



Original Article

“Let's talk about sleep”: a qualitative examination of levers for promoting healthy sleep among sleep-deprived vulnerable adolescents



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ABSTRACT

Objective: Deficient sleep is highly prevalent in disadvantaged adolescents and contributes to a range of adverse health and behavioral outcomes. We examined mediating mechanisms and strategies that adolescents adopt to improve sleep, and possible levers for promoting sleep in this population.

Methods: We conducted three focus groups ($N = 27$ total, age 14–18 years) in adolescents living in low- and middle-income racially/ethnically diverse neighborhoods of Boston, Massachusetts. Participants completed a survey on their sleep and health habits prior to the moderator-led discussions. Discussions were audio-recorded, transcribed, and thematically analyzed.

Results: The study population did not meet the minimum sleep recommendations, and we found a high prevalence of “social jet-lag.” We also identified a disconnect between the acknowledgment of the importance of sleep and actual behavior, especially for electronic use. Phone use and screen time were the most commonly cited barriers to a good night's sleep, along with caffeine consumption, which was also high in this sample. There was also a general lack of awareness of sleep hygiene practices and recommendations. Participants reported regulating food intake and physical activity, using allopathic sleep aids, creating a comfortable sleeping environment, and a routine as some strategies to improve sleep.

Conclusion: Results from this study suggest facilitating the linkage between participant-generated mediating factors and strategies for better-designed interventions. These include making the negative impact of sleep on health more explicit, improving youth awareness about sleep hygiene, targeting caffeine consumption and electronic use, and introducing sleep recommendations through appropriate and effective channels.

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1. Introduction

Adolescence is a unique period of neurobiological, developmental, and socio-environmental change, which affects overall

behavior including sleep. Several critical factors during the second decade of life contribute to deficient sleep, defined as both sleep duration insufficient to meet sleep needs and sleep timing incompatible with developmentally normal circadian rhythms. Intrinsic factors include delays in circadian-mediated sleep onset, and wake times associated with pubertal onset and reduction of the sleep drive (the accumulation of sleep pressure building up during the day) [1]. Extrinsic factors such as early school schedules, late-

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afternoon and evening extracurricular activities, and electronic media use are also known to alter sleep patterns in teens [2–4]. The National Sleep Foundation Sleep in America Poll found that 75% of 12th graders had sleep durations of less than 8 h per night compared with 16% of sixth graders [5,6], although an average of 8–10 h of sleep is recommended by the American Academy of Sleep Medicine (AASM) for teenagers [7,8]. As a result, adolescents comprise the most sleep-deprived age group in the United States [9].

Sorensen et al. have developed a guiding conceptual framework, the Social Contextual Model of Behavior Change (SCM), to better understand and address the impact of social context health behavior change. The model classifies factors found in the social environment as either “modifying conditions” or “mediating mechanisms.” Modifying conditions are defined as factors that may independently affect outcomes but are not influenced by an intervention, such as discrimination, school start time, athletic activities, sexual minority status, bullying, and neighborhood conditions [10–12]. Mediating mechanisms are those factors that are amenable to change and can be addressed by individual-level or multi-level behavioral interventions while taking into consideration the socio-demographic characteristics, culture, and social context of the study population. Past research highlights parent sleep education as a significant mediating condition of age-adjusted, sufficient sleep duration (estimated conservatively as ≥ 9 h for ages 6–11 years and ≥ 8 h for ages 12–17 years) [13]. Other mediating mechanisms include restrictions on the intake of caffeine and use of electronic devices (such as mobile phones) in the bedroom at night [13].

