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Interaction between School Built Environments and Physical Activity Policies and Programs on Student Physical Activity

Brenton Button[1] **and Ian Janssen**[1,2*]

[1]*School of Kinesiology & Health Studies, Queen's University, Kingston, ON, Canada*

[2]*Department of Public Health Sciences, Queen's University, Kingston, ON, Canada*

[*]**Corresponding author:** Ian Janssen, School of Kinesiology & Health Studies, Queen's University, Kingston, ON, Canada, K7L 3N6, Tel: (613)533-6000; E-mail: ian.janssen@queensu.ca

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Abstract

Objective: The school built environment may interact with school policies and programs to promote or hinder student participation in moderate-to-vigorous physical activity (MVPA). The purpose of this study was to explore the interactive effects of the school built environment and physical activity programs and policies on the MVPA of students while at school.

Methods: Data from 17,917 grade 6-10 students from 316 schools who participated in the 2009/10 Canadian Health Behavior in School-Aged Children survey were analyzed using multi-level regression. Students answered questions on the amount of time they spend in MVPA at school. Administrator reports were used to create physical activity related built environment and program/policy scores for each school.

Results: The school built environment score was positively associated with student MVPA ($p<.001$). This association was moderated by the programs and policies on MVPA such that the association existed in schools with low policy/program scores but not in schools with moderate or high program/policy scores.

Conclusion: The findings suggest that the school built environment is moderated by school policies and programs. These results set the stage for future intervention research addressing the role of the school built environment on students' health

Keywords: Adolescent; Motor activity; Schools; Environment; Policy; Health surveys; Programs

Introduction

Physical activity guidelines state that school-aged children and youth should accumulate at least 60 minutes of moderate-to-vigorous physical activity (MVPA) on a daily basis [1,2]. Unfortunately, only 7% of Canadian children and youth meet this guideline [3]. This is concerning because a lack of physical activity in school aged-children is associated with an increase in cardiovascular disease risk factors (e.g., higher body weight and blood pressure) and depression symptoms and a decrease in bone mineral density and academic performance [4,5].

Most 5-17 year olds in developed countries spend about six hours a day on almost 200 days of the year at school [6]. While at school, students have opportunities to engage in physical activity before classes begin, during recess and lunch breaks, and after classes end. During class time children can be active in physical education class and physical activity can occasionally be integrated into other parts of the curriculum. While the basic structure of the school day is similar at most schools, the physical activity levels of students vary from one school to the next [7]. This variation could potentially be explained by differences in built environment features within schools, such as gymnasiums and sports fields, and/or the policies and programs the schools have in place to promote physical activity.

Research examining the associations between school built environments, school policies and programs on physical activity, and student physical activity levels suggests that school built environments [8-10] and policies and programs [10,11] are associated with physical activity, but that these associations are weak to modest in strength and not consistent for all groups of students. Consider, for instance, a study of 16,471 students from Norway [10]. In that study grade 8-10 students who attended schools with all 8 of the assessed built environment features were approximately 2.5 times more likely to engage in physical activity during recess on a daily basis compared to grade 8-10 students who attended schools with none of the built environment features. Conversely, no association between the built environment and physical activity during recess was observed in grade 4-10 students.

The inconsistency of the associations between the school built environment and student physical activity levels in different studies and across different groups of students suggests that a third variable may be moderating these associations [12]. It is probable that the association between the school built environment and student physical activity levels is being moderated by the school policies and programs on physical activity and/or that the association between school policies and programs and student physical activity levels is moderated by the built environment. However, as this has not yet been addressed in the published literature, it is important to generate empirical evidence. Such evidence could .

The purpose of this study was to explore the interactive effects of the school built environment and physical activity policies and programs on the physical activity levels of students during the school day. We had the opportunity to examine such relationships in a large and representative sample of Canadian youth in grades 6-10.

Method

Participants

This research involved analyses of cross-sectional data from the 2009/10 Canadian Health Behaviour in School-Aged Children Survey (HBSC). The Canadian HBSC was conducted in collaboration with the World Health Organization and followed an established international protocol [13]. HBSC participants consisted of students in grades 6 to 10 in publicly funded schools across Canada. Youth attending private, special needs, or home schools were ineligible, as were institutionalized, incarcerated or homeless youth. The survey used a cluster sampling design, with classrooms reflecting the distributions of schools according to size, location, language, and religion. The survey gathered information on 26,078 students from 436 schools. Seventy seven percent of eligible students participated. This study received ethics approval. Individual schools and their school boards, parents/guardians, and the student participants provided consent.

