Int J Public Health (2012) 57:315–324
DOI 10.1007/s00038-011-0306-0

ORIGINAL ARTICLE

Factors associated with physical activity among Canadian high school students

Carly Leggett · Melinda Irwin · Jane Griffith · Lin Xue · Katherine Fradette

Received: 22 December 2010 / Revised: 6 September 2011 / Accepted: 12 September 2011 / Published online: 28 September 2011

Abstract
Objectives Identifying multi-level factors affecting physical activity (PA) levels among adolescents is essential to increasing activity to promote health within this population. This study examines the associations between PA and 11 independent factors among Manitoba high school students.
Methods The sample included 31,202 grade 9–12 students who completed the Manitoba Youth Health Survey. Associations between PA and independent factors were examined separately and through multivariate regression. Analyses were stratified by gender.
Results Perception of athletic ability, school location, parental encouragement and number of active friends were strong predictors of activity for moderately active and active males and females. Grade was a significant predictor of PA for females at both levels of activity but only significant for males when comparing active to inactive students. Perception of schoolwork and means of transport were minimally associated with PA.
Conclusions Results highlight the importance of targeting multiple levels of influence to increase PA among youth. Programs should focus on older students, females and those who are inactive or moderately active. In addition, social modeling of PA and increasing self-efficacy around activity should be encouraged.

Keywords Physical activity · Adolescents · Canada · High school · Risk factors

C. Leggett (✉)
Epidemiology and Cancer Registry, CancerCare Manitoba, RM OG008, 409 Tache Avenue, Winnipeg, MB R2H 2A6, Canada
e-mail: carly.leggett@cancercare.mb.ca

M. Irwin
Yale School of Public Health, New Haven, CT, USA
e-mail: melinda.irwin@yale.edu

J. Griffith
Department of Community Health Sciences, Faculty of Medicine, CancerCare Manitoba, University of Manitoba, Winnipeg, MB, Canada
e-mail: jane.griffith@cancercare.mb.ca

L. Xue · K. Fradette
CancerCare Manitoba, Winnipeg, MB, Canada
e-mail: lin.xue@cancercare.mb.ca

K. Fradette
e-mail: katherine.fradette@cancercare.mb.ca

Introduction

Background of the issue

According to the World Health Organization (WHO), physical activity (PA) plays a major role in promoting and maintaining health throughout life. Physical inactivity is a risk factor for various chronic diseases with estimates predicting that 1.9 million global deaths are attributable to physical inactivity annually (WHO 2009a). Over time, increases in sedentary behaviors and decreases in PA have led to a rapid increase in global obesity. In 2005, the WHO estimated that 1.6 billion adults worldwide were overweight and approximately 400 million adults were obese with a predicted rise to 2.3 billion overweight and over 700 million obese by 2015 (WHO 2009b). Evidence also suggests that childhood obesity is associated with increased risk of premature death and disability in adulthood and that

adult chronic disease reflects lifetime exposures to damaging environments (WHO 2010a).

Social–ecological models suggest that health behaviors such as PA are influenced by factors at the individual, social, and physical environmental levels (Sallis et al. 2000). Younger age, male gender and living in an urban setting are consistently positively associated with PA (Sallis et al. 2000; Loucaides et al. 2007; Ismailov and Leatherdale 2010). Similarly, self-efficacy, intention and perception of ability along with social support at the family, peer and school levels have all been linked to higher levels of PA (Loucaides et al. 2007; Pan et al. 2009).

The WHO defines settings for health as "the place or social context in which people engage in daily activities in which environmental, organizational and personal factors interact to affect health" (Nutbeam 1998). As such, schools are in a position to positively impact the health of youth through policy change and school culture. In particular, focusing on asset development, protective factors and social connectedness can support youth development and reduce the risk of health-related issues (CASH 2006).

Physical activity and youth

The Public Health Agency of Canada (PHAC) suggests that over half of Canadian youth do not perform enough PA for optimal growth and development. Canada's Physical Activity Guide for Youth recommends that adolescents of ages 10–14 accumulate at least 90 min of PA per day through a combination of moderate and vigorous activities (MVPA) and that youth simultaneously decrease the time they spend on sedentary activities by at least 30 min a day (PHAC 2010).

According to 2004 estimates for Canadian children of ages 6–11, only 41% participated in the 7–13 h of PA a week required to meet these daily recommendations, with females showing lower PA levels than males (HealthCanada 2004). In 2008, a cross-Canadian study showed that 88% of youth were not accumulating enough daily steps to meet the recommendations (approximately 16,500 steps/day), while overall steps decreased with age and boys consistently took more steps than girls (CFLRI 2005). Global data suggest similar trends. In 2009, only 18% of American high school students reported 60 min of activity/day (CDC 2010), while results from the international Health Behavior in School Aged Children Survey show that only 34% of youth meet these international guidelines for PA (WHO 2004). However, due to small sample sizes and methodology issues, there remains a lack of accurate data showing the levels and correlates of PA among Canadian youth, specifically among Manitobans of ages 15–19.

