



The Canadian 24-hour movement guidelines and self-rated physical and mental health among adolescents

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Abstract

Objective The Canadian 24-hour movement guidelines for children and youth recommend a minimum of 60 min/day of moderate-to-vigorous physical activity, no more than 2 h/day of recreational screen time, and 8–11 h/night of sleep depending on age. The objective of this study was to examine the associations of meeting combinations of these recommendations with self-rated physical and mental health.

Methods This study used data from the 2017 ($n=5739$) and 2019 ($n=6960$) cycles of the Ontario Student Drug Use and Health Survey (OSDUHS), a biennially repeated cross-sectional study of Ontario students in grades 7 through 12. Multivariable ordered logistic regression models were adjusted for age, gender, ethnoracial background, subjective socio-economic status, and body mass index z -scores.

Results Similar patterns were seen in the 2017 and 2019 samples. Compared with meeting none of the recommendations, meeting different combinations of recommendations in the 2019 sample was associated with positive self-rated physical and mental health. A dose–response gradient between the number of recommendations met and self-rated physical ($p < 0.001$) and mental ($p < 0.001$) health was observed, with meeting one (AOR: 1.82; 95% CI: 1.58–2.09), two (AOR: 3.54; 95% CI: 2.98–4.22), or three recommendations (AOR: 6.34; 95% CI: 4.46–9.02) being increasingly associated with positive self-rated physical health compared with meeting none; and meeting one (AOR: 1.51; 95% CI: 1.33–1.71), two (AOR: 2.70; 95% CI: 2.31–3.17), or three recommendations (AOR: 3.58; 95% CI: 2.57–4.98) being increasingly associated with positive self-rated mental health compared with meeting none.

Conclusion Meeting the 24-hour movement guidelines is associated with better self-rated physical and mental health among adolescents.

Résumé

Objectif Les *Directives canadiennes en matière de mouvement sur 24 heures pour les enfants et les jeunes* recommandent un minimum de 60 min par jour d'activité physique d'intensité moyenne à élevée, un maximum de 2 heures par jour de temps de loisir devant un écran et de 8 à 11 heures de sommeil selon l'âge. L'objectif de cette étude était d'examiner les associations entre l'adoption d'une combinaison de ces recommandations et l'autoévaluation de la santé physique et mentale.

Méthode Cette étude s'est appuyée sur les données tirées des cycles de 2017 ($n=5\,739$) et de 2019 ($n=6\,960$) du *Sondage sur la consommation de drogues et la santé des élèves de l'Ontario* (SCDSEO), un sondage transversal réalisé tous les deux ans auprès d'élèves de la 7^e à la 12^e année en Ontario. Les modèles de régression logistique multivariés ont été ajustés en ce qui a trait à l'âge, au genre, aux antécédents ethnoraciaux, au statut socioéconomique subjectif et aux scores- z de l'indice de masse corporelle.

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Résultats Des tendances similaires ont été observées dans les échantillons de 2017 et de 2019. L'adoption d'une combinaison des recommandations parmi l'échantillon de 2019, comparativement au fait de ne se conformer à aucune d'elles, était associée à une autoévaluation positive de la santé physique et mentale. Un gradient dose-réponse entre le nombre de recommandations adoptées et l'autoévaluation de la santé physique ($p < 0,001$) et mentale ($p < 0,001$) a été observé. L'adoption d'une (RCa : 1,82; IC de 95% : 1,58 à 2,09), de deux (RCa : 3,54; IC de 95% : 2,98 à 4,22) ou de trois recommandations (RCa : 6,34; IC de 95% : 4,46 à 9,02) était étroitement associée à une autoévaluation positive de la santé physique, comparativement au fait de ne se conformer à aucune d'elles; et l'adoption d'une (RCa : 1,51; IC de 95% : 1,33 à 1,71), de deux (RCa : 2,70; IC de 95% : 2,31 à 3,17) ou de trois recommandations (RCa : 3,58; IC de 95% : 2,57 à 4,98) était étroitement associée à une autoévaluation positive de la santé mentale, comparativement au fait de ne se conformer à aucune d'elles.

Conclusion La conformité aux directives en matière de mouvement sur 24 heures est associée à une meilleure autoévaluation de la santé physique et mentale chez les adolescents.

