



Protective or risky? The longitudinal association of team sports participation and health-related behaviours in Canadian adolescent girls

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Abstract

Objectives Female sport participation is a prioritized action area in the 2018 Canadian federal budget for improving health and well-being. This study examined team sport participation prevalence and longitudinal associations with health-related behaviours among Canadian adolescent girls.

Methods We analyzed data from the COMPASS study. Participants included 1978 female secondary-school students who self-reported the following information at all measurement time-points (grades 9, 10, 11, and 12): socio-demographic, team sport participation status (consistent, intermittent and non-participator), moderate-to-vigorous physical activity (MVPA), dietary behaviours, smoking, cannabis use and binge drinking. Linear mixed models and generalized estimating equation models were used to examine team sport participation status in association with changes in health-related behaviours across grades.

Results The prevalence of team sport participation declined by an average of 38.4% between grades 9 and 12. Proportions of participants being categorized as consistent, intermittent and non-participators were 25.7%, 36.4% and 37.9%, respectively. Compared to non-participators, consistent participators reported significantly greater decline in MVPA ($\beta = -2.77$, 95% CI $-5.36, -0.18$), and the increase in odds of becoming more frequent cannabis users (OR 1.11, 95% CI 1.00, 1.26) and binge drinkers (OR 1.13, 95% CI 1.04, 1.23) was significantly greater. Girls' team sport participation had no significant longitudinal association with dietary behaviours and smoking status.

Conclusion Team sport participation outside of school settings is risky for prospective health-related behaviours in adolescent girls. Our findings highlight the need for investing in tailored participation initiatives that also consider how to prevent harmful substance use.

Résumé

Objectifs La participation des filles et des femmes au sport est un champ d'action prioritaire d'amélioration de la santé et du bien-être dans le budget fédéral canadien de 2018. Nous avons examiné la prévalence de la participation des adolescentes canadiennes aux sports d'équipe et ses associations longitudinales avec leurs comportements de santé.

Méthode Nous avons analysé les données de l'étude COMPASS. Les répondantes étaient 1978 élèves du secondaire ayant fait état des informations suivantes à tous les points de mesure dans le temps (9^e, 10^e, 11^e et 12^e année) : données sociodémographiques, participation aux sports d'équipe (constante, intermittente et nulle), activité physique modérée à vigoureuse (APMV), comportements alimentaires, tabagisme, consommation de cannabis et consommation occasionnelle excessive d'alcool. Des modèles linéaires mixtes et des modèles d'équations d'estimation généralisées ont servi à examiner la

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participation aux sports d'équipe en association avec les changements dans les comportements de santé d'un niveau scolaire à l'autre.

Résultats La prévalence de la participation aux sports d'équipe diminuait en moyenne de 38,4 % entre la 9^e et la 12^e année. Un peu plus du quart (25,7 %) des répondantes se classaient dans la catégorie de participation constante, 36,4 % dans la catégorie de participation intermittente, et 37,9 % dans la catégorie de participation nulle. Comparativement aux non-participantes, les répondantes de la catégorie de participation constante ont fait état d'une diminution significativement plus importante de leur APMV ($\beta = -2,77$, IC de 95 % : $-5,36, -0,18$), et présentaient une probabilité significativement plus élevée de devenir des consommatrices plus fréquentes de cannabis (RC : 1,11, IC de 95 % : 1,00, 1,26) et des buveuses excessives occasionnelles (RC : 1,13, IC de 95 % : 1,04, 1,23). La participation des filles aux sports d'équipe ne présentait aucune association longitudinale significative avec les comportements alimentaires et l'usage du tabac.

Conclusion La participation aux sports d'équipe hors du milieu scolaire pose un risque pour les comportements de santé prospectifs des adolescentes. Nos constatations soulignent le besoin d'investir dans des initiatives de participation adaptées qui comportent aussi des mesures de prévention de la consommation nocive de substances.

Keywords Physical activity · Dietary behaviours · Substance use · High school student

Mots-clés Exercice physique · Comportements alimentaires · Consommation de substances · Élève du secondaire

Introduction

Physical activity (PA) promotion is a global public health priority (World Health Organization 2018). There is a call-for-action recommending all countries consider the seven “investments that work for physical activity” from the Toronto Charter for Physical Activity to guide PA promotion at the population level (Trost et al. 2014). Consistent with one of the recommendations of the Toronto Charter, Canada has recently released its first singular policy—*A Common Vision for Increasing Physical Activity and Reducing Sedentary Living in Canada: Let's Get Moving* (Federal, Provincial and Territorial Ministers Responsible for Sport, Physical Activity and Recreation 2018). The *Common Vision* highlights Canadian Sport Policy as a critical platform for achieving the goal of increasing PA in the population. Additionally in 2018, the federal government budgeted over \$70 million over the next 3–5 years to support research, innovative practice and national sport organizations in order to promote sport across sectors (Sport Matters 2018), but with a particular focus on the sport, PA and recreation sectors (non-school-based sport participation).

Adolescence has been identified as an important window for promoting sport participation for females. During adolescence, there tends to be a steep decline in female sport participation (Tucker Center for Research on Girls and Women in Sport 2018), which is of concern considering sport participation may enhance important protective factors (e.g., self-esteem) against many mental health issues (e.g., depression, anxiety) and adverse outcomes (e.g., substance abuse, antisocial behaviours) in adolescence and later in life (Faulkner and Tamminen 2016). Previous studies have found that girls' self-esteem tends to deteriorate during their adolescent years (Robins and Trzesniewski 2005). Sport participation was found to be an effective way of improving self-esteem through fostering physical competencies, sport self-

concept, and favourable body image (Richman and Shaffer 2000). Of note, the positive associations between sport participation and self-esteem were more consistently observed in team sports compared to individual sports (Pedersen and Seidman 2004). This could be attributed to increased opportunities to interact with a coach (“a caring adult role model”) and prosocial peers (Pedersen and Seidman 2004) in team sport contexts. Similarly, the beneficial effects of sport participation on health were also found to be stronger in team sports compared to individual sports (Harrison and Narayan 2003; Eime et al. 2013b).