Being in developmental transition, adolescents are particularly sensitive to contextual or surrounding influences [14], and thus may be both vulnerable to the influence of myriad social and environmental factors and, at the same time, uniquely suited to respond to an appropriately designed intervention promoting sleep. Growing evidence points to the mediating role played by the Internet electronic media and cellphones [15–18] however, little is known about the sleep-related health beliefs, behaviors, and mediators among ethnically diverse teens. Low–socioeconomic status (SES) children often engage in poor sleep hygiene practices [19] and experience unfavorable social and environmental surroundings, making them more vulnerable to sleep deprivation and its impact [20–22]. A recent review on racial/ethnic sleep disparities in US children compared results from 23 studies and found that individuals of white ethnicity had more sufficient sleep than minorities; Hispanics had more sufficient sleep than blacks, whereas data were inconclusive for Asians and others [23]. A national survey on the sleep habits of nearly 10,000 British children 5–11 years of age demonstrated that Afro-Caribbean and Asian minority children had shorter adjusted sleep durations over a 7-day week than did white children [24]. Perceived stress and the physical, emotional, and social components of home environments of ethnically diverse adolescents have recently been implicated in influencing sleep duration and timing [15]. These results point to the importance of disentangling the complex effects of race/ethnicity and SES, and building on the limited evidence on the mediating mechanisms that may be leveraged to ensure that racial/ethnic minority and low-SES youth obtain adequate sleep.

A nuanced and detailed approach that has the potential to illuminate adolescents’ perspectives on these matters, from their point of view, is needed. This may be best addressed by using both quantitative and qualitative research methodologies. Although some studies have attempted this approach [25–27], the diversity within their sample and the insight obtained on the range of potential mediators is limited. To address these gaps, we used qualitative methods to identify the mediating mechanisms influencing

sleep among low-SES and minority youth, and examined the types of strategies that adolescents adopt to improve sleep.

2. Methods

The design of the study has been previously described [28]. Data for this study were collected using a self-administered questionnaire and focus group discussions (FGD). The questionnaire provided detailed quantitative evidence on participants’ current sleep patterns. The FGD methodology was selected because it encourages conversation, provides an opportunity to learn through group consensus or disagreements, and presents minimal risk for participation.

2.1. Participants’ recruitment

A sample size of 25–30 was deemed to be sufficient for data saturation for this study [29,30]. We recruited 27 English-speaking adolescents, aged 14–18 years, from one housing site (Roxbury Tenants of Harvard) and two youth-serving agencies (Boston Asian Youth Essential Service and Sociedad Latina) within low-SES, ethnically diverse neighborhoods in Boston, Massachusetts. We conducted a total of 3 FGD with 8–10 participants in each session. Recruitment strategies included community-based presentations, distribution of flyers, and direct approach of adolescents by agency staff. We conducted a telephone interview with parents to determine the following exclusion criteria: a diagnosed sleep disorder, major psychiatric illness, pregnancy, and/or no smartphone access. The study was approved by Partners Health-Care System Institutional Review Board, and all participants and their parents (if < 18 years) provided informed consent prior to data collection.

2.2. Study procedures and data collection instruments

Consenting participants were informed of the study day, time, and venue through community-based workers from their youth programs. Before the start of every FGD, participants were briefed about the study’s overall goal and were encouraged to clarify all questions, by two trained researchers, who served as the moderator and the note taker. A total of three focus group discussions (FGDs) were conducted with 22–75% male participants in every group. All procedures were conducted in a quiet and private room within each of the three partnering community-based organizations. Participants were given a \$20 gift card as reimbursement for their time.

Data from participants was collected at two stages. First, a quantitative self-administered questionnaire was completed by individual participants. The questionnaire gathered information on demographics, general health habits (smoking, alcohol, and caffeine consumption), and sleep patterns (bedtimes and rise times). The questionnaire also included the Epworth Sleepiness Scale [31], questions from the sleep environment survey (use of electronics at bedtime) [32], and a single question for self-assessing one’s chronotype from the Horne–Ostberg questionnaire (“One hears about morning types and evening types of people. Which one of these types do you consider yourself to be?”) [33]. The questionnaire took an average of 10 min to complete and was immediately followed by a 60-min FGD. A trained moderator (E.K.) used a semi-structured guide for the FGDs, which included open-ended questions on topics such as knowledge of sleep hygiene recommendations [34], barriers and facilitators to good sleep (Table 1), and suggested probes based on the SCM [35]. Each FGD session followed prescribed methodology [36–38]. All FGD and interviews were audio-recorded and transcribed.

