



RESEARCH ARTICLE

Physical Activity and Mental Health: A Cross-sectional Study of Canadian Youth

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Abstract

Objective: Our objective was to examine the associations between recreational and non-recreational physical activity with mental health outcomes among Canadian youth aged 12-17. **Methods:** Cross-sectional data from the 2015/2016 Canadian Community Health Survey was used for analysis. Physical activity was classified as either recreational or non-recreational. Both types of physical activity were categorized using the Canadian Physical Activity Guidelines. Mental health outcomes included the Patient Health Questionnaire-9 (PHQ-9) scale dichotomized with 5+ and 10+ cut-offs, self-perceived mental health, and self-reported professionally diagnosed mood and anxiety disorders. Descriptive statistics (proportions with 95% confidence intervals), and multivariable logistic regression were used in the analysis. **Results:** It was found 21.20% of youth were not participating in recreational physical activity and 40.97% were engaging in below guideline recreational physical activity. No activity, or below guideline recreational physical activity was associated with negative mental health. Non-recreational physical activity models were generally non-significant. Additionally, it was determined that associations between recreational physical activity and PHQ-9 score were only evident in males. For the no activity and below guideline activity levels the odds ratios (ORs)=2.57 and 3.19 for males and OR=0.95 and 0.96 for females, respectively. **Conclusions:** Recreational physical activity is associated with youth mental health (particularly in males), but non-recreational physical activity is not consistently associated. While the data are cross-sectional and cannot support causal inference, these results highlight the potential importance of accessible recreational physical activity programs. Further, these results may inform guidelines about types of youth physical activity and their apparent mental health benefits.

Key Words: *physical activity, mental health, Canadian youth*

Résumé

Objectif: Notre objectif était d'examiner les associations entre l'activité physique récréative et non récréative et les résultats de santé mentale chez les adolescents canadiens de 12 à 17 ans. **Méthodes:** Les données transversales de l'Enquête sur la santé dans les collectivités canadiennes de 2015-2016 ont servi à l'analyse. L'activité physique était classée récréative ou non récréative. Les deux types d'activité physique ont été répartis en catégories selon les Lignes directrices canadiennes en matière d'activité physique. Les résultats de santé mentale comportaient le Questionnaire sur la santé du patient -9 (QSP-9), une échelle dichotomisée avec 5+ et 10+ seuils d'inclusion, la santé mentale auto-perçue, et les troubles de l'humeur et anxieux diagnostiqués professionnellement et auto-déclarés. Les statistiques descriptives (les proportions ayant des intervalles de confiance à 95 %) et la régression logistique multivariée ont été utilisées dans l'analyse. **Résultats:** Il a été constaté que 21,20 % des adolescents ne participaient pas à des activités physiques récréatives et que 40,97 % s'adonnaient à des activités physiques récréatives inférieures aux lignes directrices. Aucune

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activité ou des activités physiques récréatives inférieures aux lignes directrices étaient associées à une santé mentale négative. Les modèles d'activité physique non récréative étaient généralement non significatifs. En outre, il a été déterminé que les associations entre l'activité physique récréative et le score au QSP-9 n'étaient manifestes que chez les garçons. Pour l'absence d'activité et les niveaux d'activité inférieurs aux lignes directrices, les rapports de cotes (RC) = 2,57 et 3,19 pour les garçons et RC = 0,95 et 0,96 pour les filles, respectivement. **Conclusions:** L'activité physique récréative est associée à la santé mentale des adolescents (particulièrement chez les garçons), mais l'activité physique non récréative n'est pas associée constamment. Bien que les données soient transversales et qu'elles ne puissent soutenir une inférence causale, ces résultats soulignent l'importance potentielle de programmes accessibles d'activité physique récréative. De plus, ces résultats peuvent éclairer les lignes directrices au sujet des types d'activités physiques des adolescents et de leurs avantages apparents pour la santé mentale.

Mots clés: *activité physique, santé mentale, adolescents canadiens*

Introduction

The reported prevalence of mental disorders in youth populations varies greatly, but it is believed that one in every four to five youth will suffer from mental illness (Patel et al., 2007). Additionally, it is estimated that 75% of adults in the US with mental illness had an onset at less than 24 years of age, emphasizing the need to study youth mental health (Kessler et al., 2005).

Physical activity is a potential determinant of mental health. There is evidence that regular physical activity is a protective factor for youth mental health (Pascoe & Parker, 2019, McPhie & Rawana, 2015). Physical activity is also associated with a decrease in depressive symptoms for youth already experiencing depression (Korczak et al., 2017).

