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Risk Factors for Coronary Heart Disease Among Overweight Children: A Case for Cholesterol Screening in Canada

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Abstract

Background: Rates of childhood obesity and its associated risks are increasing in Canada. The purpose of this article is to examine the prevalence of hypercholesterolemia among overweight Canadian children to determine increased risk for coronary heart disease (CHD) and recommendations for cholesterol screening.

Methods: A retrospective analysis was performed using data from the Pediatric Weight Clinic (PWC) in Calgary, Alberta, Canada. The sample included 294 children (aged 3–19 years) with a BMI greater than the 85th (overweight) and 95th (obese) percentile for age and gender. Blood lipid profiles with measurements of total cholesterol, low-density lipoprotein (LDL) and high-density lipoprotein (HDL) cholesterol, as well as triglycerides were analyzed.

Results: Abnormal total cholesterol levels were detected in 50.8% of children (n = 126). The prevalence of abnormal LDL and HDL cholesterol were 47.5 and 20.2% respectively (n = 116, n = 49). Triglyceride levels were abnormal in 38.8% of children (n = 94). Rates were adjusted to valid percents in order to reflect the number of members in each lipid subsample.

Conclusions: The prevalence of hypercholesterolemia among overweight Canadian children is high. Given that these children present with two risk factors for CHD (obesity and hypercholesterolemia), cholesterol screening guidelines are recommended for prevention and early intervention.

Introduction

Coronary heart disease (CHD) continues to be the leading cause of death worldwide.[1] Major risk factors include hypertension, high blood cholesterol, tobacco smoke, excessive alcohol consumption, diabetes, physical inactivity, and obesity.[2,3,4] Although clinical signs of CHD tend not to appear until adulthood, several studies have shown that the process of atherosclerosis begins early on in childhood.[5,6] Risk factors during childhood such as elevated cholesterol and increased BMI have been shown to increase the risk of CHD and stroke in adulthood, as well as cause early signs of atherosclerosis (including coronary artery calcification, reduced arterial distensibility, and increased carotid intimal-medial thickness).[7,8,9,10] In general, researchers have shown that children who are overweight or obese are more likely to present with an abnormal lipid profile and have a greater number of CHD risk factors.[11]

In July 2008, the American Academy of Pediatrics (AAP) revised its cholesterol screening guidelines to reflect the current childhood obesity epidemic. The AAP recommended that children over the age of 2 be screened on the basis of the following risk factors: family history of hypercholesterolemia or early cardiovascular disease; children with diabetes, hypertension, or history of smoking; and children who are overweight (based on a BMI greater than the 85th percentile for age and sex).[12] In Canada, recommendations for cholesterol screening are not at a consensus. The Canadian Pediatric Society (CPS) and Canadian Cardiovascular Society (CCS) have not released guidelines pertaining to cholesterol and cardiovascular health in children. Furthermore, the Canadian Consensus Conference on Cholesterol (1988)[13] and Canadian Task Force on the Periodic Health Examination (1993)[14] have not been updated to recognize obesity as a risk factor for cholesterol screening, despite a rate of 26% of children falling in the overweight or obese category.[15] The 2006 Canadian Clinical Practice Guidelines (CCPG) on the Management and Prevention of Obesity in Adults and Children (2006) is the only body that recommends

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screening in overweight children and adolescents. However, these recommendations only apply to children over the age of 10, and are vague in suggesting how often the screening tests be performed.[16]

According to the latest AAP policy statement regarding lipid screening, overweight children are part of a special risk category and are in need of cholesterol screening regardless of family history or other risk factors.[12] There is clear evidence warning of early development of atherosclerosis in children, especially among those with elevated cholesterol concentrations and higher BMIs. The imminent concern is that a large percentage of Canadian children are living with two major risk factors for CHD (obesity and hypercholesterolemia), yet screening guidelines are either nonexistent, outdated, or are only catching those within a certain age category. More comprehensive screening, as recommended by the AAP, may better provide early detection, prevention, and intervention in this high risk population. The purpose of the present study was to determine the prevalence of hypercholesterolemia in overweight Canadian children and determine the need, if any, for screening recommendations.

