

Sugar-sweetened beverages and their association with obesity in South Asian children

by

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Abstract

The prevalence of obesity among South Asian (SA) children is increasing in comparison to their ethnic counterparts. This is of great concern given that SA adults have a greater predisposition to cardiovascular disease and type II diabetes. This increase in obesity may be further exacerbated by the adoption of 'Westernized' lifestyle behaviours such as dietary changes. Over the past fifty years, consumption of sugar sweetened beverages (SSBs) has dramatically increased to high levels which have led SSBs to become highly scrutinized as a major contributor to the rise in childhood obesity. Evidence suggests the consumption of SSBs is associated with a rise in body mass index (BMI) in young children and adolescents. It is unknown whether this effect is exacerbated in specific populations at high risk of obesity, such as SA children. For this investigation a total of 363 SA children enrolled in grades 2 and 3 were randomly recruited from communities in Vancouver, British Columbia and Hamilton, Ontario. Children were evaluated using the RICH LEGACY Questionnaire that included a comprehensive assessment of the child's lifestyle and physical measures. Independent multiple linear regression models adjusted for age and sex displayed an association between consumption of SSBs with z-BMI ($p=0.02$) but not with waist circumference (WC) ($p=0.35$) and waist to height ratio (W:Ht) ($p=0.86$). Diet beverages were not associated to z-BMI, WC or W:Ht ($p=0.43, 0.46, 0.43$, respectively). This new evidence is key in shaping future public health policies and interventions aimed at reducing the prevalence of childhood obesity.

Keywords: sugar-sweetened beverages; SSB; childhood obesity; South Asian children; Indian children; diet risk factors

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List of Acronyms

BMI	Body mass index
CAC	Community advisory committee
CDC	Center for Disease Control
CHMS	Canadian Health Measures Survey
CVD	Cardiovascular disease
DBP	Diastolic blood pressure
DEXA	Dual-energy X-Ray absorptiometry
DRS	Dietary risk score
FFQ	Food frequency questionnaire
GL	Glycemic load
HDL	High-density lipoproteins
HFCS	High-fructose corn syrup
IOTF	International Obesity Task Force
LDL	Low-density lipoproteins
NHANES	National Health and Nutritional Examination Survey
NSCH	National Survey of Children's Health
RICH LEGACY	Research in International Cardiovascular Health: Lifestyles, Environments and Genetic attributes in Children and Youth
SBP	Systolic blood pressure
SES	Socioeconomic status
SSB	Sugar-sweetened beverage
Term	Initial components of the term
USDA	US Department of Agriculture
WC	Waist circumference
WHO	World Health Organization

1.1. Obesity

1.1.1. Epidemiology

1.1.1.1. Measuring childhood obesity

The body mass index (BMI) is the internationally accepted indicator of obesity due to its low cost and convenience. It is a ratio of weight to height used to identify overweight and obese individuals at the population level. There are well-defined cut off points used to define overweight and obese in adults; in children the definition varies by age due to the substantial physical changes observed during childhood development. The criteria (Table 1) used to classify childhood obesity vary by establishment: World Health Organization (WHO), Center for Disease Control and Prevention (CDC) and International Obesity Task Force (IOTF). Since 2004, Health Canada has used the age/sex-standardized cut-offs established by IOTF (1).

Standardized growth charts are used to monitor appropriate growth trajectories of children and adolescents. The charts are applicable to children and youth aged 2-18 years old; there are adjusted growth curves for children under two years old and the adult BMI cut points apply to children above 18 years old. In Canada, health care professionals refer to the WHO growth charts to assess the development of height and weight in children. The charts were established by collecting evidence from six countries with environments considered to support optimal growth in children (Figure 1 and 2). The growth trajectories are appropriate for children of all ethnic and socioeconomic backgrounds, in addition to children that were formula or breastfed during infancy.

