A Multilevel Examination of School and Student Characteristics Associated With Moderate and High Levels of Physical Activity Among Elementary School Students (Ontario, Canada)

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ABSTRACT

Objectives: Schools represent an important environment for physical activity (PA) promotion among youth. Schools can promote PA through policies and programs but our understanding of how these school characteristics associate with student PA levels is largely unknown. Developing this understanding is critical for implementing new prevention interventions. The aim of this study was to identify the school- and student-related characteristics associated with moderate and high levels of PA in a sample of Ontario elementary schools.

Methods: Using multi-level logistic regression analyses, we explored the school- and student-level characteristics associated with being moderately and highly active using data collected from administrators and from students in grades 5 to 8 at 30 elementary schools in Ontario. Students' PA levels, sex, grade, and the number of physical education classes per week were linked to school environment data – specifically, a school's chosen implementation model for daily physical activity and whether it offers intramural and interschool PA programming.

Results: Findings indicate that there was significant between-school variation for being moderately and highly active. Students were less likely to be moderately or highly active if they attended a school offering interschool PA programming. An important student characteristic positively associated with student PA levels included participating in at least two physical education classes per week.

Conclusion: The residual differences in PA by school suggest that school-level characteristics facilitate higher levels of student PA beyond individual-level factors. Although most variation in student PA lies between students within schools, there is sufficient between-school variation to be of interest to practitioners and policy-makers.

Key words: Physical activity; youth/child; schools; school environment; multilevel modeling

La traduction du résumé se trouve à la fin de l'article.

Can J Public Health 2010;101(5):495-99.

Physical inactivity is associated with an increased risk for chronic illnesses.¹ Current data indicate that 87% of Canadian youth do not meet the Canadian physical activity (PA) guidelines.² Lower levels of PA have contributed to the rising prevalence of youth obesity in Canada in the last two decades.^{3,4} Increasing the PA levels of Canadian youth is an important public health challenge.

Most existing PA interventions assume that PA is self-determined by an individual,⁵ despite ecological models suggesting there are reciprocal influences between the individual and the environment in which they are situated.^{6,7} To increase PA at the population level, a better understanding of environmental influences on PA is required. Schools are an important environment for PA promotion since school-based PA accounts for up to 40% of total activity among youth populations.⁸ Numerous school-based PA interventions have been targeted to individual students, yet such programs tend to produce only modest effects.^{9,10} More recently, interventions have targeted characteristics of the school environment. Significant between-school variability in PA exists¹¹⁻¹⁶ and studies have begun to identify school characteristics that explain that variability (e.g., having PA facilities on school grounds^{13,15,16}). Additional research is needed to examine how school policies and programs are associated with PA among students.

In an effort to promote youth PA, many health and education experts have called upon schools to offer daily physical education (PE).^{17,18} Despite this call to action for daily PE, most provincial and

territorial governments have instead opted for a policy requiring schools to provide elementary students with a specified amount of daily PA. The Ontario Ministry of Education (OME), for example, recently mandated Memorandum 138 [Daily Physical Activity (DPA)] whereby “school boards must ensure... a minimum of 20 minutes of sustained moderate to vigorous PA each school day during instructional time.”¹⁹ However, this policy does not mandate how schools or teachers must implement DPA into their schedules. Moreover, the frequency of PE classes and the provision of other PA programs (e.g., intramurals) are not specified by government policy, creating differences in implementation across schools. Our understanding of how these school PA-related policies and pro-

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Acknowledgements: Data used in this analysis were drawn from the PLAY-ON project, funded by the Heart and Stroke Foundation of Ontario (grant awarded to S. Leatherdale). The project was conducted by the SHAPES team at the University of Waterloo. Dr. Leatherdale is a Cancer Care Ontario Research Chair in Population Studies. The Canadian Cancer Society provided funding to develop SHAPES, the system used to collect the PLAY-ON data. Erin P. Hobin is supported by a Canadian Institutes of Health Research Canada Graduate Scholarship Doctoral Research Award.

Conflict of Interest: None to declare.