Table 1
Sample questions from the focus group discussions moderator guide.

Category	Sample questions
Knowledge, belief, and awareness of the importance of sleep	Why do you think you need sleep? PROBE: Link between sleep and health How important is sleep to you? PROBE: At home, at school, doing homework, in sports, in your relationships
Resiliency	What keeps you from getting a good night's sleep? What keeps you awake? PROBE: Do school schedules, homework, extracurricular activities or after-school jobs interfere with your sleep? Do electronics such as a tablet or a smartphone keep you from sleeping? Imagine your bedroom, what is not optimal (light, temperature, noise)? Do you have nightmares or are you scared? Do you feel unsafe at night? Do you worry about things?
Strategies to improve sleep	What would be a reason or motivator for you to get more sleep? PROBE: Link between sleep and school performance, appearance/beauty/body shape, and energy/mood. What of these examples is most important to you?

2.3. Analytic approach

Data were analyzed using a combination of inductive and deductive approaches, pre-identified questions in the FGD guide, and the SCM. The transcripts from the FGDs were read and analyzed by two researchers (M.Q., N.K.), working independently. All transcripts were open coded to identify themes, emerging concepts, and different ideas mentioned by participants that related to the research questions [39]. Whereas the initial reading of transcripts helped identify broad categories of themes, further readings helped refine themes by identifying subcategories under each theme. The themes and subcategories generated through this iterative process were given labels or codes and relevant sections within transcripts that related to a particular theme or subcategory were coded (ie, identified and assigned the corresponding label). This process of data immersion contributed to the development of a codebook that provided the basic framework of the analysis: a working definition of all themes, their codes, and example quotes or excerpts from the transcripts (Table S1). The codebook was further refined through extensive discussion (M.Q., N.K.) and expert input (S.R., J.O.). In the final step, we used the codebook to recode all FGD transcripts. Recoding and final analysis was conducted in Nvivo 11.0, which helped identify variations within themes and subcategories.

3. Results

3.1. Results from questionnaire about participant sleep habits

3.1.1. Demographics

The mean age of the participants was 15.7 years (SD 1.4 years) with approximately equal proportions of boys and girls; 23.1% of the respondents identified themselves as Hispanic, 7.4% as white, 11.1% as black, 66.7% as Asian, and 14.8% as other.

3.1.2. Alcohol, caffeine, and electronics use

Almost half of the sample drank one or more cups of caffeine-containing beverages a day. Drinking alcohol on 1 or more days in a typical week during the past year was reported by three individuals (11.1%). No participant reported being a current cigarette

smoker. Use of electronics at bedtime was reported by 48.1% of the sample.

3.1.3. Sleep patterns

The average self-reported sleep duration was 6.2 h (standard deviation [SD] 1 h 7 min) on school nights and 9.2 h (SD 2 h 26 min) on weekends. The average school-night bedtime was on average at 23:46 PM (range 22:00–01:30), and the participants awoke on average at 6:19 (range 05:00–09:00). During weekends, participants went to bed at 1:06 (range 21:30–05:00), with a mean wake time of 8:23, which was highly variable (range 07:00–15:00). Social jetlag, considered as the difference between mid-sleep time (midpoint between falling asleep and waking in the morning) between weekdays and weekends, was high (2.75 h, SD 2 h); 60% of the participants had 2 h or more of social jetlag. One-third of the sample scored >10 on the Epworth Sleepiness Scale, indicating excessive daytime sleepiness. The sample had a clear circadian preference for the evening (88.9%). There were no significant differences found in sleep habits (eg, sleep duration and sleep timing) between adolescents participating in the three focus groups. The survey results are shown in Table 2.

