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Gender-specific associations between involvement in team sport culture and canadian adolescents' substance-use behavior



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ABSTRACT

Canadian adolescents have some of the highest rates of substance use in the world. The etiology of this phenomenon has not been fully explored, and one possible contextual determinant is involvement in sport activities that foster risk-taking behaviors through physical and social mechanisms. Using the 2013-14 Health Behaviour in School Aged Children (HBSC) study we therefore examined this hypothesis in a contemporary national sample of Canadian adolescents.

The strength and direction of the relationship between sport and substance use varied by gender and substance, with team sport participation associated with increased binge drinking (RR 1.33 [95% CI 1.13–1.56] for boys, RR 1.21 [1.06–1.38] for girls) and use of smokeless tobacco (RR 1.68 [1.34–2.10] for boys, RR 1.32 [1.01–1.72] for girls), but with lower prevalence levels of cannabis use (RR 0.73 [95% CI 0.61–0.88]) and cigarette smoking (RR 0.79 [95% CI 0.70–0.89]) in girls alone. We also compared team sport athletes with high social involvement (sports team as primary peer group) and physical involvement (higher number of days/week physically active) to those with low involvement. For boys, the combination of high physical and high social involvement was associated with the highest risk, while high social involvement alone was associated with the greatest risk for girls.

While team sport participation confers only a small increased risk for substance use, the prevalence of sport participation results in a large population impact. Given this fact, interventions such as education for parents and coaches and policies encouraging engagement in a variety of extracurricular activities should be explored.

1. Introduction

Participation in sport during adolescence has known positive health benefits spanning the physical, physiological, and psychological domains (Eime, Young, Harvey, Charity, & Payne, 2013; Merkel, 2013). Sport participation promotes moderate-to-vigorous physical activity, counteracting the negative impacts of the sedentary lifestyles of Canadian youth (Colley et al., 2011; Merkel, 2013). This is increasingly important in light of the high rate of childhood obesity (Ball & McCargar, 2003; Rao, Kropac, Do, Roberts, & Jayaraman, 2016; Statistics Canada, 2015b). Involvement in sport has also been linked to improved academic achievement (Janssen, 2007; Samarasinghe, Khan, McCabe, & Lee, 2017; Yeung, 2015); improved resilience (Hall, 2011; Johnson, 2015); decreased likelihood of mental health-related issues such as depression and anxiety (Eime et al., 2013; Jewett et al., 2014); increased self-confidence, self-esteem, and emotional health (Samarasinghe et al., 2017); and improved skills in areas such as goal-

setting, time management, teamwork, and leadership (Donnelly, Darnell, Wells, & Coakley, 2007). Furthermore, children and adolescents who participate in sport are more likely to continue being physically active as adults (Dohle & Wansink, 2013; Tammelin, Näyhä, Hills, & Järvelin, 2003).

Despite these positive benefits, adolescent sport participation is sometimes paradoxically associated with risky substance use, including binge drinking (Mays, DePadilla, Thompson, Kushner, & Windle, 2010; Pate, Trost, Levin, & Dowda, 2000; Veliz, Boyd, & McCabe, 2016), use of tobacco products (Pate et al., 2000), cannabis use (Pate et al., 2000; Veliz et al., 2016), and misuse of other prescription and illicit drugs (Pate et al., 2000; Veliz et al., 2016). In other contexts, however, sport has been associated with a lower risk of substance use, which varies by both type of sport and the region in which the sport is played (Merkel, 2013; Pate et al., 2000). Associations between sport and engagement in substance use also vary by gender (Denham, 2011; Lipowski, Lipowska, Jochimek, & Krokosz, 2016; Schuster, Mermelstein, & Wakschlag,

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2013).

There is a pervasive promotion of substance use within the culture of sport, which is influenced by the actions of parents, coaches, professional athletes, and the media. Parents and coaches may engage in their own use of substances during or following a game, while the use of recreational drugs is prevalent among professional team sport athletes (Waddington, Malcolm, Roderick, Naik, & Spitzer, 2005). One study found that over half of professional football players self-reported opioid use at some point during their career (Cottler et al., 2011). The use of performance enhancing drugs (such as steroids) is also prevalent among professional athletes, though it varies by sport: 67% of professional power lifters self-reported use at some point during their careers, compared to 9% of professional football players (Kersey et al., 2012). Smokeless tobacco use is prevalent among professional baseball players (about 40% self-reported use over the past year) as well as football players (about 30%) (McDuff & Baron, 2005). While there has been little investigation into the prevalence of coaches' engagement in substance use, several studies have found that coaches play an important role in athletes' decisions to engage in substance-use behaviors (Mastroleio, Marzell, Turrisi, & Borsari, 2012; Van Hoye, Heuzé, Van den Broucke, & Sarrazin, 2016). This suggests that coaches' open engagement in substance use may have a significant impact on the substance-use behaviors of their athletes. Sporting venues and televised competitions are saturated with alcohol-related marketing, an exposure shown to increase adolescents' drinking behavior (Anderson, de Bruijn, Angus, Gordon, & Hastings, 2009). Despite regulations in place to protect vulnerable populations, such as Canadian youth, from being the target audience of alcohol marketing, recent evidence suggests the alcohol industry is not adhering to these self-regulation guidelines (Public Health Ontario, 2016). Additionally, these guidelines do not apply to certain types of marketing ads, such as events sponsorship or branded merchandise, both of which are abundant in the professional sports industry, to which adolescent athletes are regularly exposed (Public Health Ontario, 2016).

Through this process of socialization, adolescent athletes may learn to adopt similar behaviors. Additionally, peer influences can have a significant impact on adolescents' tendencies to engage in substance use. Peer Cluster Theory (PCT) posits that adolescents are drawn to engage in the same behaviors as their peers (Rose, 1999). As youth transition from childhood to adolescence, the influence of one's peers tends to increase, as does the time spent with friends and the desire to explore peer-related risk-taking behaviors (Albert, Chein, & Steinberg, 2013; Gardner & Steinberg, 2005). Adolescents engaged in organized sport are repeatedly exposed to the same group of peers. This continued exposure to one another increases the likelihood of engagement in risky substance use, even among adolescent athletes with a low propensity to engage in these behaviors. The type of team (recreational or competitive) and level of involvement may also affect an adolescent's propensity to engage in substance-use behaviors. For example, pressure to perform well on a competitive team within a highly structured environment may lead an adolescent to turn to substance use as a way to regain autonomy and to cope with their rigid environment. Additionally, an adolescent who is highly socially involved on a sports team, and lacks any other extracurricular activities may find themselves immersed in the culture of sport, which promotes substance use through the aforementioned social pathways.