BMI and growth charts have limitations when used to classify obesity in children for research purposes. The growth and development observed in childhood and adolescence significantly varies among individuals thus an alternative method is needed. An internationally accepted approach used in research and clinical settings are standardized BMI (z-BMI). The z-BMI scores are calculated by adjusting BMI values for age and sex to categorize children by weight class at the population level. Definitions of

weight categories are outlined by WHO as described in table 1 (e.g. a child with normal weight would have a z-BMI score of (-2) – 1, inclusive).

Table 1. Definitions of childhood obesity

Organization	Definition
World Health Organization (2)	<p><i>WHO Reference 2007 (ages 5 to 19)</i></p> <ul style="list-style-type: none"> • Obese: BMI >2 standard deviations above the WHO growth standard median • Overweight: BMI >1 standard deviations above the WHO growth standard median • Underweight: BMI <2 standard deviations below the WHO growth standard median
US Center for Disease Control and Prevention (2)	<p><i>CDC growth charts (ages 2 to 19)</i></p> <p>BMI is assessed by age and sex specific percentiles:</p> <ul style="list-style-type: none"> • Obese: BMI >95th percentile • Overweight: BMI >85th percentile and <95th percentile • Normal weight: BMI >5th percentile and <85th percentile • Underweight: BMI <5th percentile
International Obesity Task Force (3)	<ul style="list-style-type: none"> • Provides international BMI cut points by age and sex for overweight and obesity for children age 2 to 18 • The cut points correspond to an adult BMI of 25 (overweight) or 30 (obesity)

1.1.1.2. Prevalence of childhood obesity

Childhood obesity has become an epidemic according to emerging evidence from global data trends. It is estimated that 155 million or one in 10 school-age children are classified as overweight or obese. The prevalence of childhood obesity is highest - close to 20-40% of the population - in developed regions, such as Europe and the Americas (4). Approximately 40 million children under the age of five are overweight; close to 30 million overweight children reside in developing nations (5). Newly industrialized areas in countries such as Brazil, Chile, Mexico and Egypt have experienced a dramatic shift from underweight to overweight in children and adolescents. The lowest prevalence of childhood obesity is seen in parts of Southeast Asia and South Africa, whereas South America and Central America, the Middle East and North Africa display moderate trends (6).

The Canadian Health Measures Survey (CHMS) from 2009-2011 identified 17% of children and youth aged 2-18 years old as overweight; 7% of those children were classified as obese (7). Similar estimates were reported by the CDC in the US, with approximately 17% of children and youth classified as overweight or obese in 2009-2010 (8). These estimates have not changed significantly from previous years; however, more data are needed to determine if prevalence is increasing or stabilized (1). Also, there is limited information regarding the prevalence of obesity in minority groups in Canada. Reports examined differences between children of various ethnic groups within Canada reported prevalence of overweight/obesity were similar in Caucasian and Black children at 26% and 29%, with lower rates (18%) observed in Southeast/East Asian children (9).

An emerging public health concern is increasing prevalence of childhood obesity in countries previously associated with low rates of obesity (4). Research has demonstrated many low- and middle-income countries now face a double burden — battling rising obesity trends while attempting to reduce rates of malnutrition and communicable diseases (5). A clear shift from malnutrition to over-nutrition in children residing in India, Brazil and China has occurred over two to six decades, respectively (6). Furthermore, within developing nations there are disparities in the prevalence of obesity across urban and rural populations. These changes were more pronounced in

populations residing in urban rather than rural populations in these countries (6, 10). A possible explanation is likely due to gains in economic prosperity, which have led to urbanization and the adoption of western lifestyles similar to those from higher socioeconomic backgrounds.

