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The integration of pediatric sleep health into public health in Canada

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ABSTRACT

The concept of sleep health is gaining momentum globally. Rather than "medicalizing" sleep with a focus on sleep disorders and their treatment, there is growing interest in sleep health promotion for all and on the prevention of sleep problems. In Canada, sleep health is increasingly becoming part of a holistic vision of health and provides a metric for health promotion efforts. One of the outcomes of this evolving understanding of sleep health in Canada has been the release of the world's first integrated 24-hour movement guidelines for the pediatric population in 2016. These were the first systematic review-informed sleep guidelines in Canada, and provided important benchmarks for surveillance. They also integrated sleep health with other lifestyle behaviors by putting the emphasis on the full 24-hour period rather than nocturnal sleep duration. Among the possible solutions to counter the adverse effects of insufficient sleep, public health policies are crucial to help prioritizing sleep health in children. The future of pediatric sleep health in Canada is bright, and we need to align our efforts and continue to push for this important topic in the public health arena. It is expected that this action will result in the prioritization of sleep health by the public health community in Canada so that it becomes an equal counterpart to the attention and resources given to other lifestyle behaviors such as healthy nutrition and sufficient amounts of physical activity.

1. Introduction

It is increasingly recognized that sleep is an important pillar of healthy development and overall health [1,2]. Healthy sleep encompasses many dimensions, including adequate duration, good quality, appropriate timing, and the absence of sleep disorders [3]. However, lack of sufficient sleep has become common in today's environment with constant availability of technologies and commodities [4,5]. In Canada, the most recent findings indicate that approximately one-third of children and adolescents do not meet current sleep duration recommendations [6–8]. These statistics are not encouraging, because an accumulating body of scientific evidence shows that lack of sufficient sleep threatens the academic success, health, and safety of youth [1–5].

Public health authorities in Canada and around the world should not only continue to monitor sleep of individuals, but should also update and improve their national surveillance of sleep health. A better understanding of sleep health at the population level is important for resource allocation and to help inform the development of tailored intervention strategies. The objective of this article is to provide a brief overview of the history and current state of affairs as it relates to the integration of pediatric sleep into public health initiatives in Canada. Future directions for pediatric sleep health in Canada are also provided.

2. Sleep medicine: a focus on identifying and treating sleep disorders

Historically, the focus of sleep medicine has been on the identification, understanding, and treatment of sleep disorders. The "medicalization" of sleep is not really surprising and has followed the pattern established by other medical disciplines, ie, with a focus on diseases, disorders, and their treatment. However, there is growing interest in health promotion for all and on the prevention of health problems by keeping healthy people healthy [9]. "Sleep health" has emerged as a term that embraces this holistic vision of health and provides a metric for health promotion efforts at the individual and population level [9]. Sleep health posits sleep characteristics on a continuum, not only as the presence or absence of sleep disorders. Sleep health also indicates how well an individual or population is doing in term of sleep, and highlights the

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positive role of sleep in overall health rather than the negative role of sleep problems [9].

The emerging field of sleep health in Canada is consistent with a global trend reflected in phenomena such as the creation of a scientific journal called *Sleep Health* in 2015 to advance the sleep health of all members of society. As recently discussed, "the concept of sleep health synergizes with other health care agendas, such as empowering individuals and communities, improving population health, and reducing health care costs" [9]. The promotion of sleep health also offers the field of sleep medicine new research opportunities [9]. Thus, this allows "prevention" and "treatment" to be integrated in order to facilitate a common vision of improving sleep and health outcomes.

The term "sleep health" has been defined by Buysse [9] as a "multidimensional pattern of sleep-wakefulness, adapted to individual, social, and environmental demands, that promotes physical and mental well-being. Good sleep health is characterized by subjective satisfaction, appropriate timing, adequate duration, high efficiency, and sustained alertness during waking hours". This definition may evolve in the coming years, but it provides good and measurable anchors for the dimensions of sleep health. It also provides flexibility (ie, sleep health may vary depending on the situation and between individuals) and frames sleep health as a positive attribute. Future refinements of the definition by new evidence and expert consensus will however be needed, especially as the definition is most appropriate for adults. Future work will be needed to adapt this definition of sleep health to children and adolescents. However, it is generally well accepted that similar sleep health dimensions such as sufficient sleep duration, good sleep quality and appropriate timing are required for optimal sleep health in pediatric populations [3]. The section below highlights how sleep health applies to pediatric populations in Canada.