Procedures

The main component of the HBSC was a student questionnaire that collected information on students' demographics, health behaviors, health determinants, and health outcomes [13]. In addition, the school principal or designate completed an administrator questionnaire, which inquired about the schools characteristics including the size and demographic distribution of the students, policies, programs and availability of facilities. The administrator questionnaire was created from education researchers in Canada with expertise in school health [14]. Information from the administrator survey was linked to the individual–level information from the student participants.

For the present study, we excluded 5,829 students from 120 schools as the administrator questionnaire was either not completed or was missing data for one or more of the relevant study variables. An additional 2,332 students were excluded because of missing physical activity or covariate information. Thus, the final sample consisted of 17,917 students from 316 schools. Compared to the 8,161 students who were excluded, the final sample had a similar age (0.02 years younger), gender (1.3% less boys), and socioeconomic status.

Instruments

Physical activity at school. The outcome of interest was participation in moderate-to-vigorous physical activity at school. Students were asked "About how many hours a week do you usually take part in physical activity that makes you out of breath or warmer than usual in your class time at school?" and "About how many hours a week do you usually take part in physical activity that makes you out of breath or warmer than usual in your free time (for example, lunch) at school?". There were nine response options for each question that ranged from "none at all" through "7 or more hours". Responses from the two questions were combined to create a continuous score that ranged from 0 to 14 hours/week. A panel of physical activity experts in the international HBSC assembly developed these physical activity questions based on face validity with the intent that they be universally interpretable by 11-15 year old students. A previous validation study on a physical activity questions similar to the one used in the HBSC reported that questionnaire responses were modestly correlated with objective measures of physical activity obtained by accelerometry (r=0.39) [15], although it is important to recognize that questionnaires and accelerometers measure different aspects of physical activity (e.g., questionnaires measure time spent doing bouts of activity, including sedentary and light intensity time, while accelerometers measure all movement at a defined intensity, including bouts of MVPA and sporadic MVPA) [16].

School built environment. The HBSC administrator survey asked if students had access to the following physical activity facilities on school grounds: (1) gymnasium, (2) other large room suitable for physical activity, (3) fitness room for aerobic or strength training, (4) running track, (5) outdoor field, (6) outdoor paved area, (7) skating rink/arena, and (8) indoor swimming pool. Positive responses were given a score of 1 and negative responses a score of 0. Scores from all 8 items were summed to create a built environment score ranging from 0-8. The use of a summary score was used as a previous Canadian HBSC study found that no single specific facility was of particular importance, but that there was a linear relationship between the cumulative number of facilities and student physical activity levels [8].

School Policies and programs for physical activity

The HBSC administrator survey included 6 questions about school policies and programs relevant for physical activity. Responses were used to create a summary school policy and program score that ranged from 0 to 6. Table 1 lists the questions that were used, their response options, and how the responses were combined to create the summary score. Low, moderate and high tertiles were created based on the summary score. Because a large proportion of schools had summary scores in the middle of the range, the tertiles were not of equal size.

Policy or Program Question	Response Options (points allocated for creation of summary score)
Does your school have a committee that oversees policies and practices concerning physical activity and healthy eating at your school (e.g., health action team)?	- Yes (1 points) - No (0 points)
Does your school's improvement plan for the current school year contain any items related to physical activity and healthy eating?	- Yes (1 point) - No (0 points)

We promote physical activity during or as part of special events.	- A lot (1 point) - Some (1 point) - Very little (0 points) - Not at all (0 points)
We integrate physical activity into other curriculum areas.	- A lot (1 point) - Some (1 point) - Very little (0 points) - Not at all (0 points)
Which of the following 18 sports are offered in your varsity or intramural athletics programs: Basketball, Volleyball, Soccer, Football, Baseball/ Softball, Rugby, Ice Hockey, Lacrosse, Gymnastics, Wrestling, Track & Field, Badminton, Swimming, Skiing, Ultimate Frisbee, Other.	A summary score was created by assigned each sport a value of 0 (no) or 1 (yes), and summing all values. Schools were divided into "low" (0 points) and "high" (1 point) groups based on the median summary score.
Does your school offer late bus/transportation service to students who participate in extra-curricular activities?	- Yes (1 point) - No (0 points)