Method

A retrospective analysis was conducted using data obtained from the Pediatric Weight Clinic (PWC) in Calgary, Alberta, Canada (formerly the Pediatric Obesity Clinic). The PWC offers a multidisciplinary, family-based childhood obesity treatment program which provides individualized support to children and their families.

Participants

Patient data from 2004–2008 were retrieved from the PWC's archived files. Inclusion criteria required the following: age at initial visit, gender, initial visit BMI, initial visit weight (kg), and initial visit blood work results. A total of 294 subjects were included in the statistical analyses. The participants ranged in age from 3–19 years and were classified as either overweight or obese, based on a BMI greater than the 85th or 95th percentiles for age and gender.[17] All participants completed a medical assessment by the Clinic's pediatrician and were asked to complete blood work through Calgary Laboratory Services. Descriptive statistics (age, sex, height, weight and BMI) were recorded during this initial assessment.

Primary Measures

The primary outcome measures were levels of total cholesterol (TC), LDL, HDL, and triglycerides (TG). Cholesterol levels were classified as normal or abnormal, based on age-adjusted ranges for children by Calgary Laboratory Services (normal values are TC between 123.6-169.9 mg/dL [3.20–4.40 mmol/L], LDL between 61.8–108.1 mg/dL [1.60–2.80 mmol/L], HDL >38.6 mg/dL [>1.00 mmol/L], and TG between 15.4–50.2 mg/dL [0.40–1.30 mmol/L]). Frequencies of individual cholesterol levels were reported as valid percents (i.e., variable denominator for each calculation) due to missing values for each lipid level. The total cholesterol/HDL-cholesterol ratio was not considered in this investigation. Although several studies recognize the ratio as a predictor of CHD risk, the Third Report of the Expert Panel on Detection, Evaluation, and Treatment of the High Blood Cholesterol in Adults (Adult Treatment Panel III)[18] considers LDL cholesterol most important in predicting CHD and does not use the ratio as a specified lipid target of therapy.

Statistical Analysis

Descriptive statistics including age, gender, BMI, and weight; as well as blood lipid levels (TC, HDL, LDL, and TG) were entered into Microsoft Excel files, coded for anonymity, and sent to the University of Calgary Department of Mathematical and Statistics for analyses. Frequency output reported the number of subjects presenting with cholesterol levels in the abnormal ranges.

Results

Data from 134 boys and 160 girls were analyzed (n = 294). Physical characteristics of the study population are listed in Table 1. Age, BMI, and weight, as well as individual lipid level means and ranges were reported. The mean ages for boys and girls were 11.9 and 11.5 years respectively (Table 1). One hundred and thirty-two out of 160 girls (83%) presented with BMI percentiles above the 95th percentile, and 123 out of 134 boys (92%) presented with BMI percentiles above the 95th percentile (classification of obese).

Blood lipid levels were classified according to the previously mentioned guidelines from Calgary Labora-

Table 1. Physical Characteristics of the Study Population

Variables	Boys (n = 134)	Girls (n = 160)
Age (years) Range	11.91±3.34 5–19	11.54±3.75 3–19
BMI (kg/m^2) Number of children in the 95th percentile (obese)	31.54±13.47 123	29.95±6.31 132
Weight (kg) Range	74.16±28.27 23.28-180.60	69.15±26.35 22.85–126.65
Total Cholesterol (mg/dL) Range	165.8±32.2 94.6–290.7	170.4±29.5 96.5–264.9
LDL Cholesterol (mg/dL) Range	94.8±27.8 37.8–198.8	98.4±25.1 51.0–157.5
HDL Cholesterol (mg/dL) Range	47.5±10.6 23.2–81.1	46.3±12.2 18.1–97.7
Triglycerides (mg/dL) Range	52.0±30.3 10.8–147.9	55.5±33.0 13.1–197.7