While several studies have explored the relationship between sport participation and adolescent substance use in the US and Europe, only one study has been conducted in Canada (Michaelson, Robinson, & Pickett, 2014). Over 50% of Canadian youth participate in some form of organized sport (Canadian Heritage, 2013), while young Canadians have also reported some of the highest rates for substance use in the world (de Looze et al., 2012). In comparison to Canadian adults, many substance-use behaviors are more prevalent among adolescents. In one nationally representative study, nearly half of Canadian youth in grades 7 to 12 self-reported current binge drinking (27%), use

of tobacco products (9%), cannabis (19%), or other illicit drugs (8%) (Leatherdale & Burkhalter, 2012). Conversely, prevalence estimates for many of these substance-use behaviors are lower among adults (binge drinking 22%; tobacco products 10%; cannabis 8%; illicit drugs 0.2–1.9%) (Canadian Centre on Substance Abuse, 2014, 2016). Therefore, it is important to determine whether the culture surrounding sport participation is encouraging substance-use behaviors among Canadian youth. Even a small increased risk for substance use would result in a major population-level impact. Isolating the mechanisms driving this association is important to inform the development of effective interventions. Such interventions may target policy solutions, educational practices for coaches, parents, and athletes, as well as changes to sporting organizations and their management. To inform these potential interventions, we set out to examine the gender-specific relationships between varying levels of involvement in sport and patterns of substance use among a large sample of Canadian adolescents.

2. Methods

2.1. Data and sample

The Health Behaviour in School-aged Children Survey (HBSC) is a cross-national study conducted in a four-year cycle across 43 countries, in collaboration with the World Health Organization (Currie, Nic Gabhainn, Godeau & International HBSC Network Coordinating Committee, 2009). The study protocol involves recruitment of representative samples of young people to complete a school-based, standardized health survey, completed in a classroom setting. The goal of the survey is to determine the prevalence and distribution of psychological, social, and physical determinants of health in 11 to 15 year-olds (Freeman, King, & Pickett, 2015). All HBSC questionnaire items are developed, piloted, and validated by the HBSC international network. Cross-cultural content validity and consistency is assured by routine review of all items on the HBSC questionnaire by the international network. Through this pilot testing, items are checked for completion, understanding, and translation issues, while questionnaires are checked for layout, sequencing of questions, legibility of questions, and appropriate use of graphics. The present study used data from the nationally representative 2013–2014 cycle of the Canadian HBSC (Freeman et al., 2015).

Ethics approval was sought and obtained from Health Canada, the Public Health Agency of Canada, and the General Research Ethics Board at Queen's University. Following receipt of permission from the 10 provinces and 3 territories in Canada, active consent was provided by school boards and individual schools, while passive consent was obtained from student participants and their parents or guardians. A stratified sample of 377 schools was recruited to represent the Canadian distribution of regions, languages of instruction, school types (Public or Catholic), school sizes, and community sizes. Private schools, special needs schools, on-reserve schools, and schools for youth in custody, which collectively account for less than 7% of the Canadian population in this age range (Van Pelt, Clemens, Brown, & Palacios, 2015), were excluded. Overall, 77% of students enrolled in the participating classrooms returned the survey, resulting in a total sample of 29,784; however, we restricted our sample to students aged 14 and 15 ($N = 13,817$) for whom the full range of substance use information was collected.

2.2. Measures

A conceptual model of the association between sport participation and substance-use behaviors, as well as covariates incorporated or controlled for in our analyses (effect modifiers and confounders) is presented in Fig. 1. This model was used to direct item selection and subsequent analyses.

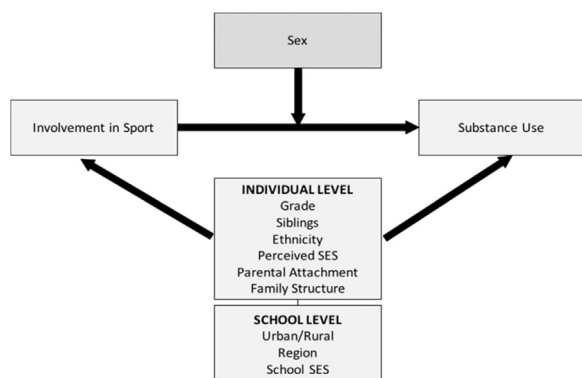


Fig. 1. Conceptual model of the relationship between involvement in sport and substance use among adolescents.

2.2.1. Exposures

Organized sport participation was assessed via two questions. Adolescents were asked whether they were involved in a “sports team” and/or “individual sport”. The exact questions asked in the 2014 HBSC can be found in [Appendix A](#). In our first analysis, we categorized each adolescent into one of four groups: non-participant (referent), individual sport participant only, team sport participant only, or both individual and team sport participant.

In our second analysis, we were interested in which aspects of team sport participation were driving the association between team sport and substance use. To investigate this, we restricted our sample to team sport participants only. We hypothesized two separate mechanisms that may be responsible for influencing the propensity to engage in substance use: the pressure of competitive sport, and the influence of other athletes within sport culture. We constructed measures of involvement to attempt to quantify the degree to which adolescents are exposed to these mechanisms: physical involvement and social involvement.

We categorized adolescents as having high social involvement in sport if they did not report any alternative extracurricular activities and indicated that their main group of friends “often” played sports. There is content and construct validity for social involvement as a measure for immersion in the culture of sport. If an individual’s only extracurricular activity is participating on a sports team, and all their friends also play on a sports team then it is likely that the culture of sport is one of their primary social influences.

We categorized adolescents as having high physical involvement in sport based on the number of days per week that they reported being physically active for more than 60 min. Since boys tend to be more physically active than girls, different cut offs were chosen for each gender ([Colley et al., 2011](#); [Statistics Canada, 2015a](#)). Boys were categorized as highly active if they reported more than 5 days per week, while girls were categorized as highly active if they reported more than 4 days per week. Physical involvement was used in order to identify students who were involved in more competitive sports teams. Students on competitive teams have more games and practices to attend per week and would therefore be physically active more days per week than students on less competitive teams. Misclassification is a potential problem with this measure, but we would expect that any misclassification would be non-differential.

Team sport participants were categorized into one of four groups: low social involvement and low physical involvement (referent), low social involvement and high physical involvement, high social involvement and low physical involvement, and both high social and physical involvement.

2.2.2. Outcomes

We examined seven substance-use behaviors as outcomes: binge drinking (at least monthly consumption of 4 (for girls) or 5 (for boys) alcoholic drinks or more on one occasion), lifetime smoking (ever

smoked a cigarette), current smoking, smokeless tobacco (ever used chewing tobacco or snus), cannabis (lifetime use of cannabis on three or more occasions), prescription medications (ever used any medications to get high, including pain relievers, stimulants, and sedatives), and hard drugs (ever used ecstasy, amphetamines, or opiates).