In one study, individuals engaging in leisure time physical activity less than one day per week were found to be at higher risk of depression and anxiety symptoms than those engaging in regular physical activity (Bélair et al., 2018). Increasing levels of physical activity may reduce depression, anxiety, psychological distress and emotional disturbance in children, (Ahn & Fedewa, 2011). Another analysis determined more frequent physical activity and participation in sport were independently associated with greater well-being, and lower levels of anxiety and depressive symptoms in youth (McMahon et al., 2017). Specifically, team sport participation was correlated with the highest reported well-being and lowest levels of anxiety and depression symptoms in this study (McMahon et al., 2017). Jewett et al. found that students consistently participating in school sports reported lower levels of depressive symptoms, lower perceived stress, and higher self-rated mental health than those who had never been involved in school sports (Jewett

et al., 2014). Further, increasing youth's participation in sport was also reported to be associated with diminished depression and suicidal ideation (Babiss & Gangwisch, 2009). Participation in physical activity within a sports club was related to a lower prevalence of depressive symptoms in Norwegian adolescents compared to other types of physical activity, such as individual fitness activities (Klepang et al., 2018). Doré et al. reported a dose-response relationship between years of participation in recreational and performance sport and mental health, with no differences between these sport categories (Doré et al., 2019). These findings mainly associate sport-related activities with positive youth mental health, framing the question of whether certain types of physical activity have different impacts on mental health. However, whether recreational (as opposed to non-recreational) physical activity have different associations with mental health has not been directly addressed by former studies. Recent Canadian population surveys have measured recreational and non-recreational physical activity separately, providing an opportunity to study this question.

In summary, while physical activity is believed to have a positive influence on mental health, it is possible that all types of physical activity are not equal. Recreational activity may have a stronger benefit for mental health than non-recreational activity, and the two are rarely differentiated. Additionally, few of the extant studies were based on representative samples from the general population and are therefore vulnerable to bias and have questionable generalizability. The objective of the current study was to compare the association of recreational and non-recreational physical activity on youth mental health using data that are representative of the Canadian household population.

Methods

The data source for this study was the 2015/2016 Canadian Community Health Survey (CCHS) which is based on a national sample representative of the household population (N=110,100; noting here that this and all subsequent counts reported from the survey must be rounded according to Statistics Canada data release guidelines). The CCHS reported a 59.5% response rate during 2015-2016 (Statistics Canada, 2018), which represents a combination of household and individual level non-response. The survey uses a multi-stage sampling procedure with clustering, unequal selection probabilities, and several different sampling frames. A set of 1000 replicate bootstrap weights are provided by Statistic Canada in order to allow investigators to account for these design effects during analysis. All of the analyses reported here have incorporated this procedure. The CCHS includes respondents aged 12 and over living in private dwellings, however, excluded from the sampling frame are individuals living on Indigenous Reserves and settlements, Crown Lands, institutionalized residents, homeless individuals, full-time members of the Canadian Forces, children living in foster homes, and residents of certain remote regions. In total, these exclusions represent about 3% of the total Canadian population.

To investigate the effects of physical activity on youth mental health, the sample was restricted to include only individuals aged 12-17 (rounded n=9,000). Youth ages 12-15 required verbal permission from parents/guardians to be interviewed. Household-level information was collected from the person most knowledgeable in each household at the end of each survey if there was a person in the household better able to answer such questions than the interviewed youth.

Interviews for the CCHS are conducted either in-person or over the phone using computer assisted interviewing, and data was entered directly into a computer processing system. To measure youth physical activity the CCHS included a 'physical activities for youth' module. This module asked how many hours/minutes of physical activity occurred during the previous week (phrased during questioning as "in the last 7 days..."). Types of physical activity included active transportation (walking or biking to get someplace), physical activity at school/day camp (sports, fitness, etc.), physical activity during leisure time (sports or playing with friends), and other physical activities (paid/unpaid work, or chores). For physical activity during school/camp, leisure

time, or other physical activity, it was required that the specified activities made the youth "sweat at least a little and breathe harder". Further, total minutes of each type of activity were calculated by Statistics Canada and provided as a derived variable for use by investigators.

Total calculated minutes of youth physical activity during school/camp, and leisure time physical activity were summed to create a "total minutes of recreational physical activity per week" variable. The same procedure was applied to the active transportation and other physical activities variables to create a "total number of non-recreational physical activity minutes per week" variable. Recreational physical activity was defined as activities of voluntary participation, or those which have a social component (such as those during school/camp). Non-recreational are activities which are necessary to perform other tasks, such as chores, or work, or active transportation.

As defined by the Canadian Physical Activity Guidelines (CPAG), physically active youth aged 12-17 should have at least 60 minutes of moderate to vigorous physical activity each day (Tremblay et al., 2011). As noted above, moderate physical activity was defined as activity that causes a person to "breathe harder" and "sweat at least a little". We defined physically active youth roughly based on CPAG as 420 minutes per week (approximately 60 minutes a day). Youth were categorized into no physical activity (0 minutes per week), below guideline physical activity (less than 420 minutes, but greater than 0 minutes a week) and at or above guideline physical activity (greater than or equal to 420 minutes per week). This categorization was done separately for both the recreational, and non-recreational weekly physical activity variables.

In this study, five different mental health outcomes were analyzed. One measurement of self-reported depression given by the CCHS is the Patient Health Questionnaire (PHQ-9) (Kroenke et al., 2001). Questions in the PHQ-9 ask respondents about their sleep patterns, mood, etc. using 9 items that roughly align with the DSM-5 "A" criterion symptoms. Each item is scored 0-3, leading to possible scores of 0-27. Scores of 5 and above are interpreted as mild depression, and a score greater than 10 is interpreted as moderate to severe depression, and is often used as a screening cut-point (Kroenke et al., 2001). Thus, these two cut-off points were used to create dichotomous variables for individuals rating above or equal to 5, and 10 on the PHQ-9 scale. The PHQ-9 was included in the CCHS

depression module that was optional content and was taken by respondents in: Newfoundland, P.E.I., Nova Scotia, New Brunswick, Ontario, Manitoba, Saskatchewan, and the North West Territories, yielding a smaller youth sample size than the other mental health indicators.