1.1.1.3. Economic burden of obesity

The high incidence of adult and childhood obesity has profound financial implications on the health care system. Measures of the cost of obesity include both the direct and indirect costs to the health care system. An investigation of eight chronic diseases associated with obesity reported the total health care costs due to obesity in Canada rose from \$3.9 to \$4.6 billion from 2000-2008 (11). Another study, using comparable methodology and investigating 18 obesity-related chronic diseases, estimated the economic cost of obesity to be \$7.1 billion (2006 dollars) (12). In Canada there is limited literature regarding the direct costs of childhood obesity on the health care system. A Canadian study found the effect of obesity on physician costs was not different between normal weight adolescents and overweight/obese adolescents. However, this study found strong evidence for increased physician costs associated with age; compared with normal weight groups, costs were 5.3% higher for obese young adults (18-39 years old), 7.0% higher for obese middle-aged adults (40-59 years old) and 28.3% higher for obese older adults (60+ years old) (13). These results suggest that age is associated with increasing physician costs for obese individuals, likely due to the development of obesity-related health consequences. Therefore childhood obesity may not have direct, but an indirect economic burden on the health care system long term.

1.1.2. Prevalence of obesity in South Asian children

The emerging dual burden of obesity and malnutrition are significant health problems affecting youth in India (14). In Indian children, prevalence of overweight has been reported to range from 9-27.5% and that of obesity from 1-12.9% (15, 16). There are increasing amounts of cross-sectional data to confirm the increasing prevalence of obesity in children and adolescents are localized to urban regions of India (17-20). In

Delhi, current estimates of children and young adolescents classified as overweight range from 22–25% and those suffering from obesity is approximately 2–6% (21).

Due to immigration, there are extensive South Asian communities emerging outside of India in western countries, most prominently Canada, UK and US. An investigation of approximately 5600 ethnically diverse school children residing in the UK found the odds of being overweight in Pakistani and Indian boys were about 1.3 to 1.5 times higher compared to their ethnic counterparts (22). The same study reported Pakistani girls to be 1.7 times more likely to be obese than their ethnic counterparts; however, Indian girls were less likely to be obese (odds ratio 0.39) (22). The Canadian Community Health Survey of 2004 reported 18% of Southeast Asian children under the age of 18 years to be overweight or obese (9). Exclusive data in the US on South Asians is limited as Black, Hispanic and non-Hispanic white populations are the most prevalent ethnic groups. The 2007 National Survey of Children's Health (NSCH) reported 18% of Asians aged 10-17 years old to be overweight and 9% to be obese (23).

1.1.3. Increased risk of obesity in South Asian children

Evidence indicates that South Asian adults experience cardiovascular disease (CVD) and type 2 diabetes 5-10 years earlier in comparison to individuals of other ethnicities (24). Metabolic consequences in South Asian adults may differ than their European counterparts due to their higher rates of central adiposity and insulin resistance (25, 26). These metabolic consequences arise due to the differential accumulation of visceral adipose tissue (27). South Asians exhibit a unique “thin-fat” phenotype that leads to increasing amounts of visceral adipose tissue coupled with a lower lean mass (28). This altered body composition is associated with the increased risk of CVD and type 2 diabetes seen in South Asian adults.

Similar trends of central obesity and high insulin levels are observed in South Asian adolescents (18, 29, 30). In Canada, South Asian male adolescents have the lowest rates of obesity but displayed adverse cardio metabolic risk factors in comparison to European adolescents; similar patterns were not observed in females (29). The

metabolic consequences are likely a result of the differential accumulation of visceral adipose tissue similarly observed in South Asian adults. Nightingale *et al.* (31) demonstrated UK South Asian children aged 9-10 years old had higher levels of adiposity in comparison to European children. The authors reported BMI to be lower in South Asian children than European children at any given fat mass. Collectively this evidence suggests visceral adipose tissue may increase the risk of obesity and CVDs in South Asian children.

An alternative hypothesis to explain the current obesity epidemic in India is traditionally attributed to “thrifty” genes, which helped survival in times of nutritional deprivation; but has become detrimental in modern times of excess food supply and reduced physical work (32). The “thrifty” phenotype proposes chronic fetal under-nutrition may lead to metabolic and structural changes that increase the prevalence of risk factors associated with type 2 diabetes and CVDs later in life. Research indicates ethnic differences in body fat composition are present at birth; South Asian infants tend to exhibit higher amount of body fat than white infants (33). The aforementioned “thin-fat” phenotype in adults may originate *in utero* and place South Asian individuals at higher risk of developing adverse cardio metabolic risk factors before birth.

