A cross-cultural comparison of body composition, physical fitness and physical activity between regional samples of Canadian and English children and adolescents

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ABSTRACT

OBJECTIVES: Cross-cultural comparisons in children's body composition, health-related fitness and physical activity (PA) are rare due to a shortage of comparable data, but such comparisons may help avert worrying global prevalence in childhood obesity, and declining fitness and PA.

METHODS: We drew samples of Canadian and English children (10 years, $n=1630$, 50% boys) and adolescents (15 years, $n=1406$, 56% boys) from three separate, regional studies that conducted comparable school-based assessments (2006-2011). For each age-sex group, we assessed between-country differences for body composition (mass, height, BMI, waist circumference), cardiorespiratory fitness (CRF; 20 m shuttle run test), strength (handgrip) and self-reported PA. We used multiple regression to investigate whether between-country differences in fitness were explained by body composition and PA.

RESULTS: At any age, Canadian boys and girls were taller, heavier, and had greater BMIs and waist circumferences. English children had higher CRF than Canadians, which was explained by differences in body composition and PA. Canadian children were significantly stronger, partly due to greater body size. There were no between-country differences in adolescent boys. Canadian adolescent girls reported more PA than their English counterparts, but neither PA nor body size explained why Canadian adolescent girls had greater CRF or strength.

CONCLUSION: Future cross-cultural studies of PA should include indices of growth and fitness to better understand the relationship between intricate differences in PA and health outcomes.

KEY WORDS: Physical fitness; physical endurance; muscle strength; body mass index; exercise

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

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Obesity predisposes children to a myriad of cardiometabolic health complications, including elevated blood pressure, dyslipidemia, and insulin resistance.¹ In recent decades, Canada and England have witnessed an accelerated increase in childhood obesity, compared with other western societies.² In both countries, approximately one in four youth are overweight or obese.^{3, 4}

Cardiorespiratory^{5, 6} and muscular fitness^{7, 8} are positively and independently related to cardiometabolic health. Higher fitness levels may attenuate some of the adverse health outcomes associated with obesity.⁹ In light of this, it is of concern that both Canada^{10, 11} and England^{12, 13} have independently documented secular declines in health-related fitness among children and youth. While it seems intuitive that the rise in obesity and decline in fitness might be causally related, only about 50% of the reduction in child and youth fitness may be explained by fatness.¹⁴ Further, a concurrent decline in physical activity (PA) patterns is likely to play a role. Although population-level data have identified these disconcerting global trends, direct comparisons across cultures are able to specify common behavioural characteristics that contribute to this current public health crisis. International comparisons are rare due to limited availability of standardized datasets, and are typically restricted to single, multi-country studies that operate within regional contexts (e.g., the European Youth Heart Study⁵).

Thus, we conducted cross-sectional analyses to address three objectives: 1) to assess differences in fitness between regional samples of Canadian and English children and adolescents; 2) to assess the influence of body composition/size on between-country differences in fitness; 3) to assess whether PA explains between-country differences in fitness.

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METHODS

Sample

We drew the analytic sample from three studies: the East of England Healthy Hearts Study (EoEHHS), Action Schools! BC (AS! BC), and the Health Promoting Secondary Schools (HPSS) study. All studies took place in public schools, used similar school-based protocols and validated field-tests,¹⁵ collected data within the last decade and no more than five years apart from each other, and were from regions (East of England, UK; British Columbia, Canada) with a lower childhood obesity burden compared with their respective national averages.^{16, 17}

The EoEHHS is a large ($n=8800+$) school-based health and fitness survey of 10-16 yr-olds (overall consent: 98%).⁹ We included students with data on sex, age, height, body mass, and who were in either grades 5-6 on measurement day (May–Sept. 2008; $n=1003$, 51% boys, 10.7 ± 0.6 years; 97% Caucasian) or grade 10 (June–Sept. in 2006, 2007 and 2008; $n=966$, 59% boys, 15.1 ± 0.4 years; 95% Caucasian). The sample of the EoEHHS included students from 14 elementary and 12 secondary schools from the counties of Essex and Suffolk. For each student with complete/valid home postal codes (96%), we obtained Index of Multiple Deprivation scores (IMD 2007)¹⁸ as a proxy for socio-economic status (SES). IMD is a composite score of deprivation indicators at the Lower Super Output Area level. In the EoEHHS sample, IMD scores were lower (median 10.3, interquartile range (IQR) 6.9-16.9) than regional (12.4, 7.5-20.3) or national values (17.1, 9.6-30.2), indicating comparably low area level deprivation in the EoEHHS sample.

