The Québec Child and Adolescent Health and Social Survey: Design and methods of a cardiovascular risk factor survey for youth

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BACKGROUND: Although atherosclerosis begins in childhood, there are no recent Canadian data on cardiovascular risk factors in provincially or nationally representative samples of youth.

OBJECTIVE: To describe the design and methods of the 1999 Québec Child and Adolescent Health and Social Survey, which assessed the prevalence and distribution of risk factors in a representative sample of Québec youth.

METHODS: School-based, multistage, cluster sampling survey of youth aged nine, 13 and 16 years. Measures included height, weight, subscapular and tricipital skinfolds, blood pressure (measured with the Dinamap), a fasting blood draw for assessment of lipoproteins and glucose, an age-adapted youth questionnaire on lifestyles and a parent questionnaire.

RESULTS: One thousand two hundred sixty-seven, 1186 and 1160 subjects aged nine, 13 and 16 years, respectively, responded to the questionnaire and had height, weight, skinfold thickness and blood pressure measured (response proportions of 83%, 79% and 78% respectively); 783, 818 and 874 subjects of the same age agreed to the blood draw (response proportions of 52%, 55% and 59%, respectively). Comparisons of characteristics of participants and nonparticipants in the blood draw showed few differences. The mean relative difference between lipoprotein and glucose values obtained at the study laboratory and a reference method varied from –0.3% to 6.1%. Design effects for means and proportions varied from 1.0 to 1.8.

CONCLUSION: Despite its complexity, this survey was able to achieve a high level of precision for multiple measures. It will provide the most complete data on cardiovascular risk factors ever collected among children and adolescents in Canada.

Key Words: *Epidemiology; Pediatrics; Population health; Risk factors*

L'Enquête sur la santé et la condition sociale des enfants et des adolescents du Québec: Conception et méthodologie d'une enquête sur le facteur de risque cardiovasculaire chez les jeunes

HISTORIQUE : Bien que l'athérosclérose se déclare pendant l'enfance, aucune donnée canadienne récente ne porte sur les facteurs de risque cardiovasculaire auprès d'échantillons provinciaux ou nationaux représentatifs des jeunes.

OBJECTIF : Décrire la conception et la méthodologie de l'Enquête sur la santé et la condition sociale des enfants et des adolescents du Québec, menée en 1999, qui a permis d'évaluer la prévalence et la distribution des facteurs de risque dans un échantillon représentatif de jeunes Québécois.

MÉTHODOLOGIE : Enquête en grappes, à plusieurs degrés et en milieu scolaire auprès de jeunes de 9 ans, 13 ans et 16 ans. Les mesures incluaient la taille, le poids, le pli cutané sous-scapulaire et tricipital, la tension artérielle (mesurée à l'aide du Dinamap), une prise de sang à jeun afin d'évaluer les lipoprotéines et le glucose, un questionnaire sur les modes de vie adapté à l'âge des jeunes et un questionnaire pour les parents.

RÉSULTATS : Mille deux cent soixante-sept, 1 186 et 1 160 sujets de 9, 13 et 16 ans, respectivement, ont répondu au questionnaire et ont fait mesurer leur taille, leur poids, l'épaisseur de leur pli cutané et leur tension artérielle (proportion de réponse de 83 %, 79 % et 78 %, respectivement), et 783, 818 et 874 sujets du même âge ont accepté de subir la prise de sang (proportion de réponse de 52 %, 55 % et 59 %, respectivement). La comparaison des caractéristiques des participants et des non-participants à la prise de sang a révélé peu de différences. La différence relative moyenne entre les valeurs de lipoprotéine et de glucose obtenues au laboratoire d'étude et une méthode de référence variait entre –0,3 % et 6,1 %. Les effets conceptuels relatifs aux moyennes et aux proportions oscillaient entre 1,0 et 1,8.

CONCLUSION : Malgré sa complexité, cette enquête a permis d'obtenir un taux de précision élevé pour des mesures multiples. Elle fournira les données plus complètes sur les facteurs de risque cardiovasculaire jamais compilées auprès d'enfants et d'adolescents au Canada.

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Although it has been almost 50 years since the first autopsy studies reported atherosclerosis in the arterial tree of young adults, the pediatric roots of ischemic cardiovascular disease (CVD) remain relatively understudied. Korean and Vietnam war autopsy studies identified coronary atherosclerosis in 44% to 77% of young male war casualties (mean age at death was 22 years) (1,2). Advanced lesions were found in 5% to 15%, suggesting that the atherosclerotic process had begun years earlier. Subsequent research revealed the presence of fatty streaks and atherosclerotic plaques in the aorta and coronary arteries of young children and adolescents who had died of external causes (3-5). More recent investigations have even documented fatty streaks in human fetal aortas (6).