Table 1: Physical activity policies and programs questions from the administrator questionnaire

Potential covariates

Both student- and school-level confounders were considered. Student-level confounders included socioeconomic status, grade, and gender. Socioeconomic status is determined in the HBSC using the Family Affluence Scale (FAS), which is comprised of four items: vehicle ownership by family, having a bedroom for yourself, family vacations during past year, and computer ownership. This scale was used to create a 3-point Family Affluence Scale (low, medium, and high) which was used as a proxy for socioeconomic status [17,18]. The FAS has good criterion validity and is less affected by non-response bias then other socioeconomic measures [18]. School-level confounders included urban-rural school location and school size. Based on the population of the municipality where the schools were located, they were classified as being in a rural area (0 – 999 people), small city (1000 - 29,999 people), medium city (30,000 - 99,999 people), or metropolitan area (≥ 100,000 people). Principals reported the number of students attending their school, and schools were divided small, medium, and large populations using tertiles.

Data analysis

Analyses were performed in IBM SPSS version 20. Descriptive statistics including frequencies, means, and standard deviations were conducted. Relationships between study variables were examined using multi-level linear regression models to account for the clustered and hierarchical nature of the data. Backwards deletion was used to build a model for the main exposure variables (built environment score and policies and programs score) that only included the relevant covariates. The model building started with all candidate covariates. If deletion of the variable caused less than a 10% change in the effect estimate for either of the main exposure variables, the potential covariate was not included in the model [19]. This process was repeated with all potential covariates. A second model included the variables that were included in model 1 and an interaction term between the built environment score and the policies and programs score. Finally, two stratified analyses were performed. The first stratified analyses examined the association between the built environment score and physical activity within low, moderate, and high policy and program score groups. The second stratified analyses examined the association between the built environment score and school policies and programs within low, moderate and high built environment groups. In order to prevent multi-collinearity in the model, school built environment and policy and program scores were centered.

Results

The distribution of the student participants according to demographic characteristics are shown in Table 2. The sample was evenly split across the two genders and five grade groups. On average, students reported participating in 4.4 ± 3.5 hours/week of MVPA at school. All participating schools had at least one of the built environment features that were assessed, and 55% had at least five of the eight features (Table 3). A small percentage (2%) of schools had none of the six physical activity policies and programs and 54% had at least three of the six (Table 3).

	N	%
Gender	8615	48
Male	9302	52
Female		
Grade	3513	20
≤6	3388	19
7	3632	20
8	3793	21
9	3591	20
≥10		
Family Affluence Scale	467	3
Low	9371	52
Moderate	8079	45
High		
Physical Activity at School	5075	28
Low (<2 hours/wk)	7046	39
Medium (2-5 hours/wk)	5796	32

High (≥ 6 hours/wk)		

Table 2: Distribution of the student sample according to student-level variables (N=17 917)

	N	%
Built Environment Feature (% yes) Gymnasium	304	96
Other large room suitable for physical activity	191	60
Fitness room for aerobic or strength training	138	44
Running track	92	29
Outdoor field	263	83
Outdoor paved area	195	68
Skating rink/arena	36	11
Indoor swimming pool	18	6
Built Environment Score 0 (low) 1 2 3 4 5 6 7	0 1 11 40 57 64 61 47	0 0 4 13 18 20 19 15
8 (High)	35	11
Physical Activity Policies and Programs (% yes) Committee to increase physical activity School improvement plan for physical activity Promotes physical activity during special events Integrates physical activity into curriculum Offers more than 9 intramural and varsity sports Offers late bus transportation	170 167 289 214 139 37	54 53 92 68 44 12
Physical Activity Policies and Programs Score 0 (low) 1 2 3 4 5 6 (High)	7 24 58 82 101 38 6	2 8 18 26 32 12 2

Table 3: Distribution of the school sample according to school-level variables (N=316)

The association between the school built environment, school policies and programs around physical activity, and student physical activity levels is shown in Table 4. As shown in model 1, each one unit increase in the built environment score was associated with a .073 hour per week increase in MVPA performed at school (p<.001). Conversely, each one unit increase in the physical activity policies and programs score was associated with a .080 hour per week decrease in MVPA performed at school (p<.001).