2.2.3. Confounders

Potential confounders were selected based on previous literature, and their availability within the HBSC questionnaire. Individual-level confounders included demographics such as grade level, number of siblings, ethnicity, perceived socioeconomic status (SES), and region, as well as family-related contextual variables including family structure and parental attachment. School-level confounders included urban/rural geographic location, region, and school-level SES.

2.2.3.1. Individual level. We dichotomized grade level into two groups (grade 9, and grade 10 and above). Grade level serves as a proxy for age and developmental stage, as well as a marker for individual or group-influenced social development, a dominant theme in our study. Engagement in risk behavior has been shown to vary by grade level ([Johnson & McRee, 2015](#)), while participation in sport declines with age ([Telama & Yang, 2000](#)).

Adolescents indicated the number of siblings they had. We dichotomized these responses into “siblings” or “no siblings”. Adolescents’ substance use has been linked to siblings’ engagement in the same behaviors ([Samek, Rueter, Keyes, McGue, & Iacono, 2015](#)), as has their participation in sport ([Rees, Lopez, Averett, & Argys, 2008](#)).

Ethnicity was measured categorically in the following groups: Caucasian, Mixed Caucasian, Aboriginal, South Asian, East and Southeast Asian, Black, Arab, Latin American, Multiple visible minority/other. Risk behavior, including substance use, has been shown to vary between ethnicities ([Denham, 2011](#)). Similarly, sport participation is more prevalent among some ethnicities than among others ([Miller et al., 2003](#)).

Self-perceived affluence (SES) was an ordinal variable with five response categories ranging from “very well off” to “not at all well off.” Adolescents from lower SES families are less likely to be involved in sport ([Fairclough, Boddy, Hackett, & Stratton, 2009](#)). Adolescent substance use has also been shown to vary across both social classes and substances ([Luthar & Latendresse, 2005](#); [Modecki, Barber, & Eccles, 2014](#)).

Four questions were used to assess degree of parental attachment: a) My family tries to help me, b) I get the emotional help and support I need from my family, c) My family is willing to help me make decisions, and d) I can talk about my problems with my family. All items were reported on a five-point Likert scale anchored by “strongly agree” and “strongly disagree.” We categorized adolescents into four groups based their responses to these questions: all positive, all neutral, all negative, and polarized. Assessment of parental attachment is important as quality of communication between parents and children has been found to result in more effective management of problems raised during adolescence, such as risk-taking behavior ([Luthar & Latendresse, 2005](#); [Soloski, Kale Monk, & Durtschi, 2015](#)). Parental attachment is also predictive of adolescents’ experiences in sport, including continued participation ([Ullrich-French & Smith, 2009](#)), and quality of sport-related friendships ([Carr, 2009](#)).

Family structure was a categorical variable that was constructed based on whether specific caregivers were present in the home (mother, father, stepfather, stepmother). Participants were classified as belonging to a single parent family, a traditional family (two parents), a reconstituted family (two parents, one or two of them step-parents), or a foster/other type family structure. Adolescents from certain family structures (e.g., single parent, reconstituted) experience disparities in sport participation ([McMillan, Mcisaac & Janssen 2016](#)). Family structure is also predictive of adolescents’ substance use ([Griffin, Botvin, Scheier, Diaz, & Miller, 2000](#); [Hemovich & Crano, 2009](#)).

2.2.3.2. *School level.* Schools were categorized into five groups based on the population of the surrounding area: rural (< 1,000), small population center (1,000 to 29,999), medium population center (30,000 to 99,999), large population center (100,000 to 499,999), and metropolis (> 500,000) (Statistics Canada, 2011). Sport participation is higher in urban rather than rural areas, likely due to accessibility (Statistics Canada, 2014), and substance-use behaviors vary by population size (Mcinnis, Young, & Student Drug Use Surveys Working Group, 2015).

Region was a categorical variable comprising each of the ten provinces and three territories of Canada. Both participation in sport and adolescent substance use vary by region (Young et al., 2011).

A composite (mean) indicator of self-perceived SES was computed at the school level, indicated from the combined individual student reports. Higher SES schools provide more opportunities for students to participate in sports, while lower SES schools have fewer resources to spend on sporting activities (Morin, Lebel, Robitaille, & Bisset, 2016). Similarly, school-level SES may be predictive of the prevalence of substance use (O'Malley, Johnston, Bachman, Schulenberg, & Kumar, 2006).

2.2.4. *Effect modifiers*

All analyses were stratified by gender, as sport participation, substance use, and the relationship between the two vary by gender (e.g., Denham, 2011; Hoffman, 2006; Lipowski et al., 2016; Schuster et al., 2013; Veselska et al., 2009).

2.3. *Missing data*

In the sample, 13.4% of respondents (1857 of the 13,817 adolescents aged 14–15) had missing data on at least one important covariate (Fig. 2). These individuals were excluded from our primary analysis. Inference from this complete-case sample will be consistent provided that missingness is conditionally independent of the response given the covariates in the model (e.g., data are missing completely at random [MCAR]) (McIsaac & Cook, 2014). Sensitivity analyses showed that our

findings were robust to our assumptions about the missing data mechanisms; accounting for missing data through imputation did not change any of our effect estimates substantially and did not change the interpretation of any of the findings (see Appendix B).

2.4. *Statistical analyses*

The majority of the outcomes under study were not rare (> 10%). As our intent was to provide estimates of relative risk, we employed modified Poisson regression models, allowing for overdispersion and accounting for clustering using generalized estimating equations (Zou & Donner, 2013). To quantify the proportion of the variance in the outcomes that were explained by school-level factors, we computed intraclass correlation coefficients (ICC) using the latent variable method for binary outcomes (Snijders & Bosker, 2012). All potential confounders indicated in the literature were included in our models, irrespective of their statistical significance. All statistical analyses were performed using SAS 9.4.

2.5. *Population attributable fraction (PAF) calculation*

Population attributable fraction estimates were calculated for all substance-use behaviors significantly associated with team sport participation. We applied Miettinen's formula for adjusted relative risks (Miettinen, 1974) and weighted prevalence estimates of substance-use behaviors from the HBSC. Confidence intervals were estimated through application of the lower and upper confidence limits of the relative risk estimates. PAF's for team sport participants and for adolescents that participated in a combination of team and individual sports were summed to estimate an overall PAF for each substance-use behavior.

2.6. *Sensitivity analyses*

Three sensitivity analyses were conducted to ensure that the results were robust to assumptions made in the analysis strategy.