Additional evidence supporting the pediatric origins of atherosclerosis includes statistically significant associations between CVD risk factors (RFs) and the extent of coronary atherosclerosis found at autopsy among youth who died of violent causes. In the Pathobiological Determinants of Atherosclerosis in Youth (PDAY) study, complete RF assessment by postmortem measurements were obtained from 1479 of 2876 subjects aged 15 to 34 at the time of death. Low high density lipoprotein cholesterol (HDL-C), elevated non-HDL cholesterol, smoking, obesity, hypertension and glycohemoglobin levels were associated with the extent or severity of atherosclerosis in the coronary arteries or the aorta (7-12). Among individuals with a favourable lipoprotein profile (non-HDL-C less than 4.14 mmol/L and HDL-C greater than or equal to 0.91 mmol/L) smoking, elevated glycohemoglobin, obesity in men and hypertension in African Americans were associated with atherosclerosis (13).

The Bogalusa study (14) showed strong dose-response relationships between the extent of coronary and aortic fatty streaks and fibrous plaques at autopsy of adolescents and young adults who died of violent causes, and the number of RFs measured years earlier. Studies using noninvasive methods to assess atherosclerosis among youth have also shown strong relationships between hyperlipidemia and coronary artery calcifications detected by ultrafast computed tomography (15), endothelial dysfunction measured by brachial reactivity (16-18) and carotid artery intima-media thickening assessed by ultrasonography (19,20). In addition, echocardiography has demonstrated increased left ventricular mass and diastolic dysfunction among hypertensive adolescents (21).

The importance of the study of CVD RFs in youth stems not only from their association with pediatric atherosclerosis but also from their persistence into adulthood, a phenomenon known as tracking. Both elevated levels of total cholesterol (TC) and blood pressure have been shown to track into adulthood (22-24). In addition, childhood obesity, physical inactivity and cigarette smoking are correlated with adult levels of these RFs (25).

Given the high degree of tracking of CVD RFs and the possibility that preventive efforts might be more effective if implemented during childhood and adolescence (25), obtaining reliable estimates of the population distribution of RFs is an important first step for the development of rational public policy for CVD prevention. With the exception of smoking, there are no recent representative national or provincial data on CVD RFs in Canadian youth. This report describes the design of the Québec Child and Adolescent Health and Social Survey (QCAHS), which was conducted to provide such data (26). It also presents the background, target population, sample design and recruitment, measurements and procedures, response rates, selected data analysis issues and ethical considerations for this survey, with a particular emphasis on its cardiovascular component.

OBJECTIVE OF THE QCAHS

The objective of the QCAHS was to provide a profile of general health and social well being of Québec youth. The cardiovascular component aimed to document the distribution of major CVD RFs and associated lifestyles, including blood lipoprotein levels, blood pressure, overweight and obesity status, smoking and physical inactivity. An additional objective was to assess the association between CVD RF and environmental (family, socioeconomic status, etc) and genetic factors. Because of the added measurement complexity, a separate survey was designed to assess dietary intake in another sample of Québec youth and is not considered in this paper.

METHODS

Design of the QCAHS

The QCAHS was a multistage, stratified, cluster sampling survey of in- and out-of-school youth in Québec. The survey was conducted between January and May 1999 and included an age-specific youth self-administered questionnaire, a parent questionnaire, a school director questionnaire, and biological and anthropometric measures. Because the school director questionnaire was not related to CVD, it will not be considered further.

Population

The QCAHS target population consisted of Québec youth aged nine, 13 or 16 years on March 31, 1999. Single year age categories were selected because many biological and behavioural variables can change within a narrow age range. Nine-year-old children were selected because, based on the authors' previous experience and results from the pilot study, they are the youngest group from which reliable information can be gathered from self-administered questionnaires (27); this age group was also chosen because most nine-year-olds are prepubertal. Thirteen-year-olds were selected because most will have entered puberty and because most youth begin high school at this age in Québec. Finally, by age 16, most boys and almost all girls will have completed puberty. In addition, school is obligatory up until age 16 in Québec and corresponds to the beginning of a transition period to adulthood.

Students attending federal government schools, native schools, schools in very remote regions, schools in which more than 50% of youth are handicapped and schools with fewer than 12 subjects of the desired age were excluded. The sampling frame contained 97% of all children aged nine, 13 and 16 years in Québec. About 5% of 16-year-old adolescents in Québec have dropped out of school. To maintain representativeness, a random sample of out-of-school 16-year-olds was also selected, but only to participate in the questionnaire portion of the survey.

Sampling

The sampling frame consisted of the 1998 to 1999 Québec Ministry of Education student roll, which contains the name, date of birth, home address and the name of the school attended for all students in Québec. In addition, the student roll of 1997 to 1998 was used to identify adolescents aged 16 in 1998 to 1999 who had dropped out of school or moved out of province.