Despite numerous positive benefits of team sport participation, it is important to acknowledge the potential negative health consequences as well. Research shows an association between team sport participation and risky substance use (e.g., alcohol consumption) among adolescent girls. These negative health behaviours may stem from the social nature of team sports, peer pressure and different sport subcultures which may influence behaviour. There is consistent evidence connecting team sport participation and increased alcohol use in adolescent girls (Garry and Morrissey 2000; Wichstrom and Wichstrom 2009). However, evidence regarding the impact of team sport participation on smoking and cannabis use has been mixed (Boyes et al. 2017; Garry and Morrissey 2000; Wichstrom and Wichstrom 2009). In fact, previous research (Canadian Centre on Substance Use and Addiction 2017; Kwan et al. 2014) suggested the protectiveness of team sport participation against substance use. This relationship is likely to be dependent on the unique sporting context, which may include the team culture, experience of team sport, location (in-school vs out-of-school) and level of competition (e.g., elite vs recreational). Therefore, the effects of team sports on substance use or other health behaviours may not be generalized across socio-cultural groups.

In the Canadian context, the prevalence of early cannabis use (age ≤ 15 years) ranked the highest and underage drinking is above the mean, compared to 24 European and North American countries (de Looze et al. 2012). Some substance use behaviours are increasingly prevalent among adolescent girls compared to other age groups and compared to boys (Johnston et al. 2018). There is currently a lack of longitudinal data examining trends in team sport participation among Canadian youth, and a paucity of evidence examining the link between adolescents' team sport participation and their health risk behaviour profile. Identifying trends is necessary to inform and evaluate current initiatives to promote sport participation among girls in Canada. Additionally, sport may also be a pathway toward substance use in Canadian adolescent girls and longitudinal data would provide insight into this possibility (Canadian Centre on Substance Use and Addiction 2017). Accordingly, the current study aims to (1) examine the prevalence of team sport participation among Canadian adolescent girls, and (2) investigate the longitudinal association between team sports participation status and health-related outcomes, including PA, dietary behaviours, smoking status, cannabis use and binge drinking.

Method

Participants

The current study analyzed 4 years of linked student-level data from the Canadian COMPASS study. Study protocol (Leatherdale et al. 2014a) and sampling methods (Bredin and Leatherdale 2014) of the COMPASS study are described in detail previously. Briefly, COMPASS is an ongoing prospective cohort study (started in 2012–2013) designed to examine longitudinal associations between school policies and programs with youth health behaviours. COMPASS collects hierarchical longitudinal data from a convenience sample of grade 9–12 students attending secondary schools in Ontario ($n = 79$) and Alberta ($n = 10$), Canada (Leatherdale et al. 2014a). All eligible grade 9–12 students attending these schools were invited to participate and reported data on health behaviours (e.g., PA and substance use) by completing the COMPASS student questionnaire (Cq) annually. Across the 4 years, the average sample size was 38,066 persons per year and the average completion rate was 79.5%. Missing respondents resulted primarily from scheduled spares or absenteeism at the time of the Cq, and minimally from student or parent refusal ($< 1\%$ annually). The COMPASS study was approved by the institutional Human Research Ethics Board and participating school board committees.

As described elsewhere (Qian et al. 2015), unique self-generated identification codes were used to link data sets for 4 years and create longitudinal data across year 1 (2012/13, $n = 24,173$), year 2 (2013/14, $n = 45,298$), year 3 (2014/15, $n =$

42,335) and year 4 (2015/16, $n = 40,436$). In the current study, participants were required to have complete data for all 4 years to be included in the analysis. First, we considered female students attending schools that participated in COMPASS for all 4 years ($n = 5685$). Of those, 1980 female students completed the Cq for all 4 years. We further excluded 2 students who did not report information on age. The final longitudinal sample for the current analysis included 1978 female students. A comparison of baseline characteristics between the included and excluded participants is presented in Table 1.

Measures

All the study variables were measured annually at each of the four measurement time points. At each measurement time point, students were asked to respond to 15 items from the Cq regarding their team sports participation, physical activity (PA), dietary behaviours, cigarette smoking, cannabis use and binge drinking, and socio-demographic questions (i.e., age, race/ethnicity and the weekly stipend (a proxy measure of socio-economic status-SES)).

Team sport participation Students responded to a single item from the Cq regarding their participation in team sports: “Do you participate in league or team sports outside of school?” (0 = no, 1 = yes) (Bredin and Leatherdale 2014). These responses were used to categorize participants into three sport participation status. Participants who reported participation for all 4 years were categorized as consistent participant, between 1 and 3 years as intermittent participant, and no participation for all 4 years as non-participant.

Physical activity Two items were used to assess how many minutes of moderate and vigorous physical activity (MVPA) the students did on each of the last 7 days. Moderate PA was defined as lower intensity activities, such as walking, biking to school and recreational swimming. Vigorous PA was defined as activities that increase your heart rate and make you breathe hard and sweat, such as jogging, team sports, fast dancing and jump-rope. The responses were then used to construct a continuous outcome of average time spent in MVPA (minutes/day). This outcome was calculated as the total of combined moderate and vigorous PA time divided by 7 days. This measure has demonstrated adequate validity and reliability (Leatherdale et al. 2014b).