Specific objectives

Identifying multi-level factors affecting PA levels of Manitoba high school students can facilitate the planning of programs, interventions and curricula for increasing activity among this population. In addition, identifying gender differences in these associations can help focus interventions and target populations of youth. This study examined results of the 2005–2008 Manitoba Youth Health Survey (YHS) to identify determinants associated with PA. The specific research questions were:

- Which individual, social and physical environmental factors are independently associated with physical activity among Manitoba youth enrolled in grades 9–12?
- Do the associations between physical activity and these factors differ by gender?

Methods

Study design

This study used cross-sectional data from the 2005–2008 Manitoba YHS. The purpose of the YHS was to provide schools, divisions and Regional Health Authorities (RHA) with school specific information on youth health and risk factors for chronic disease. The Interlake RHA developed the survey tool using local level input and validated questions from national and international surveys and included questions on PA, nutrition, tobacco, substance use and school connectedness. Surveys were paper based and completed during class time. Questionnaires were scanned using identical software at one of three locations and data were securely stored at CancerCare Manitoba.

All high schools in Manitoba were given the chance to participate with 33,977 students in grades 9–12 completing the survey. To assess whether those surveyed were similarly distributed to the Manitoba population, survey respondents of ages 14–17 were compared to Manitoba youth of ages 14–17 for the year 2007. This comparison showed that the percentage of students at each age in the YHS data set was roughly equivalent to the age distribution in Manitoba at the time. Analysis of this same age comparison was further broken down by gender with similar results.

Physical activity measures

PA measures for the YHS were based on the University of Waterloo's SHAPES PA module (Wong et al. 2006). Two separate questions were asked to participants on how many

hours and minutes of vigorous and moderate PA they did on each day in the previous week. This inclusion of intensity, duration and frequency information allows comparisons with the previous surveys classifying PA according to energy expenditure (Craig et al. 2001). According to Wong et al. (2006), after administering the SHAPES PA module twice in a convenience sample of 2,812 students from 15 Manitoba high schools, the one-week, test–retest reliability for the PA items had a moderate kappa/weighted kappa coefficient of 0.60 ± 0.10 based on the classification system of Landis and Koch (Landis and Koch 1977). In a second study by Wong et al. (2006), the criterion validity of these PA measures was assessed using accelerometer data and measured height and weight in a sample of 67 high school students. Using Spearman rank-order correlations, results showed that the self-reported and accelerometer-measured average daily time spent performing MVPA were significantly correlated (Spearman $r = 0.44$, $p < 0.001$), although self-reported time spent performing PA was higher than measured values in the majority of participants. Based on these two studies, the module was shown to have acceptable reliability and validity for use in large-scale, school-based data collections among adolescent populations (Wong et al. 2006).

Metabolic equivalents (METs) are commonly used to express the intensity of activities and represent the ratio of a person's working metabolic rate relative to their resting metabolic rate. One MET is defined as the energy cost at rest and is equivalent to a caloric consumption of 1 kcal/kg/h. It is estimated that a person's caloric consumption is three to six times higher when being moderately active and more than six times higher when being vigorously active (WHO 2010b). For this population, a total MET-hours/day was derived by multiplying the respective total hours of PA with the MET value of vigorous PA (MET = 6.0) and moderate PA (MET = 3.0) as per the following formula (Wong et al. 2006; Leatherdale et al. 2010):

$$\text{Total MET-hours/day} = (\text{vigorous} \times 6\,\text{METS} + \text{moderate} \times 3\,\text{METS})/7\ \text{days}.$$

The SHAPES PA measures are valid for distinguishing youth who report less PA from those who report more PA. Based on categories used in the previous studies using these PA measures, youth were classified as inactive if they expended <3 MET-hours/day, moderately active if they expended 3–8 MET-hours/day or active if they expended >8 MET-hours/day (Wong et al. 2006). This represented the three-level dependent variable for analysis.

Predictor variables

Eleven variables were analyzed as potential correlates of PA level among this population. These variables represent a range of individual, social and physical environmental factors previously associated with PA levels in other populations.

Individual demographic data were collected on grade level, means of transport to school and smoking status of participants. Methodology from SHAPES was adapted to define student smoking categories with a test–retest reliability kappa/weighted kappa coefficient of 0.80 ± 0.06 (Wong et al. 2006). Four questions assessing participants' perceptions and feelings were analyzed to evaluate psychosocial relationships and self-efficacy. Participants were asked perception of their athletic ability, schoolwork performance and weight. In addition, students were asked if they had felt so sad or helpless during the previous 12 months that they stopped doing their usual activities.

Three questions addressed students' social environment. Participants were asked how much their parent(s) or guardian(s) encourage them to be physically active, how many of their five closest friends are physically active and how strongly they agreed with the statement "I feel close to people at this school."

Students attending a school within the urban centers of Winnipeg (population of 694,668) or Brandon (population of 48,256) were classified as "urban." All others were classified as "rural" (StatsCan 2006).