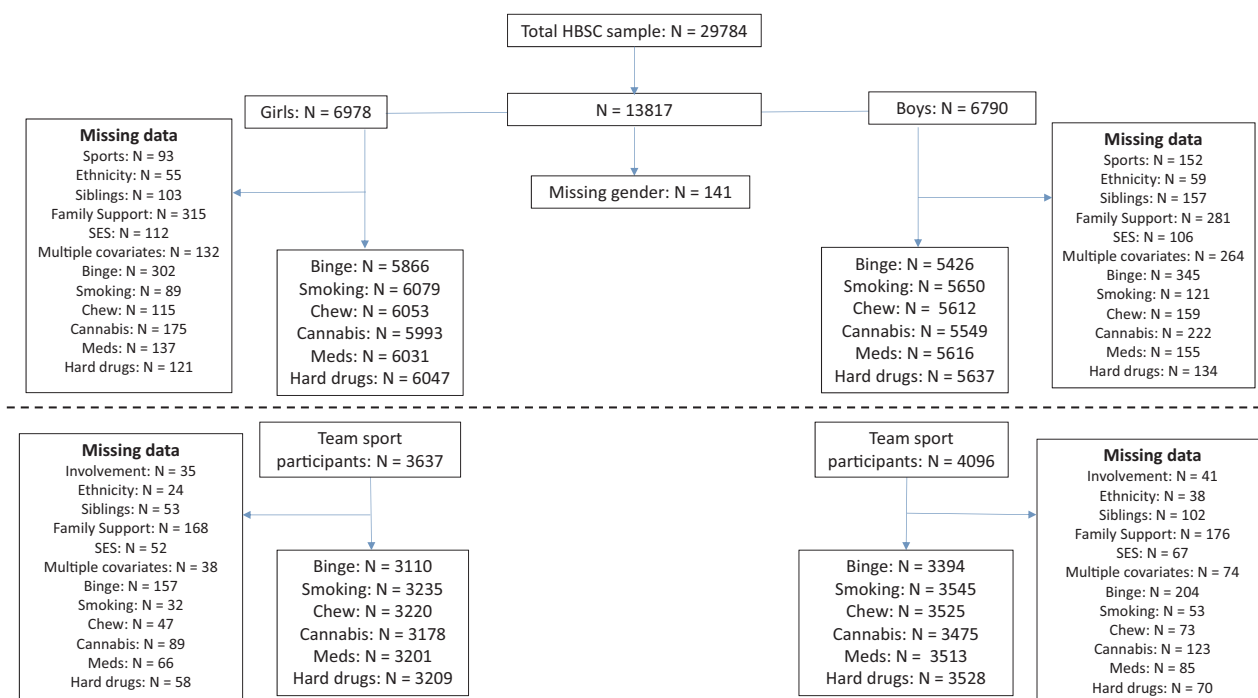


Fig. 2. Sample sizes and missing data. The top half of the figure depicts the missing data by covariate and final participant counts for the analysis of sport participation with each type of substance-use behavior. The bottom half of the figure depicts the missing data by covariate and final participants counts for the analysis of type of involvement in team sport and each substance-use behavior.

2.6.1. Family affluence scale

Previous studies using the HBSC have assessed socioeconomic status using the Family Affluence Scale (Currie et al., 2009; Holstein et al., 2009). However, the Family Affluence scale has limited application to Canadian adolescents. Some of the items, such as number of computers and number of cars, do not have high variability. Number of cars may indicate different levels of SES depending on urban/rural status. Because of these limitations, we chose to control for confounding using self-reported SES instead. A sensitivity analysis was conducted using FAS to assess the effect of this choice.

2.6.2. Alternative alcohol consumption measure

The HBSC includes multiple questions that assess alcohol consumption. We chose to look at binge drinking in particular because it represents misuse of alcohol while the others could be thought of as “use” of alcohol. As a sensitivity analysis, we examined an alternative definition of alcohol consumption: “Lifetime > 10 days Alcohol Use.”

2.6.3. Composite sport participation

We examined the association between school-level team sport participation (percentage of students in that school who play team sports) and individual substance use (see Appendix B), and tested models for the main analysis that included this variable as a confounder.

Table 1
Description of demographic characteristics of the sample by sport participation.

	Nonparticipant n = 3779 (28.38%)	Individual sport n = 1784 (13.4%)	Team sport n = 3505 (26.32%)	Team and individual n = 4250 (31.91%)
Gender				
Male	1561 (41.3%)	814 (45.6%)	1824 (52.0%)	2272 (53.5%)
Female	2201 (58.2%)	968 (54.3%)	1675 (47.8%)	1962 (46.2%)
Missing	17 (0.5%)	2 (0.1%)	6 (0.2%)	16 (0.4%)
Grade				
Nine	1769 (46.8%)	896 (50.2%)	1840 (52.5%)	2261 (53.2%)
Ten plus	2010 (53.2%)	888 (49.8%)	1665 (47.5%)	1989 (46.8%)
Ethnicity				
Caucasian	2241 (59.3%)	1125 (63.1%)	2328 (66.4%)	2837 (66.8%)
Caucasian + Other	333 (8.8%)	136 (7.6%)	247 (7.1%)	311 (7.3%)
Aboriginal	351 (9.3%)	109 (6.1%)	305 (8.7%)	344 (8.1%)
South Asian	154 (4.1%)	86 (4.8%)	112 (3.2%)	103 (2.4%)
East/SE Asian	301 (8.0%)	150 (8.4%)	205 (5.9%)	248 (5.8%)
Black	103 (2.7%)	35 (2.0%)	129 (3.7%)	107 (2.5%)
Arab	92 (2.4%)	26 (1.5%)	37 (1.1%)	73 (1.7%)
Latin American	37 (1.0%)	16 (0.9%)	24 (0.7%)	35 (0.8%)
Multiple Visible minority/other	119 (3.2%)	82 (4.6%)	95 (2.7%)	135 (3.2%)
Missing	48 (1.3%)	19 (1.1%)	23 (0.7%)	57 (1.3%)
Socioeconomic status				
Very well off	542 (14.3%)	287 (16.1%)	636 (18.2%)	982 (23.1%)
Quite well off	1068 (28.3%)	640 (35.9%)	1202 (34.3%)	1422 (33.5%)
Average	1629 (43.1%)	632 (35.4%)	1323 (37.8%)	1406 (33.1%)
Not very well off	356 (9.4%)	150 (8.4%)	192 (5.5%)	245 (5.8%)
Not at all well off	83 (2.2%)	31 (1.7%)	53 (1.5%)	84 (2.0%)
Missing	101 (2.7%)	44 (2.5%)	99 (2.8%)	111 (2.6%)
Family Structure				
Traditional	2113 (55.9%)	1082 (60.7%)	2305 (65.8%)	2804 (66.0%)
Reconstituted	485 (12.8%)	230 (12.9%)	363 (10.4%)	379 (8.9%)
Single parent	822 (21.8%)	338 (19.0%)	569 (16.2%)	700 (16.5%)
Foster/other	252 (6.7%)	85 (4.8%)	157 (4.5%)	237 (5.6%)
Missing	107 (2.8%)	49 (2.8%)	111 (3.2%)	130 (3.1%)
Siblings				
Yes	3091 (81.8%)	1435 (80.4%)	2952 (84.2%)	3582 (84.3%)
No	579 (15.3%)	303 (17.0%)	442 (12.6%)	542 (12.8%)
Missing	109 (2.9%)	46 (2.6%)	111 (3.2%)	126 (3.0%)

Table 2

Intraclass correlation coefficients and estimated outcome prevalence for boys and girls.