	Model 1			Model 2		
	β	SE	P value	β	SE	P value
Built Environment Score	.073	.017	<.001	.070	.017	<.001
Policies and Programs Score	-.080	.021	<.001	-.072	.021	.001
School Size Large (ref.) Medium Small	.307 .376	.061 .072	<.001 <.001	.375 .375	.072 .061	<.001 <.001
Built Environment Score Policies and Programs Score	N/A	N/A	N/A	-.027	.013	.031

Note: β coefficient represent the change in the physical activity outcome (e.g., hours per week of moderate-to-vigorous activity at school) per each one unit change in the built environment score, one unit change in the policies and programs scores, or the schools with a medium or small population relative to the schools with a large population.

Table 4: Multi-level regression analyses of the association between the school built environment, school physical activity policies and programs, and student physical activity levels at school

An interaction term between the built environment score and the policies and programs scores was added to model 2 (Table 4). There was a minimal change in the parameter estimates for the built environment score and the policies and programs score from those observed in model 1, and the interaction term contributed significantly to the model (p=.031). This indicated that the association between the schools built environment and student MVPA was moderated by the schools policies and programs on physical activity. To help interpret this interaction, a stratified analysis was performed in which the association between the built environment and MVPA was examined separately within schools with low, moderate, and high policy and program scores. As shown in the left panel of Figure 1, there was a significant positive association between the built environment score and student MVPA levels for schools with low programs and policies

scores but not for schools with moderate or high programs and policy scores. A second stratified analysis was performed in which the association between the school policies and programs score and MVPA was examined separately within students attending schools with low, moderate, and high built environment scores. As shown in the right panel of Figure 1, there was a negative association between the school policies and programs score with student MVPA levels for schools with moderate and high built environment scores but not for schools with low built environment scores.