Statistical analysis

Analyses were done using SAS 9.2 at the Yale School of Public Health. The full data set ($N = 33{,}977$) was limited to participants with responses for the dependent variable (PA) and all independent variables ($N = 31{,}202$). Predictor and outcome data were arranged into categorical variables for analysis. First, bivariate logistic regression compared each independent variable with PA with an alpha level set at 0.05. Analyses were performed independently for males and females and results were presented separately by gender, based on methodology used in the previous literature to eliminate effect modification by this variable. Independent variables that were significant in bivariate analyses were initially included in multivariate analyses.

Since PA level was reported as an ordered category, ordinal logistic regression could have been used. However, the Score Test for the Proportional Odds Assumption ($\chi^2 = 282.189$, $df = 15$, $p = < 0.0001$) rejected the null hypothesis of proportionality across levels of PA, suggesting that multinomial logistic regression was the more appropriate method for analysis. Using the inactive group as the reference category for PA, single multinomial logistic regression models were run for males and females to separately compare the moderately active group and the active group with the reference category. In SAS, backward and forward elimination procedures were used for

both male and female models with consistent results. Results from the backward selection model are reported. The Wald test was used for statistical significance with alpha set at 0.05.

Results

The study sample ($N = 31,202$) included 49.6% males and 50.4% females. The majority of students were in grades 9 or 10 (54.2%) with grades 11 or 12 representing 45.8% of the sample. Forty-nine percent of the sample was categorized as active while 33% were moderately active and 19% were inactive.

Results of the bivariate analyses between study variables and PA level are shown in Table 1 for males and Table 2 for females. Among males, at least one level of each independent variable was significantly associated with either moderate or active levels of PA ($p < 0.05$). As such, all 11 variables were included as covariates in the multivariate analysis for males. The bivariate analysis for females shows that all independent variables except for "feelings of sadness/helplessness" were significantly associated with either moderate or active levels of PA ($p < 0.05$). This variable was not included as a covariate in the multivariate analysis for females.

To identify significant determinants of PA, multivariate multinomial logistic regression analyses were performed for males and females. After running the full multivariate model for males, "feelings of sadness/helplessness" and "perception of body weight" were non-significant and removed from the final model. The results of the likelihood ratio test of the final model for males ($\chi^2 = 1,906.41$, $df = 22$, $p = < 0.001$) indicate the statistical significance. After running the full multivariate model for females, "closeness to others at school" was non-significant and removed from the final model. The results of the likelihood ratio test of the final model for females ($\chi^2 = 1,951.80$, $df = 24$, $p = < 0.001$) indicate the statistical significance.

Table 3 shows the results of the multivariate analysis for males. After adjusting for the other covariates, urban setting, active friends, parental encouragement of PA and perception of athletic ability were most positively correlated with PA. These associations were particularly strong when comparing the active to inactive students. Grade and smoking were only significant when comparing active to inactive males but non-significant when comparing moderately active to inactive males. Means of transport, closeness to people at school and perception of school work showed significance but did not differ appreciably between levels of PA.

Table 4 shows the results of the final multivariate analysis for females. Consistent with the male results, the strongest positive associations were for urban setting, active friends, parental encouragement of PA and perception of athletic ability. Again, these associations were significant at both levels of PA but stronger when comparing active students to inactive students. In addition, grade emerged as a strong predictor of PA for females. Consistent with the male results, smoking was only significant when comparing active to inactive females. Means of transport and perception of both school work and body weight showed minimal levels of significance.

Interestingly, after adjusting for other covariates, smoking changed direction of association for both genders while perception of body weight changed direction among females. During bivariate analysis, smoking was significantly associated with lower levels of PA. However, during multivariate analysis, smoking became significantly associated with higher levels of PA for both genders when comparing active to inactive students. Similarly, perception as very/slightly overweight was originally associated with lower levels of PA among active females but after adjustment became associated with higher levels of PA.

Discussion

A better understanding of factors associated with PA among high school students is essential to implement programs and interventions to increase activity levels. The present study examined associations between selected individual, social and physical environmental factors with self-reported measures of PA in Manitoba students' grades 9–12. Although similar associations have previously been reported, this study is unique as the first large-scale assessment of the factors associated with PA among Manitoba youth. The sample size and the similarity of age and gender distributions to the province of Manitoba add to the strength of these results. The present study can be used to identify differences between youth who are achieving high or moderate levels of PA versus those who are inactive.

Almost half of the sample (49%) was placed in the highest category of activity after reporting participating in >8MET-hours/day of PA. However, 19% of students reported PA levels <3 MET-hours/day, which is well below the PA level needed for optimal health. In addition, 33% of the sample reported participating in 3–8 MET-hours/day of PA, indicating a moderate but not optimal level of PA. Compared to objectively measured results from the Canadian Fitness and Lifestyle Institute CANPLAY study, these Manitoba results show higher levels of participation in PA (CFLRI 2005). However, youth have been shown to consistently over report their levels of PA, potentially leading to biased results in this self-reported study (Wong et al. 2006). In addition, researchers used

Table 1 Bivariate associations between study variables and physical activity level among males surveyed in the Manitoba Youth Health Survey, Manitoba, Canada 2008