Additional mental health indicators included self-reported professionally diagnosed anxiety disorders and self-reported professionally diagnosed mood disorders including depression, bipolar, mania, or dysthymia.

We also included “perceived mental health” as an outcome. This was based on a single item where respondents were asked how they perceived their overall mental health. Options to answer were: excellent, very good, good, fair and poor. Excellent, very good, and good mental health were grouped together, and fair/poor were grouped together to create a dichotomized measure of perceived mental health.

The covariates included in the models were: age, income, geographic region, student status, smoking status, alcohol consumption, chronic conditions, and the use of illicit drugs. Age ranged from 12-17 years. Income was measured as an adjusted household income ratio, and was split into quartiles, the highest quartile being the highest income ratio. Geographic region referred to if the respondent lived in an urban centre, or a rural area. Student status referred to whether the respondent was currently attending school, college, CEGEP, or university at the time of the interview. Smoking status was coded “yes” for current smokers, and “no” for never smoked/past smokers. Alcohol consumption referred to the respondents’ binge drinking, which is defined as 5+ drinks for males, and 4+ drinks for females on at least one occasion per month. The chronic conditions variable was coded “yes” if the respondent had one or more of the following chronic conditions: arthritis, asthma, back problems, cancer, diabetes, heart disease, high blood pressure, migraine, and/or effects of a stroke. The use of illicit drugs was also covered by the survey questionnaire. At the time of data collection, cannabis was an illicit drug. The covariates selected have been previously cited as determinants of youth mental health, and were included in the analysis since any independent determinant of mental health could confound associations between physical activity and mental health. Also, as such variables could modify the effects of physical activity, we explored interactions between these variables and physical activity.

Statistical analysis was performed in STATA v15 (Stata-Corp, 2019). The analysis began with univariate analysis,

and subsequent bivariate and multivariable models were constructed. Proportions and descriptive statistics are reported as percentages with 95% confidence intervals. Logistic regression models were used to determine odds ratios and 95% confidence intervals for recreational and non-recreational physical activity with each of the mental health outcomes. The highest category of each type of physical activity (equal or greater than 420 minutes per week), served as the reference group in models. When interaction terms in the model were significant, the sample was stratified by that variable and subsequent models were run in the resulting strata. Some covariates, such as education, were excluded from the final all-inclusive models due to the small sample sizes in some groups (such as the “graduated from high school” group among respondents aged 12-17). Employment status was also excluded from the models after examining multiple models and continuously seeing no effect, probably due to the age of the sample.

Results

Characteristics of the sample are presented in Table 1. There is a greater proportion of female youth who are in the lower activity categories than males. The mean age in the “no activity” category is slightly elevated from the “meeting guidelines” category, indicating older youth do less recreational physical activity. The highest percentage of youth who do not do any recreational physical activity are in the lowest income quartile, highlighting the potential importance of income for recreational physical activity participation. The proportion of youth in the zero-activity category who report smoking and drug-use are elevated compared to the other categories. The lowest percentage of youth who do non-recreational physical activity were also in the lowest recreational physical activity category, indicating that youth who do not participate in recreational physical activity are also less likely to participate in non-recreational physical activity. There is a greater percentage of obese youth in the no recreational physical activity group.

For each negative mental health outcome examined, there is a reduced frequency of poor mental health in association with higher levels of recreational physical activity, (Table 2). However, we identified a significant sex by recreational PA interaction term (coefficient=0.000957, $p=0.03$), necessitating stratification by sex in subsequent analysis. This effect modification was not hypothesized a priori, but the subsequent stratification was considered necessary due to evidence of effect modification.

Table 1. Demographic characteristics of the sample (proportions)

