SHORT REPORT

Prevalence of cardiovascular disease risk in Ontario adolescents

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We assessed traditional cardiovascular disease (CVD) risk factors in 3293 Canadian adolescents (age: 14.1 (SD 0.6) years; body mass index (BMI): 23.0 (SD 6.3)). Prevalence for obesity, borderline hypertension and hyperlipaemia was 23.7% (95% CI 1.5%), 9.1% (95% CI 1.0%) and 9.7% (95% CI 1.0%), respectively, with increased estimates in children with low cardiorespiratory fitness ($p<0.05$). Participants demonstrated increased CVD risk, highlighting the necessity of placing adolescents in the forefront of preventive CVD programs.

Cardiovascular disease (CVD) is the leading cause of mortality in Canada, accounting for 74 626 deaths in 2002.[1 2] Although the considerable medical and public health advances that have been achieved during the past three decades in Canada have reduced the CVD attributed mortality rates, there is clearly a need to increase current knowledge regarding CVD risk factors in the Canadian population.[1] Our objective was to assess the prevalence of recommended CVD risk factors in a large cohort of Canadian adolescent children in Ontario.

MATERIALS AND METHODS

Participant selection and description

A total of 3293 (1595 males, 1698 females; age range: 14–15 years) adolescent students from 33 schools in Southern Ontario volunteered from the approximately 4300 attending the region's secondary schools. As this was part of a routine monitoring program run by Heart Niagara, all grade 9 students attending the region's schools were invited to participate. Thus, only children with pre-existing physical limitations, excused from physical education classes due to medical reasons, were excluded from the assessments. The cohort was multi-ethnic, but most participants were Caucasian middle-class urban dwellers. Written informed consents were obtained from the participants and their parents after full oral and written explanation of the data collection procedures and the purpose of the study. The study conformed to the standards set by the Declaration of Helsinki and was approved by the Heart Niagara Board in cooperation with Brock University and the local school boards. All measurements were conducted at the beginning of the school year (ie, September–October) during school physical and/or health education classes at a similar time of the day. Except for blood pressure measurements (performed by two public health nurses), each measurement was taken by a single trained investigator to minimise inter-observer bias.

Procedures

Age was recorded (accurate to 1 month) and standing height was measured to the nearest 0.5 cm with the subject's shoes off and head at the Frankfort horizontal plane, and body mass was assessed to the nearest 0.5 kg with participants being lightly dressed and barefooted (Seca Beam Balance 710; Seca, Hamburg, Germany). Relative body fat was measured using bio-electrical impedance analysis (Quantum II; RJL Systems, Clinton, MI, USA) with the participants being sufficiently hydrated (ie, ad libitum water consumption approximately 20 min prior to data collection; this was done after participants' weight had been recorded). Systolic and diastolic blood pressure were measured three times (the mean of all measurements was recorded) by registered nurses using conventional mercury sphygmomanometers (Welch Allyn, NY, USA), after the participant had been sitting quietly for at least 5 min, and were used to calculate mean arterial pressure (ie, diastolic+(0.333·(systolic−diastolic)). All blood pressure measurements were taken by a total of two nurses using the same sphygmomanometers. We measured total serum cholesterol using one drop of capillary blood via an Accutrend GCT (Roche, Mannheim, Germany). Aerobic fitness was assessed by predicted maximal oxygen uptake ($\dot{V}O_{2max}$; in $ml \cdot kg^{-1} \cdot min^{-1}$) using the 20 m multistage shuttle run test which was performed according to standardised procedures.[3]

Statistical analyses

One way analysis of variance (ANOVA) was used to compare values for males and females and χ^2 tests were used to detect gender-specific differences in prevalence rates for the various CVD risk factors. The prevalence rates for overweight and obesity based on body mass index (BMI) data were calculated according to age- and gender-specific cut-off values proposed by the International Obesity Task Force.[4] Clinical obesity was considered to be present at $\geqslant$25% and $\geqslant$30% relative body fat for males and females, respectively.[5] The cut-off values for healthy, borderline and at risk children in relation to systolic, diastolic and mean arterial pressure were adopted by the Task Force Report on High Blood Pressure in Children and Adolescents.[6] The prevalence rates for borderline hyperlipaemia were calculated using the cut-off value of total serum cholesterol $>$4.15 mmol/l recommended by the American Academy of Pediatrics.[7] Finally, male and female adolescents were further classified into two fitness groups based on the gender specific median value of $\dot{V}O_{2max}$ in order to examine the effect of low fitness level on estimates of CVD risk factors using one way ANOVA. The level of significance set at $p \leqslant 0.05$.