	Prevalence (%)		ICC (%)	
	Boys	Girls	Boys	Girls
Binge Drinking	24.64	23.51	10.16	12.22
Lifetime Cigarette Smoking	22.42	21.24	12.24	18.39*
Current Cigarette Smoking	5.44	4.81	20.19	28.48
Smokeless Tobacco	12.52	4.85*	21.88	29.52
Cannabis	13.29	14.35	11.54	12.8
Medications	15.43	21.85*	9.6	12.69
Hard Drugs	6.2	5.97	5.7	10.3

* Significantly different at a p-value of 0.05

3. Results

3.1. Sample characteristics

The demographic characteristics of the study population are summarized in Table 1. The most common ethnicity was “Caucasian”. Most students came from a traditional family structure. More than half of students in the study had at least one sibling. Students were most likely to report an “average” SES. In total, 58% of the sample participated in an organized team sport, while 45% participated in an individual sport.

The gender-stratified prevalence of each of the substance-use behaviors are summarized in Table 2, along with the results of the variance partitioning analysis that reflects the degree of clustering at the school level. Males reported a significantly higher prevalence of

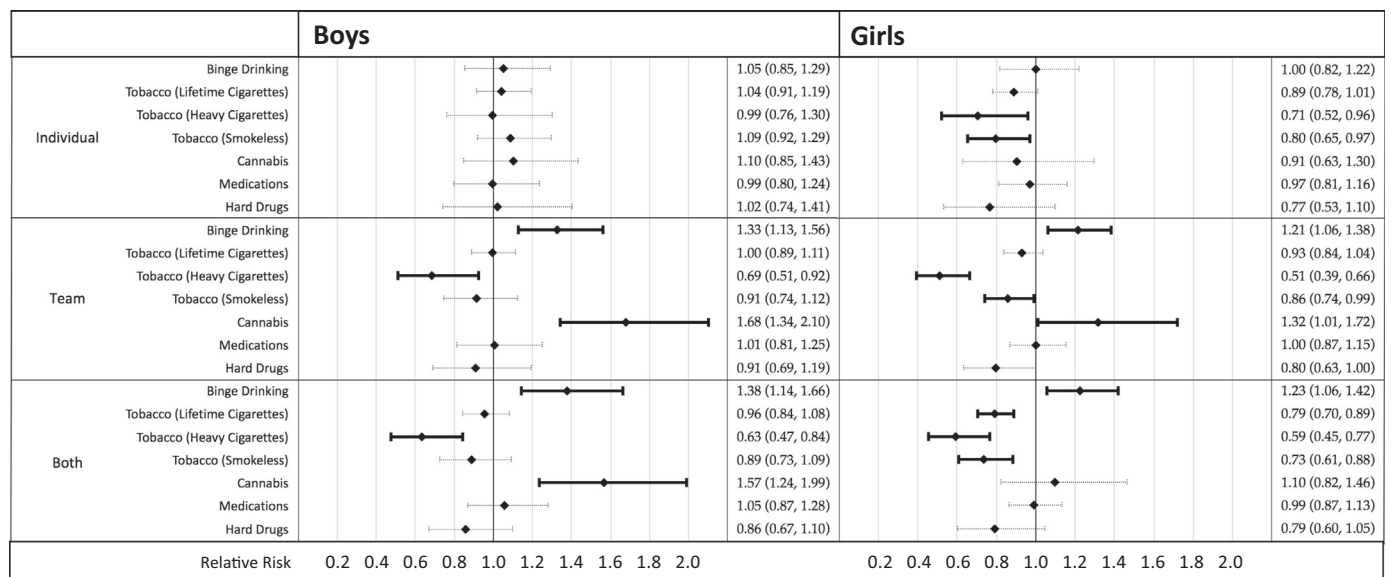


Fig. 3. The differential relationship of sport participation and substance-use behaviors among adolescent boys and girls. For boys, team sport and the combination of team and individual sport participation was associated with binge drinking and use of smokeless tobacco. For girls, any sport participation was protective against the use of cannabis, while the combination of team sport and individual sport involvement was also protective against cigarette smoking. Team sport and the combination of individual and team sport participation was associated with an increased risk of binge drinking, while team sport alone was also associated with increased use of smokeless tobacco.

smokeless tobacco use ($p < 0.05$), while females were more likely to misuse prescription medications ($p < 0.05$). Overall, a high degree of clustering was observed at the school level for all substance-use behaviors, excluding hard drug use. There was a general trend for substance use to cluster more for girls than for boys. However, only current cigarette smoking clustered significantly more for girls than for boys ($p < 0.05$).

3.2. Sport participation and substance use

The relationships between type of sport participation and substance-use behaviors are summarized for boys in Fig. 3. Individual sport participants were not at increased risk for engaging in any of the substance-use behaviors, in comparison to non-participants. In contrast, team sport or combined individual and team sport participants were at increased risk for binge drinking (RR 1.33 [95% CI 1.13–1.56] and RR 1.38 [95% CI 1.14–1.66], team and combined sports, respectively) and use of smokeless tobacco (RR 1.68 [95% CI 1.34–2.10] and RR 1.57 [95% CI 1.24–1.99], respectively). In terms of current cigarette smoking, team sport or combined individual and team sport participants were at a decreased risk (RR 0.69 [95% CI 0.51–0.92] and RR 0.63 [95% CI 0.47–0.84], respectively) in comparison to non-participants.

For girls, the patterns of association were more nuanced (Fig. 3). Only decreased cannabis use and current cigarette smoking were significantly associated with individual sport participation (RR 0.80 [95% CI 0.65–0.97] and RR 0.71 [95% CI 0.52–0.96]) compared to non-participants. Girls that only participated in a team sport were found to be at increased risk for binge drinking (RR 1.21 [95% CI 1.06–1.38]) and smokeless tobacco use (RR 1.32 [95% CI 1.01–1.72]), but at significantly decreased risk for cannabis use (RR 0.86 [95% CI 0.74–0.99] and current cigarette smoking (RR 0.51 [95% CI 0.39–0.66]). Girls that participated in both individual and team sports were at significantly increased risk for binge drinking (RR 1.23 [95% CI 1.06–1.42]), but decreased risk for lifetime cigarette smoking (RR 0.79 [95% CI 0.70–0.89]), current cigarette smoking (RR 0.59 [95% CI 0.45–0.77]) and cannabis use (RR 0.73 [95% CI 0.61–0.88]).