The prevalent indicator used in population-based studies to define and classify obesity in individuals is BMI. Studies have established South Asian adults and children display increased amounts of adiposity yet have lower levels of BMI in comparison to other ethnic groups (34). Since BMI is an indicator of relative weight rather than adiposity it may underestimate the prevalence of obesity in the South Asian population due its inherent limitations (35-37). Alternative measures, such as waist circumference (WC), may serve as a better indicator of obesity in South Asians due to their predisposition towards central obesity.

1.1.4. Determinants of childhood obesity

At the individual level there are numerous determinants that influence the development and progression of childhood obesity. These determinants include: genetics, behaviour and environments, which have a potential influence on the

accumulation of adiposity in children (38). The model of obesity (Figure 1) outlines its various components; however, it does not emphasize the intricacies of the origins of obesity. Certain unmodifiable factors, such as genetics, set heritable conditions that begin the progression of obesity from an early age (38). Genetics are a critical component in how our bodies regulate the internal energy balance. While genetics regulate fundamental physiological processes of the human body, environmental factors have a significant influence on the progression of obesity.

Socioeconomic status (SES) is used to describe the social welfare and economic well being of an individual; the definition is adapted in children as a child's quality of life, which is often determined by family income. SES can also be measured through a combination of parental occupation, income or education (4). It is well known that SES has strong correlations to obesity and other chronic conditions across all age categories (39). In many developed countries lower SES groups have the highest levels of overweight and the lowest levels of physical activity; adolescent girls are at highest risk of obesity (38). However, a reverse trend is observed in developing countries where children from urban areas are more likely to be obese than those from rural villages (4). A higher SES background may provide access to an "obesogenic" lifestyle, characterized by sedentary activity and consumption of Westernized foods (38). Therefore family income, a large determinant of a child's SES, may serve as a proxy that influences the risk of obesity in children.

The model of obesity is based on the fundamentals of energy balance, which requires the adequate intake of energy to sustain normal growth and development without promoting weight gain (40). Energy balance has two critical components: energy intake and energy expenditure. Energy expenditure refers to the energy used by the body during physical activity, thermogenesis and basal metabolism (Figure 1). Energy released via thermogenesis and basal metabolism varies in each individual, as they are intrinsic characteristics unique to every individual. Of these three factors, physical activity is modifiable and has an essential role in weight management (38). Recent reports indicate that 9% of Canadian boys and 4% of girls achieve at least 60 minutes of exercise at least six days a week; a greater percentage of boys (83%) and girls (73%)

accumulate 30 minutes of moderate exercise at least three days a week (41). On average Canadian children and adolescents spend 62% of their waking hours consumed in sedentary behaviours and these numbers are reported to increase with age (9). Physical activity is significantly lower in Asian countries where children are taught to focus on academics, which is thought to detract from involvement in sports and other physical activities (38). Multi-ethnic population studies report South Asian adults and children tend to have the lowest levels of physical activity (42). There is strong evidence to support physical inactivity and increases in sedentary behaviours are linked to obesity regardless of racial background (43).