Independent samples were drawn for each age. Four levels of stratification were used to optimize provincial representativity of the sample. First, the 17 administrative regions of Québec were divided into outlying (four regions) and other regions. For cost and logistic reasons, two of the four outlying regions were randomly selected with probability of selection proportional to the number of age-appropriate students. The 13 other regions were all selected for the next stage.

Within administrative regions, schools were stratified according to 1) language of instruction (French or English); 2) public or private status (only for French schools); and 3) geographic location based on metropolitan census areas. Approximately 60 schools were randomly selected for each age group. Finally, within each school sampled, random samples of approximately 25 subjects stratified by sex were selected. Because some youth aged 13 years are still in elementary school, these adolescents were sampled from the same elementary schools already sampled for nine-year-old children, as well as from a sample of high schools.

A sample size of 1500 per age was targeted to obtain coefficients of variation of less than 15% for sex-specific proportions of 10% and of 7% for both sexes combined, taking the cluster sampling design and an estimated response proportion of 80% into account.

Survey recruitment

The survey resulted from a partnership between the Institut de la statistique du Québec, the Ministère de la Santé et des Services Sociaux and the Ministère de l'Éducation du Québec, several regional public health departments and university researchers. Information letters were sent to the principal of each school and an appointment was made to explain the purpose of the study and answer questions about the protocol.

Subjects were given an envelope to be brought home to their parents. It contained a colour flyer and a letter describing the survey and a request for participation, a consent form for parents and children, a parental questionnaire and a stamped preaddressed return envelope for the parent questionnaire and consent form.

Data collection

Data were collected at school in a 3 h morning session. An additional data collection period was occasionally necessary for students who were absent. Separate teams of 10 persons including pediatric nurses, kinesiologists, interviewers and a team coordinator collected data in each of 10 geographical territories in Québec. A pilot test of several survey instruments was conducted among 329 students from three elementary and three high schools in the Montréal area in 1996 and a pretest of the full survey procedures and instruments was conducted among 196 youth in six Québec schools and 50 out-of-school adolescents in March and April 1998. A two-day training session for team coordinators and a four-day training session for all staff were held before the survey. All aspects of data collection were reviewed during the training session with a particular focus on adherence to the measurement protocol. Staff were tested and certified for the blood pressure and anthropometric measures.

Measurement and variables

Blood lipids, apolipoproteins, insulin and glucose: Because subjects had fasted for at least 10 h, the blood draw was the first procedure conducted, followed by a light breakfast. Ten millilitres of blood was collected by phlebotomy in a sterile tube containing 1 mg/mL ethylenediaminetetraacetic acid, immediately put on ice, centrifuged on site within 90 min, separated into five aliquots of plasma and one cell pellet and frozen on dry ice. Blood samples were shipped within 24 h to the nutrition laboratory, Ste-Justine Hospital, where they were stored at –80°C until analyzed. The biochemical analyses were performed by the Department of Clinical Biochemistry at Ste-Justine Hospital.

Plasma TC, HDL-C and triglyceride (TG) concentrations were measured colourimetically on a Synchron Cx7 (Beckman Couter, USA) using Beckman Coulter reagents. TC was measured by the cholesterol oxidase method, HDL-C with a homogeneous assay and TG by enzymatic hydrolysis followed by the measurement of free glycerol. Low density lipoprotein cholesterol (LDL-C) concentrations were calculated according to the Friedewald equation (28). Plasma glucose was measured enzymatically using glucose oxidase on a Beckman Coulter Synchron Cx7. Insulin concentrations were determined with the ultrasensitive insulin kit on the Access immunoassay system from Beckman-Coulter. This technique consists of a double antibody sandwich assay using chemiluminescence as the detection method; the antibodies used are specific to insulin and do not cross-react with proinsulin or peptide C. Apolipoproteins A1 and B were measured by rate nephelometry using the Beckman array. Standardization was conducted according to the recommendations of the International Federation of Clinical Chemistry with reagents and standards from Beckman Coulter.

Blood pressure: Blood pressure was measured on the right arm after subjects had been sitting at rest for at least 5 min and no less than 30 min after breakfast. Blood pressure cuff size was based on arm circumference measurement and according to the Project Heartbeat Protocol (29). Measurements were obtained with an oscillometric instrument (Dinamap XL, model CR9340, Critikon Co, Tampa, USA) with demonstrated validity (30) and according to procedures developed by the Child and Adolescent Trial for Cardiovascular Health Program (31). Three consecutive measures of resting blood pressure were obtained at 1 min intervals and the average of the last two measures was used in the analyses. In addition, the mean arterial pressure and resting pulse, which are measured automatically by the Dinamap, were recorded. The 10 Dinamap instruments used for data collection were calibrated against a standard mercury manometer before the start of the survey.