3.3. Type of team sport involvement and substance use

After finding an association between team sport participation and the use of several substances among both boys and girls, we sought to further determine which aspects of team sport were driving this behavior. We examined two types of involvement in team sport: social and physical. The results of this analysis are shown in Fig. 4.

Boys with only high social or only high physical involvement in sport did not have a significantly different risk for substance use compared to those with low physical and low social involvement. In contrast, boys who reported both high social and high physical involvement were at significantly greater risk for binge drinking (RR 1.48 [95% CI 1.23–1.79]), smokeless tobacco use (RR 1.56 [95% CI 1.22–2.01]), and cannabis use (RR 1.41 [95% CI 1.06–1.87]), compared to boys with low physical and low social involvement. However, boys with both social and high physical involvement were significantly less likely to engage in current cigarette smoking (RR 0.39 [95% CI 0.21–0.72]) compared to boys with low physical and low social involvement.

Girls with only high social involvement in team sport were at significantly greater risk for binge drinking (RR 1.57 [95% CI 1.22–2.01]), cigarette smoking (RR 1.31 [95% CI 1.04–1.65]), smokeless tobacco use (RR 1.73 [95% CI 1.13–2.65]), and cannabis use (RR 1.39 [95% CI 1.04–1.85]), compared to girls with low social and low physical involvement in team sport. In contrast, girls with only high physical involvement in team sport were not at increased risk for any of the substance-use behaviors, compared to girls with low social and low physical involvement. Girls who reported both high physical and high social involvement were at increased risk for binge drinking (RR 1.57 [95% CI 1.22–2.02]) compared to girls with low social and low physical involvement.

3.4. Population attributable fraction estimates

Assuming a causal relationship between team sport participation and substance-use, 12.8% (95% CI: 4.5 to 20.0%) of binge drinking and 23.8% (95% CI: 12.7 to 32.9) of smokeless tobacco use among boys is attributable to team sport participation. If no adolescent boys played sports, we would expect the rate of current cigarette smoking to be 22.0 percentage points (95% CI: 8.0 to 32.8) higher.

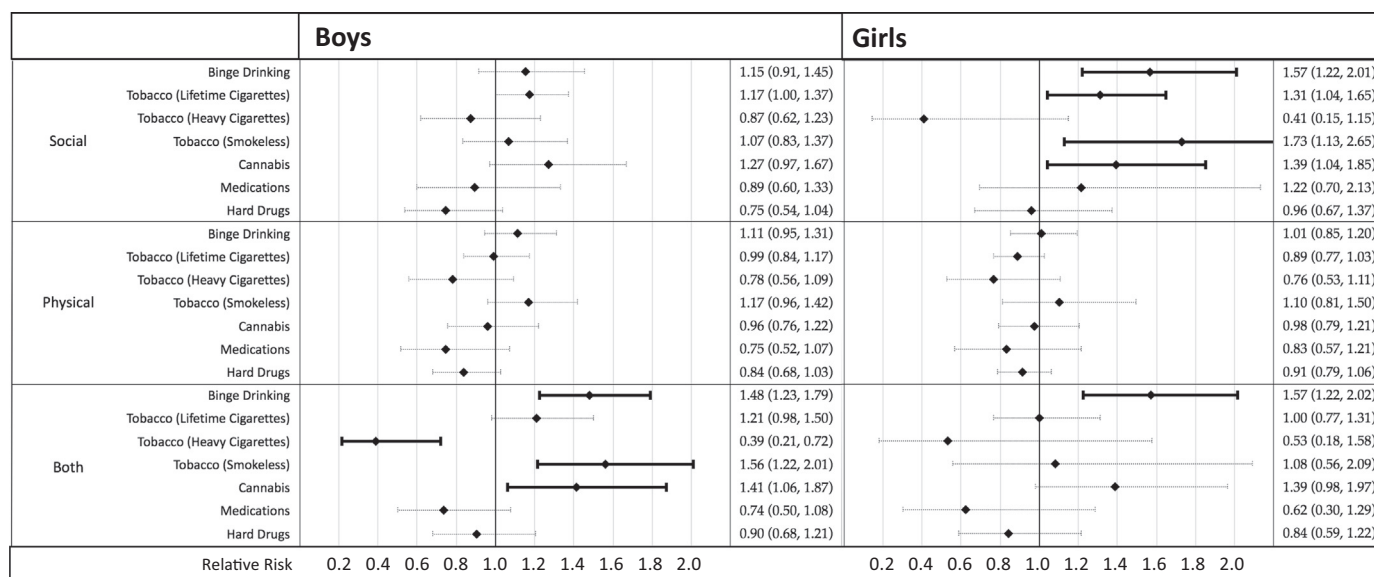


Fig. 4. The differential relationship of the type of team sport involvement and substance-use behaviors among adolescent boys and girls. For boys, the combination of high social and high physical involvement in team sport was associated with binge drinking, use of smokeless tobacco, and use of cannabis. For girls, high social involvement in team sport was associated with binge drinking, cigarette smoking, use of smokeless tobacco, and use of cannabis. The combination of high social and high physical involvement was only associated with binge drinking.

In girls, 7.7% (95% CI: 2.1 to 13.0) of binge drinking and 9.3% (95% CI: 2.4 to 14.6) of smokeless tobacco use is attributable to team sport participation. Participation in team sport or both team and individual sport also contributed to the prevention of the use of multiple substances. We would expect the rate of lifetime cigarette smoking to be 6.1 percentage points higher (95% CI: 3.1 to 8.6), the rate of current cigarette smoking to be 22.9 percentage points higher (95% CI: 14.4 to 29.6), and the rate of cannabis use to be 11.0 percentage points higher (95% CI: 3.2 to 17.2) if no adolescent girls played sports.

3.5. Sensitivity analyses

Using alternative definitions of socioeconomic status and alcohol consumption did not affect the significance of any effect estimate or change the point estimate by more than 5%. Including the school level team sport participation percentage as a confounder did not change the significance or direction of any result, but did attenuate the point estimate for the effect of individual sport participation on smokeless tobacco use in girls by 14% and the point estimate for the effect of team sport participation on smokeless tobacco use in girls by 9.9%. All other changes were lower than 5%. An assessment of the relationship of the composite school level team sport participation with individual level substance-use can be found in Appendix C.

4. Discussion

This national analysis of young Canadians resulted in three important findings: (1) team sport participation was associated with increased risk for binge drinking and smokeless tobacco use; (2) there is a consistent, protective effect of sport for cannabis use that is observed for girls but not for boys; (3) the aspects of team sport participation associated with substance use also varied by gender. Boys with both high physical and high social involvement were at greatest risk for substance use, while for girls, the combination of high social involvement and low physical involvement was associated with the greatest risk.