RESULTS

Physical and physiological data as well as prevalence rates for the studied CVD risk factors appear in table 1. Males were taller by 4.0 cm and heavier by 10.0 kg than average using growth charts proposed for use in Canadian children.[8] Using the same growth charts, females appeared to be normal for height but heavier by 8.0 kg than average. These norms, published in

Abbreviations: BMI, body mass index; CVD, cardiovascular disease

Table 1 Physical and physiological measures and prevalence rates of the studied CVD risk factors in the cohort

	Males (n = 1595)	Females (n = 1698)	Entire cohort (n = 3293)
Age (years)	14.1 (SD 0.5)	14.1 (SD 0.6)	14.1 (SD 0.6)
Height (m)	1.67 (SD 0.1)	1.60 (SD 0.1)**	1.63 (SD 0.1)
Mass (kg)	63.4 (SD 14.1)	59.6 (SD 11.1)**	61.5 (SD 17.5)
BMI ($kg \cdot m^{-2}$)	22.7 (SD 4.5)	23.3 (SD 7.6)**	23.0 (SD 6.3)
% Normal	77.1 (95% CI 2.1)	74.4 (95% CI 2.1)	75.8 (95% CI 1.5)
% Overweight	15.4 (95% CI 1.8)	17.1 (95% CI 1.8)	16.3 (95% CI 1.3)
% Obese	7.5 (95% CI 1.3)	8.5 (95% CI 1.3)	8.1 (95% CI 0.9)
Relative body fat	15.2 (SD 6.5)	27.1 (SD 9.5)**	21.4 (SD 9.3)
% Healthy	88.6 (95% CI 1.6)	64.0 (95% CI 2.3)††	76.3 (95% CI 1.5)
% Clinically obese	11.4 (95% CI 1.6)	36.0 (95% CI 2.3)††	23.7 (95% CI 1.5)
Systolic blood pressure (mm Hg)	117.3 (SD 12.5)	111.9 (SD 12.3)**	114.5 (SD 12.7)
% Healthy	77.0 (95% CI 2.1)	77.9 (95% CI 2.0)	77.5 (95% CI 1.4)
% Borderline	16.1 (95% CI 1.8)	12.1 (95% CI 1.6)	14.1 (95% CI 1.2)
% At risk	6.9 (95% CI 1.2)	0.0 (95% CI 0.0)†	3.5 (95% CI 0.6)
Diastolic blood pressure (mm Hg)	70.8 (SD 9.6)	70.7 (SD 9.6)	70.7 (SD 9.7)
% Healthy	89.0 (95% CI 1.5)	89.0 (95% CI 0.5)	89.0 (95% CI 1.1)
% Borderline	10.0 (95% CI 1.4)	11.0 (95% CI 1.5)	10.5 (95% CI 1.1)
% At risk	1.0 (95% CI 0.4)	0.0 (95% CI 0.0)	0.5 (95% CI 0.2)
Mean arterial pressure (mm Hg)	86.3 (SD 8.5)	84.4 (SD 9.2)**	85.3 (SD 9.1)
% Healthy	89.0 (95% CI 1.6)	90.9 (95% CI 1.4)	90.0 (95% CI 1.1)
% Borderline	9.9 (95% CI 1.5)	8.2 (95% CI 1.9)	9.1 (95% CI 1.0)
% At risk	1.1 (95% CI 0.5)	0.9 (95% CI 0.4)	1.0 (95% CI 0.3)
Total serum cholesterol (mmol/l)	3.7 (SD 0.8)	4.0 (SD 0.9)*	3.8 (SD 0.9)
% Healthy	92.7 (95% CI 1.3)	88.0 (95% CI 1.5)	90.4 (95% CI 1.0)
% Hyperlipaemic	7.3 (95% CI 1.3)	12.0 (95% CI 1.5)	9.7 (95% CI 1.0)
$\dot{V}O_{2max}$ ($ml \cdot kg^{-1} \cdot min^{-1}$)	43.7 (SD 9.1)	37.3 (SD 5.4)**	40.4 (SD 8.1)

Values are mean (SD) or % (95% CI). BMI, body mass index; $\dot{V}O_{2max}$, maximal oxygen uptake.
ANOVA mean differences between genders significant at *$p \leq 0.05$ and **$p \leq 0.001$.
χ^2 prevalence differences between genders significant at †$p \leq 0.05$ and ††$p \leq 0.001$.

