults — United States, 2014. MMWR Morb Mortal Wkly Rep 2016;65:137–41. https://doi.org/10.15585/mmwr.mm6506a1.
[4] Nasim M, Saade M, AlBuhairan F. Sleep deprivation: prevalence and associated factors among adolescents in Saudi Arabia. Sleep Med 2019;53:165–71. https://doi.org/10.1016/j.sleep.2018.08.031.
[5] Adams R, Wittert G, Appleton S. Submission to inquiry into sleep health awareness in Australia. 2018.
[6] Centers for Disease Control and Prevention. Sleep and sleep disorders: data and statistics. 2014. https://www.cdc.gov/sleep/data_statistics.html.
[7] Duffy JF, Willson HJ, Wang W, Czeisler CA. Healthy older adults better tolerate sleep deprivation than young adults. J Am Geriatr Soc 2009;57:1245–51. https://doi.org/10.1038/jid.2014.371.
[8] Shekari Soleimanloo S, White MJ, Garcia-Hansen V, Smith SS. The effects of sleep loss on young drivers' performance: a systematic review. PLoS One 2017;12:1–24. https://doi.org/10.1371/journal.pone.0184002.
[9] Chaput JP, Dutil C. Lack of sleep as a contributor to obesity in adolescents: impacts on eating and activity behaviors. Int J Behav Nutr Phys Activ 2016;13. https://doi.org/10.1186/s12966-016-0428-0.
[10] Dutil C, Chaput J-P. Inadequate sleep as a contributor to type 2 diabetes in children and adolescents. Nature Publishing Group 2017;7:266. https://doi.org/10.1038/nutd.2017.19.
[11] Glozier N, Martiniuk A, Patton G, Ivers R, Li Q, Hickie I, et al. Short sleep duration in prevalent and persistent psychological distress in young adults: the DRIVE study. Sleep 2010;33:1139–45. https://doi.org/10.1093/sleep/33.9.1139.
[12] Short MA, Booth SA, Omar O, Ostlundh L, Arora T. The relationship between sleep duration and mood in adolescents: a systematic review and meta-analysis. Sleep Med Rev 2020;52. https://doi.org/10.1016/j.smrv.2020.101311.
[13] Littlewood DL, Kyle SD, Carter LA, Peters S, Pratt D, Gooding P. Short sleep duration and poor sleep quality predict next-day suicidal ideation: an ecological momentary assessment study. Psychol Med 2019;49:403–11. https://doi.org/10.1017/S0033291718001009.
[14] Dregan A, Armstrong D. Adolescence sleep disturbances as predictors of adulthood sleep disturbances-A cohort study. J Adolesc Health 2010;46:482–7. https://doi.org/10.1016/j.jadohealth.2009.11.197.
[15] Kyle SD, Henry AL. Sleep is a modifiable determinant of health: implications and opportunities for health psychology. Br J Health Psychol 2017;22:661–70. https://doi.org/10.1111/bjhp.12251.
[16] Beebe DW, Fallone G, Godiwala N, Flanigan M, Martin D, Schaffner L, et al. Feasibility and behavioral effects of an at-home multi-night sleep restriction protocol for adolescents. JCPP (J Child Psychol Psychiatry) 2008;49:915–23. https://doi.org/10.1111/j.1469-7610.2008.01885.x.
[17] Arnal PJ, Sauvet F, Leger D, van Beers P, Bayon V, Bougard C, et al. Benefits of sleep extension on sustained attention and sleep pressure before and during total sleep deprivation and recovery. Sleep 2015;38:1935–43. https://doi.org/10.5665/sleep.5244.
[18] Barber LK, Cucalon MS. Modifying the Sleep Treatment Education Program for Students to include technology use (STEPS-TECH): intervention effects on objective and subjective sleep outcomes. Stress Health 2017;33:684–90. https://doi.org/10.1002/smi.2746.
[19] Irish LA, Veronda AC, van Lamsweerde AE, Mead MP, Wonderlich SA. The process of developing a sleep health improvement plan: a lab-based model of self-help behavior. Int J Behav Med 2021;28:96–106. https://doi.org/10.1007/s12529-020-09904-6.
[20] Griggs S, Conley S, Batten J, Grey M. A systematic review and meta-analysis of behavioral sleep interventions for adolescents and emerging adults. Sleep Med Rev 2020;54:101356. https://doi.org/10.1016/j.smrv.2020.101356.
[21] Niu X, Zhou S, Casement MD. The feasibility of at-home sleep extension in adolescents and young adults: a meta-analysis and systematic review. Sleep Med Rev 2021;58:101443. https://doi.org/10.1016/j.smrv.2021.101443.