Our finding that team sport participation was associated with binge drinking and smokeless tobacco use for boys is consistent with the results of previous research (Dever et al., 2012; Johnson & McRee, 2015; Michaud, Jeannin, & Suris, 2006; Pate et al., 2000; Schepis et al., 2011; Stansfield, 2017). However, our finding that female team sport athletes

are also at increased risk for smokeless tobacco use may be specific to Canadian adolescents. While previous studies have found team sport participation to be protective against smoking, use of cannabis, and use of hard drugs for both boys and girls (Pate et al., 2000; Stansfield, 2017), we observed this effect among girls only. This could be explained by a more dominant risk taking culture as an expression of masculinity among male athletes (Miller, 2009). Alternatively, risk-taking boys might be more likely to self-select into sports than risk-taking girls (Poulin, Kiesner, Pedersen, & Dishion, 2011). This points to the need to consider gender in the examination of these associations.

Our evaluation of social and physical involvement in team sport potentially offers new insights. Previous studies have established that specific sports (e.g., baseball, football, wrestling) (Denham, 2011) and sports with higher levels of contact present an increased risk for alcohol and marijuana use (Veliz et al., 2017). Higher levels of physical activity are also associated with increased risk for substance use (Dunn, 2014; Michaud et al., 2006; Peretti-Watel, Beck, & Legleye, 2002), but it is difficult to tease out the effect of physical activity from the social influences of sport as the two are highly correlated. It has also been shown that team sport athletes who do not participate in any extracurricular activities outside of sport are at increased risk for alcohol use (Mays et al., 2010). However, no study to date has evaluated the impact of the combination of both social and physical involvement in team sport. We found that the combination of physical and social involvement in team sport was associated with greater risk for substance use among boys, while high social involvement alone presented the greatest risk for females. For both boys and girls, we observed that physical involvement alone did not confer any increased risk. This may indicate that previous findings were confounded by social involvement. For boys, this involvement pattern likely reflects highly competitive team sport athletes, deeply immersed in the culture of sport. Pressure to perform and succeed, expectations to fit in with the team, and rebellion against a highly structured and supervised environment may contribute to risk-taking behavior. We speculate that this highly structured environment may remove avenues for adolescents to achieve their desired autonomy, and substance-use behaviors may act as a substitute. For girls, those with high social involvement but low physical involvement were at greatest risk for substance use. This may indicate that girls who frequently socialize with team members on more casual sports teams have weaker friend groups than girls whose main friend group consists of competitive sports teammates, or a combination of teammates and

peers outside of sport. Further, less perceived pressure and expectations from parents and coaches for competitive female athletes compared to male athletes (Amado et al., 2015) places less restriction on normative pathways to develop autonomy, and may create a healthier culture on a competitive girls' sports team.

Peer Cluster Theory is helpful in providing additional context for these results. This theory posits that both proximal and distal variables affect adolescents' propensity to engage in risk behavior, with peer association producing the most direct and dominant overall effects (Oetting & Beauvais, 1987). Through regular participation in team sport, adolescent athletes form close social bonds with teammates, as well as develop identities revolving around athleticism and a sense of belonging to the team. This sense of belonging and strength of these bonds may vary based the type of involvement and the gender of the team. Often, this sense of belonging is developed through participation in group activities, including socially-driven engagement in substance use (Newman, Lohman, & Newman, 2007). It is possible that the competitive nature of team sport may also result in a similar competitive nature translating to risky use of substances (Veliz et al., 2017). Behavior is also influenced by psychological variables (e.g., personality traits that promote attachment to peers, such as self-confidence), attitudes and beliefs (e.g., beliefs about substance use as a normative behavior in sport), and socialization links (e.g., connections with parents and coaches who may promote or inhibit engagement in substance use) (Petraitis, Flay, & Miller, 1995). Adolescent athletes' beliefs about substance use may be substantially influenced by professional athletes' portrayal of the same behaviors (Pandina, Johnson, Lagos, & White, 2005). Professional athletes' engagement in substance use further supports the idea that the use of substances is normative within the culture of sport. Adolescent athletes may internalize this belief, encouraging their peers to emulate substance-use behaviors. This effect is likely strongest in team sport participants given that these behaviors are typically displayed by professional team sport athletes. Moreover, the close bonds between team sport athletes compared to individual sport athletes may further propagate this effect. Additionally, adolescent athletes may be influenced by socialization links to parents, coaches, and siblings or older peers engaging in the substance use culture surrounding sport. This may be particularly pervasive in competitive sport settings where adolescents spend extended periods of time with parents and coaches through travel to games and long-term tournaments.

To our knowledge, this is the first study to present population attributable fractions for substance use associated with sport participation. Therefore, it is difficult to draw conclusions on the magnitude of these figures. However, it is worth noting that these figures illustrate that sport participation leads to far more binge drinking and smokeless tobacco use than it prevents lifetime cigarette smoking and cannabis use. In addition, a PAF of greater than 25% indicates that sports participation (assuming a causal relationship) is responsible for more than a quarter of substance use in this population, leaving less than 75% to other causal factors, such as SES. In this light, it would appear that these high PAFs warrant consideration for public health interventions.

The implications of the increased risk of substance-use behaviors among team sport athletes compared to non-participants warrant comment. During these formative years, adolescent substance use increases the risk of non-athletic injuries (de Looze et al., 2012) and fighting (Kodjo, Auinger, & Ryan, 2004). It can also negatively impact upon academic performance (Jeynes, 2002), and produce brain abnormalities (Squeglia, Jacobus, & Tapert, 2009). In the long-term, substance use during adolescence increases the risk of continued problematic substance use during adulthood (DeHass, 2006). Given that team sport athletes that participated in only sport-related extracurricular activities were found to be at greatest risk for substance-use behaviors, less emphasis should be placed on early specialization in sport in favor of a variety of extracurricular activities during adolescence. Participation in alternate activities may counteract the potential negative effects of being solely immersed in sport culture. A reduction in the frequency

of practices and sporting events for high school sports teams may provide avenues for adolescents to participate in other extracurricular activities. Finally, a multi-faceted educational program, targeted at athletes, coaches, and parents, emphasizing the negative impact of substance use on athletic performance and health may dissuade the promotion of and engagement in problematic substance use (Gansky et al., 2005; Goldberg et al., 2000).

This research has a number of strengths. The 2013–14 Canadian HBSC involved a large, contemporary sample that aimed to be representative of Canadian adolescents. In addition to investigating the relationship between sport participation and substance use, we also assessed the impact of social and physical involvement within team sport, and the impact of these exposures on risks via population attributable fractions. We sought to minimize bias by controlling for a number of known confounders and by performing sensitivity analyses that included multiple imputation to ensure robustness of our findings to the assumptions made by our primary analyses. Finally, we looked at a variety of substance-use behaviors, which allowed us to gain a better estimate of the patterns of substance use among adolescent athletes across Canada.