Characteristics	All youth: proportion % (95% CI) n = 9,000*	No recreational physical activity proportion % (95% CI) n = 1,800*	Some recreational physical activity but <420 minutes per week proportion % (95% CI) n = 3,800*	≥420 minutes per week of recreational physical activity proportion % (95% CI) n = 3,400*
Sex				
Female	48.65 (48.65-48.65)	55.70 (52.69-58.71)	53.84 (52.02-55.66)	39.25 (37.37-41.13)
Student status				
Current student	96.25 (95.74-96.77)	92.12 (90.36-93.89)	96.87 (96.15-97.59)	97.77 (97.14-98.41)
Adjusted household income (ratio to low income cut-off)**				
Quartile 1	31.37 (30.16-32.59)	39.24 (35.91-42.56)	32.42 (30.27-34.56)	25.74 (23.54-27.94)
Quartile 2	24.17 (22.89-25.45)	21.37 (18.63-24.10)	24.34 (22.29-26.40)	25.63 (23.58-27.67)
Quartile 3	22.68 (21.58-23.78)	22.74 (19.89-25.59)	22.87 (21.09-24.66)	22.55 (20.59-24.50)
Quartile 4	21.77 (20.83-22.71)	16.66 (14.44-18.88)	20.36 (18.70-22.03)	26.08 (24.19-27.98)
Geographic region				
Population centre	80.69 (79.80-81.59)	82.37 (80.20-84.54)	80.93 (79.51-83.36)	79.55 (77.88-81.21)
Rural	19.31 (18.41-20.20)	17.63 (15.46-19.80)	19.07 (17.64-20.49)	20.45 (18.79-22.12)
Smoking status				
Current smoker	3.93 (3.34-4.63)	6.91 (5.30-8.52)	3.22 (2.52-3.93)	3.04 (2.06-4.02)
Alcohol consumption				
Binge drinking***	4.00 (3.40-4.59)	4.30 (3.12-5.48)	3.69 (2.85-4.53)	4.28 (3.23-5.33)
BMI				
Obese	5.85 (5.10-6.60)	6.65 (4.86-8.44)	6.33 (5.20-7.45)	4.90 (3.77-6.03)
Chronic conditions				
Has one or more chronic condition****	22.92 (21.68-24.16)	22.32 (19.49-25.15)	22.13 (20.22-24.05)	24.01 (21.96-26.06)
Non-recreational physical activity				
Reports non-recreational physical activity in the week	72.89 (71.50-74.27)	60.19 (56.62-63.76)	76.35 (74.47-78.23)	77.28 (75.25-79.32)
Drug use				
Has used illicit drugs in the past 12 months	5.59 (4.87-6.30)	6.90 (5.28-8.53)	5.54 (4.45-6.63)	5.04 (3.90-6.19)
Age, mean (SD)	14.52 (14.47-14.57)	14.95 (14.83-15.07)	14.48 (14.40-14.57)	14.34 (14.26-14.41)
*Rounded to the nearest hundred.				
**Quartile 1 as the lowest income quartile; quartile 4 the highest.				
***Binge drinking is defined as 5+ drinks for males, and 4+ drinks for females on one occasion once, or more than once a month in the past year.				
****The chronic conditions included in this variable are arthritis, asthma, back problems, cancer, diabetes, heart disease, high blood pressure, migraine, and/or effects of a stroke.				

Table 2. Mental health characteristics of the sample (proportions)

	All youth: proportion % (95% CI) n=9,000*	No recreational physical activity % (95% CI) n=1,800*	Some recreational physical activity but <420 minutes per week % (95% CI) n=3,800*	≥420 minutes per week of recreational physical activity % (95% CI) n=3,400*
Categorized depression scores**				
PHQ-9 score ≥10	8.05 (6.80-9.30)	10.26 (7.69-12.83)	8.85 (6.51-11.19)	6.00 (4.28-7.73)
PHQ-9 score ≥5	22.46 (20.57-24.35)	27.40 (22.86-31.95)	23.99 (20.89-27.09)	18.29 (15.66-20.92)
Mood disorder				
Has a mood disorder	4.97 (4.33-5.60)	7.82 (5.99-9.64)	5.37 (4.30-6.43)	2.97 (2.24-3.94)
Anxiety disorder				
Has an anxiety disorder	8.62 (7.69-9.54)	11.69 (9.52-13.85)	8.82 (7.42-10.21)	6.83 (5.45-8.21)
Self-perceived mental health				
Has fair/poor self-perceived mental health	4.30 (3.72-4.88)	6.77 (5.20-8.33)	4.57 (3.60-5.54)	2.76 (1.97-3.55)
Depression scores**				
PHQ-9 score, mean (SD)	3.04 (2.86-3.21)	3.48 (3.06-3.91)	3.16 (2.87-3.45)	2.65 (2.41-2.90)
*Rounded to the nearest hundred due to Statistics Canada data release guidelines.				
**PHQ-9 questions were asked in Newfoundland and Labrador, PEI, Nova Scotia, New Brunswick, Ontario, Manitoba, Saskatchewan, North West Territories				

Table 3 presents crude and adjusted odds ratios (ORs) for the recreational physical activity exposure. A similar pattern is seen for each of the mental health outcomes except self-reported professionally diagnosed anxiety disorders. For the other outcomes, there is a higher frequency of negative mental health in those with below-guideline (<420 minutes) recreational physical activity participation for males in both the unadjusted and adjusted estimates. This pattern was not seen as consistently in females. The PHQ-9 data based on a 10+ cut-point was the most striking example of this pattern since the confidence intervals for the ORs do not cross the null value in the males, whereas in females the estimated ORs fall near the null value.

Comparing the results of the recreational physical activity analysis, and the non-recreational analysis in relation to mental health, it is clear that unlike recreational physical activity, a lack of non-recreational physical activity is not associated with negative mental health outcomes, Table 4. The ORs are less than one, suggestive of a protective effect.