2002, also revealed that both males and females had higher BMI values by 3.0 and 3.9, respectively. On another note, both males and females demonstrated lower than average aerobic fitness values by 8.3 and 7.7 $ml \cdot kg^{-1} \cdot min^{-1}$, respectively, compared to normative data published in 1990.[9] Similarly, the current cardiorespiratory fitness values are lower than those recently reported for North American (males: 50.0 $ml \cdot kg^{-1} \cdot min^{-1}$; females: 44.0 $ml \cdot kg^{-1} \cdot min^{-1}$)[10] and European (males: 50.6 $ml \cdot kg^{-1} \cdot min^{-1}$; females: 41.6 $ml \cdot kg^{-1} \cdot min^{-1}$)[11] age-related peers. Regarding CVD prevalence rates, females revealed increased prevalence for clinical obesity, while a considerable number of adolescents were borderline for increased systolic, diastolic and mean arterial blood pressure as well as total serum cholesterol. Interestingly, when participants were further classified into two fitness groups based on the gender specific median $\dot{V}O_{2max}$ (table 2), both male and female adolescents with lower fitness levels had increased estimates of CVD risk factors.

DISCUSSION

Our findings suggest that that the examined females demonstrate increased prevalence for clinical obesity, while both genders demonstrate increased BMI and decreased aerobic fitness values compared to international and normative data for this age group.[8–11] A considerable number of children were also borderline for hypertension based on increased systolic, diastolic and mean arterial pressure as well as total serum cholesterol. Therefore, the present results complement the limited previous CVD risk factor estimates on Canadian youth suggesting increased prevalence rates.[2 12 13] It is also important to highlight that children with low cardiorespiratory fitness levels demonstrated statistically increased estimates of CVD risk factors, particularly regarding relative body fat and BMI. These findings are in line with longitudinal data from Europe showing that adiposity is inversely related to cardiorespiratory fitness, a relationship mediated by physical activity participation.[14] Although we did not monitor physical activity participation, it seems reasonable

Table 2 Physiological measures of males and females classified by fitness levels based on the gender specific median value of $\dot{V}O_{2max}$ and ANOVA comparisons between the two fitness groups for the each gender

	Males with $\dot{V}O_{2max}$ >43 $ml \cdot kg^{-1} \cdot min^{-1}$ (n = 707)	Males with $\dot{V}O_{2max}$ <43 ml $kg^{-1} \cdot min^{-1}$ (n = 841)	Δ between male fitness groups	Females with $\dot{V}O_{2max}$ >36 ml $kg^{-1} \cdot min^{-1}$ (n = 769)	Females with $\dot{V}O_{2max}$ <36 ml $kg^{-1} \cdot min^{-1}$ (n = 835)	Δ between female fitness groups
BMI ($kg \cdot m^{-2}$)	21.6 (2.9)	24.1 (5.7)	2.5 (0.2)**	21.7 (3.0)	24.8 (9.1)	3.1 (0.4)**
Body fat (%)	11.9 (6.7)	18.5 (9.1)	6.6 (0.6)**	23.7 (7.5)	29.6 (9.9)	5.6 (0.5)**
Systolic blood pressure (mm Hg)	117.1 (12.1)	117.9 (11.8)	0.9 (0.6)	111.3 (11.8)	113.0 (12.4)	1.8 (0.6)*
Diastolic blood pressure (mm Hg)	70.2 (9.2)	71.3 (9.5)	1.1 (0.5)*	70.3 (9.1)	71.9 (10.4)	1.6 (0.5)*
Mean arterial pressure (mm Hg)	85.8 (8.5)	86.8 (9.2)	1.0 (0.5)*	84.0 (8.5)	85.6 (9.6)	1.6 (0.5)**
Total serum cholesterol (mmol/l)	3.5 (0.6)	3.8 (0.9)	0.28 (0.05)**	3.9 (0.8)	4.0 (0.9)	0.05 (0.04)

Values are mean (SD). Participants with a $\dot{V}O_{2max}$ value equal to the gender-appropriate median value were excluded from the analysis. BMI, body mass index; $\dot{V}O_{2max}$, maximal oxygen uptake.
*$p \leq 0.05$; **$p \leq 0.001$.

to assume that children with increased cardiorespiratory fitness levels were generally more active, which may have contributed to their overall healthier CVD risk factor profile.

Although there was no significant difference in mean age between the two groups and the vast majority of the participants were post-pubertal, it is possible that the results of between- and within-gender comparisons may reflect differences in pubertal development which were not examined. This is particularly relevant to total serum cholesterol, as puberty has a strong influence on children's lipid profile. Although realising this limitation, we decided to use the current hyperlipaemia cut-off value since it has been recommended by the American Academy of Pediatrics.[7] Within the limitations of the present study, it is concluded that the present Ontario adolescents, especially those with low cardiorespiratory fitness, appear to be at increased risk for developing CVD at a later life stage. These findings highlight the necessity of placing adolescents in the forefront of preventive cardiovascular disease programs and should receive particular attention by healthcare authorities in order to minimise future CVD attributed mortality rates.

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