Several limitations must also be acknowledged. We used self-report data, which may be subject to social desirability bias, especially given the sensitivity of the topic of adolescent substance use (Krumpal, 2013). Adolescents may also align their answers with those of their peers regardless of true participation in substance-use behaviors. Non-differential exposure misclassification is also a potential concern because the HBSC lacks direct measures of social and physical involvement in sport, as well as competitive sport participation. We also lacked data on the type of sports played (e.g., hockey, baseball, etc.), inhibiting our ability to identify the sports that confer the greatest risk for substance-use behaviors. Uncontrolled or residual confounding may be present due to our inability to control for factors such as family history of substance use and information on sibling sport participation. Finally, it is difficult to establish the temporality of the relationship due to the cross-sectional study design, therefore limiting causal inference and a causal interpretation of our PAF estimates. Longitudinal confirmation of the observed results would strengthen our conclusions. In addition, future studies should assess the relationship of social and physical involvement with substance use by the type of sport or sport culture. Finally, the mechanisms that potentially mediate the relationship of team sport participation and substance use and the reasons for gender differences may be further elucidated through qualitative or mixed methods studies.

5. Conclusion

In this study, we investigated the relationship between sports participation and substance-use behaviors in Canadian adolescents. Team sport participation is associated with both increased and decreased risk of substance-use behaviors in girls, while only increased risk of substance use among boys was observed. Among team sport athletes, boys who had high social and physical involvement in sport were the most likely to engage in substance-use behaviors (binge drinking, smokeless tobacco and cannabis use), while girl team sport athletes with only high social involvement were the group at highest risk. Although the relative change in behavior associated with team sport participation is small, the population impact is high due to the prevalence of team sport participation in Canada. Monitoring these behaviors, keeping parents and coaches informed of this risk, and encouraging adolescent participation in a more diverse set of extracurricular activities may help to mitigate this effect.

Conflicts of interest

The authors declare no conflicts of interest.

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Ethical statement

Ethics approval for the Health Behaviour in School Aged Children Survey was sought and obtained from Health Canada, the Public Health Agency of Canada, and the General Research Ethics Board at Queen’s University. Following receipt of permission from the 10 provinces and 3 territories in Canada, active consent was provided by school boards and individual schools, while passive consent was obtained from student participants and their parents or guardians.

Appendix A. Canadian HBSC questions used to ascertain social involvement in a team sport

69. Are you involved in any of these kinds of activities or groups?

(Check “yes” or “no” for each line)

- a. A sports team (e.g., volleyball, hockey, soccer)
- b. An individual sport (e.g., running, cycling, skating)
- c. Volunteer work
- d. Arts groups (e.g., music, dance, drama)
- e. Community groups (e.g., scouts, girl guides, 4-H, cadets)
- f. Church or other religious/spiritual group
- f. Other activity or group (e.g., chess, math, debate)

56. Think about the group of friends with whom you spend most of your leisure time.

(Please mark one box for each line)

Most of the friends in my group...

- f. Participate in organized sports activities with others: (never or rarely; sometimes; often; I don’t know)

Appendix B. Missing data sensitivity analyses

Siblings

A total of 610 survey respondents had missing information on siblings. The effect of these missing data on our conclusions was tested using a single extreme imputation methodology. Models were fit to the data using the assumption that all people who did not respond to the question had siblings (Method 1), and again assuming that all non-respondents had no siblings (Method 2). The results of this are shown in [Table B.1](#).

Family support scale

By default, all students with missing information on any part of the family support scale were excluded. We conducted a sensitivity analysis to determine whether discarding this partial information had the potential to bias our results. A multiple imputation model was constructed using available information on other variables in the scale to fill in missing information and allow partial respondents to be included (Method 5). The percentage changes in parameter estimates caused by this model are shown in [Table B.1](#).

Socioeconomic status

A total of 581 survey respondents had missing information on perceived socioeconomic status. For 310 of these students, information for which perceived socioeconomic status could be inferred was available in the form of answers to related questions, including “Do you have a dishwasher at home?”, “Do you have your own bedroom?”, “How many bathrooms are there in your house?”, and “Did your family take a vacation last year?”. Two

Table B.1
Influence of five independent imputation methods on estimated relative risk.

Gender	Variable	Method	Average RR change	Max. RR decrease	Max. RR increase
Male	Siblings	All Yes	0.6%	-10.1%	7.8%
	Siblings	All No	-0.2%	-2.7%	2.6%
	Family	Multiple Imputation	0.8%	-1.3%	4.2%
	SES	Multiple Imputation	-0.3%	-1.9%	3.0%
	SES	Adjusted MI	-1.1%	-8.6%	4.3%
Female	Siblings	All Yes	0.3%	-5.8%	6.0%
	Siblings	All No	0.0%	-8.3%	4.8%
	Family	Multiple Imputation	0.1%	-1.2%	0.8%
	SES	Multiple Imputation	-0.5%	-3.3%	2.3%
	SES	Adjusted MI	-0.3%	-9.0%	7.1%

multiple imputation models for perceived socioeconomic status were constructed based on these other questions. The first assumed that the chance of SES data being missing did not depend on SES itself (Method 3). The second attempted to model what would happen if lower SES students were less likely to respond (Method 4). Twenty-five imputed data sets were created and analyzed to determine whether these missing data had a significant impact on our conclusions. The percentage changes in parameter estimates between the complete case analysis and the multiple imputation sets are shown in Table B.1.

Appendix C. Effect estimates for sport as a contextual factor

When controlling for student-level sport participation in addition to all factors controlled for in the main analysis, school level sport participation had significant protective effects in girls for tobacco (ever use) [RR 0.94 (0.88, 1.00)], cannabis [RR 0.92 (0.85, 1.00)], and hard drug use [RR 0.82 (0.72, 0.94)]. No significant effects were observed in boys. Table C.1

Table C.1

Relative risk of a 10 percentage point increase in school level team sport participation in boys and girls.

Substance	Boys	Girls
Binge Drinking	1.06 (0.99, 1.13)	1.06 (0.97, 1.15)
Tobacco (Lifetime Smoking)	0.99 (0.93, 1.05)	0.94 (0.88, 1.00)
Tobacco (Current Smoking)	0.92 (0.79, 1.08)	0.93 (0.84, 1.02)
Tobacco (Smokeless)	1.04 (0.94, 1.15)	0.97 (0.84, 1.11)
Cannabis	1.05 (0.98, 1.12)	0.92 (0.85, 1.00)
Hard Drugs	1.00 (0.91, 1.10)	0.82 (0.72, 0.94)
Medications	1.01 (0.92, 1.10)	0.99 (0.91, 1.09)

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