Keywords Physical activity · Screen time · Sleep · Physical health · Mental health · Youth

Mots-clés Activité physique · temps d'écran · sommeil · santé physique · santé mentale · jeunes

Introduction

The Canadian 24-hour movement guidelines for children and youth are evidence-based guidelines that provide integrated guidance on the amount of physical activity, screen time, and sleep duration that should be achieved for better health (Tremblay et al., 2016). These guidelines recommend that children and youth get at least 60 min/day of moderate-to-vigorous physical activity (vigorous physical activities and muscle and bone strengthening activities should each be incorporated at least 3 days per week), engage in light physical activities for several hours per day, spend no more than 2 h/day in recreational screen time, and sleep for 9 to 11 h/night (children aged 5 to 13 years) or 8 to 10 h/night (youth aged 14 to 17 years), with consistent bed and wake-up times (Tremblay et al., 2016). Meeting these guidelines has been associated with improved indicators of social, physical, and mental health (Carson et al., 2017; Janssen et al., 2017; Saunders et al., 2016). Recent research has also shown that meeting the Canadian 24-hour movement guidelines is associated with less mental health problems among adolescents, such as psychological distress, suicidality, aggressive behaviours, and substance use (Sampasa-Kanyinga et al., 2020a, 2020b, 2020c, 2020d). However, no studies have examined the link between meeting the 24-hour movement guidelines and a more global measure of self-perception of health, such as self-rated health.

Self-rated health is a subjective, multi-dimensional indicator of one's health status as impacted by physical, psychological, and social functioning (Leidy et al., 1999). In younger age groups, self-rated health is more dependent on health behaviours as opposed to health problems (Krause & Jay, 1994), thus making self-rated health a somewhat different construct in children/adolescents than in adults. The measure may therefore be more representative of health as an enduring self-concept rather than a fleeting assessment of health at present (Boardman, 2006). Indeed, the World Health Organization (WHO)

considers self-rated health a more appropriate measure of adolescent health than traditional morbidity and mortality measures (Currie et al., 2009). Self-rated health is often used in health surveys to assess health-related quality of life. A study specific to combinations of the Canadian 24-hour movement guidelines found that meeting more recommendations was associated with better health-related quality of life in children, as measured by a 10-question survey (Sampasa-Kanyinga et al., 2017). However, the association between meeting the 24-hour movement guidelines and health-related quality of life in adolescents is largely unknown.

Research has shown that individual movement behaviours are associated with self-rated health. A recent systematic review and meta-analysis study demonstrated consistent findings of better self-rated health observed in children and adolescents who reported 2 h or less of daily recreational screen time and those who reported higher levels of physical activity (Zhang et al., 2020). Moreover, self-rated health can be further partitioned into self-rated physical and mental health (Boak et al., 2017; Statistics Canada, 2013). For example, Herman et al. (2015) found that adolescents exceeding 2 h of daily recreational screen time had 30% greater odds of suboptimal self-reported health (defined here as self-perceiving health as good, fair, or poor, as opposed to optimal health, defined as excellent or very good perceptions), and 30–50% greater odds of suboptimal self-reported mental health. Shorter sleep duration has also been found to be associated with poorer self-rated health in various age groups, including adolescents, young adults, and adults (Geiger et al., 2012; Štefan et al., 2017; Yeo et al., 2019).

To our knowledge, the association between different combinations of physical activity, screen time, and sleep duration with self-rated health or self-rated physical or mental health as single-item global health questions has yet to be explored. This is particularly important for two reasons. First, physical activity, screen time, and sleep duration are codependent

(Chaput et al., 2014), and it is necessary to get a better understanding of the combined influence of movement behaviours on self-rated physical or mental health. Second, the use of a global health status assessment of physical and mental health could be essential to capture adolescents' well-being beyond consideration of specific health problems (Krause & Jay, 1994; Vingilis et al., 2002). While it should not serve as a replacement for objective and specific measures of physical illness and morbidity, self-rated health has been associated with mortality and physical and psychological health status, exhibiting its potential use as a screening tool (Gallagher et al., 2016; Lorem et al., 2020; Williams et al., 2017). Furthermore, studying the relationship between movement behaviours and self-rated health with physical and mental health as distinct entities can provide insight into the roles that combinations of movement behaviours may separately play in different aspects of health perception by adolescents.