3. Surveillance of pediatric sleep health in Canada

3.1. History

The surveillance of pediatric sleep health in a representative sample of Canadians is relatively recent. In 2001, the Public Health Agency of Canada, in partnership with Statistics Canada, started monitoring sleep of Canadians twelve years of age or older as part of the Canadian Community Health Survey (CCHS). In 2007, as part of the Canadian Health Measures Survey (CHMS), sleep monitoring of Canadians has been implemented for those aged 3–79 years. Similarly, in 2013 the Canadian Health Behaviour in School-aged Children (HBSC) study included questions related to sleep health for students aged 11–15 years. Surveillance of sleep health also occurs at the health agencies at the provincial and local levels.

3.2. Key issues related to the measurement of pediatric sleep health in public health surveys

For national surveillance, two main aspects of sleep health of Canadian youth are currently subjectively reported: sleep duration (ie, number of hours spent sleeping) and sleep satisfaction/quality (eg, having trouble sleeping, whether sleep is refreshing, and difficulty staying awake during the day). Sleep health is either self-reported by the respondents or parent-reported depending on age. More information on the Canadian surveys to assess pediatric sleep health can be found at the following websites: CCHS (http://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&SDDS=3226), CHMS (http://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&SDDS=5071), and HBSC (http://www.hbsc.org).

Despite growing interest in the assessment of sleep health on a population level standpoint, wider consensus needs to be achieved on the key components of sleep health that need to be measured. It is also important to better quantify the strength of their associations with a broad set of health outcomes, and determine if they measure similar sleep health constructs or not (eg, independent, additive or synergistic effects). In addition, psychometric properties of sleep questions used in population health surveys need to be known. At present, national surveys typically include single sleep questions that have not been validated, with an emphasis on needs and space availability. It is hoped that a standardized and validated set of sleep questions could be used around the world in the future to facilitate comparisons across countries and better learn from each other.

Hundreds of questionnaires and scales about sleep exist around the world [10,11]; yet, most sleep questionnaires are geared towards screening for sleep disorders rather than assessing overall sleep health. Many of these questionnaires have been validated with good psychometric properties [12–14], but would be too long to administer in national surveys (generally taking over 10 min to complete). Developing a sleep module for government agencies is thus a search for the best compromise possible. Sleep questions should capture the dimensions of sleep health well, should be easy to administer, and should be reliable and valid. Moreover, the instrument should be back-compatible with existing data if possible to examine trends over time, with good spatio-temporal coverage. It is our responsibility as sleep experts to push for more sleep questions in national surveys. Sleep should be considered more seriously by the public health community and by our society in general, ie, given as much attention and resources as nutrition and physical activity [15].

3.3. Present and future directions in the measurement of pediatric sleep in Canada

As our understanding of sleep health has expended to appreciate its involvement in a healthy 24-hour day [16–19], an evidence-based re-writing of the metrics used for surveillance of sleep health in Canada was necessary. This work is important in order to capture the most relevant characteristics of sleep health and to ensure it is measured at the population level in a meaningful and informative way for public health action. Given the growing evidence of other important sleep characteristics (eg, sleep timing, sleep continuity, sleep variability), public health agencies in Canada are in the process of developing an improved sleep module for national surveillance of sleep health.

A key domain of improvement includes the attempt to address multiple aspects of sleep health including measures of sleep continuity (eg, sleep onset latency, awakenings after sleep onset, sleep efficiency), sleep timing (eg, bedtime/wake-up times and midpoint of sleep), sleep consistency (eg, day-to-day variability and seasonal changes in sleep parameters), daytime sleep (eg, napping), and sleep hygiene characteristics (eg, screen use, bedtime routines, bedroom environment, sleep aids).