3.2. Results from focus group discussions

We organized the results from the FGDs into individual factors and environmental factors to represent the two broad categories of mediating mechanisms amendable to change. We also present the strategies that participants had implemented at the time of data

Table 2
Survey results on demographics, health habits, and sleep patterns.

Characteristic	n (%)
Male	15 (55.6%)
Race	
White	2 (7.4%)
Black	3 (11.1%)
Asian	18 (66.7%)
Other	4 (14.8%)
Ethnicity	
Hispanic	6 (22.2%)
Current smoker	0 (0%)
Caffeine	
None	7 (25.9%)
Less than 1 cup a day	7 (25.9%)
Approximately 1 cup (8 oz) a day	8 (29.6%)
More than 1 cup, less than 3 cups a day	2 (7.4%)
More than 3 cups a day	3 (11.1%)
Chronotype	
Definitely morning	2 (7.4%)
Rather morning than evening	1 (3.7%)
Rather evening than morning	12 (44.4%)
Definitely evening	12 (44.4%)
Electronics at bedtime	14 (51.9%)
ESS >10	8 (33.3%)
≥8 h sleep per night (WD)	4 (14.8%)
≥8 h sleep per night (WE)	22 (84.6%)
Social jetlag ≥ 2 h	15 (60.0%)
	Mean (SD or range)
Age, y, mean (SD)	15.7 (1.4)
Alcohol use, days/wk	0.44 (1.4)
Mean sleep duration, h (WD)	6.19 (1.11)
Mean sleep duration, h (WE)	9.23 (2.44)
Average bedtime (WD)	23:46 PM (22:00 to 01:30)
Average bedtime (WE)	1:06 (21:30 to 05:00)
Average wake time (WD)	6:19 (05:00 AM to 09:00)
Average wake time (WE)	8:23 (07:00 to 15:00)
ESS score, 0–24	9.4 (3.2)
Social jetlag, hours	2.75 (2.0)

ESS, Epworth Sleepiness Scale; WD, weekday; WE, weekend.

collection or had experimented with previously to improve their sleep.

3.2.1. Individual factors: knowledge, belief, and awareness of the importance of sleep

In regard to perceived health implications of good sleep, nearly all participants seemed aware of the role of healthy sleep on physical, psychological, psychosocial, and emotional functions. Specifically, when asked about the importance of sleep, they mentioned the energizing, relaxing, stress-reducing, and restorative qualities of sleep. Sleep was also described as important to promote growth and for concentration and memory. Participants identified several consequences of poor sleep, including adverse effects on mood, patience, memory, and energy levels.

MOD: Why do you think you need sleep?

PF1: I think we need sleep to energize us.

PM1: I think we need sleep because we need to pay attention more during school.

MOD: Okay, pay attention during school? Does sleep help us with anything else?

PM2: Growth.

PM2: To recover.

With regard to perceived importance of sleep, during the FGD, participants were asked to rank the importance of sleep in comparison to other behaviors with “1” implying most important and “10” being least important. There was a wide variation in how adolescents ranked the importance of sleep relative to other activities. The average ranking for sleep was 3 on a scale of 1–10. Activities such as homework and going to school were ranked higher than sleep. However, some participants ranked sleep lower (4–5), and in these instances, social media, watching movies, basketball, hanging out with friends, eating, and exercising took precedence.

PF1: A four. I find schoolwork more important than sleep.

MOD: Okay. How about you?

PF2: A three.

MOD: A three? Can you think of things that are more important to you than sleep?

PF2: Outside life.

PF3: A three. Basketball and hanging with friends [is more important].

PM1: A four. School and basketball [are more important].

With regard to awareness of sleep recommendations, although the study participants were unaware of the full set of sleep hygiene recommendations that were presented, specific recommendations were familiar to a few participants. Four of the male participants were aware of recommendations to avoid electronics prior to bedtime, not to force sleep, and the value of exercising in the morning rather than evening. Limiting caffeine closer to bedtime and having a set sleep routine were familiar to one of the female participants.