Anthropometric measures: Height was measured with a standard measuring tape. Subjects removed their shoes and heavy clothing and stood straight against a wall. A triangular level with a 90° angle was placed against the wall and the head of the subject to ensure that the head remained in the Frankfort horizontal plane. Height was recorded to the nearest millimetre (0.1 cm) during maximal inspiration. Weight was measured to the nearest 0.2 kg in light indoor clothing without shoes or extra sweaters using a spring scale tested daily for accuracy and calibrated using a set of standard weights. Triceps and subscapular skinfold thickness were measured on the right side to the nearest 0.1 cm using a Lange caliper (Beta Technology, USA) and the method described by Lohman et al (32). Subjects stood with their feet together and arms at their sides. They could request that measures be taken over their clothing and when this was done the thickness of the garment was measured with the caliper and subtracted from the overall measurement (skinfold plus garment) before recording.

All measurements were repeated and, if they differed by more than 0.5 cm for height, 0.2 kg for weight and 1 mm for skinfolds, a third measure was taken. The average of the two closest measures was used in data analysis. The body mass index was computed as weight (kg)/height^2 (m^2). Waist and hip circumferences were not measured.

Youth questionnaire

Two questionnaires were developed, one for nine-year-old children and one for 13- and 16-year-old adolescents. The questionnaire for nine-year-olds contained fewer questions and fewer response categories for certain questions. In addition, the wording of selected questions was simplified. Thirteen- and 16-year-old adolescents completed their questionnaires individually. Nine-year-old children were grouped with two interviewers; one interviewer standing in front of the group read the questions one by one providing instructions according to a manual of instructions. The second interviewer circulated among the students responding to queries and verifying that children were following instructions. The questionnaire was administered in French or English according to the language used in the school; 45 to 60 min was required for completion.

Most questions included in this survey were previously validated or used in major national or Québec-wide surveys (and, hence, available in French and English). Other questions were validated in French and English in local research. The cardiovascular component of the questionnaire included questions on smoking, physical activity and puberty. Other questions pertained to sociodemographic characteristics, school performance and well-being, social support, parent-child relationship, self-perceived body size, time spent in activities such as reading, television viewing, computer usage or video game playing, alcohol and drug consumption, health problems and use of motor vehicles. Additional questions for adolescents included participation in the workforce and sexuality. Finally, questions on the use of medication were included in the adolescent questionnaire but were asked in the parent questionnaire for nine-year-old children.

Frequency of physical activity was determined in a seven-day recall adapted from the Weekly Activity Checklist (33) and used extensively in our prior school studies (34). The original instrument correlated with an objective activity measure at r=0.34, P<0.01 (33). For each day of the preceding week (Monday to Sunday), subjects checked which of 18 physical activities they had participated in for at least 15 consecutive minutes on that day. The list of activities was slightly different for children and adolescents to reflect the different activities that interest these age groups. The list included the activities most frequently practised by the specific age groups during the winter and early spring, including physical education classes and activities during free play (34). A frequency score was computed by summing the total number of activities checked for each day of the week. Sedentary behaviours were measured using three questions that assessed the number of hours per day spent watching television (recorded separately for weekdays and weekends) and the use of home computers.

Cigarette consumption was assessed using questions from the 1994 Canadian survey of smoking among youth (35). All subjects answered two questions about lifetime use of cigarettes. Six additional questions were asked of 13- and 16-year-olds including lifetime use of at least 100 cigarettes, current use of cigarettes, and smoking by siblings and peers.

Although the wording was simplified for nine-year-olds, all subjects answered questions about puberty adapted from the Canadian National Longitudinal Study of Children and Youth (36), including questions on voice change and facial hair for boys, breast growth for girls, and underarm and pubic hair for both sexes.

Subjects aged 13 and 16 years indicated the presence of chronic health problems diagnosed by a physician or other health professional from a list of 13 items including diabetes and cholesterol or lipid problems. They also indicated medications used in the past two weeks from a list of seven categories (medication for pain or fever, for cold or allergies, for breathing problems, vitamins or minerals, antibiotics, to help concentration or calm down, or other medications). For nine-year-old children, the presence of chronic health problems and use of medication were assessed in the parent questionnaire. Finally, sociodemographic questions included age, sex, language spoken with friends, ethnicity (for 13- and 16-year-olds) and current grade.

Parent questionnaire

A parent questionnaire pertained to the family and social environment, health, use of health services, use of medication and schooling of study subjects, health behaviours of parents, family history of CVD and respiratory disease, and sociodemographic information. The instructions requested that the parent who 'knew the subject best' complete the questionnaire.

Lifestyle behaviours of parents related to CVD were assessed using questions drawn from the Canadian Heart Health Surveys (37), the Québec enquête sociale et de santé, 1998 (38) and the National Longitudinal Survey of Children and Youth (36), and included activity limitation, smoking status, self-reported height and weight, weight loss behaviour, frequency of leisure time physical activity, and consumption of alcohol and drugs. The respondent also answered questions about the smoking, alcohol use and physical activity habits of the current spouse or partner, as well as questions about the number of smokers in the household and the approximate number of cigarettes smoked daily in the household.