Measurement methods will also improve so that future cycles of the CHMS will have 24-hour actigraphy monitoring to provide objective indicators of sleep health. In addition, the self-reported sleep module will include approximately seven questions for each age group. This improved and evidence-informed pediatric sleep health module will be included in future health surveys in Canada and will include questions on sleep duration, sleep quality, sleep timing, sleep duration variability, and sleep hygiene.

4. Integration of pediatric sleep health into public health guidelines in Canada

Sleep health recommendations in Canada have been issued by several organizations over the years but it is only in 2016 that robust and evidence-based sleep guidelines became available [17]. This was the result of two fields of research joining efforts – exercise science and sleep medicine. Historically, exercise physiologists have been interested in documenting the effects of exercise on health outcomes while sleep experts have focused their efforts on the identification and treatment of sleep disorders.

Recently, Canadian leaders in pediatric healthy active living, public health, pediatric sleep health, and preventive medicine have joined forces in an attempt to integrate their domains of expertise to quantify and understand the range of behaviors that vary in their level of movement and comprise the entire 24-hour period. The behaviors include very minimal or no movement (sleep and sedentary behavior) and high level of movement (light, moderate and high-intensity physical activity). The goal of these experts was to better understand how these behaviors interact and influence one another to ultimately impact health outcomes [16,20–22] (Fig. 1). The use of innovative analytical methods, namely compositional data analyses, have opened new opportunities to quantitatively assess time-dependent behavior compositions in relation to health outcomes of interest [23–25]. These discoveries have allowed the Canadian experts to assess the interplay and the overall combination of behaviors children need in order to optimize a healthy 24-hour day rather than focusing on individual behaviors alone. Such a focus on the interrelationships among sleep, sedentary behavior and physical activity is an important advancement in public health messaging. It emphasizes that all of these behaviors matter, and that a balance between these behaviors is required to ensure optimal health for youth. In addition, this integrated view takes into consideration the developmental changes that occur in each of these behaviors and in their overall balance. As young children grow and develop, they need to work towards high levels of physical activity, low levels of sedentary behavior, and sufficient sleep each day to be healthy. They need to Move, Sleep and Sit the right amounts [16–19].

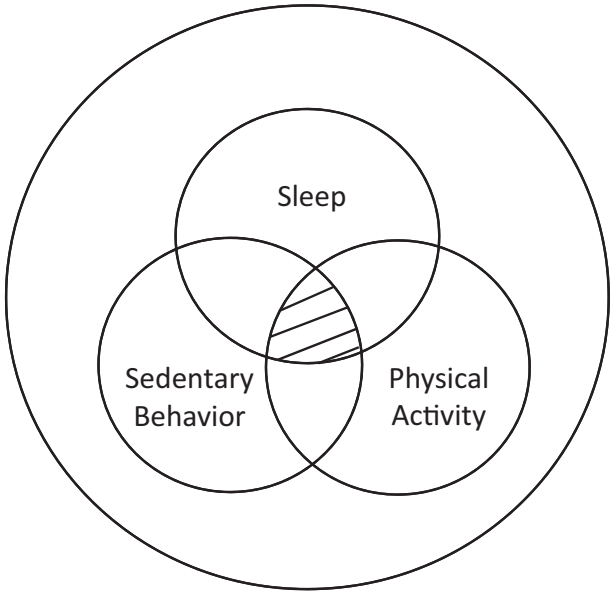

Fig. 1. Interrelationships among sleep, sedentary behavior, physical activity and overall health. This Venn diagram shows the eight possible combinations. The best combination is represented by the dashed area (ie, meeting all three behavior recommendations) while the worst is to meet no recommendations (ie, being outside the circles). For example, meeting all three behavior recommendations in children aged 5–17 years would mean sleeping 9–11 h/night for school-aged children or 8–10 h/night for adolescents, engaging in no more than 2 h of recreational screen time per day, and engaging in ≥60 min of moderate-to-vigorous physical activity per day [17]. Studies show a dose–response gradient between the number of recommendations achieved and health outcomes.