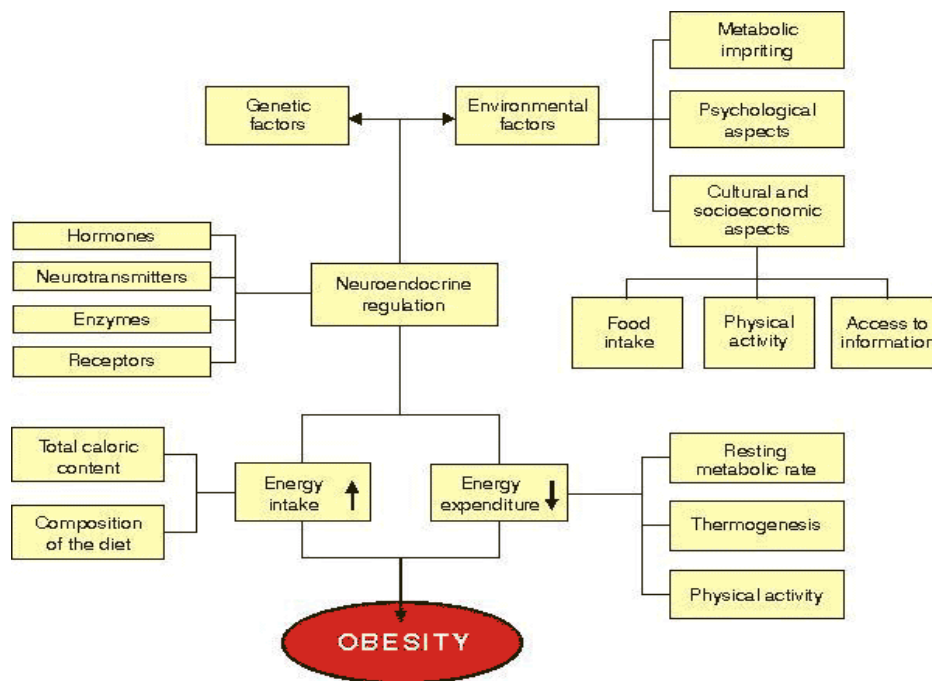


Figure 3. Causal model of obesity

1.1.5. Health consequences of childhood obesity

Obesity is a condition marked by increased amounts of body fat as well as the growth of excess adipocytes (44). The excess body fat has damaging effects to an individual's overall health and is especially detrimental in children. Children and adolescents that are overweight and obese are at greater risk of becoming overweight

and obese adults. In addition, these children will face increased risks of various chronic conditions such as: cardiovascular, endocrine, psychosocial, gastrointestinal, pulmonary and renal diseases (45). These conditions may arise as consequences of obesity during childhood and will become increasingly severe if left untreated into adulthood.

Childhood obesity can result in a wide spectrum of adverse health outcomes including premature death to serious chronic conditions that reduce the overall quality of life (44). Overweight and obese children are at high risk of type 2 diabetes, sleep apnoea, respiratory disorders, osteoarthritis, endocrine disorders and cancers (45-47). A cross-sectional study of children two to five years old found the overweight and obese children had four times higher risk of becoming overweight adults than normal weight children (48). The severity of obesity and its related health consequences will persist into adulthood if preventative measures are not taken during early childhood.

Other metabolic risk factors associated with childhood obesity are high blood pressure and hyperlipidemia. Signs of adiposity in early age and family history of hypertension play critical roles in developing hypertension. In a Canadian population based study, obese children were found to have 7.6 mmHg higher SBP than their normal weight counterparts (49). Multiple investigations in school children found overweight and obese children to have higher LDL and lower HDL cholesterol than their normal weight counterparts (40). Combined these health risks can have damaging effects on the heart as the children progress into adulthood.

The outcomes of childhood obesity are not just limited to physical health issues. Other long-term health risks in obese children and adolescents include the development of psychosocial and mental disorders (50). Children with higher amounts of body fat are often viewed as “more mature” and are mistaken for being older than their chronological age. Consequently, adults tend to have greater expectations, which can lead to frustration or a sense of failure in this subset of children. In addition, overweight or obese children are known to have lower self-esteem than their normal weight counterparts (45). It is unclear whether psychosocial effects contribute to or result from obesity.