Additional questions assessed each biological parent's personal history of hypertension, high blood cholesterol, diabetes, heart attack or angina, stroke, cerebral vascular disease or peripheral vascular disease, asthma and hay fever, as well as the use of medication to lower blood cholesterol, hypertension medication or any medication for the heart.

Sociodemographic information included the province or country of birth of each of the subject, biological father and biological mother; language most often spoken at home; self-reported ethnocultural group; total household income; and level of education and employment status of the respondent and current spouse or partner. Copies of the questionnaires and data collection forms are available in French and English from the corresponding author or at the Institut de la statistique du Québec Website <www.stat.gouv.qc.ca>.

Data analysis: sample weights and design effect

Sample weights were calculated to reflect the number of individuals in the total population who are represented by each study subject. Study subjects were initially weighted according to the inverse of their probability of being sampled. These weights were adjusted by the inverse of the response proportions for schools and the inverse of the age-specific youth response proportions for the questionnaire, the blood draw or the parent questionnaire, respectively. The youth questionnaire weights were applied to the anthropometric and blood pressure variables because their response proportions were very similar. A final adjustment was calculated to equate the age-specific sum of weights and the total number of individuals in the target population. For data analysis purposes, these population weights were transformed into sample weights such that the sum of the age-specific weights equalled the observed number of children surveyed in that age group.

The design effect reflects loss of precision that results from complex cluster sampling designs compared with a simple random sample of the same size. It is defined as the ratio of the variance under the complex design to the variance that would have been obtained under simple random sampling. Although a specific design effect can be computed for each parameter of interest, most variables are affected similarly by the design. Separate design effects were calculated for means and proportions. For means, the average of the age-specific design effect for TC, HDL-C, TG, LDL-C and glucose was computed. For proportions, the average of the age-specific design effect for over 50 variables from the child, adolescent and parent questionnaires was computed.

Ethical considerations

Approval of the study protocol was obtained from the ethics committees of the Direction Santé Québec of the Institut de la statistique du Québec, the Ministère de l'Éducation du Québec and Ste-Justine Hospital. The use of provincial lists of schoolchildren as the sampling frame was approved by the Commission d'accès à l'information du Québec. Signed informed consent was obtained from parents and their children. Separate consents were required for the questionnaire and physical measures, the blood draw, the anonymous storage of residual samples and cell pellets for future genetic analyses, and the permission to send the results of the blood pressure, TC, HDL-C, TG and glucose tests to the child's home.

The questionnaires, data collection forms and blood samples were identified by a unique identification number. The master list matching student names and identification numbers was kept locked at the Direction Santé Québec offices and destroyed after the results of the blood pressure, TC, HDL-C, TG and glucose measures were sent to the parents who had consented. An explanatory letter described the results and encouraged parents to consult their pediatrician or family physician if an abnormal result was reported.

RESULTS

Response proportions

Because independent samples were drawn for each age group, age-specific response proportions are presented. Among the 189 schools sampled (out of over 3000 schools in Québec) for nine-, 13- and 16-year-olds, 97.2% (69 of 71), 96.3% (52 of 54) and 97.0% (61 of 63; one school sampled was deemed ineligible), respectively, agreed to participate. Because of the high response proportion and to avoid the loss of precision due to school refusals, two schools each were added for the nine- and 13-year-olds and three schools for the 16-year-olds.

Table 1 presents response proportions according to measurement. The age-specific response proportion is computed by dividing the number of respondents by the number of eligible individuals. Ineligible individuals were those who had been sampled from the Québec Ministry of Education's master list but who were currently living in institutions, severely handicapped, unknown to the school or deceased. Eligible subjects included 1520 of 1564 sampled nine-year-olds, 1498 of 1556 sampled 13-year-olds, 1495 of 1560 sampled 16-year-olds and 130 of 140 sampled out-of-school 16-year-olds. Among eligible nine-, 13- and 16-year-olds, 1267, 1186 and 1160, respectively, completed the questionnaire. Similar numbers of subjects provided measures of height and weight, skinfold thickness and blood pressure. Only 783, 818 and 874 of nine-, 13- and 16-year-olds, respectively, provided blood samples and parents of 1065, 1031 and 952 subjects completed the parent questionnaire.