In line with an integrated (holistic) versus segregated (silo) approach to health, the *Canadian 24-Hour Movement Guidelines for Children and Youth: An Integration of Physical Activity, Sedentary Behaviour, and Sleep* were created and subsequently released in Canada in June 2016 [17]. These guidelines followed rigorous and transparent guideline development procedures, including the conduct of four systematic reviews of the evidence, novel compositional data analyses, a stakeholder survey, focus groups and interviews with stakeholders, and expert input from national and international scientists [17]. These 24-hour guidelines were a world's first and represent a new approach to health promotion by including several general recommendations together for a healthy 24-hour period, and specific recommendations for the different behaviors. The "sleep" portion of these guidelines is presented in Table 1.

Using a similar and rigorous guideline development process, the *Canadian 24-Hour Movement Guidelines for the Early Years (0–4 years): An Integration of Physical Activity, Sedentary Behaviour, and Sleep* were created and released in Canada in November 2017 [19]. Here again, these were the first systematic review-informed sleep guidelines for the early years in Canada. These guidelines were the impetus for the development of similar guidelines in Australia [26], New Zealand [27], and the initiation of similar global guidelines by the World Health Organization. The guidelines specific to sleep are shown in Table 1.

Similar integrated 24-hour movement guidelines for adults and older adults are currently being developed to cover the entire lifespan. It is expected that the integration of "sleep" within these 24-hour guidelines will help to bring more public health policy attention and resources to further support the encouragement and interest in sleep health of Canadian youth in the future.

5. Pediatric sleep health: examples of public health policies in Canada

Insufficient sleep is increasingly recognized as an important public health issue that needs to be addressed in our 24/7 society [3,4]. Among the possible solutions, public health policies are important and needed to help prioritizing sleep health [28]. Public policies about sleep health not only send a message to the

Table 1
Specific sleep recommendations included within the Canadian 24-Hour Movement Guidelines [17,19].

Infants (less than 1 year)
• 14–17 h (for those aged 0–3 months) or 12–16 h (for those aged 4–11 months) of good-quality sleep, including naps.
Toddlers (1–2 years)
• 11–14 h of good-quality sleep, including naps, with consistent bedtimes and wake-up times.
Preschoolers (3–4 years)
• 10–13 h of good-quality sleep, which may include a nap, with consistent bedtimes and wake-up times.
Children and Youth (5–17 years)
• Uninterrupted 9–11 h of sleep per night for those aged 5–13 years and 8–10 h per night for those aged 14–17 years, with consistent bed and wake-up times.

*The sleep guidelines reported here do not include other pertinent information of the 24-hour guidelines such as the preamble or accompanying material. More information can be found elsewhere [17,19].

Table 2
Examples of public health policy recommendations for promoting sleep health in the pediatric population.

Public health policy recommendation	Suggestion based on evidence
Delaying school start times for adolescents	National standards that middle and high schools start no earlier than 8:30am to accommodate the known circadian phase delay in adolescent sleep–wake cycles [29].
Eliminating daylight saving time	This yearly removal of an hour is disruptive to sleep and has been linked to injuries, increased car accidents and adverse effects on health [28]. Some have also reported that daylight saving time decreases economic efficiency and increases energy costs, which is in contrast to the original goal [43,44].
Regulating extracurricular activities	Late-night extracurricular activities and/or working schedules can impact sleep. Circadian misalignment or social jetlag can have safety and health implications [45]. It is recommended that extracurricular activities end at no more than 9:00pm for adolescents to allow them to meet sleep duration guidelines.
Blocking the blue light of screens	It is increasingly known that the blue light of screens suppresses melatonin secretion, which may delay sleep onset and reduce sleep quality [46,47]. Companies should design self-luminous display screens that decrease circadian stimulation or provide settings to do so (eg, nightshift mode in the setting of iPhones).
Regulating sleep in child care settings	Regulations related to healthy sleep practices in child care facilities are lacking or vary widely. Healthy sleep practices in child care settings should adopt regulations consistent with evidence-based recommendations [48].
Integrating sleep health literacy into school curriculum	Early childhood is a critical time in which the foundations of life-long health are built. Healthy sleep is a key but often neglected building block. The integration of sleep health literacy into early childhood programs and school curricula has the potential to impact the life-course development of children [49].

population that sleep is a priority, but also help to provide strategies to counter the adverse effects of lack of sleep that are not only focused on changing individual behaviors (and we know that behavior modification is very challenging to accomplish). By doing so, public policies targeting sleep health have an important advantage – they allow for healthier sleep behaviors while overcoming the challenge of changing behavior at the level of the individual.