AS! BC is an active school model designed to promote PA in elementary school children,¹⁹ and was evaluated in a controlled trial (2005-2007; consent: 64%). We included students who attended schools assigned to the usual practice group, were in grades 5-6, and had valid data on sex, age, height and body mass (Sept. 2006; $n=627$, 49% boys, 10.7 ± 0.6 years, 49% Caucasian). The 14 elementary schools were located in British Columbia's Lower Mainland (including Metro Vancouver) and on the southern portion of Vancouver Island. HPSS is a 'Real Community Trial' that assessed the effectiveness of a whole school model to promote PA and healthy eating in high schools²⁰ (consent: 22%). We included students with baseline data on sex, age, height and body mass (Sept.–Oct. 2011; $n=440$, 49% boys, 15.3 ± 0.4 years, 54% Caucasian – ethnicity available for subsample of $n=181$). The 10 secondary schools were located in British Columbia's Lower Mainland (including Metro Vancouver), Southern Interior, and on the southern portion of Vancouver Island.

As a proxy for SES in the Canadian samples, we obtained area-level (Census dissemination area) family income (National Household Survey 2011) for students with complete/valid addresses (AS BC!: 68%; HPSS: 93%). Compared with regional (\$76,789; IQR: \$60,929-\$96,567) and national values (\$75,261; \$58,180-\$95,774), the area-level median family income was similar in the AS BC! sample (\$77,521; \$58,826-\$89,290), but greater in the HPSS sample (\$81,893; \$67,971-\$97,715).

For simplicity, we refer to our samples as Canadian or English children (average age 10 years) and adolescents (average age 15 years).

Protocol

The respective institutional ethics committees approved the studies. Parental consent and student assent were obtained. Measurements

were conducted at school; students were assessed in small groups during regular instructional blocks, usually physical education. Trained researchers performed the standardized field-based measurements.

Body composition

Students wore gym clothing without shoes and had their body mass (0.1 kg) and height (0.1 cm) measured using standard field equipment (calibrated according to respective manufacturers' guidelines). Body mass index (BMI; kg/m^2) was categorized into 'normal' (includes underweight), 'overweight' and 'obese' as per International Obesity Task Force criteria (IOTF), which are age-sex specific cut-offs that correspond to adult BMIs of $25 \text{ kg}/\text{m}^2$ and $30 \text{ kg}/\text{m}^2$, respectively.²¹ Waist circumference was measured with standard anthropometric tape (0.1 cm) at the natural narrowing of the waist; the lower of duplicate measurements was used for analyses.

Cardiorespiratory fitness

Cardiorespiratory fitness (CRF) was measured using the 20 m shuttle run test,²² a progressive run to maximal exertion. Students with health conditions, injuries or illnesses did not participate. Test details are described elsewhere.²² In brief, we administered the test to groups of ~12 students in school gyms, provided uniform instructions ('run for as long as possible', 'reach the line with your foot in time with the signal', 'if you miss twice in a row, your test is over'), and acted as 'spotters'. In younger age groups and where students were unfamiliar with the test, a researcher acted as 'pacer'. The last completed lap preceding volitional exhaustion, or when a student failed to maintain the required running speed twice, was recorded.