Table 1. Descriptive Statistics for the Sample of Elementary School Students Who Are Inactive, Moderately Active, and Highly Active

Student Characteristic	Inactive % (n)	Moderately Active % (n)	Highly Active % (n)
Overall	16.4% (389)	67.2% (1599)	16.4% (391)
Sex			
Male	15.5% (175)	64.9% (731)	19.6% (220)
Female	17.1% (214)	69.3% (868)	13.6% (171)
Grade			
5	17.7% (105)	65.3% (388)	14.8% (88)
6	16.0% (102)	63.9% (407)	18.1% (115)
7	14.4% (93)	66.5% (428)	16.5% (106)
8	16.1% (89)	67.9% (376)	14.8% (82)
# of PE Classes per School Week			
<2	23.8% (133)	61.7% (345)	12.9% (72)
≥2	13.7% (256)	67.1% (1254)	17.1% (319)

grams are associated with student PA levels is largely unknown. Developing this understanding is critical for appropriately tailoring and targeting PA interventions; therefore, the aim of this study was to identify the school and student characteristics associated with moderate and high levels of PA in a sample of Ontario elementary schools.

METHODS

Design

This cross-sectional study used self-reported data collected in 2007–2008 among students in grades 5 to 8 students attending 30 elementary schools in Ontario as part of the PLAY-ON study.²⁰ Schools were purposively selected within public and separate school boards located in major geographic regions of Ontario. Self-reported student-level data were collected from consenting students using the SHAPES Physical Activity Module (PAM).^{21,22} The PAM asks students about PA, sedentary behaviours, correlates for PA, and participation in teams and sporting activities at school. Validity testing has demonstrated significant criterion validity based on Spearman correlations for our self-reported measure of PA ($r=0.44$, $p<0.01$).²³

School-level data were collected from administrators using the PA categories of the elementary school version of the School Health Environment Survey (SHES).²⁴ Aligned with the Government of Ontario's Foundations for a Healthy School framework,²⁵ the school-level module assesses PA-related policies, programs and facilities in the school environment. Additional details about SHES are available in print²⁴ and online (www.shapes.uwaterloo.ca/SHES or http://www.healthyschoolplanner.uwaterloo.ca/jcshsite_app/controller/index.cfm).

Procedure

All students at the participating schools were eligible to participate. Prior to participating in the study, active consent from parents was required and at any time students were able to decline participation. Eligible students completed the PAM during class time without compensation for participation. At each participating school, the administrator(s) most knowledgeable about the school's programs, policies and facilities was asked to complete the SHES survey. The University of Waterloo Office of Research Ethics and appropriate School Board Ethics committees approved the study procedures.

Participants

Of the 4,838 students enrolled in grades 5 to 8 at the 30 participating schools, 50.6% ($n=2,449$) participated in the survey; missing respondents resulted from parent/student refusal and absenteeism

on the day of the survey. This distribution is consistent with a previous active consent study examining PA among Canadian elementary students.²⁶ Since 2.8% ($n=70$) of participating students did not provide PA data, the final sample was 2,379. The SHES survey was completed by all 30 elementary schools.

Measures

Outcomes – Physical Activity

PA level was based on kilocalories per kilogram of body weight per day (KKD). Using validated measures,²¹ students were asked how many minutes of vigorous PA (VPA) and moderate PA (MPA) they engaged in on each of the last seven days. The average KKD expended in VPA and MPA were calculated as: $\text{KKD} = [\text{Hours of VPA} \times 6\text{MET}] + [\text{Hours of MPA} \times 3\text{MET}] / 7 \text{ days}$.

Since youth over-report time spent doing PA in self-report^{23,27} and categorical dependent variables make the results more meaningful to stakeholders,²⁸ our data have been coded to differentiate groups of active and inactive students: students one standard deviation or more ($\leq 16^{\text{th}}$ percentile) below the sample mean for KKD were classified as low active, students one standard deviation or more ($\geq 84^{\text{th}}$ percentile) above the sample mean for KKD were classified as highly active; all others were classified as moderately active.

Student-level Characteristics

Consistent with previous research,²⁶ students were asked to report their sex, grade, and the number of PE classes in the previous 7 days (<2 PE classes per week, ≥ 2 PE classes per week). Frequency of PE participation was categorized as a student-level variable since not all students within a given school reported the same frequency of PE participation (e.g., scheduling differences between classes, student absence).