3.2.2. Individual factors: behaviors toward caffeinated beverages and electronics

With regard to consumption of caffeinated beverages, consumption of coffee and soda, particularly among girls, and physical factors such as hunger were some reasons that kept participants from sleeping or woke them up at night.

With regard to use of electronic devices, 16 of the 27 participants mentioned the use of electronic entertainment such as video games, movies, and television, and their smartphones in bed as factors that kept them awake, delayed bedtime, prevented them from falling asleep, and/or interfered with their sleep.

PF1: I think it's more my TV. Because then, if I'm watching my show, I want to finish the episode that I want to finish.

Although playing video games was mentioned as a factor that delayed sleep time by boys, the use of smartphones in bed was mentioned by both boys and girls. Receiving text messages from friends in the middle of the night was specifically singled out as a cause for interrupted sleep. Participants also reported sleeping with phones or waking up at night to look for their phone if they fell asleep using it.

PF1: I'm addicted to my phone. Most of the time, the reason I wake up in the middle of the night is to look for my phone because I fell asleep with it.

3.2.3. Individual factors: resiliency

Every focus group had one to two participants who reported no trouble falling asleep. However, most participants identified factors that delayed bedtime, prevented sleep, or interfered with or interrupted their sleep at night. These mediating factors were also mentioned as reasons for poor sleep quality in general.

With respect to disruptive circadian rhythms, a few participants ($n = 3$) napped during the day and overslept on weekends and during vacation time.

PF4: On the weekends, when I sleep 14–16 h, I wake up not energized. I just want to go back to sleep for some reason. I'm not energized, and oversleeping causes me to lose appetite.

With respect to emotional and cognitive factors, worry, stress, and agitated thoughts were some of the other mediating factors identified in this sample, particularly among the female participants of the group. The underlying causes for participant agitation however, were unclear, although one female participant mentioned worrying about academics such as not finishing homework.

PF2: Yeah. Thinking a lot or you just can't fall asleep. Even when I clear my mind, I can't fall asleep.

PM5: It's like when you're awake but you're sleeping. PM5: When your body is like sleeping but your mind swirls.

3.2.4. Environmental factors: immediate sleeping environment

Noisy family members, light, loud music, temperature fluctuations, and disruptive siblings were identified as mediating factors in the immediate environment that prevented participants from falling asleep or interfered with their sleep.

PF1: My brother has so much homework, and he doesn't sleep until 2:00 AM. And I'm right next door, so whenever his light is on, it bothers me.

PF2: When I try to sleep, my mom's always yelling at [my brother] because he's always getting in trouble and so I can't sleep.

3.2.5. Strategies to improve sleep

Most participants reported trying, with inconsistent success, several strategies to achieve better quality sleep with fewer interruptions.

With respect to food-related strategies, participants identified drinking milk before bedtime as a strategy for improving sleep. While some individuals endorsed avoiding eating a meal close to bedtime, others thought that a good meal would positively influence sleep.

With respect to activity-related strategies, exercising a few hours before bedtime followed by a warm shower was reported as helping sleep, particularly by males ($n = 3$).

With regard to using drugs or medicated sleep aids, a few adolescents reported having heard of people using prescribed or over-the-counter sleeping aids. Advil PM (ibuprofen and diphenhydramine citrate) was consumed by one female participant, while another male participant was prescribed a “sleep drink” by his doctor, which was ineffective.

With regard to altering the immediate sleeping environment, reorienting the bed, changing sleeping positions, making the room

quiet and dark, and lowering the ambient temperature were some of the strategies that participants had tried to make their environment more conducive to a good night's sleep.

With respect to avoiding or using electronic devices, a majority of the boys reported putting away their electronic devices, placing their smartphones a few feet away from their beds, and not answering them or not using them 1 h before bedtime. In contrast, a number of girls ($n = 4$) reported specific use of electronics, such as watching television, movies, listening to music, and talking on the phone as strategies to encourage falling asleep.