Muscular fitness

Muscular fitness was measured by handgrip tests using portable dynamometers. In the EoEHHS, students were instructed to stand with the elbow fully extended, to breathe normally, to move their dominant arm from 180° to 0° flexion at the shoulder, and to apply maximal effort between 90° and 0° flexion (TKK5001 GRIP, Takei Scientific Instruments Co. Ltd, Tokyo, Japan). Students received verbal encouragement, and we used the best out of two trials (0.1 kg). In AS! BC, students were instructed to stand with the elbow fully extended and the shoulder flexed at 45° , and to breathe normally while applying a maximal isometric effort (Almedic dynamometer, Japan). Students received verbal encouragement, and the highest value from two trials was recorded for each arm (0.1 kg). We inferred that the highest score corresponds to the dominant arm. In HPSS, students were instructed to stand with their elbow flexed at 90° and the shoulder flexed at 0° , and to breathe normally while applying a maximal isometric effort (Jamar Plus+, Lafayette Instrument Company, Lafayette, IN). For each arm, the best of three trials was recorded (0.1 kg); we used the highest score for the dominant arm for analysis. We will refer to this measure of muscular fitness as strength.

Physical Activity Questionnaire for Children or Adolescents (PAQ-C or -A)

The Physical Activity Questionnaire for Children (PAQ-C) or Adolescents (PAQ-A) is a 7-day recall tool that provides general PA estimates in 8-20 yr-olds during the school year.²³ The 8 (PAQ-A)

Table 1. Sample descriptive statistics (mean $\pm$ SD (n)) and between-country differences (95% CI†), stratified by age group and sex

	Males			Females		
	England	Canada	Difference (95% CI†)	England	Canada	Difference (95% CI†)
Children						
Age (yrs)	10.7 $\pm$ 0.6 (510)	10.8 $\pm$ 0.6 (310)	-0.1 (-0.1, 0.0)	10.7 $\pm$ 0.6 (493)	10.7 $\pm$ 0.6 (317)	0.1 (0.0, 0.1)
Body mass (kg)	38.6 $\pm$ 9.0 (510)	41.9 $\pm$ 11.5 (310)	-3.3 (-4.8, -1.8)***	39.1 $\pm$ 9.0 (493)	40.7 $\pm$ 10.0 (317)	-1.6 (-3.0, -0.3)*
Height (cm)	143.4 $\pm$ 7.5 (510)	145.9 $\pm$ 7.9 (310)	-2.4 (-3.5, -1.4)***	143.9 $\pm$ 7.7 (493)	146.2 $\pm$ 8.1 (317)	-2.3 (-3.4, -1.2)***
BMI (kg/m ²)	18.6 $\pm$ 3.1 (510)	19.5 $\pm$ 4.0 (310)	-0.9 (-1.4, -0.3)**	18.7 $\pm$ 3.1 (493)	18.9 $\pm$ 3.4 (317)	-0.1 (-0.6, -0.3)
% overweight / obese‡	20.2% / 5.3%	25.2% / 8.4%		20.5% / 4.7%	19.6% / 6.0%	
Waist (cm)	64.7 $\pm$ 8.8 (485)	67.6 $\pm$ 9.6 (309)	-3.2 (-4.5, -1.8)***	63.2 $\pm$ 8.0 (473)	65.0 $\pm$ 8.6 (317)	-1.8 (-3.0, -0.6)**
Shuttles (laps)	40.0 $\pm$ 20.6 (482)	34.8 $\pm$ 17.1 (260)	5.2 (2.5, 8.0)***	30.3 $\pm$ 15.0 (488)	27.3 $\pm$ 13.4 (354)	3.1 (0.9, 5.2)***
Handgrip (kg)	16.8 $\pm$ 3.8 (501)	21.5 $\pm$ 4.8 (264)	-4.6 (-5.3, -3.9)***	15.9 $\pm$ 2.8 (486)	19.2 $\pm$ 4.7 (357)	-3.4 (-4.1, -2.7)***
PAQ-scores§	3.28 $\pm$ 0.7 (315)	3.26 $\pm$ 0.6 (303)	0.0 (-0.1, 0.1)	3.08 $\pm$ 0.6 (304)	2.99 $\pm$ 0.6 (305)	0.1 (-0.0, 0.2)
Adolescents						
Age (yrs)	15.1 $\pm$ 0.4 (567)	15.3 $\pm$ 0.4 (216)	-0.3 (-0.3, -0.2)***	15.1 $\pm$ 0.4 (399)	15.3 $\pm$ 0.3 (224)	-0.2 (-0.3, -0.2)***
Body mass (kg)	61.6 $\pm$ 12.0 (567)	65.0 $\pm$ 11.8 (216)	-3.4 (-5.3, -1.6)***	56.3 $\pm$ 9.0 (399)	59.5 $\pm$ 11.8 (224)	-3.2 (-5.0, -1.4)***
Height (cm)	170.2 $\pm$ 8.0 (567)	173.5 $\pm$ 7.2 (216)	-3.3 (-4.5, -2.1)***	161.2 $\pm$ 6.4 (399)	163.2 $\pm$ 6.2 (224)	-2.0 (-3.0, -0.9)***
BMI (kg/m ²)	21.2 $\pm$ 3.4 (567)	21.6 $\pm$ 3.4 (216)	-0.4 (-0.9, 0.2)	21.6 $\pm$ 3.1 (399)	22.3 $\pm$ 4.2 (224)	-0.7 (-1.3, -0.1)*
% overweight / obese‡	15.2% / 4.1%	15.7% / 4.6%		16.0% / 2.0%	20.1% / 5.4%	
Waist (cm)	73.8 $\pm$ 8.8 (554)	73.8 $\pm$ 8.3 (216)	-0.6 (-1.3, 1.4)	69.7 $\pm$ 7.8 (394)	71.5 $\pm$ 9.2 (224)	-1.8 (-3.3, -0.4)*
Shuttles (laps)	65.4 $\pm$ 26.7 (522)	65.2 $\pm$ 21.7 (207)	0.2 (-3.5, 4.0)	36.6 $\pm$ 17.3 (367)	43.5 $\pm$ 17.8 (217)	-5.9 (-8.9, -3.0)***
Handgrip (kg)	36.1 $\pm$ 8.1 (521)	36.2 $\pm$ 7.7 (82)	-0.1 (-1.9, -1.8)	26.3 $\pm$ 4.9 (351)	29.0 $\pm$ 5.1 (99)	-2.7 (-3.8, -1.6)***
PAQ-scores§	2.88 $\pm$ 0.7 (552)	2.85 $\pm$ 0.5 (82)	0.0 (-0.1, 0.2)	2.48 $\pm$ 0.6 (391)	2.61 $\pm$ 0.5 (99)	-0.1 (-0.3, -0.1)*