Thus, the purpose of this study was to examine the association between meeting combinations of the 24-hour movement guidelines for physical activity, recreational screen time, and sleep duration and self-rated physical and mental health in adolescents in the 2017 and 2019 cycles of the Ontario Student Drug Use and Health Survey (OSDUHS). The 2017 and 2019 samples were examined separately to examine whether the findings would be consistent across these two cycles. We hypothesized that (1) adherence to the 24-hour movement guidelines would be associated with better self-rated physical and mental health; and (2) adherence to a greater number of recommendations ($3 > 2 > 1 > 0$) would be more strongly associated with better self-rated physical and mental health among adolescents.

Methods

Data

Cross-sectional data were derived from the 2017 and 2019 cycles of the OSDUHS, a biennial representative province-wide survey of students in grades 7 through 12 (aged 11 to 20 years or over) in publicly funded schools across Ontario, Canada (Boak et al., 2017, 2020). The survey has been ongoing since 1977 to monitor students' drug use, mental health, physical health, gambling, bullying, and other risk behaviours, as well as to identify risk and protective factors. The OSDUHS employs a stratified two-stage cluster design (school, class). Participation in the survey is anonymous and voluntary. Students completed a self-administered paper-and-pencil questionnaire during a regularly scheduled classroom period. In the 2017 cycle, the survey sampled 11,435 students in grades 7 through 12 from 52 school boards, 214 schools,

and 764 classrooms (Boak et al., 2017). The student participation rate was 61%. Students were lost due to absenteeism (12%) and parental refusal or unreturned consent forms (27%) (Boak et al., 2017). In the 2019 cycle, the survey included 14,142 students in grades 7 through 12 from 47 school boards, 263 schools, and 992 classrooms (Boak et al., 2020). The student participation rate was 59%. Students were lost due to absenteeism (12%) and parental refusal or unreturned consent forms (29%) (Boak et al., 2020). The rates of student participation were above average for a student survey that required active consent from a parent or guardian (Courser et al., 2009). Analyses were restricted to the random half samples who completed the A version of the questionnaire, which included a question on self-reported mental health ($N=6364$ and 7617 for the 2017 and 2019 data, respectively). Greater details about the survey design and methods are described elsewhere (Boak et al., 2017, 2020). The 2017 and 2019 OSDUHS protocols were approved by the Research Ethics Boards at the Centre for Addiction and Mental Health and York University, as well as the school board research review committees. All subjects gave their signed assent in addition to parentally signed consent for those aged under 18 years before they participated in the study.

Measures

Dependent variable

Self-reported physical and mental health constitute the dependent variables. Similar measures are widely used in national (Statistics Canada, 2013) and international population-based surveys, such as the Centers for Disease Control (CDC)'s Youth Risk Behavior Survey (YRBS) (Centers for Disease Control and Prevention, n.d.) and the Health Behaviour in School-aged Children study (HBSC) (Currie et al., 2009), and have shown good psychometric properties among children and adolescents.

Self-reported physical health was assessed using the following question: "How would you rate your physical health?". Response options included excellent, very good, good, fair, and poor. Response options ranging from 1 (excellent) to 5 (poor) were reverse coded and treated as an ordinal variable so that higher scores indicate positive self-reported physical health.

Self-reported mental health was measured using the following question: "How would you rate your mental or emotional health?". Response options included excellent, very good, good, fair, and poor. Response options ranging from 1 (excellent) to 5 (poor) were reverse coded and treated as an ordinal variable so that higher scores indicate positive self-reported mental health.

Independent variables

Physical activity was measured using the following item: “On how many of the last 7 days were you physically active for at least 60 min each day. Please add up all the time you spent in any types of physical activity that increased your heart rate and made you breathe hard for some of the time (Some of the examples are brisk walking, running, rollerblading, biking, dancing, skateboarding, swimming, soccer, basketball, football). Please include both school and non-school activities”. Response options ranged from 0 to 7 days. For analysis, participants who responded “7 days” were considered as meeting the physical activity recommendation (Tremblay et al., 2016). Whereas, the remaining response options were collapsed to represent those who did not meet the physical activity recommendation.

Screen time was measured using the following item: “In the last 7 days, about how many hours a day, on average, do you spend watching TV/movies/videos, texting, playing video/computer games, emailing, or surfing the Internet in your free time?”. Participants who reported spending no more than 2 h/day of recreational screen time were considered as meeting the screen time recommendation (Tremblay et al., 2016). Those who reported screen time of more than 2 h/day were considered as not meeting the screen time recommendation.