Dietary behaviour Five items were used to measure participants' consumption of fruit and vegetables, sugar-sweetened beverages, energy drinks and fast food. Fruit and vegetable consumption were assessed by asking students to record the number of servings of fruits and vegetables they had eaten the day prior to the survey (from 0 = none to 9 = 9 or more servings) with reference to the diagrams of Canada's Food Guide

Table 1 Baseline characteristics of participants excluded vs included in the current analysis, % (*n*) or mean ± standard deviation

Variables		Excluded <i>n</i> = 3707	Included <i>n</i> = 1978	<i>p</i> value
Age (years)	13	3.0 (109)	3.8 (76)	0.1746
	14	78.5 (2898)	79.3 (1568)	
	15	18.5 (682)	16.8 (332)	
	16	0.1 (2)	0.1 (1)	
	17	0.0 (0)	0.1 (1)	
	Missing	0.0 (1)	0.0 (0)	
Race	White	73.7 (2732)	77.1 (1526)	< 0.0001
	Black	3.5 (131)	2.8 (56)	
	Asian	4.8 (178)	5.8 (114)	
	Aboriginal	3.1 (116)	1.4 (27)	
	Hispanic	1.9 (70)	1.4 (28)	
	Other/mixed/missing	12.9 (480)	11.5 (227)	
Weekly spending money	Zero	19.2 (711)	22.8 (451)	< 0.0001
	\$1–\$20	40.9 (1516)	42.1 (832)	
	\$21–\$100	20.9 (773)	18.4 (363)	
	More than \$100	3.4 (126)	1.2 (24)	
	Do not know/missing	15.7 (581)	15.6 (308)	
Moderate-to-vigorous physical activity (min/day)		119.2 ± 79.1	113.2 ± 72.6	< 0.0047
Fruit and vegetable consumption (servings/day)		3.02 ± 1.99	3.10 ± 1.87	0.1470
Sugar-sweetened beverages consumption (servings/day)		2.56 ± 2.19	2.46 ± 2.11	0.0882
Energy drink consumption (servings/day)		0.30 ± 0.98	0.18 ± 0.74	< 0.0001
Fast food consumption during weekend (days/weekend)		0.50 ± 0.56	0.48 ± 0.55	0.1385
Cigarette smoking	Never	95.7 (3546)	98.1 (1940)	< 0.0001
	1–3 days	2.1 (78)	1.1 (21)	
	4–10 days	1.1 (41)	0.5 (10)	
	11 or more days	1.1 (42)	0.4 (7)	
Cannabis use	No	89.5 (3276)	95.7 (1878)	< 0.0001
	Less than once a month	4.4 (162)	1.9 (37)	
	1 to 3 times a month	3.1 (115)	1.4 (28)	
	4 or more times a month	2.9 (107)	1.0 (19)	
Binge drinking	Never	71.4 (2641)	81.7 (1615)	< 0.0001
	Not in last 12 months/less than once a month	19.7 (729)	14.2 (280)	
	1–3 times a month	7.4 (272)	3.6 (71)	
	4 or more times a month	1.6 (58)	0.5 (10)	

serving sizes. This measure has been found to be both valid and reliable (Leatherdale and Laxer 2013). Participants were asked to indicate the number of days during a usual school week (from 0 = none to 5 = 5 days) and weekend (from 0 = none to 2 = 2 days) on which they consumed: sugar-sweetened beverages (e.g., soda, Kool-Aid, Gatorade; do not include diet/sugar-free drink) and high-energy drinks (e.g., Red Bull, Monster, Rockstar). As per previous research (Godin et al. 2017), participants' responses to these questions were used to generate the weekly consumption rate of sugar-sweetened beverages and energy drinks. Weekly consumption was derived by summing the number of weekdays and weekends participants reported consuming each type of drink, with the possible values of these

outcomes, ranging from 0 to 7 days per week. Participants responded to another item reporting the number of days during a usual weekend (from 0 = none to 2 = 2 days) on which they ate food purchased at a fast food place or restaurant.

Cigarette smoking Two items were used to assess students' smoking behaviours. The first item asked students to respond to the question: "Have you ever smoked 100 or more whole cigarettes in your life?" (0 = no, 1 = yes) (Wong et al. 2012). Students who responded "no" to this question were classified as *never smoker*. Those who responded "yes" were asked to respond to a second item: "On how many of the last 30 days did you smoke one or more cigarettes?" with the response

options ranging from 1 = none to 8 = every day. Students were classified as *former smoker* if they reported “none” and *current smoker* if they indicated they smoked cigarettes at least one day in the last 30 days.

Cannabis use One item was used to determine students’ frequency of cannabis use: “In the last 12 months, how often did you use marijuana or cannabis (a joint, pot, weed, hash)?” (Elton-Marshall et al. 2011). The response options ranged from 1 = I have never used to 9 = every day. Students were categorized as a *non-user* if they indicated never used or used but not in the last 12 months, *rare/sporadic user* for those reported using < 1 time/month, *monthly user* for using 1–3 times/month, *weekly user* for using 1–6 times/week and *daily user* for using daily.

Binge drinking One item was used to determine students’ frequency of binge drinking: “In the last 12 months, how often did you have 5 drinks of alcohol or more on one occasion?” The response options ranged from 1 = never to 8 = daily or almost daily. Students’ responses were categorized as *never drinker* if they indicated they have never done that, *rare/sporadic drinker* if they did not have 5 or more drinks on one occasion in the last 12 months or less than once a month, *monthly drinker* if they reported 1–3 times/month, and *weekly* if they responded 1–7 times/week.

Covariates Students’ grade (9, 10, 11, 12), race (White, Aboriginal (First Nations, Métis, Inuit), other) and weekly spending money as a proxy measure of SES (\$0, \$1–\$20, \$21–\$100, more than \$100, “I don’t know”) were self-reported.