As previously noted, it was also possible to model the effects of minutes of physical activity continuously. Figures 2 and 3 present fitted values from a logistic regression model

with minutes of recreational physical activity included as a continuous variable, proportions with 10+ PHQ-9 scores (Figure 2) and proportions with fair/poor perceived mental health (Figure 3) as the outcomes. Figure 2 is a regression model including the significant sex by recreational physical activity term ($p=0.03$), illustrating the large change in fitted proportion of males with PHQ-9 ≥ 10 , and the smaller change in females. Figure 3, which depicts the perceived mental health outcome, had no significant interaction ($p=0.69$) and represents the more negative perception of mental health seen in females, and the better perceived mental health with higher levels of recreational physical activity (without change in the sex difference across physical activity levels). While there is an interaction in the model underpinning Figure 2, the general trends (female > male, declining prevalence with increasing activity) are similar. Note also, that the models underpinning these figures do not include covariate adjustments. When examining the two figures together, the sex differences demonstrated by differing slopes are evident in Figure 2, but not in Figure 3, displaying the significant interaction term associated with the PHQ-9 outcome.

Table 3. Crude and adjusted Odds Ratios (ORs) with each mental health outcome and recreational physical activity stratified by sex

RECREATIONAL PHYSICAL ACTIVITY	Crude						Adjusted*					
	Overall youth		Males		Females		Overall youth		Males		Females	
	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)	
PHQ-9≥10												
Zero physical activity	1.79 (1.19-2.69)**	2.75 (1.30-5.84)**	1.13 (0.69-1.85)	1.61 (0.99-2.61)	2.57 (1.03-6.41)**	0.95 (0.51-1.77)						
Below guideline physical activity	1.52 (0.98-2.35)	2.90** (1.36-6.20)	0.93 (0.55-1.57)	1.61 (0.99-2.62)	3.19 (1.30-7.85)**	0.96 (0.52-1.78)						
Above guideline (referent)	-----	-----	-----	-----	-----	-----						
PHQ-9≥5												
Zero physical activity	1.68 (1.26-2.25)**	1.99 (1.30-3.07)**	1.23 (0.83-1.82)	1.49 (1.07-2.07)**	2.17 (1.28-3.69)**	0.92 (0.59-1.45)						
Below guideline physical activity	1.41 (1.10-1.81)**	1.72 (1.17-2.53)**	1.05 (0.76-1.46)	1.36 (1.03-1.80)**	1.60 (1.05-2.45)**	1.02						
Above guideline (referent)	-----	-----	-----	-----	-----	-----						
MOOD DISORDER												
Zero physical activity	2.77 (1.88-4.08)**	3.93 (2.13-7.26)**	1.88 (1.14-3.12)**	1.69 (1.06-2.69)**	1.46 (0.66-3.23)	1.49 (0.81-2.75)						
Below guideline physical activity	1.85 (1.30-2.63)**	2.22 (1.30-3.80)**	1.44 (0.89-2.33)	1.72 (1.14-2.59)**	2.10**	1.34						
Above guideline (referent)	-----	-----	-----	-----	-----	-----						
ANXIETY DISORDER												
Zero physical activity	1.81 (1.34-2.43)**	2.46 (1.55-3.90)**	1.27 (0.85-1.90)	1.36 (0.92-2.02)	1.51 (0.79-2.88)	1.02 (0.60-1.72)						
Below guideline physical activity	1.32 (1.01-1.73)**	1.26 (0.83-1.90)	1.2 (0.83-1.74)	1.22 (0.87-1.71)	1.42 (0.83-2.41)	0.94 (0.61-1.45)						
Above guideline (referent)	-----	-----	-----	-----	-----	-----						
PERCEIVED MENTAL HEALTH												
Zero physical activity	2.56 (1.73-3.78)**	2.49 (1.31-4.75)**	2.10 (1.29-3.42)**	2.27 (1.45-3.56)**	1.91 (0.88-4.13)	1.88 (1.07-3.32)**						
Below guideline physical activity	1.69 (1.15-2.46)**	2.01 (1.07-3.79)**	1.3 (0.81-2.08)	1.64 (1.10-2.46)**	1.89 (0.93-3.83)	1.26 (0.76-2.09)						
Above guideline (referent)	-----	-----	-----	-----	-----	-----						

*adjusted models include age, income, geographic region, smoking status, alcohol consumption, chronic conditions, drug use, student status, obesity, and non-recreational physical activity, see Table 1.