Sleep duration was assessed using the following question: “On an average school night, how many hours of sleep do you get?”. Participants who reported a sleep duration falling within the recommended range (9–11 h/night for 11–13-year-olds; 8–10 h/night for 14–17-year-olds, or 7–9 h/night for those aged 18 years or older) were considered as meeting the sleep duration recommendation (Tremblay et al., 2016). Those who reported getting insufficient sleep were considered as not meeting the sleep duration recommendation.

Covariates

Covariates included age (in years), gender (determined by being boy or girl), ethnoracial background (including white, Black, East and Southeast Asian, South Asian, and Other), subjective socio-economic status (SES), and body mass index (BMI) z -score. Subjective SES was measured using the youth version of the MacArthur Scale of Subjective Social Status (Goodman et al., 2007). Minor modifications were made to the youth scale to assess the family’s place within society. The question was presented with a drawing of a ladder with 10 rungs that was described as follows: “Imagine this ladder below shows how Canadian society is set up. At the top of the ladder are people who are the ‘best off’ – they have the most money, the most education, and the jobs that bring the most respect. At the bottom are the

people who are ‘worst off’ – they have the least money, little education, no job or jobs that no one wants. Now think about your family. Please check off the numbered box that best shows where you think your family would be on this ladder”. Students self-reported their body weight (kilograms) and height (metres). BMI (kilograms/metres²) was calculated and converted into z -scores following the WHO’s reference data (World Health Organization, 2011). Age, subjective SES, and BMI z -scores were treated as continuous variables, whereas gender and ethnoracial background were treated as categorical variables.

Data analysis

All analyses were conducted using STATA 16.0 and accounted for the complex survey sample design using Taylor series methods. Population weights were used to adjust for the unequal probability of selection. The characteristics of the study participants in the 2017 and 2019 OSDUHS were described via proportions, means, and medians. Given that separate two-way interactions between both independent variables and gender were not statistically significant for both outcomes in 2017 and 2019, analyzing boys and girls separately was not necessary. Ordered logistic regression analyses were used to examine the associations between the independent variables of (1) different combinations of meeting the physical activity, screen time, and sleep duration recommendations and (2) the number of recommendations met with the outcome variables of self-rated physical and mental health for both cycles of the survey. Multivariate models adjusted for age, gender, ethnoracial background, subjective SES, and body mass index z -score. Missing data were handled through listwise deletion, reducing the sample sizes by 9.8% and 9.4% for the 2017 and 2019 datasets, respectively. Participants with missing data were more likely to be boys in the 2017 and 2019 data. They were also more likely to be in lower grades and of Black ethnoracial background in the 2019 data.

Results

Descriptive characteristics of the sample are outlined in Table 1. Almost half of the 2017 and 2019 samples were girls, just over half identified themselves as white, and the average age of each sample was 15 years. In the 2017 sample, the prevalences of suboptimal self-rated physical and mental health were 40.4% and 46.8%, respectively. However, in the 2019 sample, the prevalences of suboptimal self-rated physical and mental health were 43.1% and 55.9%, respectively.

Figure 1 displays the prevalence of participants in the 2017 (Venn diagram A) and 2019 (Venn diagram B) cycles

Table 1 Descriptive characteristics of the study sample

	2017 (N=5739)		2019 (N=6960)	
	n	%	n	%
Age (years)				
Mean (SD)	15.2	1.8	15.2	1.8
Gender				
Boys	3293	49.0	49.4	49.4
Girls	2446	51.0	50.6	50.6
Ethnoracial background				
White	3319	54.0	3860	50.9
Black	479	12.0	556	9.5
East/Southeast Asian	508	8.1	855	14.0
South Asian	433	6.4	577	9.0
Other	1000	19.6	1112	16.7
Subjective socio-economic status				
Mean (SD)	6.9	1.7	6.9	1.7
Body mass index z-score				
Mean (SD)	0.3	1.2	0.3	1.1
Physical activity				
Not meeting	4510	78.1	5550	80.3
Meeting	1229	21.9	1410	19.7
Screen time				
Not meeting	3743	66.3	5115	75.5
Meeting	1996	33.8	1845	24.5
Sleep duration				
Not meeting	3830	67.3	4570	65.9
Meeting	1909	32.7	2390	34.1
Number of recommendations met				
Zero	2248	39.9	3013	44.5
One	2134	36.9	2526	36.2
Two	1071	18.2	1144	15.8
Three	286	5.0	277	3.5
Self-rated physical health ^a				
Median	4		4	
Self-rated mental health ^a				
Median	4		3	