Data analysis

We conducted descriptive statistics to describe the distribution of the study variables, two-sample *t* tests examined differences in study variables between the included and excluded samples and chi-square for differences among sport participation status (i.e., consistent, intermittent, non-participants). We used a linear mixed effects model to examine the longitudinal effects of team sport participation status on participants’ MVPA across grades 9–12. We used generalized estimating equations (GEE) models to examine whether team sport participation status predicted changes in the following (ordinal) outcomes across grades 9–12: consumptions of fruit and vegetables, sugar-sweetened beverages, energy drinks and fast food; smoking status; cannabis use; and binge drinking. For all ordinal outcomes, we modelled the cumulative probability of becoming more frequent users over time. All models included grades (time variable), team sport participation status, team sport participation status × grade (interaction term) as predictor variables, sex, race/ethnicity and baseline age as covariates, and accounted for student-level clustering. We also accounted for school-level clustering for the MVPA model,

but not for other models. This is based on our previous analyses that showed school-level correlations for the dietary behaviour and substance use outcomes were modest (Patte et al. 2017). All analyses were conducted using the statistical software package SAS 9.4 (Cary, NC). For the linear mixed effects model, we used PROC GLIMMIX procedure. A RANDOM statement was used to adjust for data clustering. For GEE models, we used PROC GENMOD with a multinomial distribution and a cumulative logit function when fitting models with ordinal outcomes. We also used an independent working correlation structure (the only option in SAS for ordinal outcomes), a REPEAT statement to adjust for data clustering. All models included an ESTIMATE statement to produce estimates that show how the average (intercept) and change (slope) in the outcomes across grades differ between groups (pairwise comparisons). We presented these estimates in our results. All models with ordinal outcomes satisfied the parallel regression assumption. Empirical standard error estimates were used to calculate confidence intervals and test statistics. Associations were statistically significant if confidence intervals do not contain the null hypothesis values (i.e., 0 for MVPA and 1 for other ordinal outcomes).

Results

The prevalence of team sport participation for the 4 years was 52.4%, 48.1%, 41.9% and 32.3% (mean = 43.7%). On average, team sport participation declined by 38.4% between grades 9 and 12. Approximately 25.7% of female students were consistent participants, 36.4% were intermittent participants and 37.9% were non-participants. Participant characteristics by sport participation status are presented in Table 2. The sport participation status was significantly different by race/ethnicity and SES. The non-participant group had a greater proportion of participants who were non-White and lower SES (i.e., no weekly spending money). As grade increased, participants engaged in significantly less minutes of MVPA per day; the probability of having more frequent consumptions of fruit and vegetables, sugar-sweetened beverages, energy drinks and fast food increased significantly. The probability of becoming more frequent smokers, cannabis users and binge drinkers also increased significantly (data not shown).

Table 3 presents the pairwise comparisons results that indicated whether changes in health-related outcomes differed between team sport participation status. The intercepts are cross-sectional parameters that show differences in averaged values of the outcome variables across the 4 years between team sport participation status. Cross-sectionally, team sport participation status was significantly associated with increased MVPA (e.g., consistent vs non-participant + 62.39 min/day), higher odds of having more frequent consumption of fruit and vegetables (e.g., consistent vs non-participant: OR 2.01, 95% CI 1.59, 2.54) and

Table 2 Baseline characteristics of participants by sports participation status, % (n)

		Consistent participator (n = 509)	Non-participator (n = 748)	Intermittent participator (n = 721)	p value
Age at baseline	13	5.9 (30)	2.9 (22)	3.3 (24)	0.181
	14	77.4 (394)	80.0 (601)	79.5 (573)	
	15	16.7 (85)	16.4 (123)	17.2 (124)	
	16/17	0 (0)	0.2 (2)	0 (0)	
Race/ethnicity	White	85.7 (436)	70.3 (527)	78.0 (563)	< 0.0001
	Black	2.0 (10)	4.1 (31)	2.1 (15)	
	Asian	1.7 (9)	9.7 (73)	4.4 (32)	
	Aboriginal	0.4 (2)	2.0 (15)	1.4 (10)	
	Hispanic	0.2 (1)	2.4 (18)	1.3 (9)	
	Other/mixed/missing	10.0 (51)	11.5 (86)	12.8 (92)	
Weekly spending money	Zero	21.0 (107)	28.2 (209)	18.7 (135)	< 0.0001
	\$1–\$20	38.0 (193)	44.9 (333)	42.4 (306)	
	\$21–\$100	20.0 (102)	14.3 (107)	21.4 (154)	
	More than \$100	1.2 (6)	0.8 (6)	1.7 (12)	
	Do not know/missing	19.8 (101)	11.7 (95)	15.8 (114)	

Participants who reported participation for all 4 years in the COMPASS student survey were categorized as consistent participator, between 1 and 3 years as intermittent participator, and no participation for all 4 years as non-participator

higher odds of being more frequent binge drinkers (e.g., intermittent vs non-participator: OR 1.51, 95% CI 1.14, 2.01).

The slopes are the longitudinal parameters and the key estimates of interest. These estimates were differences in the changes in outcome variables over the 4 years between team sport participation status. Compared to non-participators, the decline in MVPA over the 4 years was significantly greater in consistent participators (2.77 min/day) and intermittent participators (4.09 min/day); the increase in odds of becoming more frequent cannabis users (+ 11%) and binge drinkers (+ 12%) was significantly greater in consistent participators, while holding other variables constant.

Compared to intermittent participators, the increase in odds of having more frequent consumption of sugar-sweetened beverage was significantly smaller (− 8%) and the increase in odds of becoming more frequent binge drinkers was significantly greater (+ 10%) in consistent participators over time, while holding other variables constant. There were no statistically significant overall differences between sport participation status for prospective consumption of fruits and vegetables, energy drinks, and the number of weekend days eating at a fast food place or restaurant or smoking.

