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School Start Time and the Healthy Weight of Adolescents

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A B S T R A C T

Purpose: Studies have found that an early school start time is detrimental to the sleep, health, and well-being of youth, but its association with body weight remains unclear. We examined this association in Canadian adolescents.
Methods: We collected information on start times from 362 schools that participated in the 2013/2014 Canadian Health Behaviour in School-aged Children Study (n = 29,635 students; ages 10–18). We estimated body mass indices (BMIs) and BMI z-scores, and identified overweight and obesity using international growth references. Multilevel regression models tested the associations between school start times and our outcomes, adjusted for grade, family affluence, school rurality, latitude, and province.
Results: The average BMI was 21.2 (standard deviation 4.9) and BMI z-score was .48 (standard deviation 1.23). Every 10-minute delay in school start time corresponded with a .02 (95% confidence interval .00, .04) smaller BMI z-score. This association translated to BMIs in the 70th and 64th percentiles when comparing students from schools that started at 8:00 A.M. and 9:30 A.M., respectively. School start time was not significantly related to overweight or obesity.
Conclusions: Later school start time was linked to lower BMI in Canadian adolescents. Delaying school start time may be an additional strategy to support the healthy weight of adolescents. Future intervention and impact studies are recommended to confirm these findings.

IMPLICATIONS AND CONTRIBUTION

School start time policies impact the sleep and health of adolescents, but their association with body weight is unknown. This study shows that later school start times relate to lower adolescent body weight. Delaying school start time may be an additional strategy to promote healthy weight in youth.

Youth overweight is a recognized global public health issue. Excess weight during childhood and adolescence is detrimental to the quality of life, health, and well-being of young lives [1] and is a strong predictor of adult obesity [2] and mortality risk [3]. Despite major public health initiatives across North America, the prevalence of overweight and obesity among youths has more than doubled in the last 30 years and approximately one third of adolescents are now living with overweight or obesity in Canada and the United States [4,5].

Interventions that target healthy weights have traditionally focused on promoting physical activity and healthy eating, but emergent research shows that sleep is an additional health behavior that influences body weight in youth [6,7]. In a recent systematic review of 22 longitudinal studies, Fatima et al. [8] found that children and adolescents who had a short sleep duration had twice the odds of overweight or obesity compared to those with longer sleep (odds ratio [OR] 2.15, 95% confidence interval [CI] 1.64, 2.81). Ruan et al. [9] replicated these findings in a systematic review of 25 longitudinal studies, and found that children

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and adolescents who were short sleepers gained, on average, .13 (95% CI .01, .25) BMI units more per year than long sleepers. The association is further supported by experimental studies that found that restricting sleep in children leads to weight gain [6]. Altogether, the growing body of evidence suggests that protecting sleep should be part of efforts to promote healthy weights in youth.

Although several behavioral, environmental, and cultural factors are known to impede sleep [10], an early school start time has been identified as a key factor in youth [11]. An early school start time conflicts with the circadian rhythm in adolescence, the 24-hour internal clock that drives daily patterns of eating, activity, and sleep. Biological changes during adolescents delay the circadian clock by up to 2 hours, resulting in a natural sleep period between approximately 11:00 P.M. and 8:00 A.M. [10]. A school schedule that requires adolescents to get up before their natural wake time can therefore impact sleep [11,12] and disrupt circadian rhythms that affect a number of metabolic functions involved in weight regulation [7,13]. Studies in adults suggest that circadian desynchronization from shift work leads to weight gain and a greater risk of obesity in adults [14,15]. Similar circadian disruptions from an early school start time, independently or combined with insufficient sleep, might also lead to weight gain in youth. It is currently unknown whether an early school start time is associated with higher weight in adolescents.

Our study builds on previous research on the impact of school start time on adolescent health [11] by exploring the association between school start time and body weight in a representative sample of adolescent students in Canada. Our aim was to inform school policies and public health research on the potential link between school start time and excess weight. Since this relationship may vary between gender, grade level, and socioeconomic classes, we further explored associations across these subgroups. We hypothesized that an earlier school start time would be associated with a higher body weight.

Methods

Participants

Data were collected in the 2013/2014 Canadian Health Behaviour in School-Aged Children (HBSC) survey, a nationally representative cross-sectional survey of 30,117 students in grades 6 to 10 (1,320 classes in 367 schools) from all provinces and territories in Canada. The HBSC used a two-stage cluster approach to select a representative sample of students by grade and school, reflecting characteristics of the school population such as religion, community size, school size, and language of instruction. The survey was administrated using a standard self-completion questionnaire format, item order, and testing conditions in accordance with an international protocol [16]. Teachers or trained interviewers administrated the questionnaires in class. Further details on the survey can be found elsewhere [17]. Youth in private and special needs schools and street and incarcerated youth were excluded. These excluded individuals represent less than 10% of Canadian adolescents [18]. The Queen's University General Research Ethics Board approved the research. Participating school boards, individual schools, parents, and students provided consent. Student participation was voluntary and anonymous. For this study, we excluded students from grades 5 (n = 25), 11 (n = 294), and 12 (n = 5) since they were not the focus of the HBSC and survey weights were unavailable; children younger than 10 years old (n = 12) since we were interested in adolescents; students from three schools where start time was unavailable because the schools were permanently closed (n = 132); and students from two schools that did not have a specific start time (n = 5). The final sample included 29,635 students between ages 10 and 18 years from 362 schools.

Measures

We collected information on school start times through school Web sites or by contacting school officials directly. We defined school start time as the start of the first class in the morning.

We calculated body mass indices (BMIs) from self-reported weight and height (kg/m^2) and identified the standardized age- and gender-specific BMI z-score (BMIz), overweight (≥1 standard deviation [SD] for BMI), and obesity (≥2 SD for BMI) according to the World Health Organization growth references [19]. Because adolescents tend to misreport their height and weight [20], we conducted a sensitivity analysis by applying a correction formula proposed by Brettschneider et al. [21] that accounts for the age, gender, and body perception of adolescents to adjust for misreporting.

We selected variables that could confound the association between school start time and health, including the grade and family affluence of participants and the rurality, latitude, and province of schools. Grade and gender were self-reported. Family affluence was assessed with the HBSC Family Affluence Scale III [22]. The scale asks participants about six common indicators of family wealth and the response scores were summed to create a score ranging from 6 to 19. These scores were categorized into approximate tertiles (low, medium, high affluence) based on proportional ranks within grade and gender groups. We geocoded schools using publicly available geospatial software (http://www.gpsvisualizer.com/geocoder) to identify latitude and estimated rurality (rural vs. nonrural) from their alphanumerical postal code [23]. We further collected information on characteristics of students that could modify the association between school start time and health, including grade, gender, race (white; nonwhite), family affluence, and season of survey (spring: April–June; fall: September–December; winter: January–March).

Statistical analysis

Statistical analyses were conducted in Stata (version 14.1, Stata Corp, College Station, TX). All analyses were weighted using survey weights to ensure results were representative of public school students in Canada. We examined the association between school start time and BMIz, overweight, and obesity separately using multilevel regression models where student characteristics represented level 1 variables and school factors represented level 2 variables. We used a linear model for BMIz and a modified Poisson approach for overweight and obesity because these outcomes were common [24]. All models were adjusted for grade, family affluence, and the rurality, latitude, and province of schools. We modeled school start time linearly and used restricted cubic splines to test for nonlinearity. Because the results of the linear and nonlinear models were almost identical, we chose to present the output using the linear term for simplicity. We calculated the predicted BMIz (from the linear models) and the predicted probabilities of overweight and obesity (from the Poisson models) for the available range of school start times using the margins com-