School-level Characteristics

Offering intramural PA programs was measured by asking administrators, "Does your school offer intramural programs/club activities that involve PA?" (Yes/No). Offering interschool PA programs was measured by asking administrators, "Does your school offer interschool programs that involve PA?" (Yes/No). To measure the chosen implementation model for DPA in schools, administrators were asked to report how the DPA policy is implemented at their school (i.e., in addition to daily PE class, as part of daily PE class, or only on days with no PE class).

Data analysis

A basic 2-level nested structure was created where individual students (level 1) were nested within schools (level 2). As such, multi-

Table 2. Descriptive Statistics for the Sample of Elementary Schools (N=30)

School Characteristic	Total % (N)
Offer Intramural PA Programs	
Yes	83.3% (25)
No	16.7% (5)
Offer Interschool PA Programs	
Yes	90.0% (27)
No	10.0% (3)
DPA Implementation Model	
In addition to daily PE class	20.0% (6)
As part of daily PE class	10.0% (3)
Only on days with no PE class	70.0% (21)

level logistic regression analyses were then used to contrast 1) moderately active and low active students, and 2) highly active and low active students. Each analysis used a 3-step modeling procedure. Step 1 tested whether the odds of being either moderately active or highly active were random or fixed across schools. Step 2 included a series of univariate analyses examining whether each of the school-level indicators was associated with being moderately active or highly active. Only significant school-level variables ($p < 0.05$) were retained for further analyses. In Step 3, multivariate models were developed to examine how the significant school-level characteristics identified in Step 2 and student-level characteristics were associated with being moderately active (Model 1) and highly active (Model 2). Analyses were conducted using SAS version 9.1.3 (Cary, NC).

RESULTS

Student characteristics

The sample was 47.3% ($n=1,126$) male and 52.7% ($n=1,253$) female. As presented in Table 1, 16.4% of students were classified as low active, 67.2% were classified as moderately active, and 16.4% were classified as highly active. More males reported being highly active than females ($X^2 = 15.05$, $df = 2$, $p < 0.001$). The PA levels of children excluded due to missing data were not significantly different compared to those students retained for regression analysis.

School characteristics

The mean prevalence of moderately active students at a school was 66.6% (range, 53.6% to 82.8%) and the mean prevalence of highly active students at a school was 16.6% (range, 4.2% to 30.3%). As presented in Table 2, the majority of schools offered intramural (83.3%) and interschool (90%) sports programs. Chosen DPA implementation models varied between schools, with 70% offering DPA only on days without PE class, 20% offering DPA in addition to daily PE class, and 10% offering DPA as part of daily PE class.

Characteristics associated with being moderately active or highly active

Significant between-school variation was identified for being moderately active [$\sigma^2_{\mu 0} = 0.166(0.043)$, $p < 0.001$] and highly active [$\sigma^2_{\mu 0} = 0.259(0.067)$, $p < 0.001$]. Using the null models, we found school-level differences accounted for 4.8% of the variability in the odds of being moderately active and 7.3% of the variability in the odds of being highly active when controlling for individual-level variance. After completing the final models, we found the proportion of between-school variability explained by the school-level factors included in the models was 72.5% for the odds of being moderately active and 81.0% for the odds of being highly active.

Table 3. Odds Ratios for School- and Student-level Factors Associated With Being Moderately Active or Highly Active Among Youth in Grades 5 to 8 (Ontario, Canada)

	Adjusted Odds Ratio	
	Model 1 Moderately Active vs. Low Active n=1988 moderately active	Model 2 Highly Active vs. Low Active n=780 highly active
Student-level Characteristics		
Sex		
Male	1.00	1.00
Female	0.97 (0.76-1.22)	0.59 (0.43-0.81)**
Grade		
5 and 6	1.00	1.00
7 and 8	1.11 (0.88-1.41)	0.99 (0.72-1.36)
# of PE classes per week		
<2 PE classes per school week	1.00	1.00
≥2 PE classes per school week	1.86 (1.43-2.40)‡	2.12 (1.47-3.05)‡
School-level Characteristics		
Offer Intramural PA Programs		
No	1.00	1.00
Yes	0.85 (0.54-1.32)	1.14 (0.66-1.96)
Offer Interschool PA Programs		
No	1.00	1.00
Yes	0.61 (0.48-0.77)‡	0.26 (0.18-0.36)‡
DPA implementation model		
Only on days with no PE class	1.00	Not included in model as not significant in univariate analysis
As part of daily PE class	0.63 (0.39-1.00)	
In addition to daily PE class	1.00 (0.39-1.02)	
Random Variance	0.046	0.053