Discussion

The current study presents new longitudinal data showing a fairly substantial decline in team sport participation among Canadian adolescent girls from grade 9 to grade 12. The decline

is quite marked (38.4% reduction) over a relatively short period of time which corresponds to a critical developmental period in the life course. Although girls may have dropped out from team sports and joined individual sports or moved on to non-organized activities, this is unlikely given previous findings that the decline was even more profound in the participation of individual sports (Denault and Poulin 2018). This decline highlights the timeliness of the Canadian federal government's budgetary focus on female sport participation. Given the numerous developmental benefits of team sport participation, it is important to examine the correlates of team sport participation. One such correlate observed in the current study was SES. We found that girls who did not participate in any team sports for all 4 years (non-participators) were more likely to be non-White and be lower SES compared to consistent participators. Our findings indicate that continual efforts are necessary to address SES disparities in team sport participation among Canadian girls. As previously mentioned, a positive step is the Canadian government's allocation of federal budget to promote greater inclusion of females in all facets of sports (Sport Matters 2018). Previous studies suggest investing funds toward increasing access to sports facilities (Eime et al. 2013a) and increasing the affordability of sports programs (e.g., subsidizing) (Tucker Center for Research on Girls and Women in Sport 2018) may be effective strategies for increasing sports participation in girls from ethnic minorities and low SES families.

Team sport participation had a negative prospective association with health-related behaviours among adolescent girls. Cross-sectionally, team sport participators engaged in

Table 3 Results from linear mixed models and generalized estimating equation models examining longitudinal associations between sport participation status and health-related outcomes among girls

		Consistent participators vs non- participators	Consistent participators vs intermittent participators	Intermittent participators vs non- participators
		Estimates (95% CI)	Estimates (95% CI)	Estimates (95% CI)
MVPA (min/day)	Intercept	<i>62.39</i> (53.61, 71.17)	25.71 (16.92, 34.49)	<i>36.69</i> (28.72, 44.65)
	Slope	-2.77 (-5.36, -0.18)	1.32 (1.29, 3.93)	-4.09 (-6.45, -1.73)
Fruit and vegetable consumptions	Intercept	<i>2.01</i> (1.59, 2.54)	1.24 (0.99, 1.57)	<i>1.61</i> (1.31, 1.99)
	Slope	1.00 (0.93, 1.07)	1.03 (0.96, 1.11)	0.97 (0.91, 1.03)
Sugar-sweetened beverage consumptions	Intercept	1.18 (0.93, 1.48)	<i>1.36</i> (1.08, 1.71)	0.87 (0.70, 1.07)
	Slope	0.96 (0.89, 1.03)	<i>0.92</i> (0.86, 0.99)	1.03 (0.97, 1.11)
Energy drink consumptions	Intercept	0.59 (0.32, 1.10)	0.76 (0.41, 1.41)	0.78 (0.49, 1.24)
	Slope	1.03 (0.83, 1.29)	0.91 (0.73, 1.13)	1.14 (0.98, 1.32)
Fast food consumptions in weekend	Intercept	0.85 (0.64, 1.11)	1.00 (0.76, 1.31)	0.85 (0.67, 1.09)
	Slope	1.03 (0.94, 1.12)	1.01 (0.93, 1.10)	1.01 (0.94, 1.09)
Smoking status	Intercept	0.75 (0.33, 1.72)	0.69 (0.29, 1.64)	1.08 (0.54, 2.17)
	Slope	1.05 (0.84, 1.31)	1.03 (0.82, 1.29)	1.01 (0.85, 1.22)
Cannabis use	Intercept	0.73 (0.45, 1.18)	0.69 (0.43, 1.10)	1.06 (0.70, 1.60)
	Slope	<i>1.11</i> (1.00, 1.26)	1.06 (0.93, 1.20)	1.05 (0.94, 1.17)
Binge drinking	Intercept	1.02 (0.75, 1.40)	<i>0.68</i> (0.50, 0.91)	<i>1.51</i> (1.14, 2.01)
	Slope	<i>1.13</i> (1.04, 1.23)	<i>1.10</i> (1.01, 1.20)	1.03 (0.95, 1.11)

MVPA, moderate-to-vigorous physical activity. For all ordinal outcomes, we modelled the odds of becoming more frequent users. All models adjusted for baseline age, race/ethnicity and weekly spending money as covariates and student-level clustering. Model for MVPA also accounted for school-level clustering. Associations were statistically significant if confidence intervals do not contain the null hypothesis values (i.e., 0 for MVPA and 1 for other ordinal outcomes). Statistically significant associations were italicized

significantly more MVPA across grades 9 to 12 compared to non-participators. However, team sport participation was also

associated with greater declines in MVPA over time. These findings are consistent with those reported in Telford et al. (2016) that sports club participants engaged in more MVPA on average across ages 8–16, but had a steeper decline in MVPA over time. The more significant decline in MVPA in consistent and intermittent participators could be due to several reasons. First, team sport participants started with higher levels of MVPA and had more potential for reduction. Second, team sport participation is one source of PA, but it may not be enough to combat the declining trend in overall PA. Speculatively, the greatest source of PA is through unstructured activities and play (Janssen 2014) and these activities generally decline over time. Further studies are needed to examine the contribution of team sport participation vs other types of activities on girls' overall PA. Third, low participation frequency (Hebert et al. 2015) or insufficient PA opportunities during the sport practice (Leek et al. 2011) may also explain our findings. Given the nature and aim of the COMPASS study, the student survey did not include items related to the sporting context (e.g., frequency, types, duration and quality). There is a need for better sport participation data to examine how these factors may affect the effectiveness of team sports in relation to PA promotion among adolescent girls.

Our results showed that consistent participators had greater increases in the odds of becoming more frequent binge drinkers and cannabis users compared to non-participators; no association was found for smoking. These findings are consistent with past research (Garry and Morrissey 2000; Kwan et al. 2014; Zarrett et al. 2018). In fact, evidence regarding the relationships between team sport participation and substance use in female adolescents appears to be dependent on the norm of a socio-cultural group or a team with which an individual is affiliated (Eccles and Barber 1999; Fredricks and Eccles 2006; Parent et al. 2016; Pate et al. 2000; Ford 2007). Some socio-cultural groups or sport teams create a setting that promotes substance use, whereas others foster an environment that discourages it (Ford 2007). For example, sport participation was associated with higher alcohol consumption in North American adolescents, but not in African-American and European adolescents, potentially because alcohol use is less culturally relevant among African-American adolescents than their White peers (Eccles and Barber 1999; Fredricks and Eccles 2006). Additionally, substance use was found to be more prevalent in girls affiliated with soccer teams compared to those in cross-country or diving teams (Ford 2007).