TABLE 1
Response proportions of the Québec Child and Adolescent Health and Social Survey, Québec, 1999

	Age			
Response (%)	9 (n=1520)	13 (n=1498)	16 In school (n=1495)	16 Out of school* (n=130)
Questionnaire	83.4	79.2	77.6	40.0
Height and weight	83.1	79.1	77.4	–
Skinfold thickness	82.6	78.3	76.6	–
Blood pressure	82.4	78.8	77.4	–
Blood draw	51.5	54.6	58.5	–
Parent questionnaire	70.1	68.8	63.7	–

**Out-of-school 16-year-olds were asked to complete a postal questionnaire only*

Response proportions were similar for both sexes except among 16-year-olds; 74% of boys and 81% of girls responded to the adolescent questionnaire, and among those who were out of school 46% of girls and 36% of boys completed the questionnaire. In addition, both 13-year-old boys and girls in elementary school had lower response proportions than those in high schools (74% versus 80%). The much lower response proportion for the blood draw raises the possibility of selection bias. However, statistically significant differences for participation in the blood draw were only noted for language spoken at home for nine-year-olds (53% for anglophone versus 67% for francophones) and physical activity for 16-year-olds (72% for those physically active versus 81% for those least active). No differences in the response proportion for blood draw were noted according to sex, pubertal status, smoking, weight category (underweight, normal weight, overweight, obesity) or parental history of CVD or CVD RFs including smoking, parent education level, household income, or rural or urban status of the school (see appendix table).

Quality control

Interviewers verified questionnaires for completeness and omissions before subjects left the data collection area. A private firm performed the coding and double data entry with careful attention to admissible codes, logic errors and filter questions. Ten per cent of anthropometric measures were repeated by a different interviewer to assess interobserver reliability. The intraclass correlations for the interrater reliability for height, weight, and subscapular and tricipital skinfolds were 0.99, 0.99, 0.96 and 0.94, respectively, indicating excellent reliability.

The Department of Clinical Biochemistry of Ste-Justine Hospital participates on a regular basis in provincial and international quality control programs and is accredited by the Canadian External Quality Assessment Laboratory (CEQAL) (Vancouver, British Columbia). CEQAL's lipid reference

TABLE 2
Interassay coefficients of variation for selected control plasma measurements

Analyte	Level (n)	CV (%)
Apolipoprotein A1 (g/L)	0.46 (46)	3.8
	0.97 (36)	3.6
	2.18 (47)	3.4
	2.54 (39)	6.5
Apolipoprotein B (g/L)	0.52 (44)	3.9
	1.02 (45)	3.5
	1.65 (35)	3.4
	1.97 (37)	6.1
Total cholesterol (mmol/L)	2.91 (24)	1.4
	3.98 (24)	1.1
	5.55 (24)	1.0
	7.45 (25)	1.3
Glucose (mmol/L)	2.2 (24)	3.8
	6.4 (24)	1.3
	13.7 (24)	1.4
High density lipoprotein cholesterol (mmol/L)	0.56 (25)	3.7
	1.63 (25)	4.3
Insulin (mmol/L)	92 (24)	4.1
	286 (23)	4.9
	694 (24)	5.0
Triglycerides (mmol/L)	1.05 (24)	4.2
	1.40 (24)	5.4
	2.13 (24)	4.0
	5.12 (25)	3.9

CV Coefficient of variation

TABLE 3
Same-day and seven-day test-retest median coefficients of variation (%) for biochemical variables

Analyte	Same-day CV % (n)	Seven-day CV % (n)
Total cholesterol (mmol/L)	0.54 (124)	1.09 (122)
HDL-C (mmol/L)	1.03 (124)	2.21 (122)
Triglycerides (mmol/L)	1.16 (124)	1.77 (122)
Glucose (mmol/L)	0.00 (124)	1.37 (122)
Insulin (mmol/L)	1.49 (116)	3.13 (116)
Apolipoprotein A1 (g/L)	0.62 (125)	2.21 (123)
Apolipoprotein B (g/L)	0.97 (122)	2.16 (120)

CV Coefficient of variation; HDL-C High density lipoprotein cholesterol

methods are directly traceable to the methods of the Centers for Disease Control and Prevention – National Heart, Lung, and Blood Institute Lipid Standardization Program. Additional laboratory reference methods have been sanctioned by the National Reference System for the Clinical Laboratory and the International Federation of Clinical Chemistry. Calibration was performed extemporaneously with each lot of samples analyzed for plasma glucose, insulin, TC, TG, HDL-C, and apolipoproteins A1 and B. For each measure, controls at different analyte levels were included with each batch and were used to compute interassay coefficients of variation (Table 2).

TABLE 4
Mean relative difference in plasma lipid and glucose values between Ste-Justine Hospital and the reference method of the Canadian External Quality Assessment Laboratory (CEQAL)*

Analyte level	Total cholesterol (n=75) (%)	HDL-C (n=75) (%)	Triglycerides (n=75) (%)	Glucose (n=50) (%)
Tertile				
1st	1.2	1.0	6.1	–
2nd	0.9	–0.3	0.8	–
3rd	1.9	–3.1	–1.3	–
Below median	–	–	–	3.2
Above median	–	–	–	3.4

**Calculated as [(Ste-Justine Hospital – CEQAL) / CEQAL] × 100. HDL-C High density lipoprotein cholesterol*

TABLE 5
Average design effects of the Québec Child and Adolescent Health and Social survey