* Mean±SD. LDL = low-density lipoprotein; HDL = high-density lipoprotein

tory Services and are presented in Table 2. Lipid profiles were adjusted to valid percents due to missing data for each lipid (Table 2). One hundred and twenty six children presented with abnormal TC levels (valid percent = 50.8). Results for abnormal TG and LDL cholesterol were 47.5 valid percent (n = 116) and 38.8 valid percent (n = 94) respectively. Abnormal HDL cholesterol levels were present in 20.2 valid percent (n = 49) of children. The number of children with both abnormal triglycerides and abnormal HDL cholesterol was 33 (valid percent = 13.7%) (Table 2). In children 10 and under, abnormal total cholesterol, LDL cholesterol, HDL cholesterol and triglycerides were detected in 48.2, 36.1, 18.1, and 39.8 valid percent of children respectively (Table 3).There were no significant differences between boys and girls within the data.

Discussion

Coronary heart disease risk is increased by major factors such as obesity and hypercholesterolemia. At the Pediatric Weight Clinic (PWC), individualized support is provided to children seeking treatment for childhood obesity. Over the course of 5 years (2004–2008), 294 children attended the PWC and provided blood chemistry results. The present study sought to retrospectively examine the prevalence of hypercholesterolemia among overweight Canadian children and to determine the need (if any) for cholesterol screening in this population.

A large number of overweight children attending the PWC presented with abnormal lipid profiles. Having a minimum of 2 risk factors (hypercholesterolemia and obesity) puts these children at a much greater risk for CHD. Approximately 50% had high total cholesterol, which is greater than the rates found in American children as reported by Boyd et al.[20] High total cholesterol has been cited as an independent risk factor for CHD, and has been associated with atherosclerotic lesions starting early in adolescence.[21,6] Rates of abnormal triglycerides and LDL cholesterol were also more prevalent than in Boyd et al[20] and in Invitti et al.[22] LDL cholesterol is regarded as the strongest predictor of cardiovascular risk by the ATP III, and has been

Table 2. Frequency and Classification of Plasma Lipid Parameters to Abnormal and Normal Categories

Classification	mg/dL	Frequency	Percent of Whole Sample (n=294)	Valid Denominator (whole sample minus missing values)	Percent of Valid Sample
Total Cholesterol					
Normal	123.6–169.9	122	41.2	248	49.2
Abnormal	<123.6 or >169.9	126	42.9	248	50.8
LDL Cholesterol					
Normal	61.8–108.1	148	50.3	242	61.2
Abnormal	<61.8 or >108.1	94	32	242	38.8
HDL Cholesterol					
Normal	>38.6	194	66	243	79.8
Abnormal	<38.6	49	16.7	243	20.2
Triglycerides					
Normal	15.4–50.2	128	43.5	244	52.5
Abnormal	<15.4 or >50.2	116	39.5	244	47.5
Triglycerides and HDL Cholesterol		33	11.2	241	13.7

* Classification ranges based on guidelines from Calgary Laboratory Services.
LDL = low-density lipoprotein; HDL = high-density lipoprotein.

Table 3. Frequency of Abnormal Lipid Levels in Boys and Girls Aged 10 and Under

Lipid Level	Frequency	Percent of Sample Aged 10 and Under (n=109)	Valid Denominator (n=109 minus missing values)	Percent of Valid Sample Aged 10 and Under
Total Cholesterol	40	36.7	83	48.2
LDL Cholesterol	30	27.5	83	36.1
HDL Cholesterol	15	13.8	83	18.1
Triglycerides	33	30.3	83	39.8