With regard to creating a sleep routine and being cognizant of internal cues, participants mentioned inconsistently experimenting with structuring their schedules to allow for earlier completion of homework, avoiding mid-day napping, listening to internal sleep cues, and having a consistent sleep time and routine. In their opinion, these were other examples of strategies that were conducive to good sleep.

4. Discussion

In this study, we assessed mediating individual and environmental mechanisms influencing sleep among a sample of low-SES and minority youth, including factors that may be particularly relevant in low-income communities, such as household noise and disruption. We also examined the strategies that participants used, or were aware of, for improving sleep. Consistent with national survey data [13], both the questionnaire responses and focus group discussions indicated that a majority of low-SES and minority teens in our study reported excessive daytime sleepiness, and habitual sleep time less than the AASM recommended 8–10 h on school nights. A high prevalence of social jet lag was also reported, mirroring a trend recently reported among youth and adolescents [40,41]. Despite this, participants reported awareness of the importance of sleep for their well-being and performance, and agreed that they needed more and better-quality sleep, especially on weekdays. In fact, a majority of the youth ranked the importance of sleep as high, just after academic and social activities, in comparison to other health behaviors. Thus, these results identify a disconnect between overall knowledge of the importance of sleep and actual sleep-promoting behavior.

A gap in knowledge regarding sleep hygiene recommendations was observed. In particular, avoiding naps, structuring the environment to limit noise, light, and other forms of stimulation, and going to bed at night when sleepy were some recommendations that the participants seemed less aware of. Interestingly, the discordance between knowledge and behavior was most evident for electronic use. The recommendation that the participants were most aware of was about limiting use of mobile phones and television during bedtime. However, most participants admitted to using electronic devices either close to bedtime or in bed, or even as an aid to sleep, despite realizing their disruptive potential. Of note, research has shown that adolescents owning a smartphone sleep fewer hours on school days than their peers [42]. In general, raising awareness of sleep recommendations seemed more of a priority for intervention among this sample than raising participant perceptions on the importance or the consequences of good sleep.

Anecdotal beliefs about sleep hygiene may explain some of the strategies teens in our study used to induce or improve sleep; for instance, a few participants reported drinking warm milk to induce sleep. The consumption of milk as a sleep aid is seen as controversial in the literature [43] and it is not an evidence-based or recommended strategy, despite its reported popularity [41,44,45]. These results suggest a need to provide youth with age- and culturally appropriate information on sleep hygiene practices.

Electronic devices, disrupted sleep–wake patterns, environmental noise, family activities, stress, and use of stimulants were reported as mediating factors contributing to deficient sleep. Phone use and screen time were the most commonly cited barriers to a good night's sleep, and the youth also attributed their use to poor sleep. In fact, the FGD revealed that the youth had few boundaries regarding phone use, which included taking their phones to bed and checking the phone through the night. These patterns are consistent with the literature that shows both a high prevalence of electronic device use in youth (eg, more than 60% of a nationally representative sample of US high school students report using screen devices for at least 1 h daily [46]), and an adverse effect of screen time on both sleep quality and sleep duration [3,47]. There are several mechanisms by which electronic media may affect sleep [48]: First, media use may directly displace sleep. Second, media use may cause increased mental, emotional, or physiological arousal. Third, blue light exposure from screens may delay the circadian phase, making it more difficult to fall asleep [48]. Of note, a qualitative study with 57 young adults from Australia identified technology use for social purposes as an important barrier to healthy sleep [26].