**indicates statistical significance at the 95% level of confidence where the lower confidence limit is >1.0.

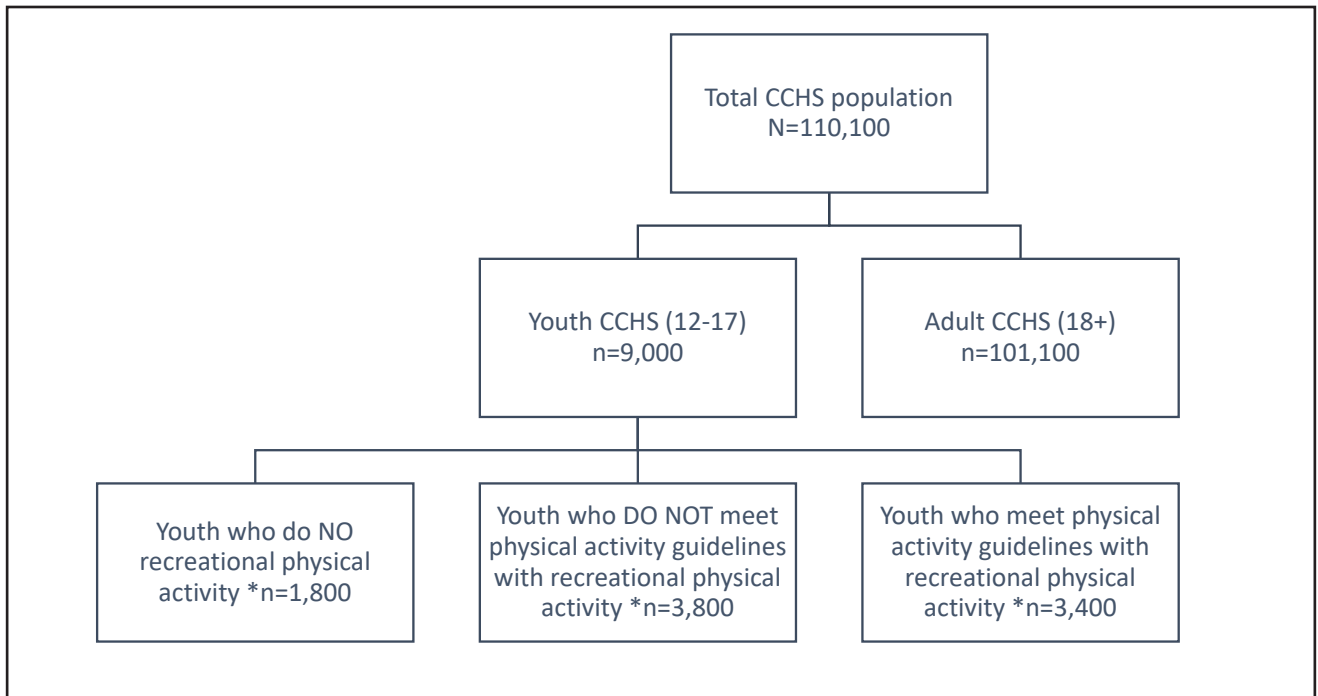
Table 4. Crude and adjusted Odds Ratios (ORs) with each mental health outcome and categorized non-recreational physical activity		
NON-RECREATIONAL PHYSICAL ACTIVITY	Crude OR (95% CI)	Adjusted* OR (95% CI)
PHQ-9≥10		
Zero physical activity	0.5 (0.30-0.85)	0.48 (0.26-0.88)
Below guideline physical activity	0.58 (0.36-0.93)	0.62 (0.36-1.05)
Above guideline (referent)	-----	-----
PHQ-9≥5		
Zero physical activity	0.73 (0.52-1.01)	0.77 (0.53-1.11)
Below guideline physical activity	0.78 (0.58-1.07)	0.84 (0.60-1.19)
Above guideline (referent)	-----	-----
MOOD DISORDER		
Zero physical activity	0.58 (0.38-0.89)	0.51 (0.30-0.87)
Below guideline physical activity	0.55 (0.38-0.78)	0.71 (0.46-1.09)
Above guideline (referent)	-----	-----
ANXIETY DISORDER		
Zero physical activity	0.72 (0.51-1.01)	0.66 (0.43-1.00)
Below guideline physical activity	0.59 (0.44-0.81)	0.69 (0.48-1.00)
Above guideline (referent)	-----	-----
PERCIEVED MENTAL HEALTH		
Zero physical activity	0.67 (0.44-1.01)	0.73 (0.48-1.13)
Below guideline physical activity	0.67 (0.46-0.98)	0.73 (0.49-1.08)
Above guideline (referent)	-----	-----
*adjusted models include age, income, geographic region, smoking status, alcohol consumption, chronic conditions, drug use, student status, and obesity.		

Discussion

In addressing the initial objectives of this study, it was determined that recreational physical activity was associated with positive mental health for youth, however, non-recreational physical activity showed generally small and insignificant associations with mental health outcomes. Some of the associations with (a lack of) non-recreational activity suggested a protective effect, which seem implausible and may be related to uncontrolled confounding, or Type I error. The identified associations between recreational physical activity and mental health in youth are supported by literature which finds activities that fall under our categorization of “recreational” to be associated with better mental health (White et al., 2017). However, we extend this literature by clarifying that the effect of recreational physical activity may be stronger in male compared to female youth. The association in females was not significant in our analysis, but our models (see Figures 2 and 3) suggest that the

association may exist in both sexes. We may have lacked power to detect such association in females. Previous research has indicated that no differential effect of physical activity in males and females exists, with regard to mental health outcomes (McPhie & Rawana, 2015). In fact, other cross-sectional analyses have found activities such as team sports to be more impactful on positive mental health outcomes for females than males (Guddal et al., 2019).

The study which categorized physical activity in the most similar manner to the CCHS approach, found sport-type activity to have the strongest effect on psychological distress (as their main mental health outcome) compared to what they called domestic physical activity (defined by gardening or chore-type activities). However, this study was conducted in an adult population in Scotland (Hamer et al., 2009) and may not be generalizable to Canada. Our data supports that meeting physical activity guidelines

Figure 1. STROBE diagram of population stratification from total CCHS.