Bold indicates statistical significance; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Note: all comparisons are unadjusted for multiple comparisons.

† 95% CI – upper and lower limit 95% confidence intervals; ‡ BMI weight classification as per International Obesity Task Force criteria.²¹

§ PAQ-score – Physical Activity Questionnaire score: mean score of 8-9 questionnaire items, scored between 1 (no/low PA) and 5 (very high PA).

or 9 (PAQ-C) items capture the frequency of participation in different activities and sports (activity checklist), effort during physical education, activity during recess (PAQ-C only), lunch, after school, evening and at the weekend. Canadians completed the original PAQ-C/A;²³ the English samples completed a modified activity checklist to account for contextual differences (e.g., netball replaced cross-country skiing).²⁴ Each item is scored on a 5-point scale (1=low, 5=very high PA) and the average denotes the PAQ-score.

Statistical analyses

We stratified analyses by age and sex due to age-, sex- and age*sex interaction effects for anthropometric and fitness variables (data not shown). We assessed between-group differences using independent two-tailed t-tests (objective 1). To assess the association between country, anthropometry and fitness (objective 2), we first identified which indices of body composition/size were correlated with fitness outcomes ($p < 0.05$). We then fit multiple linear regression models for each fitness outcome (dependent variable), using relevant body size/composition variables, as well as a dummy variable for country (0=Canada, 1=England) as independent variables (Model 1). When independent variables were collinear (i.e., body mass and BMI), we used the measure that was most strongly correlated with the dependent variable (i.e., waist circumference for CRF; height and body mass for strength; see Table 2). To evaluate whether self-reported PA explained between-group differences in fitness (objective 3), PAQ-score was added to the models (Model 2). We did not adjust for ethnicity as it was not a significant factor in the models. Analyses were performed in Stata/MP 10.1 for Windows (StataCorp LP, TX).

