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Modifiable predictors of insufficient sleep durations: A longitudinal analysis of youth in the COMPASS study

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ABSTRACT

The purpose of the current study was to simultaneously examine commonly proposed risk and protective factors for sleep deprivation over time among a large cohort of Ontario and Alberta secondary school students. Using 4-year linked longitudinal data from youth in years 1 through 4 (Y_1[2012/2013], Y_2[2013/2014], Y_3[2014/2015], Y_4[2015/2016]) of the COMPASS study (n = 26,205), the likelihood of students meeting contemporary sleep recommendations was tested based on their self-reported substance use, bullying victimization, physical activity, and homework and screen time. Models controlled for the effect of student-reported gender, race/ethnicity, grade, school clustering, and all other predictor variables. Relative to baseline, students became less likely to meet the sleep recommendations if at follow-up they had initiated binge drinking, experienced cyber bullying victimization, or were spending more time doing homework, with other factors held constant. The likelihood of reporting sufficient sleep increased if students had begun engaging in resistance training at least three times a week. No longitudinal effect was observed when students increased their caffeine consumption (energy drinks, coffee/tea), initiated cannabis or tobacco use, experienced other forms of bullying victimization (physical, verbal, or belongings), engaged in more moderate-vigorous physical activity, or increased their screen use of any type. Few of the commonly purported modifiable risk and protective factors for youth sleep deprivation held in multinomial longitudinal analyses. Causal conclusions appear premature, with further research required to confirm the targets likely to be most effective in assisting more youth in meeting the sleep recommendations.

1. Introduction

Sleep deprivation is widespread among youth (Chaput and Janssen, 2016; Garaulet et al., 2011; Smaldone et al., 2007; Patte et al., 2017; Matricciani et al., 2017), yet contributing factors and how to effectively intervene is unclear. Exploring potential risk and protective factors simultaneously is necessary to assess their relative importance, and inform where to focus public health efforts. Sufficient sleep is essential for youth's everyday functioning and future health and wellbeing (Chaput et al., 2016).

Adolescence represents a critical age for sleep interventions as nightly durations typically decline, while needs remain high to support continued development (Hayley et al., 2015; Keyes et al., 2015; Maslowsky and Ozer, 2014; Reidy et al., 2016). For example, Maslowsky and Ozer (Maslowsky and Ozer, 2014) found a consistent decrease in sleep duration across adolescence, from a high of 8.5 h per night at age 13 to a low of 7.3 h at age 18. According to both US (Hirshkowitz et al., 2015) and Canadian guidelines (Tremblay et al., 2016), 14-to-17-year-olds require an average of 8 to 10 h per night, a duration which an alarming number fall short (Chaput and Janssen, 2016; Garaulet et al., 2011; Smaldone et al., 2007; Patte et al., 2017). Approximately one-third of Canadian youth fail to meet the recommendations, with the vast majority reporting insufficient sleep (Chaput and Janssen, 2016). A recent systematic review concluded that existing research supports benefits of longer sleep for adiposity, emotional regulation, academic achievement, and quality-of-life/wellbeing, as well as potential associations with cognition, harms/injuries, and cardiometabolic biomarkers (Chaput et al., 2016; Tremblay et al., 2016).

Based on a nationally representative sample, average weekday sleep duration was 8.3 h among 14–15-year-old Canadian youth and 8.2 h among 16–17 year olds (Chaput and Janssen, 2016). Estimates are similar in American (Smaldone et al., 2007) and European studies (Garaulet et al., 2011). While some shift in timing is natural (Crowley et al., 2007), evidence suggests average sleep durations have continued to drop over past years, alongside escalating reports of tiredness and difficulties sleeping (Patte et al., 2017; Matricciani et al., 2017; Keyes et al., 2015; Kronholm et al., 2015; Matricciani et al., 2012). The trends

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appear primarily attributable to later bedtimes (Dollman et al., 2007; Iglowstein et al., 2003; Pääkkönen, 2005; Randler, 2009).

Several risk factors have been proposed for youth sleep deprivation, including: screen/electronic media use, prebedtime worry, substance use (including caffeine), heightened demands on youth's time due to school work, part-time employment, and/or extracurricular/social activities, and permissive contextual factors, such as artificial light and lax parental monitoring (Matricciani et al., 2017). Less evidence is available on protective factors – referred to as the "neglected half of adolescent sleep research" (Sivertsen et al., 2015) – although physical activity and healthy sleep hygiene (e.g., limiting arousal before bed) demonstrate promise (Owens, and Adolescent Sleep Working Group, Committee on Adolescence, 2014).

Despite many theories, empirical evidence on the primary drivers of youth sleep debt is largely limited to cross-sectional designs and/or studies focused on one risk/protective domain. Interpretation of findings is obscured by potential confounding and reverse/reciprocal causation, given the believed contributors often cluster together, and sleep deficiencies represent a risk factor for many of these behaviours, as well as a consequence. Further research is required to ensure prevention strategies have a sizeable impact. The purpose of this study is to examine how commonly purported modifiable risk/protective factors influence the likelihood of youth meeting sleep recommendations.