* rounded according to Statistics Canada guidelines

**Physical activity categories do not add up to total youth CCHS population due to missing values

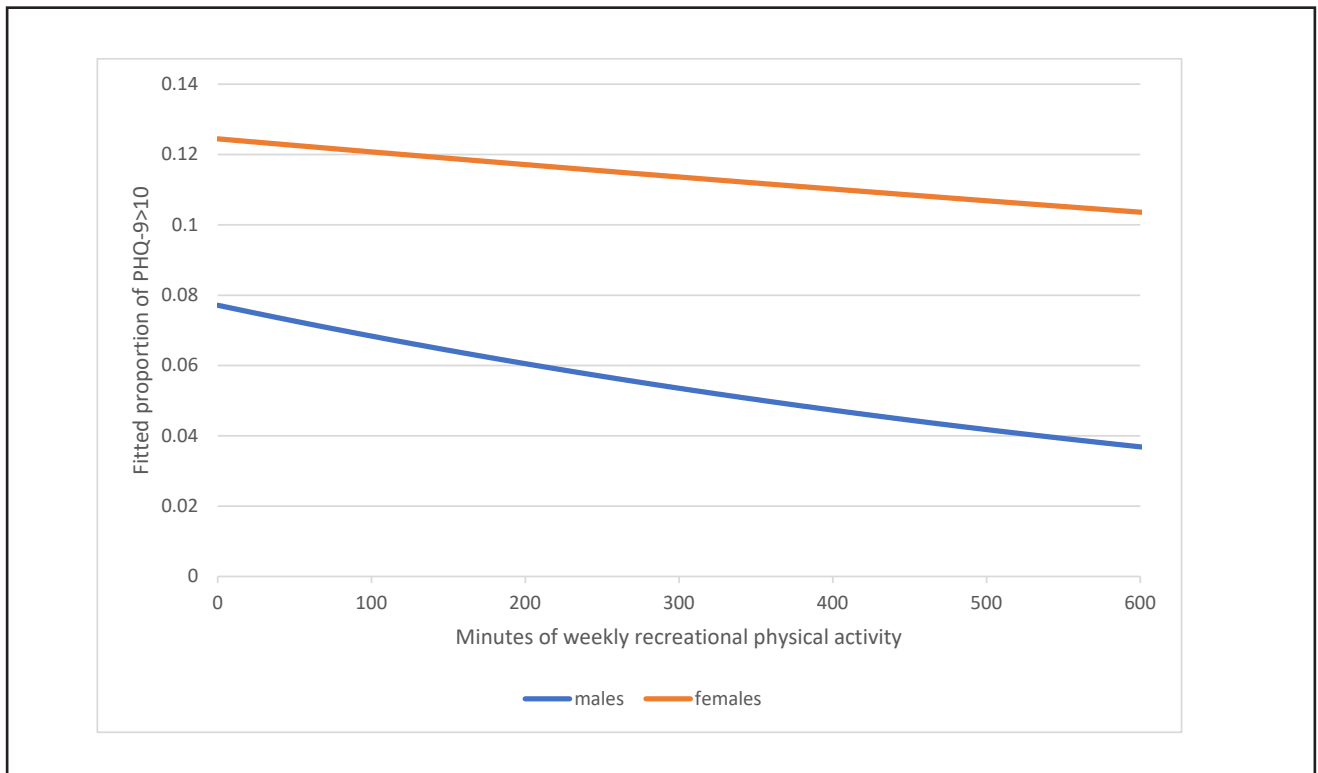
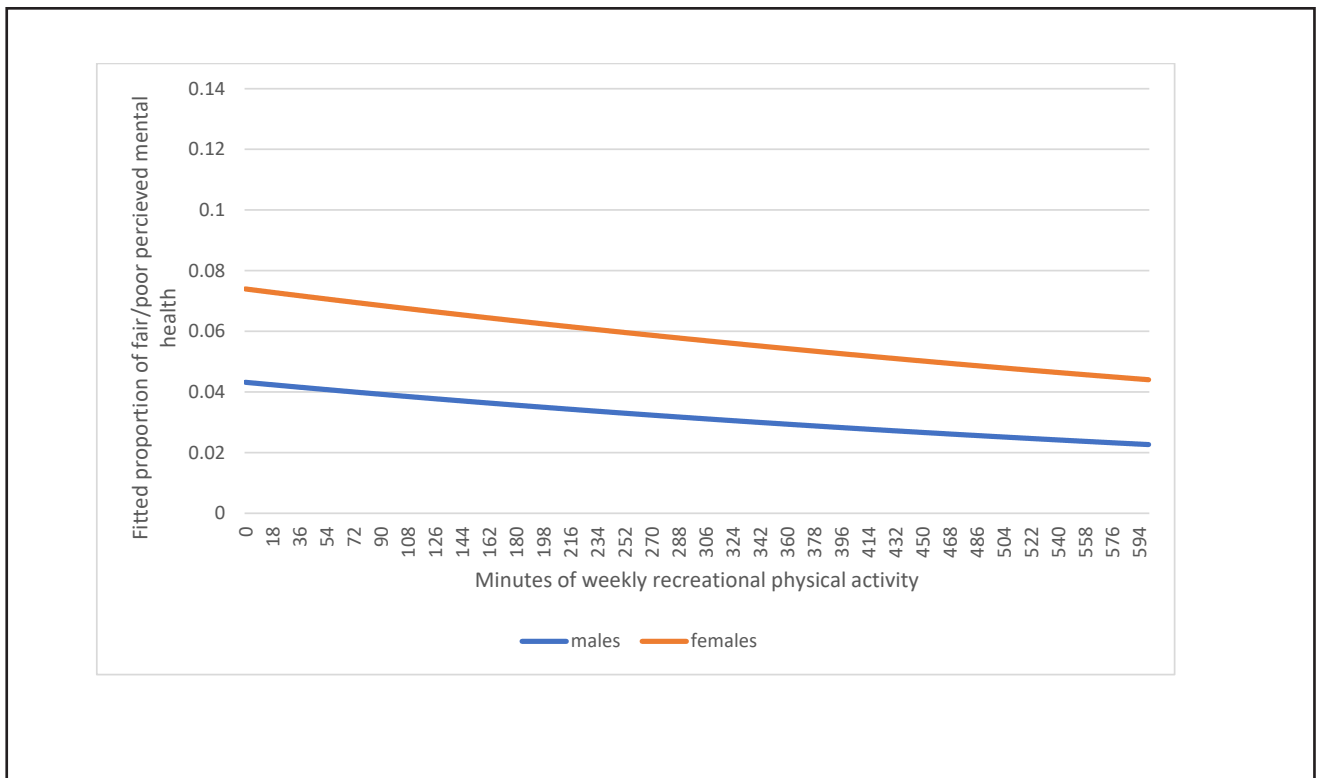
Figure 2. Proportion of youth males and females with PHQ-9 \geq 10 and weekly minutes of recreational physical activity