RESULTS

Between-country differences in body composition, fitness and physical activity

Descriptive characteristics of children and adolescents by sex and respective between-country differences are reported in Table 1. Children from England were significantly lighter, shorter and had lower BMI and waist circumference compared with their Canadian counterparts. Similar to recent national estimates,^{3,4} in both countries approximately 1 in 4 children were overweight or obese. English adolescents were significantly lighter and shorter than Canadians; BMI and waist circumference were significantly lower only in English vs. Canadian girls. Overall, 1 in 5 adolescents was overweight or obese, slightly lower than national estimates.^{3,4}

English children had higher CRF, whereas Canadian children were significantly stronger. There were no between-country differences in fitness measures between Canadian and English adolescent boys. Canadian adolescent girls, however, had greater CRF and strength than English adolescent girls. PAQ-scores differed only in adolescent girls, with English girls reporting less PA than Canadian girls. There was a three-way interaction effect for sex, age group and country ($p < 0.001$), whereby the magnitude of difference in PAQ-scores between children and adolescents was greater for English vs. Canadian girls.

Associations between indices of body composition and fitness

The regression models are presented in Table 2 (Model 1). Waist circumference was inversely related to CRF; adjusting for it reduced between-country differences in CRF (Table 1). Height and body mass were positively related to strength; adjusting for them somewhat

Table 2. Multiple regression analyses for indices of fitness, stratified by age group and sex

	Males		Females	
	Model 1	Model 2	Model 1	Model 2
	β † (95% CI‡)	β † (95% CI‡)	β † (95% CI‡)	β † (95% CI‡)
Children (10 yrs)§				
DV: Shuttle run (laps)				
Country (UK; ref: Canada)	3.22 (0.59, 5.86) *	2.57 (-0.12, 5.26)	2.55 (0.49, 4.60) *	1.25 (-0.90, 3.39)
Waist (cm)	-1.03 (-1.17, -0.89) ***	-0.84 (-0.99, -0.70) ***	-0.66 (-0.78, -0.54) ***	-0.61 (-0.74, -0.48) ***
PAQ-score		7.39 (5.33, 9.46) ***		5.31 (3.49, 7.12) ***
r^2 (n)	0.242 (718) ***	0.291 (534) ***	0.151 (722) ***	0.201 (534) ***
DV: Handgrip (kg)				
Country (UK; ref: Canada)	-3.95 (-4.51, -3.40) ***	-4.14 (-4.78, -3.53) ***	-2.81 (-3.34, -2.28) ***	-3.14 (-3.75, -2.52) ***
Height (cm)	0.18 (0.13, 0.22) ***	0.18 (0.13, 0.24) ***	0.21 (0.16, 0.25) ***	0.21 (0.16, 0.27) ***
Body mass (kg)	0.08 (0.04, 0.12) ***	0.10 (0.06, 0.14) ***	0.09 (0.05, 0.13) ***	0.10 (0.05, 0.14) ***
PAQ-score		0.87 (0.41, 1.32) ***		0.57 (0.05, 1.08) *
r^2 (n)	0.398 (765) ***	0.451 (566) ***	0.395 (743) ***	0.416 (545) ***
Adolescents (15 yrs)§				
DV: Shuttle run (laps)				
Country (UK; ref: Canada)	1.01 (-4.73, 6.84)	0.83 (-4.53, 6.18)	-5.10 (-9.08, -1.11) *	-4.60 (-8.49, -0.72) *
Waist (cm)	-0.98 (-1.21, -0.74) ***	-0.95 (-1.16, -0.73) ***	-0.65 (-0.86, -0.43) ***	-0.63 (-0.84, -0.42) ***
Handgrip (kg)	1.07 (0.81, 1.32) ***	0.99 (0.75, 1.23) ***	0.55 (0.21, 0.88) ***	0.39 (0.05, 0.72) *
PAQ-score		12.97 (10.29, 15.66) ***		7.33 (4.67, 9.98) ***
r^2 (n)	0.171 (548) ***	0.288 (541) ***	0.098 (426) ***	0.156 (419) ***
DV: Handgrip (kg)				
Country (UK; ref: Canada)	1.58 (0.02, 3.13) *	1.56 (-0.01, 3.13) †	-1.83 (-2.86, -0.80) **	-1.77 (-2.80, -0.74) **
Height (cm)	0.20 (0.11, 0.28) ***	0.19 (0.10, 0.27) ***	0.14 (0.07, 0.21) ***	0.15 (0.07, 0.22) ***
Body mass (kg)	0.28 (0.23, 0.34) ***	0.29 (0.23, 0.35) ***	0.18 (0.13, 0.23) ***	0.17 (0.12, 0.22) ***
Shuttles (laps)	0.09 (0.07, 0.11) ***	0.09 (0.07, 0.12) ***	0.05 (0.02, 0.07) ***	0.04 (0.01, 0.06) **
PAQ-score		-0.08 (-0.91, 0.76)		0.79 (0.07, 1.52) *
r^2 (n)	0.376 (556) ***	0.378 (548) ***	0.244 (429) ***	0.254 (422) ***