Generally, females and males reported different patterns of phone use. Females reported phone use for social media and texting and for calling friends, and males reported phone use for playing games and accessing online shows. Gender differences were also suggested in how males and females approached electronic use in relationship to their sleep. Whereas some of the male participants reported limiting the use of screen time and electronic devices as a strategy to improve sleep, several females reported using electronic devices as a sleep aid, particularly ones that generated white noise. In fact, gender differences in electronic use by boys vs girls are reported in the literature. Boys are more frequent electronic media users, and they also spend more time playing video games, whereas girls are more engaged in communication activities [49]. These findings suggest a need to tailor sleep hygiene recommendations, particularly those that relate to electronic device use, differently for males and females. Given the ubiquitous use of electronic and screen-based devices by the youth, there also may be opportunities to leverage this platform as an aid to improving sleep health behaviors in adolescents.

This sample of participants reported frequently consuming coffee or other caffeine-containing beverages, and identified coffee consumption as a barrier to sleep. Although it was unclear whether excess consumption or consumption too close to bedtime were reasons for interference with sleep, addressing these mediating mechanisms may benefit the 15 participants who mentioned consuming these stimulants. Data from the 2009–2010 National Health and Nutrition Examination Survey (NHANES), a nationally representative survey of the civilian noninstitutionalized population in the United States, show that about 70% of children and adolescents consume caffeine, with soda accounting for the majority of caffeine intake. In NHANES, the mean intake was 73.1 mg in boys and 57.7 mg in girls [50]. In our study, drinking caffeinated beverages was especially notable among girls. Interestingly, Temple et al. reported that acute caffeine administration in adolescents resulted in greater energizing effects in girls than in boys [51]. Although caffeine has consistently shown to prolong sleep latency, reduce total sleep time and sleep efficiency, and worsen perceived sleep quality [52], participants did not identify limiting consumption of these beverages as a strategy to promote sleep, despite admitting to consuming these to stay alert. Instead they mentioned resorting to pills and over-the-counter medication to induce sleep. Fewer participants, particularly boys, mentioned lifestyle-related strategies such as exercising for sleep promotion. Indeed, regular moderate-intensity aerobic exercise is recommended in the treatment or

the prevention of sleep disorders, and there is also evidence that good sleepers are more physically active [53]. Participants generally reported sleep medication over behavioral measures as strategies. Emphasizing the behavioral measures that could be undertaken for enhancing sleep quality is an opportunity for future preventive efforts.

Environmental factors such as light, loud music, temperature fluctuations, and family activities were identified as contributors to poor sleep. In fact, chaotic household with sleep-disturbing behavior of family members is highly prevalent in minorities and low-SES families, and seems to contribute to the sleep difficulties of adolescents [54]. In addition, Wilson et al. found, in a cross-sectional study of 133 low-income preschoolers in southeastern Michigan, that children who had suboptimal sleep environments in comparison to their peers were at higher risk for shorter nocturnal sleep duration and for falling asleep later [55]. The adolescents also discussed changes in sleeping positions and ambient temperature as strategies for improving sleep. In line with our findings, a sample of 384 US high school students reported controlling light (45%) and temperature (37%) as strategies that they use to get to sleep or stay asleep [41]. The focus group participants also reported napping and irregular sleep habits, including oversleeping, as barriers to good sleep. Participants also identified the importance of creating a sleep routine as a coping strategy to challenges in keeping sleep consistent between weekends and weekdays. Targeting this mediating factor could improve participant-disrupted sleep patterns and promote a good night's rest.

Finally, emotional factors such as worries or stress were identified by the participants as barriers to sleep. Cognitive–behavioral sleep interventions address both sleep and emotional problems, which often share common etiological origins. A recent meta-analysis suggests that adolescent cognitive–behavioral sleep interventions are efficacious for sleep problems [56]. Interestingly, Blake et al. reported that adolescents with higher levels of anxiety and depressive symptoms experienced the most benefit from a cognitive–behavioral sleep intervention [57].