1.2. Diet

1.2.1. Nutrition and obesity

Nutritional intake and diet composition are crucial factors influencing energy balance in an individual; where the deposition of body fat is the result of an overall positive energy balance (51). The adoption of western lifestyles and urbanization across the world has contributed to changes in nutritional intake of individuals. This economic advancement has dramatically changed the dietary patterns of children to include increased consumption of energy dense foods and sweetened drinks (52). Due to the demands of modern society, children are often left unsupervised or with a caretaker for a significant amount of time with a surfeit of food choices. Children left to make independent decisions about dietary choices tend to replace nutrition rich foods with those lacking nutrients but high in energy. A study conducted in children with parents whom work outside of the home reported children will opt for energy dense, nutritional poor foods, such as sugar sweetened beverages due to ease of accessibility and availability (53).

1.2.2. Sugar-sweetened beverages

In recent years, attention has turned to the rising consumption of sugar-sweetened beverages (SSBs) and their contribution to the obesity epidemic in children. SSBs contain high amounts of sugar and are consumed more frequently than recommended by national dietary guidelines. Examples of SSBs include soft drinks, fruit juices (with added sugar), fruit cocktails, flavoured water, flavoured milk, energy or sport drinks. Certain beverages are marketed as health products, which includes: low-calorie, high-protein meal replacements, nutritional supplements providing the recommended daily allowance of vitamins, or include caffeine or artificial sweeteners (54). Regardless of the additional health ingredients and their benefits, the addition of sugars – even in their natural form – can be detrimental. High sugar intake in children can lead to early development of tooth decay, obesity or type 2 diabetes mellitus (55).

The prevailing mechanism of weight gain due to SSB consumption is linked to a positive energy balance due to increases in energy intake (56). These beverages are devoid of nutritional value while being caloric dense with an average intake of 140-150 calories and 39 grams of sugar in a 12 oz. serving, equivalent to a can of soda. According to the USDA, a standard serving size of soda is 12 oz. although in reality fast food outlets serve an average serving size of 23 oz. A typical serving of SSB can contribute up to 10% greater energy intake than in non-SSB consumers (57). Following the principles of energy balance, the additional consumption of a serving of SSB daily (56) would amount to weight gain of five lbs. in approximately one year (56). The consumption of liquid calories provides little satiety and does not suppress appetite thus resulting in compensatory intake of solid foods. The continuation of such habits will lead to weight gain due to increases in positive energy balance, which consequently leads to the deposition of body fat (51).

An alternative, yet highly controversial mechanism proposes the differential metabolism of fructose-containing sugars can lead to weight gain (58). The commercial sweeteners used in SSB production are high fructose corn syrup (HFCS) and sucrose, which is composed of equal ratios of glucose to fructose. From a physiological perspective, glucose and fructose are differentially metabolized in the liver. Fructose metabolism has been linked to a variety of metabolic diseases based on evidence from epidemiological studies, animal studies and experiments involving pure fructose and pure glucose (59).

1.2.3. Consumption trends of sugar-sweetened beverages

Over the past few decades the consumption of SSBs in children and adolescents has doubled in North America. The American Heart Association recommends limiting consumption to less than 450 kilocalories – the equivalent of three 12 oz. cans of soda - per week (60). NHANES (National Health and Nutrition Examination Survey) data show US children between the ages 2-18 years consume between 1075-1927 mL per day and with an average intake of 228 kcals. In Canada the consumption amounts are less however still high, averaging between 500-1000 mL per day (61). The highest

consumed beverages - after water - were soft drinks, whole-fat milk and juice, respectively. In addition, the majority of SSB consumption tends to occur at home as opposed to the school environment (62, 63). This is partly due to recent nutritional policies adopted by schools that have led to the reduction of snacks and drinks with added sugars in the school environment.

The 2004 Canadian Community Health Survey reported SSBs comprise 30% of the total calorie intake for children aged 4-13 years old and 40% of a child's total beverage intake. The highest rates of SSB consumption are witnessed in boys and girls aged 6-11 years old (61). Further analysis revealed increased consumption of soft drinks, opposed to other beverages, was strongly associated to BMI (64). Another longitudinal study conducted on the development of 170 female children residing in central Pennsylvania assessed beverage intake every two years from age 5-15 years. The findings revealed that consumption of soft drinks - not including milk or fruit juices - at five years was a predictor of adiposity into adolescence (65). Ludwig *et al.* (57) further confirmed the association between increased SSB consumption and obesity through a 19-month observational study with school children aged 11-17 years old. There is increasing evidence to support the relationship between increasing weight gain and SSB consumption in children.