In the Canadian context, adolescents perceive alcohol consumption and cannabis use as part of youth culture, socially acceptable in both team sport and larger societal contexts (Jenkins et al. 2017; de Grace et al. 2017). Drinking and cannabis use, not cigarette smoking, are often used as a means of socializing, gaining recognition and fulfilling expectations from senior peers within the team (Jenkins et al. 2017; de Grace et al. 2017). Alcohol

consumption is also a socially acceptable form of celebration, as reflected by continued alcohol industry sponsorship of sport in Canada. A Major League Soccer (MLS) team, the Vancouver Whitecaps, awards a “man of the match” award each game that is sponsored by Labatt Breweries of Canada. In this study, we observed a dose-response relationship between team sport participation and binge drinking, with consistent participators engaging in binge drinking more frequently than intermittent and non-participators. This finding is consistent with previous research on substance use in athletes (Kulesza et al. 2014; Kwan et al. 2014). The team sport context may normalize experimentation with substance use, particularly alcohol.

The current study did not find significant differences in dietary behaviours between consistent/intermittent and non-participators. However, existing cross-sectional evidence suggests that sport participation was associated with unhealthy dietary behaviours (e.g., consumption of sugar-sweetened beverages, energy drinks and fast foods) due to low availability of nutritious food at sport venues and time constraints associated with attending sport practices and events (Nelson et al. 2011; Thomas et al. 2012; Chaumette et al. 2009). Perhaps, the null findings can be partly attributed to the ongoing efforts in promoting healthy eating and reducing food marketing in sports settings in Canada (Olstad et al. 2015; Prowse et al. 2018; Naylor et al. 2015). Previous studies found a significant improvement in dietary practices among provinces that implemented these initiatives, but further studies are needed to verify the effects of these policy-level changes on youth-level dietary outcomes.

There are several limitations to the study. First, the single item measure of team sport participation provides no information on what, when and with whom team sport occurred. These contextual factors likely moderate associations with the health-related behaviours of interest. The focus on team sport participation outside of school overlooks possible team participation at school but this is not assessed in COMPASS. Second, all measures were self-reported and are prone to social desirability and recall bias. Participants may have overestimated PA and underestimated dietary consumption and substance use behaviours. Third, students who were excluded from this analysis significantly differed from those who were included. Those excluded were more likely to be non-White, physically active, having more unhealthy dietary behaviours, be smokers and cannabis users and non-drinkers. Therefore, including them would strengthen the observed associations. Fourth, this study did not consider other potential confounders of the association of interest, such as types and experience of team sports, self-esteem, sibling health-related behaviour or parental support. The influence of parents, peers and coaches, and the structure and delivery of sport programs undoubtedly shapes the relationship between substance use and participation. Finally, multiple comparisons may lead to inflation of type I error.

Conclusion

This longitudinal study revealed a remarkable decline in team sport participation among Canadian adolescent girls from grade 9 to grade 12. Socio-economic and cultural disparities persist. Team sport participation outside of school settings has a negative prospective association with adolescent girls’ health-related behaviours. Participation in out-of-school team sport was associated with steeper declines in MVPA and a greater increase in the odds of becoming more frequent cannabis users and binge drinkers. With new investment committed to women and girls sport participation, these results reinforce the need to develop tailored interventions for girls that also address financial and cultural barriers to sport participation. At the same time, further research is needed examining the necessary conditions for sport participation to have beneficial outcomes in terms of preventing harmful substance use (Kwan et al. 2014).

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

References

- Boyes, R., O’Sullivan, D. E., Linden, B., McIsaac, M., & Pickett, W. (2017). Gender-specific associations between involvement in team sport culture and Canadian adolescents’ substance-use behavior. *SSM - Population Health*, 3, 663–673. <https://doi.org/10.1016/j.ssmph.2017.08.006>.
- Bredin, C., & Leatherdale, S. T. (2014). *Development of the COMPASS Student Questionnaire. COMPASS Technical Report Series. (Vol. 2)*. Waterloo: University of Waterloo.
- Canadian Centre on Substance Use and Addiction (2017). *Youth sport participation and substance use: understanding the relationship*. <http://www.ccsa.ca/Resource%20Library/CCSA-Youth-Sport-and-Substance-Use-Summary-2017-en.pdf>. Accessed 10 Apr 2019.
- Chaumette, P., Morency, S., Royer, A., Lemieux, S., & Tremblay, A. (2009). Food environment in the sports, recreational and cultural facilities of Quebec City: a look at the situation. *Canadian Journal of Public Health*, 100(4), 310–314.
- de Grace, L. A., Knight, C. J., Rodgers, W. M., & Clark, A. M. (2017). Exploring the role of sport in the development of substance addiction. *Psychology of Sport and Exercise*, 28, 46–57. <https://doi.org/10.1016/j.psychsport.2016.10.001>.