CI = confidence interval

Controlling for school nesting and all other variables in the model

* $p < 0.05$, † $p < 0.01$, ‡ $p < 0.001$

Moderately active (Model 1)

A student participating in ≥2 PE classes per week was more likely to be moderately active than a student participating in <2 PE classes per week (OR=1.86, 95% CI: 1.43-2.40). A student attending a school that offered interschool programs was significantly less likely to be moderately active than a student attending a school that did not offer interschool programs (OR=0.61, 95% CI: 0.48-0.77). There were no significant associations with sex, grade, implementing DPA as part of daily PE class or offering intramural PA programs at school.

Highly active (Model 2)

Female students were less likely to be highly active than male students (OR=0.59, 95% CI: 0.43-0.81). Conversely, a student participating in ≥2 PE classes per week was more likely to be highly active than a student participating in <2 PE classes per week (OR=2.12, 95% CI: 1.47-3.05). A student attending a school that offered interschool programs was significantly less likely to be highly active than a student attending a school that did not offer interschool programs (OR=0.26, 95% CI: 0.18-0.36). There were no significant associations with grade or offering intramural PA programs at school. Since DPA implementation was not significant in the univariate analysis, it was excluded from the final model.

DISCUSSION

The school environment appears to be associated with the PA levels of youth. Consistent with previous research,¹¹⁻¹⁶ we identified significant variation in PA across schools. Although the amount of school-level variability identified was modest, from a population

perspective it is meaningful as even small shifts in PA at the school level could result in a substantial population-level impact when applied across a large number of schools.²⁹

As anticipated, PA levels were associated with the frequency of participating in PE classes. This is positive considering that there is an emergence of education policies designed to increase the frequency of PE classes or extend the number of PE credits required for graduation (e.g., the policy recently implemented in Manitoba³⁰) for the purposes of increasing youth PA. This finding is also consistent with the advice of stakeholders who have been advocating for schools to provide daily PE classes to students.^{17,18} DPA policies present another curricular-based opportunity to increase student PA levels, yet our results suggest that the DPA implementation model chosen by a school was not associated with the PA levels of its students. More research examining the association between student PA and DPA implementation models and the association between the fidelity of DPA implementation and students' overall PA is required.

We also identified that interschool PA programming is associated with student PA. It was surprising that interschool programs were associated with being low active since such programs provide students with additional opportunities to be active. However, considering that interschool programs are traditionally sports-based competitive programs, they may in fact discourage less skilled students from participating. Further research examining the role of interschool PA programs on student PA is necessary.

Limitations

Causal relationships cannot be inferred from cross-sectional data. Data were based on self-report and thus susceptible to several sources of bias, however the tools used demonstrated reliability and validity,²³ and honest reporting was encouraged by ensuring confidentiality during data collection. Data were not available for examining other relevant measures associated with implementation of PE curriculum (e.g., teacher training) or student overweight status.

CONCLUSIONS

There is substantial variation between schools in student PA. Participating in at least two PE classes per week is associated with increased PA levels, whereas attending a school with interschool PA programs is associated with decreased PA levels. Additional research evaluating different DPA implementation models and reconsidering how interschool PA programs can best contribute to PA of youth is required.

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Received: July 23, 2009
Accepted: July 6, 2010

RÉSUMÉ

Objectifs : Les écoles sont un important milieu où promouvoir l'activité physique chez les jeunes. Elles peuvent le faire dans leurs politiques et leurs programmes, mais on ignore presque tout de l'association entre ces

caractéristiques des écoles et les niveaux d'activité physique des élèves. Or, il est essentiel d'en savoir davantage pour mettre en œuvre de nouvelles mesures de prévention. Nous avons voulu déterminer les caractéristiques des écoles et des élèves associées aux niveaux d'activité physique modérés et élevés dans un échantillon d'écoles primaires de l'Ontario.