[22] Baron KG, Duffecy J, Reutrakul S, Levenson JC, McFarland MM, Lee S, et al. Behavioral interventions to extend sleep duration: a systematic review and meta-analysis. Sleep Med Rev 2021;60:101532. https://doi.org/10.1016/j.smrv.2021.101532.
[23] Moher D, Liberati A, Tetzlaff J, Altman DG, Altman D, Antes G, et al. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. PLoS Med 2009;6. https://doi.org/10.1371/journal.pmed.1000097.
[24] Bramer W, Bain P. Updating search strategies for systematic reviews using EndNote. J Med Libr Assoc 2017;105. https://doi.org/10.5195/jmla.2017.183.
[25] Amir-Behghadami M, Janati A. Population, Intervention, Comparison, Outcomes and Study (PICOS) design as a framework to formulate eligibility

criteria in systematic reviews. Emerg Med J 2020;37:387. https://doi.org/10.1136/emermed-2020-209567.
[26] Couban R. Covidence and rayyan. J Can Health Libr Assoc/Journal de l'Association Des Bibliothèques de La Santé Du Canada 2016;37:124–6. https://doi.org/10.5596/c16-025.
[27] Deeks JJ, Higgins JP, Altman DG. Cochrane Statistical Methods Group. Analysing data and undertaking meta-analyses. In: Cochrane handbook for systematic reviews of interventions; 2019. p. 241–84.
[28] Jørgensen L, Paludan-Müller AS, Laursen DRT, Savović J, Boutron I, Sterne JAC, et al. Evaluation of the Cochrane tool for assessing risk of bias in randomized clinical trials: overview of published comments and analysis of user practice in Cochrane and non-Cochrane reviews. Syst Rev 2016;5:1–13. https://doi.org/10.1186/s13643-016-0259-8.
[29] Wells GA, Shea B, O'Connell D, Peterson J, Welch V, Losos M, et al. The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses. 2003. http://www.ohri.ca/programs/clinical_epidemiology/oxford.asp. [Accessed 1 January 2021].
[30] Islam MM, Iqbal U, Walther B, Atique S, Dubey NK, Nguyen PA, et al. Benzodiazepine use and risk of dementia in the elderly population: a systematic review and meta-analysis. Neuroepidemiology 2017;47:181–91. https://doi.org/10.1159/000454881.
[31] Rossa KR. Risk taking behaviour in young adults: the role of sleep and associated psychophysiological states. Queensland University of Technology; 2018.
[32] Van Dyk TR, Krietsch KN, Saelens BE, Whitacre C, McAlister S, Beebe DW. Inducing more sleep on school nights reduces sedentary behavior without affecting physical activity in short-sleeping adolescents. Sleep Med 2018;47:7–10. https://doi.org/10.1016/j.sleep.2018.03.007.
[33] Van Dyk TR, Zhang N, Catlin PA, Cornist K, McAlister S, Whitacre C, et al. Feasibility and emotional impact of experimentally extending sleep in short-sleeping adolescents. Sleep 2017;40. https://doi.org/10.1093/sleep/zsx123.
[34] Hasler JC. The effect of sleep extension on academic performance, cognitive functioning and psychological distress in adolescents. University of Arizona; 2008.
[35] He JW, Tu ZH, Xiao L, Su T, Tang YX. Effect of restricting bedtime mobile phone use on sleep, arousal, mood, and working memory: a randomized pilot trial. PLoS One 2020;15:1–13. https://doi.org/10.1371/journal.pone.0228756.
[36] Ritland BM, Simonelli G, Gentili RJ, Smith JC, He X, Mantua J, et al. Effects of sleep extension on cognitive/motor performance and motivation in military tactical athletes. Sleep Med 2019;58:48–55. https://doi.org/10.1016/j.sleep.2019.03.013.
[37] Schwartz J, Simon RD. Sleep extension improves serving accuracy: a study with college varsity tennis players. Physiol Behav 2015;151:541–4. https://doi.org/10.1016/j.physbeh.2015.08.035.
[38] Stock AA, Lee S, Nahmod NG, Chang AM. Effects of sleep extension on sleep duration, sleepiness, and blood pressure in college students. Sleep Health 2020;6:32–9. https://doi.org/10.1016/j.sleh.2019.10.003.
[39] Mah CD, Mah KE, Kezirian EJ, Dement WC. The effects of sleep extension on the athletic performance of collegiate basketball players. Sleep 2011;34:943–50. https://doi.org/10.5665/sleep.1132.