In summary, results from this study highlight several mediating mechanisms that may be important to address in future prevention efforts targeting improved sleep quality in this population. These include making the negative impact of sleep on health more explicit despite general agreement that it is a priority, improving youth awareness about sleep hygiene, and introducing sleep recommendations as a resource for sleep strategies. We also found some suggestion of a lack of appreciation of the importance of behavioral strategies to improve sleep, and resistance to using these interventions, which may be somewhat gender specific. Data from this study suggest that some factors may be easier to directly target through intervention than others. For instance, interventions could prioritize curbing caffeine consumption, improving sleep environment, and reinforcing positive behaviors that the youth currently engage in (eg, engagement in regular physical activity; trying not to oversleep or to nap).

Sleep hygiene is used to alleviate sleep problems in adolescents. For example, several studies have attempted to modify adolescent sleep patterns through school-based sleep education programs. However, a recent review identified the paucity of quantity, quality, and effectiveness of these programs [58]. In Hong Kong, researchers conducted a large-scale clustered randomized trial with 14 secondary schools on a sleep education program (N = 3713 students). The program did not change sleep patterns among students, although it was effective in improving sleep knowledge [59]. Thus, sleep education alone is unlikely to be efficacious, mostly because adolescents lack motivation to change sleep behaviors [60].

It is important to identify appropriate and effective channels of dissemination of these sleep recommendations. In particular, given

the nearly universal use of electronic devices around bedtime by adolescents, the concept of using technology to promote rather hinder sleep is an intriguing one. Strategies might include blue light–blocking apps for screens, and apps that generate white noise or promote self-monitoring of sleep. Other barriers such as socio-cognitive stressors may be more difficult to directly target. Future programs may consider increasing youth resilience to these stressors through techniques such as mindfulness, meditation, and time management strategies. In line with these findings, El-Sheikh et al. found that children's support coping strategies have a protective role against sleep problems otherwise associated with ethnic minority status and economic adversity, and present potential targets for intervention that may help reduce health disparities in an important health domain [61]. In addition, research has found that just the act of monitoring behaviors can have strong motivational effects that stimulate healthy behaviors [62].

Focus group discussions have some general limitations that also apply to our study. For example, they are not designed to be representative for the general population, but they provide a depth of information and are hypothesis generating. Other limitations include the self-selected nature of our focus groups. Overall, our work speaks to socially connected minority teens with unrestricted access to smartphones. Generalizability is hindered by the fact that our population is based on urban teens in the New England region of the United States. Another limitation is the use of self-report of sleep patterns by adolescents. Interestingly, a recent study found that agreement of self-report with polysomnography was comparable to that of actigraphy for measures of sleep quality (wake after sleep onset and sleep efficiency) [63]. The study strengths include using questionnaire data to reiterate FGD findings and the inclusion of an understudied population of racially/ethnically diverse low- and middle-income adolescents.

5. Conclusion

In conclusion, facilitating the linkage between participant-generated mediating factors and strategies for better sleep may provide a good foundation to better design future interventions. A simple list of sleep recommendations for youth would very likely not be enough to change sleep patterns in this population. In addition to knowledge, there is a need to equip youth with actionable content, and resources.

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Conflict of interest

This was not an industry supported study. Dr. Quante has received payment for a lecture from Loewenstein Medical GmbH and for consultancy from GfK outside the submitted work. Dr. Bakker is a full-time employee of Philips Respironics, which is a company that focuses on sleep and respiratory care. Dr. Bakker also has a part-time appointment at Brigham and Women's Hospital. Dr. Bakker's interests were reviewed and are managed by Brigham and Women's Hospital and Partners HealthCare in accordance with their conflict of interest policies. Dr. Owens has received payment for consultancy or educational presentations from the AASM Foundation, Jazz Pharmaceuticals, Sleep Number, Touch Point and Uptodate and for royalties from Wolters Kluwer outside the submitted work. Dr. Redline has received grant support from Jazz

Pharmaceuticals outside the submitted work. The other authors have indicated no financial conflicts of interest.

The ICMJE Uniform Disclosure Form for Potential Conflicts of Interest associated with this article can be viewed by clicking on the following link: <https://doi.org/10.1016/j.sleep.2018.10.044>.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.sleep.2018.10.044>.

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