- de Looze, M., Pickett, W., Raaijmakers, Q., Kuntsche, E., Hublet, A., Nic Gabhainn, S., et al. (2012). Early risk behaviors and adolescent injury in 25 European and North American countries: a cross-national consistent relationship. *The Journal of Early Adolescence*, 32(1), 104–125. <https://doi.org/10.1177/0272431611414062>.
- Denault, A. S., & Poulin, F. (2018). A detailed examination of the longitudinal associations between individual and team sports and alcohol use. *Addictive Behaviors*, 78, 15–21. <https://doi.org/10.1016/j.addbeh.2017.10.019>.
- Eccles, J., & Barber, B. (1999). Student council, volunteering, basketball, or marching band: what kind of extracurricular involvement matters? *Journal of Adolescent Research*, 14(1), 10–43.
- Eime, R. M., Harvey, J. T., Craike, M. J., Symons, C. M., & Payne, W. R. (2013a). Family support and ease of access link socio-economic status and sports club membership in adolescent girls: a mediation study. *International Journal of Behavioral Nutrition and Physical Activity*, 10(1), 50. <https://doi.org/10.1186/1479-5868-10-50>.
- Eime, R. M., Young, J. A., Harvey, J. T., Charity, M. J., & Payne, W. R. (2013b). A systematic review of the psychological and social benefits of participation in sport for children and adolescents: informing development of a conceptual model of health through sport. *The International Journal of Behavioral Nutrition and Physical Activity*, 10, 98–98. <https://doi.org/10.1186/1479-5868-10-98>.
- Elton-Marshall, T., Leatherdale, S. T., Manske, S. R., Wong, K., Ahmed, R., & Burkhalter, R. (2011). Research methods of the Youth Smoking Survey (YSS). *Chronic Diseases and Injuries in Canada*, 32(1), 47–54.
- Faulkner, G., & Tamminen, K. (2016). Youth sport and mental health. In K. Green & A. Smith (Eds.), *Routledge handbook of youth sport*. London: Routledge.
- Federal, Provincial and Territorial Ministers Responsible for Sport, Physical Activity and Recreation (2018). A common vision for increasing physical activity and reducing sedentary living in Canada: let's get moving <https://www.canada.ca/content/dam/phac-aspc/documents/services/publications/healthy-living/lets-get-moving/pub-eng.pdf>. Accessed 10-04-2019.
- Ford, J. A. (2007). Substance use among college athletes: a comparison based on sport/team affiliation. *Journal of American College Health*, 55(6), 367–373. <https://doi.org/10.3200/JACH.55.6.367-373>.
- Fredricks, J. A., & Eccles, J. S. (2006). Is extracurricular participation associated with beneficial outcomes? Concurrent and longitudinal relations. *Developmental Psychology*, 42(4), 698–713. <https://doi.org/10.1037/0012-1649.42.4.698>.
- Garry, J. P., & Morrissey, S. L. (2000). Team sports participation and risk-taking behaviors among a biracial middle school population. *Clinical Journal of Sport Medicine*, 10(3), 185–190.
- Godin, K. M., Chacón, V., Barnoya, J., & Leatherdale, S. T. (2017). The school environment and sugar-sweetened beverage consumption among Guatemalan adolescents. *Public Health Nutrition*, 20(16), 2980–2987. <https://doi.org/10.1017/S1368980017001926>.
- Harrison, P. A., & Narayan, G. (2003). Differences in behavior, psychological factors, and environmental factors associated with participation in school sports and other activities in adolescence. *Journal of School Health*, 73(3), 113–120. <https://doi.org/10.1111/j.1746-1561.2003.tb03585.x>.
- Hebert, J. J., Moller, N. C., Andersen, L. B., & Wedderkopp, N. (2015). Organized sport participation is associated with higher levels of overall health-related physical activity in children (CHAMPS Study-DK). *PLoS One*, 10(8), e0134621. <https://doi.org/10.1371/journal.pone.0134621>.
- Janssen, I. (2014). Active play: an important physical activity strategy in the fight against childhood obesity. *Canadian Journal of Public Health*, 105(1), e22–e27.
- Jenkins, E. K., Slemmon, A., & Haines-Saah, R. J. (2017). Developing harm reduction in the context of youth substance use: insights from a multi-site qualitative analysis of young people's harm minimization strategies. *Harm Reduction Journal*, 14(1), 53. <https://doi.org/10.1186/s12954-017-0180-z>.
- Johnston, L., Miech, R., O'Malley, P., Bachman, J., Schulenberg, J., & Patrick, M. (2018). *National survey results on drug use: 1975-2017: Overview, key findings on adolescent drug use. Monitoring the future* (p. 49). Ann Arbor: Institute for Social Research, University of Michigan.
- Kulesza, M., Grossbard, J. R., Kilmer, J., Copeland, A. L., & Larimer, M. E. (2014). Take one for the team? Influence of team and individual sport participation on high school athlete substance use patterns. *J Child Adolesc Subst Abuse*, 23(4), 217–223. <https://doi.org/10.1080/1067828X.2013.786928>.
- Kwan, M., Bobko, S., Faulkner, G., Donnelly, P., & Cairney, J. (2014). Sport participation and alcohol and illicit drug use in adolescents and young adults: a systematic review of longitudinal studies. *Addict Behav*, 39(3), 497–506. <https://doi.org/10.1016/j.addbeh.2013.11.006>.
- Leatherdale, S. T., & Laxer, R. E. (2013). Reliability and validity of the weight status and dietary intake measures in the COMPASS questionnaire: are the self-reported measures of body mass index (BMI) and Canada's food guide servings robust? *Int J Behav Nutr Phys Act*, 10(1), 42. <https://doi.org/10.1186/1479-5868-10-42>.
- Leatherdale, S. T., Brown, K. S., Carson, V., Childs, R. A., Dubin, J. A., Elliott, S. J., et al. (2014a). The COMPASS study: a longitudinal hierarchical research platform for evaluating natural experiments related to changes in school-level programs, policies and built environment resources. *BMC Public Health*, 14, 331–331. <https://doi.org/10.1186/1471-2458-14-331>.
- Leatherdale, S. T., Laxer, R. E., & Faulkner, G. (2014b). *Reliability and validity of the physical activity and sedentary behaviour measures in the COMPASS study. COMPASS Technical Report Series (Vol. 1)*. Waterloo: University of Waterloo.
- Leek, D., Carlson, J. A., Cain, K. L., Henrichon, S., Rosenberg, D., Patrick, K., et al. (2011). Physical activity during youth sports practices. *Archives of Pediatrics and Adolescent Medicine*, 165(4), 294–299. <https://doi.org/10.1001/archpediatrics.2010.252>.
- Naylor, P. J., Olstad, D. L., & Therrien, S. (2015). An intervention to enhance the food environment in public recreation and sport settings: a natural experiment in British Columbia, Canada. *Childhood Obesity*, 11(4), 364–374. <https://doi.org/10.1089/chi.2014.0148>.
- Nelson, T. F., Stovitz, S. D., Thomas, M., LaVoi, N. M., Bauer, K. W., & Neumark-Sztainer, D. (2011). Do youth sports prevent pediatric obesity? A systematic review and commentary. *Current Sports Medicine Reports*, 10(6), 360–370. <https://doi.org/10.1249/JSR.0b013e318237bf74>.
- Olstad, D. L., Poirier, K., Naylor, P. J., Shearer, C., & Kirk, S. F. (2015). Policy outcomes of applying different nutrient profiling systems in recreational sports settings: the case for national harmonization in Canada. *Public Health Nutrition*, 18(12), 2251–2262. <https://doi.org/10.1017/s1368980014002754>.
- Parent, M. C., Bradstreet, T. C., Piper, M., Brace, T., & Parkman, T. J. (2016). Racial disparities in substance use by sport participation among high school students. *Journal of Studies of Alcohol and Drugs*, 77(6), 980–985.
- Pate, R. R., Trost, S. G., Levin, S., & Dowda, M. (2000). Sports participation and health-related behaviors among us youth. *Archives of Pediatrics & Adolescent Medicine*, 154(9), 904–911. <https://doi.org/10.1001/archpedi.154.9.904>.
- Patte, K., Qian, W., & Leatherdale, S. (2017). Binge drinking and academic performance, engagement, aspirations, and expectations: a longitudinal analysis among secondary school students in the COMPASS study. *Heather Promotion and Chronic Disease Prevention in Canada*, 37(11).