Data are shown as count and percentage unless otherwise indicated
SD, standard deviation

^a This variable was measured on a 5-point ordinal scale so that higher scores indicate a positive measure

of the OSDUHS who met recommendations for movement behaviours. Overall, meeting all three recommendations was reported by 5.0% of the sample in 2017 and by 3.5% of the sample in 2019. Not meeting any recommendation was reported by 39.9% of the sample in 2017 and by 44.5% of the sample in 2019.

Results of univariable and multivariable ordered logistic regression analyses examining the associations between meeting combinations of the physical activity, screen time,

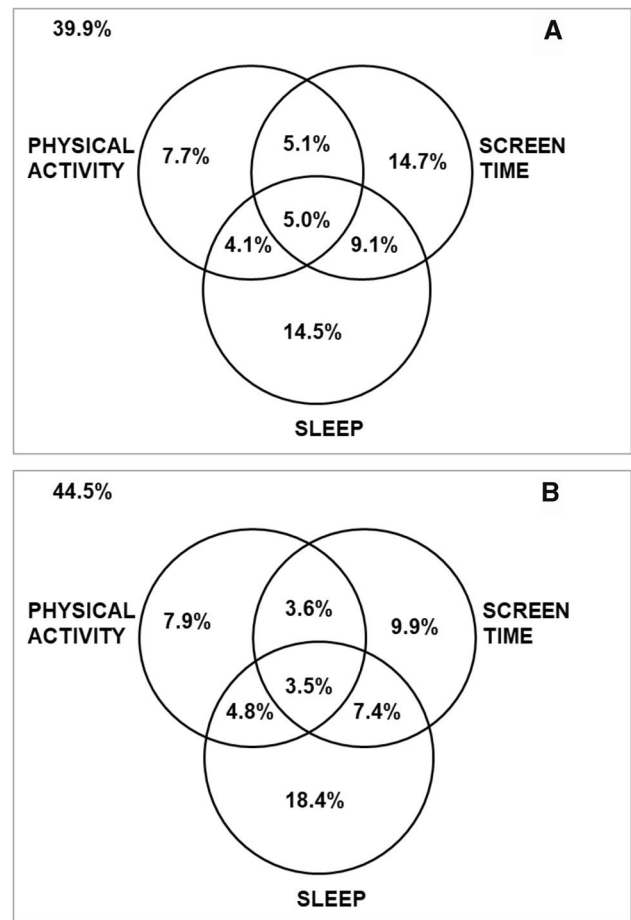


Fig. 1 Venn diagram showing the prevalence of students who meet the physical activity, screen time, and sleep duration recommendations, their combinations, and those who meet none of the 3 recommendations in the total study sample in 2017 (panel A, N=5739) and 2019 (panel B, N=6960)

and sleep duration recommendations with self-rated physical and mental health are outlined in Table 2. Findings showed that in the 2017 sample, meeting all 3 recommendations and different intermediate combinations of the recommendations were all associated with positive self-reported physical health. The same pattern was observed for self-reported mental health, except meeting the screen time recommendation only, which was not associated with this outcome (AOR = 1.33; 95% CI: 0.97 – 1.81). However, in the 2019 sample, meeting different combinations of recommendations was all associated with positive self-reported physical health and self-reported mental health.

Results of ordered logistic regression analyses examining the association between the number of movement behaviour recommendations met and self-reported physical and mental health in the 2017 and 2019 samples are

Table 2 Ordered logistic regression examining the associations of movement behaviour combinations with self-reported physical and mental health