Model 1 – Association between country and relevant indices of body composition/size on fitness outcomes; Model 2 – Model 1 plus inclusion of PAQ-score. Bold regression coefficients are significant; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Note: all models are unadjusted for multiple comparisons. † = unstandardized beta coefficient; ‡ 95% CI – upper and lower limit 95% confidence intervals; § in children, mean age±SD was 10.7±0.6 in males and 10.7±0.6 in females; in adolescents, it was 15.2±0.4 in males and 15.1±0.4 in females; || PAQ-score – Physical Activity Questionnaire score: mean score of 8–9 questionnaire items, scored between 1 (no/low PA) and 5 (very high PA).

reduced between-country differences in strength (Table 1). Associations between indices of body composition and fitness were generally stronger for children than adolescents, males than females, and strength than CRF (25–40% vs. 10–25%).

Associations with physical activity

Table 2 shows regression models with the inclusion of self-reported PA (Model 2). Self-reported PA and CRF were positively related: for each additional PAQ-score point (scored between 1–5), students completed between 5 and 13 shuttles more (Table 2). These models explained an additional 5% of the variance in CRF in most groups, and as much as 11% in the adolescent boys. There was no longer an independent country effect on CRF in children; conversely, it persisted in adolescent girls. For strength, self-reported PA explained an additional 5% of the variance in the models in children, and the independent country effect remained significant. In adolescents, self-reported PA was not significantly correlated with strength, and the regression models, as well as the country-effect in adolescent girls, were minimally altered by its inclusion.

DISCUSSION

In light of the global physical inactivity crisis,²⁵ it is crucial that we better understand the relationship between young people's health (including weight status and fitness) and health behaviours (such as PA). We contribute to a limited body of knowledge of cross-cultural differences between children and adolescents from Canada and England. We found that in children, body composition/size and PA explained between-country differences in CRF but not strength. We identified interesting similarities between adolescent boys, and startling differences between adolescent girls. We discuss our findings in detail below.

Body composition/size differences between Canadian and English groups

At all ages, Canadians were significantly taller and heavier than their English counterparts. We were unable to find reports that compared body size/composition of children and adolescents who resided in Canada vs. England and do not know whether this is also true at a population level. To provide context, we expressed height relative to WHO 2007 reference norms (largely based on US youth in 1977).²⁶ On average, all groups of 10-yr-olds were notably taller than norms (all >80th percentile). Most adolescent groups were also taller than norms, but to a smaller relative extent (>56th percentile, except English adolescent girls: 47th percentile). Similar secular increases in height, particularly in boys and at younger ages, have been described for US children; because similar increases were not observed in adolescence, these trends are thought to be attributable to accelerated maturation.²⁷ Unfortunately, we had no maturational indicators to investigate its role in accelerated growth at an early age and/or between-country differences in height.