One example is to delay school start time for adolescents. This modifiable, policy-level countermeasure to sleep deprivation is gaining a lot of momentum at the moment and has been the topic of a special issue in *Sleep Health* in December 2017 [29]. The well-known circadian phase delay of up to 2 h relative to middle childhood has been shown to shorten the amount of sleep that adolescents get on school nights [30]. Adolescents have also experienced the steepest decline in sleep duration over the past decades compared with younger children or adults, including Canadian adolescents, making them a vulnerable group in need of intervention strategies [31–34].

Declines in adolescents' sleep duration have occurred as a result of progressive delays in bedtimes, but unchanged wake-up times to go to school [35,36]. This has resulted in "catch-up sleep" on weekends as a means to address the accumulated sleep debt [3,4]. In Canada, children and adolescents sleep approximately 1 h longer on weekends compared to weekdays, despite going to bed approximately 1.5 h later [6]. Thus, interventions that can improve sleep of adolescents on weekdays are very appealing. An accumulating body of evidence has shown that delaying school start times is an effective countermeasure to chronic sleep deprivation on weekdays in adolescents [37–41]. A recent study comprising 29,635 adolescents aged 10–18 years across Canada found that students from schools that started later slept longer, were more likely to meet sleep duration recommendations, and were less likely to report feeling tired in the morning [38]. The mean school start time as reported in this representative sample of Canadian adolescents was 8:43am and ranged from 8:00am to 9:30am. Notably, the authors found no evidence of a flattening of effect within the range of start times, with the 9:30am start time benefiting Canadian adolescents the most by allowing the majority to meet sleep duration recommendations [38].

Although Canadian schools start later than those in the United States (on average at 8:43am for adolescents in Canada versus 8:03am in the United States [6,29,38]), there is compelling evidence that delaying school start time in Canadian schools would benefit adolescent sleep and associated outcomes [37–41]. Not only that shifting to later school start times can benefit the health of adolescents, but recent findings showed that it can also contribute to the economy by improving academic performance and potential lifetime earnings of students and by reducing car crash rates [42].

Other examples of public health policy recommendations for promoting sleep health in the pediatric population are presented in Table 2. Such public policy recommendations would help sleep health in pediatric populations in Canada; however, there is little work and leadership in this area while the focus is largely on the treatment of sleep disorders.

6. Future of pediatric sleep health in Canada

Although there is currently a momentum for the promotion of pediatric sleep heath in Canada, it is important to better align these efforts and continue to push for this important topic in public health agencies. The pediatric sleep health community should support the efforts of policy makers on several key issues:

- Develop a consensus on the definition of sleep health, especially around the main dimensions of sleep health in the pediatric population.
- Help standardize the measurement of sleep health.
- Continue to develop and update evidence-informed sleep guidelines for different target groups. Sleep guidelines are important because they provide recommendations for optimal health benefits and provide benchmarks for surveillance.
- Improve the monitoring of sleep health in Canada, including assessing sleep objectively with actigraphy and update and refine sleep questions for use in national health surveys.
- Test the cost-effectiveness of policies aimed at improving sleep and health outcomes in children and adolescents.

7. Conclusion

Progress has been made on the importance of a good night's sleep for all. However, the field of sleep research is still dominated by the identification and treatment of sleep disorders rather than their prevention in the first place. Sleep experts working on the public health aspects of sleep should join forces together to move this field of research forward. This includes (1) coming to a consensus on unclear research questions, (2) improving the national surveillance of sleep health, (3) advocating for better sleep health, (4) showing leadership and innovation in translating,

disseminating, and mobilizing sleep health initiatives, and (5) using international partnerships to create, promote, and evaluate sleep health initiatives. At the end of the day, we all want better sleep and health outcomes for our most precious resource, our children.

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Conflicts of interest

None declared.

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