	Self-rated physical health ^a		Self-rated mental health ^a	
	Unadjusted OR (95% CI)	Adjusted OR (95% CI)	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
2017 (N=5739)				
Meeting none	1	1	1	1
Only physical activity	4.39 (3.02 – 6.38)	3.75 (2.81 – 4.99)	2.39 (1.89 – 3.01)	1.88 (1.56 – 2.28)
Only screen time	2.02 (1.62 – 2.51)	1.74 (1.42 – 2.14)	1.31 (0.98 – 1.75)	1.33 (0.97 – 1.81)
Only sleep duration	1.76 (1.37 – 2.25)	1.39 (1.10 – 1.76)	2.22 (1.59 – 3.09)	1.99 (1.40 – 2.83)
Physical activity + screen time	8.33 (4.63 – 14.99)	5.81 (3.14 – 10.75)	3.78 (2.70 – 5.30)	2.58 (1.72 – 3.86)
Physical activity + sleep duration	10.00 (6.82 – 14.69)	6.50 (4.38 – 9.65)	7.69 (4.75 – 12.43)	4.92 (3.18 – 7.62)
Screen time + sleep duration	3.89 (2.77 – 5.47)	2.91 (1.92 – 4.39)	5.12 (3.72 – 7.04)	4.47 (3.20 – 6.25)
Physical activity + screen time + sleep duration	19.92 (11.94 – 33.22)	12.78 (6.97 – 23.41)	5.92 (4.42 – 7.93)	3.84 (2.69 – 5.48)
2019 (N=6960)				
Meeting none	1	1	1	1
Only physical activity	3.66 (2.75 – 4.86)	3.24 (2.42 – 4.33)	1.51 (1.20 – 1.91)	1.42 (1.11 – 1.79)
Only screen time	1.86 (1.50 – 2.31)	1.75 (1.44 – 2.12)	1.26 (1.03 – 1.54)	1.20 (1.00 – 1.43)
Only sleep duration	1.78 (1.54 – 2.04)	1.50 (1.29 – 1.75)	2.13 (1.80 – 2.51)	1.96 (1.65 – 2.34)
Physical activity + screen time	6.61 (4.81 – 9.09)	5.50 (3.90 – 7.76)	2.46 (1.82 – 3.32)	2.16 (1.61 – 2.91)
Physical activity + sleep duration	5.87 (4.50 – 7.67)	4.55 (3.43 – 6.03)	4.45 (3.38 – 5.86)	3.75 (2.84 – 4.96)
Screen time + sleep duration	3.32 (2.67 – 4.13)	2.56 (2.07 – 3.17)	3.76 (3.05 – 4.65)	3.17 (2.55 – 3.93)
Physical activity + screen time + sleep duration	9.86 (6.94 – 14.00)	6.49 (4.55 – 9.25)	6.01 (4.29 – 8.43)	4.40 (3.20 – 6.04)

Models are adjusted for age, gender, ethnoracial background, subjective socio-economic status, and body mass index z-score
 OR, odds ratio; CI, confidence interval

^a This variable was measured on a 5-point ordinal scale so that higher scores indicate a positive measure

Table 3 Ordered logistic regression examining the associations of number of movement behaviour recommendations met with self-reported physical and mental health

	Self-rated physical health ^a		Self-rated mental health ^a	
	Unadjusted OR (95% CI)	Adjusted OR (95% CI)	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
2017 (N=5739)				
None	1	1	1	1
One	2.22 (1.90 – 2.59)	1.84 (1.59 – 2.14)	1.83 (1.44 – 2.31)	1.75 (1.32 – 2.31)
Two	5.72 (4.95 – 6.61)	4.05 (3.39 – 4.83)	5.06 (4.11 – 6.23)	4.17 (3.36 – 5.17)
Three	19.29 (11.51 – 32.31)	12.23 (6.62 – 22.59)	5.85 (4.36 – 7.85)	4.77 (3.44 – 6.62)
p-trend	<0.001	<0.001	<0.001	<0.001
2019 (N=6960)				
None	1	1	1	1
One	2.07 (1.81 – 2.38)	1.82 (1.58 – 2.09)	1.71 (1.50 – 1.94)	1.51 (1.33 – 1.71)
Two	4.53 (3.83 – 5.37)	3.54 (2.98 – 4.22)	3.02 (3.02 – 4.27)	2.70 (2.31 – 3.17)
Three	9.69 (6.84 – 13.75)	6.34 (4.46 – 9.02)	4.26 (4.26 – 8.35)	3.58 (2.57 – 4.98)
p-trend	<0.001	<0.001	<0.001	<0.001

Models are adjusted for age, gender, ethnoracial background, subjective socio-economic status, and body mass index z-score

OR, odds ratio; CI, confidence interval

^a This variable was measured on a 5-point ordinal scale so that higher scores indicate a positive measure

summarized in Table 3. We documented a dose–response gradient between the number of guideline recommendations met (3 vs. 2 vs. 1 vs. none) and both outcome variables of self-reported physical health ($p < 0.001$) and self-reported mental health ($p < 0.001$) in both the 2017 and 2019 samples (Table 3). These findings suggest that an increase in the number of recommendations met is associated with more positive self-reported physical and mental health. Meeting all three recommendations showed the strongest association with positive self-reported physical health and self-reported mental health compared with meeting two or one recommendation(s).