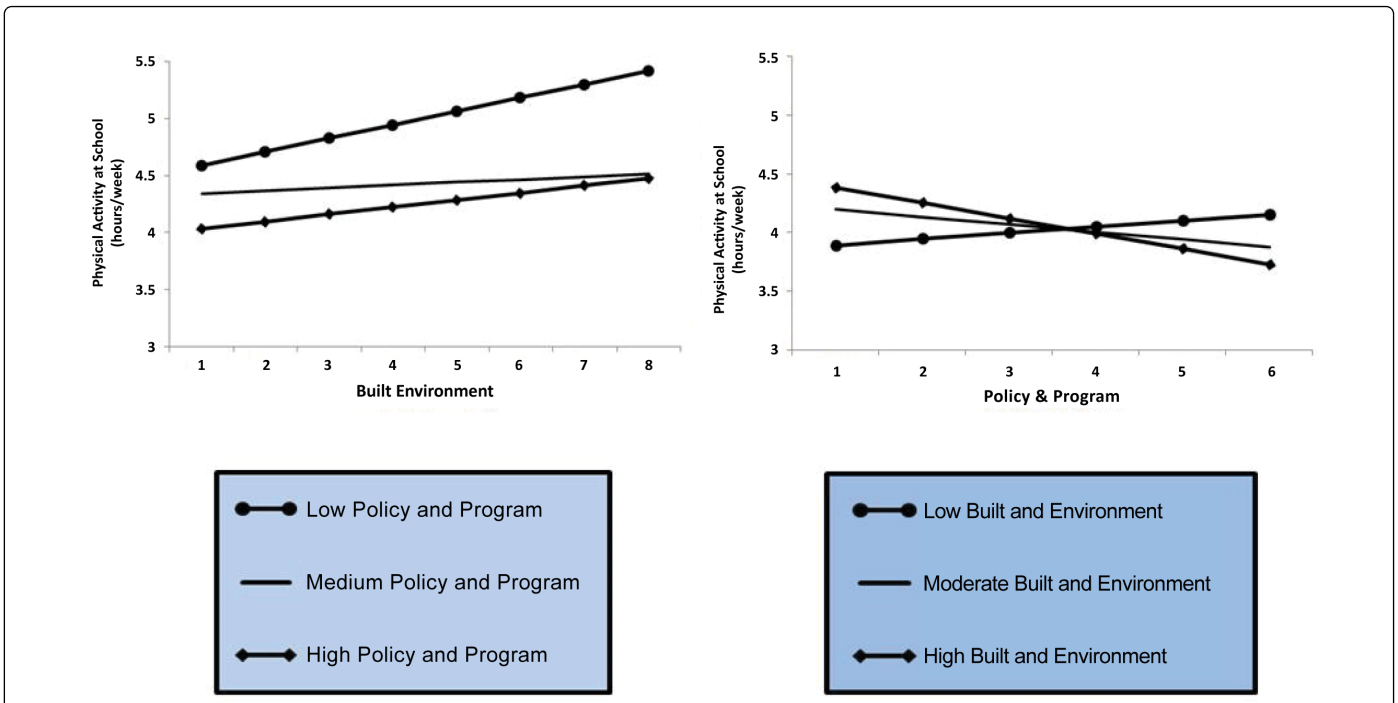

Figure 1: Left Panel: The association between the school built environment score with student physical activity levels within schools with low, moderate, and high physical activity policy and programs scores. Right Panel: The association between the school physical activity policies and programs score with student physical activity levels within schools with low, moderate, and high built environment scores.

Discussion

The key finding of this study is that the school built environment was positively associated with students MVPA levels, but that this association was only significant and meaningful within the schools that had the fewest physical activity policies and programs. This suggests that the relationship between the built environment and physical activity is complicated and varies according to the physical activity policies and programs.

Our observation that students' MVPA at school was associated with their school's built environment is consistent with previous research which found moderate gradients in physical activity according to number of school recreational features [8-10]. The findings of our regression analyses suggests that the average weekly volume of MVPA performed by students attending schools with the most built environment features (8 features) is about 4.4 minutes/day or 30 minutes/week higher than for students attending schools with only one built environment feature. Four and a half minutes/day represents a modest amount of MVPA for an individual student as it only represents about 3% of the total MVPA a student would need to accumulate to achieve physical activity guidelines; however, this volume of activity is quite meaningful at the population level as it would apply to all students attending such schools.

Previous research on the association between school physical activity policies and programs with student physical activity levels has produced mixed results. A cross-sectional study of high schools in Norway observed that students were more active if they attended schools with a written policy for physical activity [**10**], while a randomized trial of 24 middle schools in the U.S. found that a two year school-based policy and social media intervention had an influence on the physical activity level in boys but not in girls [**11**].

Surprisingly, we observed a negative association between the school policies and programs score and student MVPA levels. We can only speculate as to why such an association existed. It may be that schools with a larger number of policies and programs do not implement them properly and/or the quality of these programs was lower. It is also possible that schools with the lowest physical activity levels developed policies and programs to try and increase physical activity, which may have contributed to the counterintuitive cross-sectional association observed in our study. Other possible explanation is that the schools with the fewest policies and programs had more 15-29 minute curriculum breaks (data not shown), which would have allow the students more time to access the built environment and accumulate MVPA in their free time.

To our knowledge, this is the first study to simultaneously consider the influence of the school built environment and school policies and programs on MVPA. Consistent with previous research on smoking behaviours, we found that the association between the built environment and physical activity was moderated by policies and programs [**20**]. Specifically, the strongest positive association was

between the schools built environment and student MVPA levels in schools with few policies and programs.

This study examined a large and representative sample of Canadian youth. The findings may also be generalizable to other northern industrialized countries with similar physical activity levels, educational systems, and sociodeomgraphics. The current study is limited by its cross-sectional design and we cannot infer temporality around the observed associations. In addition, the MVPA outcome was based on a self-reported recall measure. Self-reported measures of MVPA are only modestly correlated with objective measures and research participants often have difficulty accurately recalling their activities, either because they forget or because they cannot recall unstructured bouts of activity (e.g., brief walk) [**21**]. This likely led to non-differential misclassification of the MVPA variable and biased our results towards the null.

In conclusion, the findings of this study suggest that the school built environment is moderated by school policies and programs. These results set the stage for future intervention research addressing the role of the school built environment on students' health.

Conclusion

The key observation of this study is that a student's MVPA at school is dependent upon their school's built environment, but only for students who attend schools with a limited number of policies and programs aimed at addressing physical activity. This study suggests that making improvements to a school's built environment may not be useful in all situations, particularly if the school has already developed several programs and policies around physical activity.

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