Variables	Age (years)		
	9	13	16
Means			
Sex-specific analyses	1.2	1.5	1.1
Both sexes combined	1.5	1.8	1.0
Proportions			
Sex-specific analyses	1.3	1.3	1.2
Both sexes combined	1.4	1.4	1.3

The results show very low coefficients of variation between assays for the control samples indicating the high precision of the laboratory measurements. A systematic 5% sample of plasma specimens was reanalyzed on the same day and another 5% was reanalyzed one week apart. The test-retest reliability coefficients, presented in Table 3, show that the Ste-Justine Hospital biochemistry laboratory largely exceeded the performance recommendations of the National Cholesterol Education Program (NCEP) and that achieved by the College of American Pathologists Comprehensive Chemistry Survey of 5500 laboratories in the United States (39).

To assess the accuracy of the lipid measurements, 75 random plasma samples (25 per age group) were sent to CEQAL for measurement of TC, HDL-C and TG. An additional 50 random samples were sent to CEQAL for assessment of the glucose measurements. Table 4 presents the mean relative difference between the Ste-Justine Hospital laboratory values and those from CEQAL for each tertile levels of analyte, or in the case of glucose for analyte levels above or below the median. The maximal relative difference is 6.1% indicating a high level of accuracy of the plasma lipid and glucose values. When the tertiles were collapsed into a single category, the overall mean difference was 1.4%, –0.8% and 1.9% for TC, HDL-C and TG, respectively, well below the 3% for TC and 5% for HDL-C and TG recommended by the NCEP.

Design effects

Table 5 presents the average design effects for means and proportions for the QCAHS for sex-specific analyses and for analyses with both sexes combined. The design effects for means range from 1.0 to 1.8. Sex-specific design effects are lower for nine- and 13-year-olds than for both sexes combined. In addition, the 13-year-olds show the largest design effects. The design effects for proportions range from 1.2 to 1.4 and show little difference for sex-specific or sex-combined analyses and little difference by age. Design effects greater than unity reflect the loss of precision of estimates of parameters of interest due to the cluster sampling design. They will not affect the validity or point estimates but will increase the standard errors and, hence, the confidence intervals around these estimates.

DISCUSSION

The QCAHS will provide the first CVD RF data from a representative sample of youth in a Canadian province in over 20 years. Although several recent provincial and national surveys provide information on smoking behaviour, very little data are available on other RFs. This is particularly distressing because many of these RFs are associated not only with CVD but also with many other chronic diseases including diabetes, osteoporosis and several cancers.

The only other survey that provided CVD RF data in youth was the Canada Health Survey of 1978 to 1979 (40). Over 20,000 individuals responded to a lifestyle questionnaire and one-quarter of these also had physical measures. Height, weight, skinfold thickness and blood pressure were measured in children aged two and above and total blood cholesterol was measured beginning at age 15. Unfortunately, blood cholesterol was measured in several laboratories with little standardization, and blood pressure values were based on single measures obtained by nurses using the auscultatory method.

National data on body size and physical activity were provided by the 1981 Canada Fitness Survey (CFS) and the Campbell Lifestyle Survey of 1988, which included both adults and children (41,42). Both used similar procedures, the former in 13,500 randomly sampled households including 4080 subjects aged seven to 16 years and the latter in approximately one-fifth of the original participants in the CFS. In addition, these surveys measured physical fitness.

Although the QCAHS achieved high response proportions for the questionnaire, anthropometric measures and blood pressure, only 51.5% to 58.5% of youth participated in the blood draw, thus raising the possibility of bias if important characteristics associated with lipid, apolipoprotein, insulin or glucose levels are distributed differently among those who agreed and those who did not agree to phlebotomy. Among the variables compared among respondents and nonrespondents to the blood draw, only English-speaking nine-year-olds and very physically active 16-year-olds were less likely to provide a blood sample.

The QCAHS demonstrates the feasibility of conducting a youth survey with a complex design and of achieving a high degree of precision for multiple types of measures. The survey required over 100 field staff, in addition to laboratory technicians, data entry staff, data analysts and a budget of over a million dollars. The conduct of the survey during the winter added to the complexity of the field operations. Winter data collection was inevitable because the Ministry of Education student list that served as the sampling frame becomes available only in November of each academic year and because data collection had to end before the year-end examinations. Because of this, data that are influenced by season such as physical activity will have to be interpreted with caution.

The QCAHS provides important methodological information for future surveys targeting youth. Because cluster sampling results in a loss of precision, sample sizes of future surveys using similar designs would need to be increased proportionally to the design effect to achieve desired levels of precision. For example, the sampling strategy produced only moderate clustering attested by design effects ranging from 1.0 to 1.8. This reflects the careful selection of clusters and stratifying variables and, in particular, the fact that the selection of subjects within schools was accomplished through simple random sampling, avoiding cluster sampling of classrooms. In addition, small number of subjects were selected from each school and were spread over 189 schools.