Variable	$N = 15,466$	Moderate vs. inactive		Active vs. inactive	
		OR (95% CI)	p	OR (95% CI)	p
Grade					
9 or 10	8,485	1.00		1.00	
11 or 12	6,981	0.95 (0.86, 1.04)	0.264	0.70 (0.64, 0.77)	<0.001
Smoking					
Non-smoker	12,218	1.00		1.00	
Occasional or daily smoker	3,248	0.86 (0.76, 0.96)	0.010	0.88 (0.79, 0.98)	0.020
School location					
Rural	7,325	1.00		1.00	
Urban	8,141	1.70 (1.54, 1.88)	<0.001	1.68 (1.54, 1.84)	<0.001
Means of transport to school					
Inactively	7,900	1.00		1.00	
Mixed active and inactive	3,037	1.42 (1.23, 1.63)	<0.001	1.55 (1.37, 1.76)	<0.001
Actively	4,529	1.19 (1.06, 1.33)	0.981	1.27 (1.14, 1.41)	0.741
Parental encouragement of PA					
Discourage or neither	3,791	1.00		1.00	
Encourage/strongly encourage	11,675	1.69 (1.52, 1.88)	<0.001	2.60 (2.36, 2.87)	<0.001
Number of active friends					
0–2 active friends	3,152	1.00		1.00	
3–5 active friends	12,314	1.79 (1.61, 1.99)	<0.001	3.71 (3.34, 4.11)	<0.001
Feel close to people at school					
Definitely/disagree	3,249	1.00		1.00	
Definitely/agree	12, 217	1.47 (1.32, 1.64)	<0.001	2.04 (1.84, 2.26)	<0.001
Have felt sad/helpless in past year					
No	10, 913	1.00		1.00	
Yes	4,553	0.96 (0.86, 1.07)	0.452	0.90 (0.81, 0.99)	0.030
Perception of school work					
Below average	1,914	0.70 (0.61, 0.81)	<0.001	0.67 (0.59, 0.76)	<0.001
Average	9,037	1.00		1.00	
Above average	4,488	1.25 (1.11, 1.41)	<0.001	1.27 (1.14, 1.42)	<0.001
Perception of athletic ability					
Poor/fair	3,589	1.00			
Good/excellent	11,877	1.91 (1.72, 2.11)	<0.001	5.06 (4.57, 5.60)	<0.001
Perception of body weight					
Very/slightly underweight	2,839	0.79 (0.69, 0.90)	0.139	0.78 (0.69, 0.87)	0.980
About right weight	8,978	1.00		1.00	
Very/slightly overweight	3,649	0.76 (0.67, 0.85)	0.006	0.60 (0.54, 0.67)	<0.001

Odds ratios >1.00 represent higher levels of physical activity, odds ratios <1.00 represent lower levels of physical activity

OR odds ratio (1: reference category)

different methodology to assess PA (steps vs. METs) and therefore varied in the threshold used to define PA. As such, the self-report nature of the current study and differing methodology may account for disparities between the two studies.

Age and gender are the most commonly studied demographic factors in association with adolescent PA (Loucaides et al. 2007). Research has continually shown that boys are more active than girls and that rapid declines in PA occur around age 12 (Trost et al. 2002). Consistent with the previous studies males represented the largest percentage of the active category (56.7%) while females represented the majority of the inactive category (58.2%) (Sallis et al. 2000; Santos et al. 2005). Interestingly, the

Table 2 Bivariate associations between study variables and physical activity level among females surveyed in the Manitoba Youth Health Survey, Manitoba, Canada 2008

Variable	$N = 15,736$	Moderate vs. inactive		Active vs. inactive	
		OR (95% CI)	p	OR (95% CI)	p
Grade					
9 or 10	8,426	1.00		1.00	
11 or 12	7,310	0.83 (0.77, 0.91)	<0.001	0.58 (0.53, 0.63)	<0.001
Smoking					
Non-smoker	12,400	1.00		1.00	
Occasional or daily smoker	3,336	0.83 (0.75, 0.92)	<0.001	0.89 (0.81, 0.98)	0.022
School location					
Rural	7,353	1.00		1.00	
Urban	8,383	1.61 (1.48, 1.75)	<0.001	1.68 (1.54, 1.83)	<0.001
Means of transport to school					
Inactively	8,117	1.00		1.00	
Mixed active and inactive	3,763	1.38 (1.24, 1.54)	<0.001	1.51 (1.36, 1.68)	<0.001
Actively	3,856	1.27 (1.15, 1.41)	0.139	1.38 (1.24, 1.53)	0.025
Parental encouragement of PA					
Discourage or neither	4,131	1.00		1.00	
Encourage/strongly encourage	11,605	1.74 (1.59, 1.91)	<0.001	2.52 (2.30, 2.76)	<0.001
Number of active friends					
0–2 active friends	4,387	1.00		1.00	
3–5 active friends	11,349	1.73 (1.58, 1.89)	<0.001	2.87 (2.62, 3.15)	<0.001
Feel close to people at school					
Definitely/disagree	3,594	1.00		1.00	
Definitely/agree	12,142	1.42 (1.29, 1.56)	<0.001	1.62 (1.47, 1.79)	<0.001
Have felt sad/helpless in past year					
No	8,387	1.00		1.00	
Yes	7,349	1.01 (0.92, 1.10)	0.894	0.93 (0.85, 1.01)	0.069
Perception of school work					
Below average	1,325	0.73 (0.63, 0.84)	<0.001	0.67 (0.58, 0.77)	<0.001
Average	9,462	1.00		1.00	
Above average	4,949	1.20 (1.09, 1.32)	<0.001	1.10 (1.00, 1.20)	<0.001
Perception of athletic ability					
Poor/fair	5,923	1.00		1.00	
Good/excellent	9,813	2.05 (1.88, 2.24)	<0.001	4.35 (3.98, 4.75)	<0.001
Perception of body weight					
Very/slightly underweight	1,317	0.92 (0.79, 1.08)	0.254	0.93 (0.79, 1.08)	0.935
About right weight	8,808	1.00		1.00	
Very/slightly overweight	5,611	1.01 (0.92, 1.29)	0.341	0.87 (0.80, 1.10)	0.045