Discussion

This cross-sectional study used a representative school-based sample of Ontario students in grades 7 through 12 to examine the associations of meeting different combinations of movement behaviour recommendations, including physical activity, screen time, and sleep duration with self-rated physical and mental health. Collectively, our results indicated that meeting the 24-hour movement guidelines and different combinations of movement behaviour recommendations were associated with positive self-reported physical and mental health. We found a dose–response gradient between the number of guideline recommendations met and both outcome measures of self-reported physical and mental health, whereby an increase in the number of recommendations met is associated with more positive self-reported physical and mental health. Meeting all three recommendations showed the strongest association with positive self-reported physical health and self-reported mental health compared with meeting two or one recommendation(s). The findings were consistent across the 2017 and 2019 samples.

Our results are somewhat consistent with those from previous studies indicating that meeting the physical activity, screen time, and sleep duration recommendations is associated with better self-reported health or self-reported physical and mental health (Geiger et al., 2012; Herman et al., 2015; Štefan et al., 2017; Yeo et al., 2019; Zhang et al., 2020). However, our findings extend those from previous studies by examining different combinations of meeting the 24-hour movement behaviours recommendations. To the best of our knowledge, this is the first study to demonstrate that meeting the 24-hour movement guidelines is associated with optimal self-rated physical and mental health. Indeed, research has shown that movement behaviours are codependent (Chaput et al., 2014). Therefore, examining these associations in the context of the integrated guidelines is deemed more appropriate.

Results from this study indicated that the associations with meeting different combinations of movement behaviour

recommendations were similar for both self-rated physical and mental health. Furthermore, the associations between the number of guidelines met and self-rated mental health were irrespective of which movement behaviours were met. However, previous research has found different patterns between specific physical and mental health outcomes in their associations with movement behaviours. Contrary to findings that physical activity is the most important determinant of physical health (World Health Organization, 2020), recent studies that have examined the associations between meeting the 24-hour movement guidelines and specific mental health problems, such as psychological distress, suicidality, aggressive behaviours, and substance use, have found that meeting the sleep duration and screen time recommendations are associated with mental health outcomes, whereas meeting the physical activity recommendation is not (Sampasa-Kanyinga et al., 2020a, 2020b, 2020c, 2020d). A similar pattern was also documented in two longitudinal studies examining the associations of meeting the 24-hour movement guidelines with negative (i.e., depressive symptoms) and positive (i.e., flourishing) mental health indicators in a sample of Canadian adolescents (Faulkner et al., 2020; Patte et al., 2020). It is possible that the global measures of self-rated physical and mental health dilute the effects of different movement behaviours, and thus mask possible differences between specific health problems. Our findings provide further support that the single self-reported global measures are framed on different factors beyond health problems, such as personal, socio-environmental, behavioural, and psychological factors (Krause & Jay, 1994; Vingilis et al., 2002).

Excessive duration of recreational screen time is known to be associated with negative health outcomes among adolescents, such as poorer body composition, higher cardiometabolic risk, behavioural problems, and mental health problems (Carson et al., 2016). Research has also shown that excessive screen time in childhood and adolescence is prospectively associated with poor mental health outcomes (Allen & Vella, 2015; Babic et al., 2017; Grontved et al., 2015). Surprisingly, our results showed that meeting the screen time recommendation only was associated with self-reported mental health in the 2019 sample, but not in 2017. Our findings are somewhat consistent with those from Faulkner et al. (2020), who found that meeting the screen time recommendation was not associated with an increase in flourishing in a sample of Canadian adolescents. Contrary to the latest study, the proportion of those meeting the screen time recommendation could not explain the observed differences because it dropped from 33.8% in the 2017 sample to 24.5% in the 2019 sample. It is possible that other factors, such as change over time in the pattern of screen time use and/or sample characteristics, explain the observed differences.