- Pedersen, S., & Seidman, E. (2004). Team sports achievement and self-esteem development among urban adolescent girls. *Psychology of Women Quarterly*, 28(4), 412–422. <https://doi.org/10.1111/j.1471-6402.2004.00158.x>.
- Prowse, R. J. L., Naylor, P.-J., Olstad, D. L., Carson, V., Storey, K., Mâsse, L. C., et al. (2018). Food marketing in recreational sport settings in Canada: a cross-sectional audit in different policy environments using the Food and beverage Marketing Assessment Tool for Settings (FoodMATS). *The International Journal of Behavioral Nutrition and Physical Activity*, 15, 39. <https://doi.org/10.1186/s12966-018-0673-5>.
- Qian, W., Battista, K., Bredin, C., Brown, K.S., Leatherdale, S.T., 2015. Assessing longitudinal data linkage results in the COMPASS study, COMPASS Technical Report Series. University of Waterloo, Waterloo, Ontario.
- Richman, E. L., & Shaffer, D. R. (2000). If you let me play sports: How might sport participation influence the self-esteem of adolescent females? *Psychology of Women Quarterly*, 24(2), 189–199. <https://doi.org/10.1111/j.1471-6402.2000.tb00200.x>.
- Robins, R. W., & Trzesniewski, K. H. (2005). Self-esteem development across the lifespan. *Current Directions in Psychological Science*, 14(3), 158–162. <https://doi.org/10.1111/j.0963-7214.2005.00353.x>.
- Sport Matters (2018). Highlights of the 2018 Federal Budget. <http://sportmatters.ca/highlights-2018-federalbudget>. Accessed 08-09-2018.
- Telford, R. M., Telford, R. D., Cochrane, T., Cunningham, R. B., Olive, L. S., & Davey, R. (2016). The influence of sport club participation on physical activity, fitness and body fat during childhood and adolescence: the LOOK Longitudinal Study. *Journal of Science and Medicine in Sport*, 19(5), 400–406. <https://doi.org/10.1016/j.jsams.2015.04.008>.
- Thomas, M., Nelson, T. F., Harwood, E., & Neumark-Sztainer, D. (2012). Exploring parent perceptions of the food environment in youth sport. *Journal of Nutrition Education and Behavior*, 44(4), 365–371. <https://doi.org/10.1016/j.jneb.2011.11.005>.
- Trost, S. G., Blair, S. N., & Khan, K. M. (2014). Physical inactivity remains the greatest public health problem of the 21st century: evidence, improved methods and solutions using the ‘7 investments that work’ as a framework. *British Journal of Sports Medicine*, 48(3), 169–170. <https://doi.org/10.1136/bjsports-2013-093372>.
- Tucker Center for Research on Girls & Women in Sport (2018). The 2018 Tucker Center Research Report, developing physically active girls: an evidence-based multidisciplinary approach. https://www.cehd.umn.edu/tuckercenter/library/docs/research/2018-Tucker-Center-Research-Report_Developing-Physically-Active-Girls_Full-Report.pdf. Accessed 08-09-2018.
- Wichstrom, T., & Wichstrom, L. (2009). Does sports participation during adolescence prevent later alcohol, tobacco and cannabis use? *Addiction*, 104(1), 138–149. <https://doi.org/10.1111/j.1360-0443.2008.02422.x>.
- Wong, S. L., Shields, M., Leatherdale, S., Malaisson, E., & Hammond, D. (2012). Assessment of validity of self-reported smoking status. *Health Reports*, 23(1), 47–53.
- World Health Organization. (2018). *Global action plan on physical activity 2018–2030: more active people for a healthier world*. Geneva: World Health Organization.
- Zarrett, N., P. V., & Sabo, D. (2018). *Teen sport in America: why participation matters*. Meadow: Women’s Sport Foundation.

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