Ethnicity differed between English and Canadian cohorts (~95% vs. ~50% Caucasian), but was not a significant correlate of outcomes in the current analyses. Environmental factors (such as SES) likely affect growth more than genetic and/or ethnic factors.²⁸ The potential mechanistic roles of SES, nutritional status, growth and maturation, as well as how these relate to health behaviours warrant further study.

Physical activity and body composition explain country differences in children's fitness

CRF was estimated using a weight-bearing running test (20 m shuttle run). Typically, children who weigh less perform better in

these types of tests.²⁹ Indeed, the superior test performance of the English children was partially explained by their more favourable body composition (lower waist circumference). However, only body composition and self-reported PA combined explained all of the between-country difference.

Questionnaires have the potential to offer contextual insight as to which types of PA may be important. For example, a more detailed examination of individual PAQ items (data not shown) identified that English children – particularly boys – reported to engage more frequently in aerobic-type activities of intensities great enough to promote CRF, such as soccer and jogging. In the English context, soccer is a common and often unstructured activity, meaning that it occurs without adult instruction, and is frequently observed in parks or in school grounds during break time. Indeed, ‘active play’ was recently highlighted as a key PA domain that requires international action, due to its troublesome secular decline in many western societies.³⁰

A greater level of understanding as to the exact types and doses of activities that promote CRF, as well as the context in which they occur, would be beneficial to inform future intervention.

Strength differences in children were likely maturity-dependent

Height and body mass explained up to 40% of the variance in handgrip strength. However, despite Canadian children being taller and weighing more than their English counterparts, body size differences did not explain the between-country difference in strength. We observed positive correlations between body mass and strength in accordance with others.³¹ However, a more accurate estimate of lean mass might afford a better understanding of this finding. The association between height and strength in children, which we also observed in our samples, is an important phenomenon and one that is thought to explain much of the differences in strength between similarly aged children.³² As we had no measure of maturity, we are unable to speculate as to how it contributes to between-country differences in strength per se, or its potential mediating effect via greater height.

We generally found no association between strength and self-reported PA (as we did for fitness). This is unsurprising given that the PAQ is not designed to measure specific resistance exercise known to improve muscular strength in this population.³³ As strength is related to cardiometabolic health in youth,^{7,8} further study of determinants of strength is warranted and might include measures of muscle mass, strength/power, participation in resistance-type activities and maturity level.

Why were Canadian adolescent girls fitter and stronger?

In contrast to the likeness between Canadian and English adolescent boys, Canadian girls were fitter, stronger and reported higher levels of PA than English adolescent girls. Although PA typically declines as children age,²⁴ the magnitude of this expected difference was significantly greater in English than in Canadian girls. Nevertheless, the greater levels of PA in Canadian adolescent girls did not explain the between-country differences in fitness or strength. The PAQ is unlikely to sensitively capture specific components of PA (e.g., intensity and frequency) that could explain differences in fitness in this age group. Identifying factors that

attenuate the age-dependent decline in PA is important for designing effective PA promotion strategies. Qualitative approaches might help to drill down to determine whether factors such as social desirability of PA behaviours play a role, specifically in adolescent girls.

It is notable that Canadian adolescent girls had less desirable indices of body composition than English adolescent girls, yet they performed better in the shuttle run. There is debate over the role of school-based fitness testing and its potential negative effect on emotional well-being and motivation for PA.³⁴ Our data did not support the notion that students with excess body fat (greater waist circumferences) were disadvantaged per se in the shuttle run. Adequate fitness levels can attenuate adverse health consequences associated with obesity,⁹ and maintaining fitness should be a target for health promotion in youth.