Méthode : À l'aide d'analyses de régression logistique multiniveau, nous avons étudié les caractéristiques des écoles et des élèves associées à l'activité physique modérée et élevée grâce aux données recueillies auprès d'administrateurs et d'élèves de la 5^e à la 8^e année dans 30 écoles primaires de l'Ontario. Les niveaux d'activité physique des élèves, leur sexe, leur classe et le nombre de cours d'éducation physique par semaine ont été liés aux données sur le milieu scolaire – plus précisément, au modèle de mise en œuvre choisi par l'école pour l'activité physique quotidienne et à la présence de programmes d'activité physique intramuros et inter-établissements.

Résultats : Nous avons observé d'importantes variations inter-établissements pour l'activité physique modérée et élevée. Les élèves étaient moins susceptibles d'être modérément ou très actifs s'ils fréquentaient une école ayant un programme d'activité physique inter-établissements. Une importante caractéristique des élèves positivement associée aux niveaux d'activité physique était leur participation à au moins deux cours d'éducation physique par semaine.

Conclusion : Les écarts résiduels inter-établissements pour ce qui est de l'activité physique donnent à penser qu'au-delà des facteurs individuels, les caractéristiques de l'école peuvent faciliter l'activité physique des élèves. La plupart des variations dans l'activité physique des élèves sont observées entre les élèves d'une même école, mais il existe suffisamment de variations d'une école à l'autre pour intéresser les praticiens et les responsables des politiques.

Mots clés : exercice physique; adolescent; enfant; établissement scolaire; milieu scolaire; modélisation multiniveau

LETTER

The Inevitable Health System(s) Reform: An Opportune Time to Reflect on Systems Thinking in Public Health in Canada

Dear Editor,

The Canadian Public Health Association Conference is an unparalleled space in which to reflect on how public health system(s) function in Canada. This past June, we came together for a panel at the conference to critically reflect on whether the recent "public health renaissance" with new investments and greater focus have yielded a coherent health system. Needless to say, we all came to explore this question with our perspectives, biases, interests, expectations and hopes.

As many provinces and territories have recently updated their public health laws or structures and with the 2014 renewal of the First Ministers' Health Accord approaching with inevitable reform discourse, this is an opportune time to reflect on public health through a systems lens. Not only was the panel diverse but also attendees to the session represented similar diversities. A recurring theme was the collective preoccupation with the question of how to optimize governance mechanisms to ensure that public health system(s) are coherent in Canada. We agreed on a number of issues.

First, the Canadian multilevel and multiplayer public health puzzle is a "wicked problem." New ministries and agencies have injected additional complexity in terms of system configuration. This makes already challenging governance mechanisms even more complex both horizontally (between ministries and agencies on a provincial/territorial or national level) and vertically (between national and provincial/territorial/local levels).

Second, public health system(s) that produce and implement healthy public policies will be more effective if non-governmental organizations, community organizations, other sectors of government, academia, and communities themselves play an active role in the process. This helps orient public health to tackle the set of upstream environmental, social, cultural and economic determinants of health. A political and societal system that is focused on 'governance for health' is a prerequisite for effective healthy public policies.

Third, some elected leaders are open to transformation if provided with sound system-oriented advice. That advice should be informed by relevant evidence and rigorous research of both a qualitative and quantitative nature. The policy, systems and governance

aspects of public health should increasingly be seen by academia as population health interventions which can and must be studied.

Last, the issue of public health systems thinking is not widely practised in Canada in any forum, except in part at the pan-Canadian Public Health Network Council (PHNC), through the Canadian Coalition for Public Health in the 21st Century or at CIHR's Institute of Population and Public Health (IPPH). The CIHR-IPPH has identified implementation systems in public health, and in other sectors, as a research priority. However, all of these are limited in their interaction with the broader constituency of public health in Canada and lack an overarching mandate.

As CPHA is a national organization with role and mandate for stewardship in public health, we call on CPHA to establish a permanent open forum that will systematically follow public health system aspects in Canada as part of its annual conferences. We stand ready to help CPHA in implementing this as we believe strong leadership and governance mechanisms are required to ensure the coherence of Canadian public health system(s).

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