One of the important results of the survey will be to provide reference values for blood pressure and blood lipids previously unavailable for the Canadian pediatric population. The large sample size will permit precise estimation of important percentile values for these parameters. These values will be useful for clinicians in the management of pediatric patients, and for public health and policy planners as a baseline against which to evaluate preventive efforts. The QCAHS will also provide valuable information on pediatric obesity, physical activity, smoking, and the association between behavioural and biological CVD RF and between social, parental and personal characteristics of subjects and CVD RF. A particular strength of the QCAHS is the collection of data not only from children and adolescents but also from their parents, which will permit more detailed characterization of the influence of the family environment on youth behaviour and RF. In addition, the distribution and prevalence of RFs will help forecast the future population burden of CVD.

The preservation of stored plasma and cell pellets will enable the study of novel or emerging RFs in a representative pediatric population. This is particularly relevant for the study of gene-environment interactions in Québec's French-Canadian population, which has a relatively homogeneous genetic inheritance. For example, we are currently exploring the expression and the correlates of the insulin resistance syndrome in our population.

Limitations

Although no important differences were noted between participants and nonparticipants in the blood draw, the two groups might have differed in unmeasured characteristics. In addition, no information is available on the 20% of the target population who refused to participate in any aspect of the survey. Previous studies have shown that nonrespondents generally differ from respondents in motivation and attitudes toward health as well as RF status (43).

Except for genes, the cross-sectional nature of the survey will limit the study of new RF in this population. We were unable to obtain approval from the Direction Santé Québec to follow up respondents.

Another limitation involves the data collection procedures and measurements. Although most questionnaire items were drawn from previous instruments, misclassification may have occurred because of memory bias, social desirability or variable reading skills particularly among nine-year-old children. Additional measurement error might have been introduced in the few cases where subjects asked that skinfold measures be taken over their clothing. Measurement error might also have been introduced in the parent questionnaire if the respondent did not know the child well or was unaware of the medical history of the biological parents. Finally, no dietary data were collected in the QCAHS.

CONCLUSION

The QCAHS will provide the best data on CVD RFs in children and adolescents ever collected in Canada. However, these data need to be collected by similar surveys in other provinces to permit the creation of a national database. In addition, repeating these surveys over time is crucial to characterize the evolution of RF and behaviours in a future generation of young Canadians. Atherosclerosis begins during childhood and adolescence and a comprehensive strategy to control CVD must include the pediatric population. A national CVD RF database for youth is urgently needed in Canada to anchor public policy and clinical efforts on evidence and a clear understanding of the pediatric roots of mass CVD.

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APPENDIX
Percentage of eligible subjects who participated in the blood draw according to certain characteristics. Québec Child and Adolescent Health and Social Survey, 1999

	Age (years)				Age (years)		
Variables	9	13	16	Variables	9	13	16
Sex				Family history of CVD			
Male	61	71	74	No	64	71	83
Female	63	69	76	One parent	72	73	81
Language spoken at home				Two parents	70	76	79
French	67*	73	80	Puberty status			
English	53*	76	83	Prepubertal	62	78	–
French and English	61*	57	89	Pubertal	63	70	75
Other	79*	75	79	Post pubertal	–	65	73
Ethnic origin				Smoking status of parent‡			
French Canadian	67	73	80	Regular	69	78	79
Other	64	73	81	Occasional	82	71	91
Relative household income†				Former	67	73	79
Poor to very poor	66	75	83	Never	62	70	81
Medium	67	74	81	Weight category of child§			
High to very high	67	74	80	Normal	63	70	74
Residence				Overweight	60	68	80
Metropolitan census area	62	72	73	Obese	61	74	77
Other	62	67	77	Physical activity level (quartile)			
Parent education‡				I	68	69	81*
Elementary school only	62	69	78	II	63	68	70*
High school	65	76	79	III	61	72	78*
Vocational school	68	73	82	IV	57	71	72*
College	68	73	79				
University	67	73	82				

**P<0.05 for comparison of the different categories. †Based on total household income and the number of people living in the household and computed according to the methods of Statistics Canada (Statistique Canada. Répartition du revenu au Canada selon la taille du ménage, 1992, Ottawa, Division des enquêtes-ménages, catalogue no. 13-207, 1993). ‡Parent who completed the parent questionnaire. §Normal: body mass index (BMI) greater than fifth but less than or equal to 85th percentile of the age-sex specific distribution; Overweight: BMI greater than 85th but less than or equal to 95th percentile of the age-sex specific distribution and tricep skinfold less than or equal to 95th percentile and subscapular skinfold less than 90th percentile; Obesity: BMI greater than 95th and triceps skinfold greater than 95th and subscapular skinfold greater than 90th percentile. CVD Cardiovascular disease*

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