Odds ratios >1.00 represent higher levels of physical activity, odds ratios <1.00 represent lower levels of physical activity

OR odds ratio (1: reference category)

moderately active category was predominantly female (56.6%) suggesting that there is a substantial and important sub-group of females participating in some level of PA. As such, interventions among females should not only target initiating activity but also focus on motivating moderately active girls toward higher levels of PA. Evidence suggests that increasing parental modeling of PA, reducing perceived barriers to activity and increasing activity among same-sex peers are all important considerations when promoting PA among girls (Trost et al. 1997; Bailey et al. 2005).

Based on these results and methodology used in the previous studies, all further analyses were stratified and presented by gender to assess this variable's role in

Table 3 Multivariate associations between study variables and physical activity level among males surveyed in the Manitoba Youth Health Survey, Manitoba, Canada 2008

Variable	$N = 15, 466$	Moderate vs. inactive		Active vs. inactive	
		OR (95% CI)	p	OR (95% CI)	p
Grade					
9 or 10	8,485	1.00		1.00	
11 or 12	6,981	0.99 (0.89, 1.10)	0.849	0.77 (0.69, 0.84)	<0.001
Smoking					
Non-smoker	12, 218	1.00		1.00	
Occasional or daily smoker	3,248	1.03 (0.91, 1.17)	0.603	1.22 (1.09, 1.38)	<0.001
School location					
Rural	7,325	1.00		1.00	
Urban	8,141	1.66 (1.49, 1.84)	<0.001	1.67 (1.52, 1.84)	<0.001
Means of transport to school					
Inactively	7,900	1.00		1.00	
Mixed active and inactive	3,037	1.34 (1.16, 1.54)	0.001	1.48 (1.29, 1.70)	<0.001
Actively	4,529	1.13 (1.01, 1.28)	0.747	1.23 (1.10, 1.38)	0.863
Parental encouragement of PA					
Discourage or neither	3,791	1.00		1.00	
Encourage/strongly encourage	11,675	1.35 (1.21, 1.51)	<0.001	1.68 (1.51, 1.87)	<0.001
Number of active friends					
0–2 active friends	3,152	1.00		1.00	
3–5 active friends	12,314	1.50 (1.34, 1.69)	<0.001	2.54 (2.27, 2.84)	<0.001
Feel close to people at school					
Definitely/disagree	3,249	1.00		1.00	
Definitely/agree	12,217	1.13 (1.01, 1.27)	0.040	1.27 (1.13, 1.42)	<0.001
Perception of school work					
Below average	1,941	0.85 (0.73, 1.00)	0.001	0.96 (0.84, 1.11)	0.129
Average	9,037	1.00		1.00	
Above average	4,488	1.18 (1.04, 1.33)	<0.001	1.16 (1.03, 1.30)	0.008
Perception of athletic ability					
Poor/fair	3,589	1.00			
Good/excellent	11,877	1.64 (1.47, 1.83)	<0.001	3.91 (3.51, 4.35)	<0.001

Odds ratios adjusted for all other variables in the table. Odds ratios >1.00 represent higher levels of physical activity, odds ratios <1.00 represent lower levels of physical activity

OR odds ratio (1: reference category)

modifying factors associated with PA (O'Loughlin et al. 1999; Wong et al. 2006). After adjusting for all variables, higher grade level significantly predicted a decline in PA among both genders when comparing active to inactive students and when comparing moderately active to inactive females. This finding is consistent with the previous studies showing more dramatic declines in PA with age among females (Trost et al. 2002). Again, this highlights the importance of targeting moderately active females to prevent a decline of PA with increasing age.