[40] Garner AA, Hansen A, Baxley C, Becker SP, Sidol CA, Beebe DW. Effect of sleep extension on sluggish cognitive tempo symptoms and driving behavior in adolescents with chronic short sleep. Sleep Med 2017;30:93–6. https://doi.org/10.1016/j.sleep.2016.09.003.
[41] Klerman EB, Djik D-J. Interindividual variation in sleep duration and its association with sleep debt in young adults. Sleep 2005;28:1253–9.
[42] Motomura Y, Kitamura S, Nakazaki K, Oba K, Katsunuma R, Terasawa Y, et al. Recovery from unrecognized sleep loss accumulated in daily life improved mood regulation via prefrontal suppression of amygdala activity. Front Neurol 2017;8:1–10. https://doi.org/10.3389/fneur.2017.00306.
[43] Shepherd MA. Counting Sleep: the effectiveness of message framing to increase sleep duration and quality. Florida State University; 2016.
[44] Van Ryswyk E, Weeks R, Bandick L, O'Keefe M, Vakulin A, Catcheside P, et al. A novel sleep optimisation programme to improve athletes' well-being and performance. Eur J Sport Sci 2017;17:144–51. https://doi.org/10.1080/17461391.2016.1221470.
[45] Moseley L, Gradisar M. Evaluation of a school-based intervention for adolescent sleep problems. Sleep 2009;32:334–41. https://doi.org/10.1016/j.sleep.2010.06.008.
[46] Perucho I, Vijayakumar KM, Talamas SN, Chee MWL, Perrett DI, Liu JCJ. A web-based photo-alteration intervention to promote sleep: randomized controlled trial. J Med Internet Res 2019;21:1–11. https://doi.org/10.2196/12500.
[47] Van Rijn E, Koh SYJ, Ng ASC, Vinogradova K, Chee NIYN, Lee SM, et al. Evaluation of an interactive school-based sleep education program: a cluster-randomized controlled trial. Sleep Health 2020;6:137–44. https://doi.org/10.1016/j.sleh.2019.10.006.
[48] Fucito LM, DeMartini KS, Hanrahan TH, Yaggi HK, Heffern C, Redeker NS. Using sleep interventions to engage and treat heavy-drinking college students: a randomized pilot study. Alcohol Clin Exp Res 2017;41:798–809. https://doi.org/10.1111/acer.13342.
[49] Britton WB, Bootzin RR, Cousins JC, Hasler BP, Peck T, Shapiro SL. The contribution of mindfulness practice to a multicomponent behavioral sleep intervention following substance abuse treatment in adolescents: a treatment-development study. Subst Abuse 2010;31:86–97. https://doi.org/10.1080/08897071003641297.
[50] Paavonen EJ, Huurre T, Tilli M, Kiviruusu O, Partonen T. Brief behavioral sleep intervention for adolescents: an effectiveness study. Behav Sleep Med 2016;14:351–66. https://doi.org/10.1080/15402002.2015.1007993.
[51] Dewald-Kaufmann JF, Oort FJ, Meijer AM. The effects of sleep extension on sleep and cognitive performance in adolescents with chronic sleep reduction: an experimental study. Sleep Med 2013;14:510–7. https://doi.org/10.1016/j.sleep.2013.01.012.
[52] Boergers J, Gable CJ, Owens JA. Later school start time is associated with improved sleep and daytime functioning in adolescents. J Dev Behav Pediatr 2014;35:11–7. https://doi.org/10.1097/DBP.0000000000000018.
[53] Duffield R, Murphy A, Kellett A, Reid M. Recovery from repeated on-court tennis sessions: combining cold-water immersion, compression, and sleep interventions. Int J Sports Physiol Perform 2014;9:273–82. https://doi.org/10.1123/IJSPP.2012-0359.
[54] Bonnar D, Gradisar M, Moseley L, Coughlin AM, Cain N, Short MA. Evaluation of novel school-based interventions for adolescent sleep problems: does parental involvement and bright light improve outcomes? Sleep Health 2015;1:66–74. https://doi.org/10.1016/j.sleh.2014.11.002.
[55] Blunden SL, Chapman J, Rigney GA. Are sleep education programs successful? The case for improved and consistent research efforts. Sleep Med Rev 2012;16:355–70. https://doi.org/10.1016/j.smrv.2011.08.002.
[56] Arlinghaus KR, Johnston CA. Advocating for behavior change with education. Am J Lifestyle Med 2018;12:113–6. https://doi.org/10.1177/1559827617745479.
[57] Prochaska JO, Velicer WF. The transtheoretical model of health behavior change. Am J Health Promot 1997;12:38–48.