* n=109 is the number of children in the total sample aged 10 and under

associated with early signs of atherosclerosis such as calcification and fatty streaks in the arteries.[18,6] High fasting triglycerides have also been regarded as a risk factor for heart disease and have been shown to be associated with premature vascular age.[23] Finally, the prevalence of abnormal HDL cholesterol was 20.2% in this population. This suggests that one fifth of the sample is experiencing the risks of low HDL cholesterol, which include increased risk of ischemic heart disease as well as increased mortality from CHD.[24,25] We also note that in this study, 13.7% of children had combined high triglycerides and low HDL cholesterol, which has been shown to be as strong of a predictor of ischemic heart disease as isolated LDL cholesterol.[26] Based on the prevalence of hypercholesterolemia in their study, Boyd et al[20] concluded that screening all overweight children would be beneficial. Given the even higher prevalence of hypercholesterolemia in the present sample, support is provided for screening overweight and obese Canadian children.

In Canada, cholesterol screening for overweight and obese children is only recommended through the CCPG. Still, these guidelines determine lipid profiles only in children over the age of 10, which deviates from the AAP who include all children over the age of 2. Similar to the prevalence in the whole sample, up to 50% of children aged 10 and younger presented with abnormal cholesterol. Furthermore, abnormal cholesterol levels were seen in children as young as 3. Therefore, not only are these children at risk for developing atherosclerotic changes at a young age, they are also overweight, are experiencing the risks/comorbidities associated with obesity, and present with two risk factors for CHD. When the National Cholesterol Education Program (NCEP)[27] first recommended screening for all young adults by the age of 20, they reasoned that the detection of elevated cholesterol enabled early intervention through diet, physical activity, and weight management. Children also benefit from cholesterol reducing interventions. Studies have shown that dietary intervention in young children can have a positive effect on LDL concentrations, and that nutritional counseling is effective in reducing cholesterol levels.[28,29,30] Physical activity interventions have also been proven effective in improving the lipid profile of children and adolescents.[31] It has been suggested that early detection and treatment of elevated cholesterol can prevent premature CHD and thus reduce the total burden of CHD in future years.[32] Furthermore, Law et al[33] demonstrated that an earlier reduction in cholesterol levels had a greater effect on long-term CHD risk.

Although the CCPG does recommend that overweight children receive cholesterol screening, data from the PWC indicates that most physicians are not following these guidelines. The majority of children attending the PWC were referred by their family physician or pediatrician, yet their abnormal cholesterol was not addressed until they were seen by the PWC staff. Given their weight and age (if over the age of 10), they should have been screened prior to coming to the clinic. It would appear that children who are overweight or obese would benefit from more comprehensive and clear cholesterol screening guidelines. In addition, Canada would benefit from an updated version of the Canadian Consensus Conference on Cholesterol to address the childhood obesity epidemic and other issues put forth as in the AAP's policy statement.

We acknowledge several limitations to our study. First, our data were not compared to a control group. Therefore, we were unable to examine any differences in blood profile data between normal weight and overweight/obese children. Second, we did not consider the effects of race or pubertal status, which may have had an impact on weight status. We also did not control for other factors known to affect blood lipid profiles including smoking and the use of oral contraceptives.[34,35] Finally, many of the children attending the PWC were referred by their primary physician. Although the majority of these referrals were due to obesity and not due to cholesterol issues, it is possible that some children were referred with an increased risk (meaning these high risk patients would be included in the study).

Conclusion

Twenty-six percent of Canadian children are overweight or obese. Many overweight children, as seen in the present study, also present with hypercholesterolemia and therefore have a minimum of two risk factors for coronary heart disease. Based on these results, it appears that in order to reduce these risk factors, Canadian children need to be screened. This is an easy and effective method of prevention and should be employed by children's physicians in routine health examinations. Many researchers have shown that early intervention is key to preventing cardiovascular consequences related to excess body weight and high cholesterol.[13,27,32,33] As suggested by the American Heart Association, those children identified as being at risk for CHD due to high blood cholesterol should receive targeted intervention. This can then be achieved through referrals to appropriate health professionals.[36] Further research would be beneficial to determine the prevalence of hypercholesterolemia in a broader population, as this sample was limited in its size and homogeneity.

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