After multivariate analyses, four variables emerged as the strongest predictors of PA among both genders. Consistent with the previous literature, living in an urban setting, having a higher number of active friends, strong parental encouragement of PA and a strong perception of ones' athletic ability were positive predictors of PA (Sallis et al. 2000; Ismailov and Leatherdale 2010). Self-efficacy or perceived activity competence continually appears as a strong correlate of PA among adolescents (Sallis et al. 2000; Trost et al. 2002; Kim et al. 2009; Pan et al. 2009) and has been associated with higher MVPA in students across junior and high school populations (Crocker et al. 2000; Loucaides et al. 2007). Results from this study are consistent with this trend and indicate that a students' perception of their athletic ability was the strongest predictor of PA level for both genders. Predictably, this effect was modest when comparing the moderately active to the inactive group but increased substantially when comparing

Table 4 Multivariate associations between study variables and physical activity level among females surveyed in the Manitoba Youth Health Survey, Manitoba, Canada 2008

Variable	$N = 15, 736$	Moderate vs. inactive		Active vs. inactive	
		OR (95% CI)	p	OR (95% CI)	p
Grade					
9 or 10	8,426	1.00		1.00	
11 or 12	7,310	0.88 (0.80, 0.96)	0.003	0.63 (0.58, 0.69)	<0.001
Smoking					
Non-smoker	12,400	1.00		1.00	
Occasional or daily smoker	3,336	1.05 (0.94, 1.17)	0.424	1.31 (1.18, 1.47)	<0.001
School location					
Rural	7,353	1.00		1.00	
Urban	8,383	1.60 (1.46, 1.74)	<0.001	1.73 (1.58, 1.89)	<0.001
Means of transport to school					
Inactively	8,117	1.00		1.00	
Mixed active and inactive	3,763	1.31 (1.17, 1.47)	0.004	1.42 (1.27, 1.59)	<0.001
Actively	3,856	1.25 (1.12, 1.39)	0.113	1.34 (1.20, 1.49)	0.038
Parental encouragement of PA					
Discourage or neither	4,131	1.00		1.00	
Encourage/strongly encourage	11,605	1.39 (1.26, 1.53)	<0.001	1.66 (1.50, 1.83)	<0.001
Number of active friends					
0–2 active friends	4,387	1.00		1.00	
3–5 active friends	11,349	1.47 (1.34, 1.62)	<0.001	2.14 (1.94, 2.36)	<0.001
Perception of school work					
Below average	1,325	0.89 (0.76, 1.04)	0.024	0.95 (0.81, 1.12)	0.553
Average	9,462	1.00		1.00	
Above average	4,949	1.13 (1.03, 1.25)	0.002	1.00 (0.91, 1.11)	0.669
Perception of athletic ability					
Poor/fair	5,923	1.00		1.00	
Good/excellent	9,813	1.85 (1.69, 2.03)	<0.001	3.71 (3.37, 4.09)	<0.001
Perception of body weight					
Very/slightly underweight	1,317	1.00 (0.85, 1.18)	0.211	1.07 (0.91, 1.26)	0.709
About right weight	8,808	1.00		1.00	
Very/slightly overweight	5,611	1.22 (1.11, 1.35)	<0.001	1.22 (1.11, 1.35)	0.004

Odds ratios adjusted for all other variables in the table. Odds ratios >1.00 represent higher levels of physical activity, odds ratios <1.00 represent lower levels of physical activity

OR odds ratio (1: reference category)

the active to the inactive group. Interestingly, only small and inconsistent effects were found when looking at perception of schoolwork. This may suggest that the role of self-efficacy in increasing PA is specific to the realm of athletic competence with a need to develop school programs encouraging youth to build confidence in this particular area.

Behavioural theories highlight the effect that social models can have on adolescent behaviour (Leatherdale and Wong 2008). Often, this influence is achieved through modeling, social norms or providing support for behaviors. Research has shown that both peer and parental PA along with parental encouragement are associated with higher levels of PA among adolescents, specifically among females (Trost et al. 1997; Davison et al. 2003; Leatherdale and Wong 2008). In addition, recent results suggest that sedentary behaviors in parents are linked to similar behaviors in their children (Thibault et al. 2010). Parents serve not only as indirect role models of PA, but can also provide direct support through transportation and financial aid (Gustafson and Rhodes 2006).

Results of this study show that both parental encouragement of PA and a higher number of active friends were positively associated with greater levels of PA for both genders. Similar to perception of athletic ability, these results were significant when comparing moderately active

to inactive students but predictably stronger when comparing active to inactive students. In addition, schools in an urban setting showed consistently higher levels of PA at all levels and among both genders. Taken together, these results support the adoption of social ecological models targeting multiple levels of environmental influence on PA (Sallis et al. 2000; Gustafson and Rhodes 2006).

Recent evidence suggests that youth who engage in active means of transport to school are more physically active than their peers (Chillón et al. 2010). Although many Canadian youth report walking as a leisure-time activity, the majority do not walk or bike to school (Robertson-Wilson et al. 2008). Consistent with this trend, 51% of students in the present study reported using inactive means of transport to school. After adjusting for other covariates, results showed a small but consistent relationship between students who used a mixture of transport to school and increased levels of PA at both the moderate and active levels. Interestingly, this effect was not significant when comparing students who reported using solely active means of transport. This may reflect students' interpretation of the question or may be linked to variables not available in the current study, such as distance to school. Results should be interpreted with caution as further research is needed. Nonetheless, this study implies that encouraging active transport at least some of the time may significantly increase PA levels.