Limitations

The school-based studies were not regionally representative but were volunteer samples, a common strategy to sample students from all SES relative to a study area.¹⁹ We did not have access to internationally comparable indicators of individual- or area-level SES and were thus unable to account for its potential mediating role. This is an important consideration for future cross-cultural studies aiming to elucidate mechanisms which may explain disparities in health outcomes and/or health behaviours. Consent rates differed between studies, which could have introduced selection bias; for example, students enjoying PA may have been more likely to participate. However, the ranges we noted in our objective outcomes, as well as the between-country differences, do not support the hypothesis of systematic bias (i.e., fitter Canadians would also have lower BMI). The 20 m shuttle run test is a valid tool,¹⁵ but test familiarization and day-to-day performance variation may influence individual results. However, we expect this variability would be common to both countries and would therefore not influence our findings. Handgrip is a valid field-test to estimate muscular fitness in youth;¹⁵ dynamometer and protocol may, however, affect scores.³⁵ The current studies adopted different protocols and dynamometers that should have theoretically advantaged the English groups (extended elbow, Takei dynamometer).³⁵ However, the English groups had lower scores than the Canadians; thus, we are confident that Canadians were stronger but cannot be certain of the true magnitude of the difference. Last, PA was assessed by questionnaire and although recall error is a well-documented problem in youth,³⁶ the PAQ has construct validity.²⁴ The cross-sectional design of this analysis does not enable us to infer causality.

CONCLUSION

Our findings in two developed nations lend credence to the notion of a global ‘pandemic of physical inactivity’²⁵ – with a reach that extends to encompass children and youth. Future international collaborative efforts, such as the recent global matrix of physical activity ‘grades’ across countries,³⁰ should consider extending standardized monitoring to include indices of growth and fitness, and place an emphasis on identifying underlying cross-cultural differences in the intricacies of PA behaviours (such as unstructured PA or active play).

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RÉSUMÉ

OBJECTIFS : Rares sont les comparaisons interculturelles de la composition corporelle des enfants, de leur forme physique liée à la santé et de leur activité physique en raison du manque de données comparables, mais de telles comparaisons peuvent aider à éviter la menace de la prévalence mondiale inquiétante de l'obésité juvénile, ainsi que le déclin de la forme physique et de l'activité physique.

MÉTHODE : Nous avons extrait des échantillons d'enfants (10 ans, $n=1\ 630$, 50 % de garçons) et d'adolescents (15 ans, $n=1\ 406$, 56 % de garçons) canadiens et anglais de trois études régionales distinctes ayant mené des évaluations en milieu scolaire comparables (2006-2011). Pour chaque groupe d'âge et de sexe, nous avons évalué les différences entre les deux pays pour ce qui est de la composition corporelle (masse, taille, IMC, périmètre ombilical), de la capacité cardiorespiratoire (CCR; course navette sur 20 mètres), de la force (poigne) et de l'activité physique autodéclarée. Par régression multiple, nous avons cherché à déterminer si les différences entre les deux pays au chapitre de la forme physique s'expliquaient par la composition corporelle et l'activité physique.

RÉSULTATS : À tout âge, les garçons et les filles canadiens étaient plus grands, plus lourds, et avaient un IMC et un périmètre ombilical plus élevés. Les enfants anglais avaient une CCR supérieure à celle des Canadiens, ce qui s'expliquait par les différences dans leur composition corporelle et leur activité physique. Les enfants canadiens étaient significativement plus forts, en partie en raison de leur plus grande corpulence. Il n'y avait pas de différences entre les garçons adolescents des deux pays. Chez les filles, les adolescentes canadiennes ont déclaré faire davantage d'activité physique que les Anglaises, mais ni l'activité physique, ni la corpulence n'expliquaient pourquoi les adolescentes canadiennes avaient une CCR ou une force supérieures.

CONCLUSION : Les futures études interculturelles de l'activité physique devraient inclure des indices de croissance et de forme physique pour que l'on comprenne mieux le lien entre les différences subtiles des niveaux d'activité physique et les résultats sanitaires.

MOTS CLÉS : aptitude physique; endurance physique; force musculaire; indice de masse corporelle; exercice physique