2. Methods

2.1. Design

The COMPASS study collects longitudinal data from secondary school students in grades 9–12 and the schools they attend in Ontario and Alberta, Canada (Leatherdale et al., 2014a). A full description of COMPASS and its methods are available in print (Leatherdale et al., 2014a) or online (www.compass.uwaterloo.ca). All procedures were approved by the University of Waterloo Office of Research Ethics and appropriate school board committees.

2.2. Participants

School boards and schools were purposefully selected based on whether they permitted active-information passive-consent parental permission protocols (Leatherdale et al., 2014a). This study used linked student-level data from Year 1(Y_1:2012–2013), Year 2(Y_2:2013–2014), Year 3(Y_3:2014–2015), and Year 4(Y_4:2015–2016). In Y_1, 24,173 students completed the questionnaire (80.2% participation rate) at 43 Ontario schools. In Y_2, an additional 36 Ontario and 10 Alberta schools were added, and a total of 45,298 students participated (80.1% participation). In Y_3, data were collected from 42,355 youth (79.3% participation) in 86 schools. In Y_4, data were collected from 40,436 students (79.9% participation) at 81 schools. Missing respondents resulted primarily from free/study periods or absenteeism. In the cross-sectional samples, 116 students in Y_1, 305 students in Y_2, 317 students in Y_3, and 325 students from Y_4 were removed due to missing sleep responses. An additional 1189, 2376, 2277, and 2207 participants were removed from the Y_1, Y_2, Y_3, and Y_4 datasets, respectively, based on sleep duration responses interpreted as probable misreports (< 1 h).

To explore longitudinal changes, student-level data were linked within schools. The process of linking is described in more detail by Qian and colleagues (Qian et al., 2015). Due to the rolling sample design (Leatherdale et al., 2014a), it was not possible to link students who were in grade 12 at first participation and graduated that year, or grade 9 students newly admitted in Y_4. The other main reasons for non-linkage included students transferring schools or dropping out, not providing data for grade or gender, free/study periods or absenteeism, or inaccurate data provided in the linkage measures. A total of 27,501 students were successfully linked for at least two years and had complete information (3.29%[n = 906] were linked for 4 years; 24.66%[n = 6782] for 3 years; 72.05%[n = 19,813] for 2 years). Lastly, as done in previous studies (Chaput and Janssen, 2016; Patte et al., 2017), students with sleep durations considered outliers (≥ ± 3 standard deviations from the sample mean) were excluded, leaving a final sample of 26,205 students.

2.3. Data collection tool

The student-level questionnaire for COMPASS (Cq) collects individual data pertaining to multiple behaviours/outcomes (substance use, physical activity, sedentary behaviour, diet, sleep, bullying, etc.) and demographic characteristics. In each school, the Cq was used to collect whole-school samples during class time. The cover page contains measures to create a unique self-generated code for each respondent to ensure the anonymity of participants, while allowing COMPASS researchers to link each student's data over multiple years.

2.4. Measures

2.4.1. Sleep duration

Sleep duration was assessed by asking students how much time in hours (0–9) and minutes (0, 15, 30, 45) they usually spend sleeping per day. Responses were classified as either "meets recommendations" (≥ 8 h) or "insufficient sleep" (< 8 h), according to the recommendations of 8–10 h a night (Tremblay et al., 2016). Self-report sleep surveys are shown to be valid measures for studying group-level patterns in large samples of youth (Wolfson et al., 2003).

2.4.2. Predictor variables

2.4.2.1. Substance use. Tobacco use was assessed by the questions: "have you ever smoked 100 or more whole cigarettes in your life?" and "on how many of the last 30 days did you smoke one or more cigarettes?" Youth who reported having ever smoked 100 cigarettes or more and any smoking in the previous 30 days were classified as current smokers. Binge drinking (≥ 5 drinks on one occasion) was assessed by asking respondents, "In the last 12 months, how often did you have five drinks of alcohol or more on one occasion?" Students were considered current binge drinkers if they reported binge drinking once a month or more. Cannabis use was assessed by the question, "In the last 12 months, how often did you use marijuana or cannabis? (a joint, pot, weed, hash…)." Students who reported cannabis use once a month or more were classified as current cannabis users. To gauge caffeine use, students were asked the number of days they consumed "high energy drinks (Red Bull, Monster, Rock Star, etc.)" and coffee/tea ("include cappuccino, Frappuccino, iced-tea, iced-coffees, etc.") on a usual week. Responses were categorized by whether they reported consumption on 3 or more days per week.

2.4.2.2. Physical activity. The physical and sedentary activity measures have been previously validated (Leatherdale et al., 2014b). Respondents were asked how many minutes of vigorous and moderate intensity PA (MVPA) they engaged in on each of the last 7 days. Their mean MVPA per day was entered into the models. Resistance exercise was assessed by the question "on how many days in the last 7 days did you do exercises to strengthen or tone your muscles (e.g., push-ups, sit-ups, weight training)?" Students were categorized based on whether they met the three times weekly recommendation (Tremblay et al., 2016).

2.4.2.3. Sedentary behaviours. For sedentary behaviour, students were asked the average time per day that they spent: "watching/streaming TV shows or movies," "playing video/computer games," "talking on the phone," "surfing the internet," "texting, messaging, emailing," and "doing homework."

2.4.2.4. Bullying. Experiences of bullying victimization were assessed