Literature shows that regular PA is an effective form of both primary and secondary prevention of mental health outcomes and that depression is inversely related to PA levels among adolescents of ages 13–18 (Sallis et al. 2000; Warburton et al. 2006). The present study did not find an association between our pre-depression variable and PA among this population. This may, however, suggest that the question used was not an accurate indicator of depression and therefore did not properly reflect the intended relationship. Similarly, despite the previous evidence that youth who feel connected to their school communities are less likely to engage in risky behaviors (Resnick et al. 1997; McNeely et al. 2002), the current study found no relationship between feelings of closeness at school and PA among females and only a very small association among males. However, since over 75% of the sample reported feeling close to others at their school, this may suggest that this population has pre-existing, close relationships at the school level and that schools should aim to maintain these relationships regardless of effect on PA.

The inconsistent associations with smoking for both genders and perception of body weight among females are worth noting. Although smoking has been previously associated with lower levels of PA (Pate et al. 1996; Donato et al. 1997), this study showed the opposite when comparing active to inactive students after multivariate analysis. This may, however, be a reflection of the self-report methodology, the combining of daily and occasional smokers or the instability of smoking habits in such a young population. Although the previous research shows that lower body satisfaction is associated with lower levels of PA among adolescents (Neumark-Sztainer et al. 2004), there is a lack of literature specifically linking "perception of body weight" to PA levels in youth. As such, it is unclear whether to expect youth who perceive themselves as overweight to display higher or lower levels of PA. However, the fact that the association between "perception of body weight" and PA changed direction among females after multivariate analysis in this study, suggests that these results are inconsistent and should be interpreted with caution.

All data collected from the YHS were self-reported. Although this is often the only methodology available to gather information on behaviors in large epidemiological studies, youth consistently over report PA information which can threaten reliability and validity of results (Wong et al. 2006). In addition, this study is cross-sectional by design and causal relationships cannot be inferred from such data (Aschengrau and Seage 2008). Due to the lack of data on ethnicity and socio-economic status, we were unable to examine these as independent predictors of PA or assess whether other covariates differed by these variables. Finally, due to the focused nature of this study on students from Manitoba in grades 9–12, generalizing the results to other provinces or age groups should be done with caution. Taken together, these limitations may reduce the generalizability of these results. However, the large sample size and even representation of Manitoba youth may reduce the effects of these limitations. In addition, the use of reliable and validated PA measures and the assurance of confidentiality during data collection strengthen the self-reported results (Wong et al. 2006).

Despite these limitations, this study highlights the importance of targeting factors at the individual, social, and physical environmental levels to aid in planning programs, interventions and curricula for increasing active living among Manitoba adolescents. In addition, these results demonstrate that factors affecting PA differ by both gender and level of PA.

Ethical standards The authors declare that this research complies with all current laws of Canada.

Acknowledgments The authors would like to acknowledge the Manitoba Regional Health Authorities, Partners in Planning for Healthy Living, the Yale School of Public Health and CancerCare Manitoba for their support during this research. In addition, we would like to thank survey participants for their willingness to participate along with all school staff who helped to make this survey a success.

Conflict of interest The authors declare that there is no known conflict of interest with regards to this research.

References

Aschengrau A, Seage G (2008) Essentials of epidemiology in public health. Jones and Bartlett Publishers, Sudbury

Bailey R, Wellard I, Dismore H (2005) Girls' participation in physical activities and sports: benefits, patterns, influences and ways forward. In: Centre for Physical Education and Sport Research

CASH (2006) Comprehensive School Health. In: Canadian Consensus Statement. Canadian Association for School Health, Canada

CDC (2010) 2009 National Youth Risk Behavior Survey overview. In: Youth Risk Behavior Surveillance System. Centers for Disease Control and Prevention, Atlanta

CFLRI (2005) Canadian physical activity levels among youth: CAN PLAY study. In: Kids CANPLAY Bulletin. Canadian Fitness and Lifestyle Research Institute, Canada

Chillón P, Ortega FB, Ruiz JR, Veidebaum T, Oja L, Mäestu J, Sjöström M (2010) Active commuting to school in children and adolescents: an opportunity to increase physical activity and fitness. Scand J Public Health 38:873–879

Craig CL, Cameron C, Russell SJ, Beaulieu A (2001) Increasing physical activity: supporting children's participation. In. Canadian Fitness and Lifestyle Research Institute, Ottawa, pp 121–124

Crocker P, Eklund R, Kowalski K (2000) Children's physical activity and physical self-perceptions. J Sports Sci 18:383–394

Davison KK, Cutting TM, Birch LL (2003) Parents' activity-related parenting practices predict girls' physical activity. Med Sci Sports Exerc 35:1589–1595

Donato F, Assanelli D, Chiesa R, Poeta ML, Tomasoni V, Turla C (1997) Cigarette smoking and sports participation in adolescents: a cross-sectional survey among high school students in Italy. Subst Use Misuse 32:1555–1572

Gustafson S, Rhodes R (2006) Parental correlates of physical activity in children and early adolescents. Sports Med 36:79–97