The use of 24-hour movement guidelines in public health is an important change in how we view movement behaviours. The fact that physical activity, sedentary behaviour, and sleep add up to 24 hours suggests that time-use displacements are important to consider when designing interventions that may impact health. For example, the benefits of physical activity may not be the same if the activity is done at the expense of sleep (bad trade-off) or sedentary behaviour (good trade-off). Similarly, the health benefits of physical activity would vary based on the intensity of the activity performed (Goldfield et al., 2011). For example, Parfitt et al. (2009) found that children accumulating high levels of very light activity report higher levels of anxiety and depression and lower levels of global self-worth, while children accumulating high levels of vigorous activity report lower levels of anxiety and higher levels of global self-worth. Future studies should continue to explore the interconnections among movement behaviours and how it influences health outcomes to better inform policy and practice.

The current study has several methodological strengths. First, it is an empirical study with a large sample size and an acceptable response rate for a school-based survey requiring parental or guardian active consent (Courser et al., 2009). Second, samples from two survey cycles (i.e., 2017 and 2019) were examined separately, thus offering opportunity to document consistency of the observed associations across the cycles. Third, the dose–response analysis provided evidence of proportionality in the association between the number of movement behaviour recommendations met and self-rated physical and mental health. Finally, the analyses adjusted for several potential confounders, allowing for a clearer interpretation of the main findings.

This study also has limitations worth mentioning. First, causality assumptions should not be made because of the cross-sectional nature of the data. There is also a possibility of reverse causation if participants with suboptimal self-rated physical and mental health are less likely to meet the 24-hour movement behaviour guidelines. Second, data were based on self-reports and may be subject to recall or desirability biases. However, self-reported measures of movement behaviours have shown good validity in comparison with accelerometry measures among children and adolescents (Lubans et al., 2011; Nascimento-Ferreira et al., 2016; Schmitz et al., 2004; Scott et al., 2015). Measures of recreational screen time have also demonstrated good psychometric properties in this age group. Third, the present study did not include other aspects of the 24-hour movement guidelines, such as muscle and bone strengthening activities and light physical activities (not available). Future studies that include these components are needed to replicate our findings.

Conclusion

Despite limitations, results from the present study provide further support for the Canadian 24-hour movement guidelines by showing that meeting the guidelines is associated with better self-rated physical and mental health. This has important public health implications due to the modifiable nature of physical activity, screen time, and sleep duration, particularly given the low rate of adherence to the Canadian 24-hour movement guidelines among adolescents. Our findings provide an important venue to promote adolescent well-being. All stakeholders, including public health authorities, health service providers, schools, parents, and adolescents themselves should be aware of these associations and the need to encourage adolescents to meet the Canadian 24-hour movement guidelines.

Contributions to knowledge

What does this study add to existing knowledge?

- Previous research that has examined the relationships between movement behaviours (i.e., physical activity, screen time, and sleep duration) and self-reported physical and mental health has considered the movement behaviours individually and in isolation of each other, ignoring the interconnections between these behaviours.

What are the key implications for public health interventions, practice, or policy?

- Results of this study showed that meeting the 24-hour movement guidelines and different combinations of movement behaviour recommendations were associated with positive self-reported physical and mental health.
- There was a dose–response gradient between the number of guideline recommendations met and both outcome measures of self-reported physical and mental health, with meeting all 3 recommendations showing the strongest associations with positive self-reported physical and mental health compared with meeting two or one recommendation(s).

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Author contributions All the authors contributed to the study conception and design. Data analysis was performed by HS. All the authors interpreted results. The first draft of the manuscript was written by HS

and all the authors commented on previous versions of the manuscript. All the authors read and approved the final manuscript.

Data availability Our data cannot be made available in the manuscript, the supplemental files or a public repository due to the Centre for Addiction and Mental Health's and The Ontario Public and Catholic School Board's institutional Research Ethics Board agreements. Readers, however, may contact to request the public data file underlying the findings of this study by contacting the Centre for Addiction and Mental Health at info@camh.ca.

Code availability Code is available upon request from the corresponding author.

Declarations

Ethics approval Ethics approval was granted by the Research Ethics Boards at the Centre for Addiction and Mental Health, the school board research review committees, and York University. The study has been performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

Consent to participate Informed consent was obtained from all subjects involved in the study.

Consent for publication Not applicable.

Conflict of interest The authors declare no competing interests.

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