Figure 3. Proportion of youth males and females with fair/poor perceived mental health and weekly minutes of recreational physical activity



with recreational physical activity is associated with positive mental health according to a variety of measures. No such evidence was found in this study for non-recreational activity.

Past research has generally failed to identify correlations of anxiety and physical activity, consistent with our results. A 2006 review provides an overview of similarly negative results (Larun et al., 2006). There is a body of evidence which suggests that competitive sports, in particular, can lead to anxiety, negative mood-states and over-training (Tobar, 2012), indicating a complicated relationship between anxiety and physical activity. Further research is needed in this area since anxiety is a prominent mental health concern among Canadian youth.

The categorization of physical activity in this study, though it is not exactly per CPAG guidelines due to the nature of our variables, uses the group which roughly meets CPAG guidelines as a referent, and saw effects on both the below

guidelines group and the no activity group of recreational physical activity. The strength of effect was often quite similar in these two groups, emphasizing the importance of meeting physical activity guidelines. This finding contrasts with some prior literature which found no additional effect of guideline-meeting physical activity (McMahon et al., 2017).

There are both physiological and psychosocial effects of exercise that may benefit mental health (Lubans et al., 2016). Previous research suggests adolescents with mild-to-moderate depressive symptoms in an exercise treatment program have decreased depressive symptoms and reductions of measured stress hormones, along with reduced resting heart rate and increased oxygen uptake and lung capacity (Nabkasorn et al., 2006). These are examples of physiological processes at play, whereas social factors derived from recreational physical activity participation, specifically sports, include positive experiences that improve perceived social

acceptance and reduce body dissatisfaction (Boone & Leadbeater, 2006). The results of our study in finding recreational physical activity to be associated with positive mental health points to differences in experience between recreational and non-recreational physical activity, possibly due to social factors. Youth must still fulfill physical activity guidelines to derive potential benefits, however, indicating a physiological aspect. It is interesting to speculate that the stronger effect in males may be due to the social aspects of recreational physical activity since males may have a narrower repertoire of social engagements than females and may therefore be more reliant on recreational physical activity as a source of social engagement and support.

Strengths and Limitations

Strengths of this study include its nationally representative sample and large sample size, which improves generalizability to the Canadian household population. That being said, groups such as indigenous populations living on reserves, institutionalized individuals, members of the armed forces are not represented by this study. Additionally, with a 59.5% individual response rate, there may be non-responders who have different characteristics than those surveyed. However, the replicate bootstrap provided by Statistics Canada include adjustments for non-response, which should help to prevent selection bias. The cross-sectional nature of this data means that causality cannot be inferred, thus, recreational physical activity may improve depression symptoms, or depressed individuals may not be engaging in recreational physical activity. Some information, such as if respondents were receiving treatment for existing mental health disorders, were not measured in the CCHS and thus were not able to be included as covariates. The absence of potential confounding variables could have resulted in uncontrolled confounding. Future longitudinal research that addresses the interactions of both recreational and non-recreational activity with mental health, along with potential sex differences are suggested to confirm the findings of this study and determine a causal relationship. Also, mental health treatment was not assessed in the survey and could not be included in the analysis. Due to the limitations of observational data in supporting causal inference, intervention studies of recreational physical activity would be a welcome addition to this literature.

Conclusion

Longitudinal studies are needed to confirm and replicate these findings. Ultimately, policies that increase access to recreational physical activity for youth may improve population mental health, especially in males.

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Conflicts of Interest

The authors have no financial relationships to disclose.

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