HealthCanada (2004) Canadian Community Health Survey—children's participation in physical activities, in hours per week, by sex, household population aged 6 to 11, Canada and provinces. In: CANSIM SC, Canada

Ismailov R, Leatherdale S (2010) Rural–urban differences in overweight and obesity among a large sample of adolescents in Ontario. Int J Pediatr Obes 5(4):351–360

Kim H, Kim M, Park C, Kim H (2009) Do the determinants of physical activity change by physical activity level? J Adv Nurs 65:836–843

Landis JR, Koch GG (1977) The measurement of observer agreement for categorical data. Biometrics 33:159–174

Leatherdale S, Wong S (2008) Modifiable characteristics associated with sedentary behaviours among youth. Int J Pediatr Obes 3:93–101

Leatherdale ST, Manske S, Faulkner G, Arbour K, Bredin C (2010) A multi-level examination of school programs, policies and resources associated with physical activity among elementary school youth in the PLAY-ON study. Int J Behav Nutr Phys Act 7:6

Loucaides C, Plotnikoff R, Bercovitz K (2007) Differences in the correlates of physical activity between urban and rural Canadian youth. J Sch Health 77:164–170

McNeely CA, Nonnemaker JM, Blum RW (2002) Promoting school connectedness: evidence from the National Longitudinal Study of Adolescent Health. J Sch Health 72:138–146

Neumark-Sztainer D, Goeden C, Story M, Wall M (2004) Associations between body satisfaction and physical activity in adolescents: implications for programs aimed at preventing a broad spectrum of weight-related disorders. Eat Disord 12:125–137

Nutbeam D (1998) Health promotion glossary. In. World Health Organization, Division of Health Promotion, Education and Communications, Geneva

O'Loughlin J, Paradis G, Kishchuk N, Barnett T, Renaud L (1999) Prevalence and correlates of physical activity behaviors among elementary schoolchildren in multiethnic, low income, inner-city neighborhoods in Montreal, Canada. Ann Epidemiol 9:397–407

Pan S, Cameron C, Desmeules M, Morrison H, Craig C, Jiang X (2009) Individual, social, environmental, and physical environmental correlates with physical activity among Canadians: a cross-sectional study. BMC Public Health 9:21

Pate RR, Heath GW, Dowda M, Trost SG (1996) Associations between physical activity and other health behaviors in a representative sample of US adolescents. Am J Public Health 86:1577–1581

PHAC (2010) Canada's Physical Activity Guide for Youth. In: Physical Activity. Public Health Agency of Canada, Canada

Resnick MD, Bearman PS, Blum RW, Bauman KE, Harris KM, Jones J, Tabor J, Beuhring T, Sieving RE, Shew M, Ireland M, Bearinger LH, Udry JR (1997) Protecting adolescents from harm. Findings from the National Longitudinal Study on Adolescent Health. JAMA 278:823–832

Robertson-Wilson J, Leatherdale S, Wong S (2008) Social-ecological correlates of active commuting to school among high school students. J Adolesc Health 42:486–495

Sallis J, Prochaska J, Taylor W (2000) A review of correlates of physical activity of children and adolescents. Med Sci Sports Exerc 32:963–975

Santos M, Gomes H, Mota J (2005) Physical activity and sedentary behaviors in adolescents. Ann Behav Med 30:21–24

StatsCan (2006) Population and dwelling counts, for Canada, provinces and territories, census metropolitan areas and census agglomerations, 2006 and 2001 censuses—100% data. In: Canada S (ed) Census Metropolitan Areas. Statistics Canada

Thibault H, Contrand B, Saubusse E, Baine M, Maurice-Tison S (2010) Risk factors for overweight and obesity in French adolescents: physical activity, sedentary behavior and parental characteristics. Nutrition 26:192–200

Trost SG, Pate RR, Saunders R, Ward DS, Dowda M, Felton G (1997) A prospective study of the determinants of physical activity in rural fifth-grade children. Prev Med 26:257–263

Trost S, Pate R, Sallis J, Freedson P, Taylor W, Dowda M, Sirard J (2002) Age and gender differences in objectively measured physical activity in youth. Med Sci Sports Exerc 34:350–355

Warburton D, Nicol C, Bredin S (2006) Health benefits of physical activity: the evidence. CMAJ 174:801–809

WHO (2004) Young people's health in context. Health Behaviour in School-aged Children (HBSC) study: international report from the 2001/2002 survey. In: Health policy for children and adolescents, vol 4. World Health Organization, Geneva

WHO (2009a) Diet and physical activity: a public health priority. In: Global strategy on diet, physical activity and health. World Health Organization, Geneva

WHO (2009b) Obesity and overweight. In: Media centre. World Health Organization, Geneva

WHO (2010a) Diet, nutrition and the prevention of chronic disease. In: WHO technical report series. World Health Organization, Geneva

WHO (2010b) Global recommendations on physical activity for health. In: Global strategy on diet, physical actvity and health. World Health Organization, Geneva

Wong S, Leatherdale S, Manske S (2006) Reliability and validity of a school-based physical activity questionnaire. Med Sci Sports Exerc 38:1593–1600