1.2.4. Effect of diet beverages on obesity

Similar to SSBs, the consumption of diet beverages has steadily increased over the past few decades as artificial sweeteners have been used to replace high fructose corn syrup in commercial beverages. Artificial sweeteners are potent simulators providing 100 or more times sweetness than sugar however lack nutritional value or energy. Five artificial sweeteners have been approved for commercial use: aspartame, sucralose, acesulfame potassium, saccharin and neotame (66).

There is increasing interest in the role of diet beverages in obesity and CVD management. Prospective observational studies investigating the effects of diet beverages on weight gain display mixed results with no, positive and inverse associations (57, 66-69) Theoretically, diet beverages can assist in weight loss through

decreasing total energy intake and provide similar satiation as SSBs (70). Evidence from multiple cross-sectional studies demonstrates overweight/obese individuals are the highest consumers of diet beverages in comparison to their normal weight counterparts. This may be due to the incorporation of diet beverages as a low-calorie dietary alternative for a potential weight management solution. A longitudinal study of 2294 adolescents demonstrated that regular consumption of diet beverages was associated with adolescent weight gain over five years through dieting practices (66). It has been previously shown dieting behaviours are consistent with weight gain in youth and adults (71-73). Regular diet beverage consumers may experience weight gain through increased consumption of solid foods due to the lack of satiety from diet beverages, which inadvertently increases their energy intake leading to weight gain. These results may further be explained by the bias imposed by the nature of cross-sectional studies, as they cannot evaluate whether diet beverage intake leads to obesity or vice-versa. The correlation between increased consumption of diet beverages in obese individuals is unclear: is it that obese individuals tend incorporate diet beverage intake as a weight management practice, or rather, that diet beverage consumption indirectly leads to higher obesity?

Chapter 2. Rationale

Observations about the rising global trends of childhood obesity have been well documented. Previous obesity interventions have aimed to reduce the number of individuals suffering from obesity or co-morbidities; however, the focus needs to shift to a younger demographic. There is increasing evidence to suggest the burden of obesity is rising in younger populations, especially in South Asian children (74). As previously mentioned, the incidence of obesity is a great burden on youth in urban India and a growing problem for South Asians living in western countries, such as Canada.

South Asians are one of the largest and fastest growing minority populations in Canada comprising 4% of the total population. The South Asian community in Canada is expected to increase at a faster rate than the general population as a result of immigration (75). In Canada, studies have shown South Asian adults have an adverse metabolic risk profile and increased amounts of visceral adipose tissue (76). A trend in ethnic differences for various CVD risk factors (LDL, HDL, fasting insulin, blood pressure) are present in South Asian youth similar to those seen in South Asian adults (77).

The cause behind these metabolic differences could be due to social and cultural issues that are unique to South Asians, such as dietary choices and lifestyle. Specifically, South Asians are exposed to food and beverage choices that were once unavailable or “out of reach” which could serve as a potential explanation to increased consumption of energy dense processed food items. Since South Asian youth have a greater predisposition to obesity and diabetes, increased SSB consumption could further exacerbate the risk of obesity. This study will aim to estimate the prevalence of obesity and to investigate the dietary practices of South Asian children living in Canada. Children with high SSB consumption patterns are expected to be in the overweight/obese BMI category.

Chapter 3. Research Design and Methods

3.1. Research Design

The research conducted for this thesis is part of a larger study, RICH LEGACY (Research in Cardiovascular Health-Lifestyles, Environment and Genetic Attributes in Children and Youth). The larger study is a cross-sectional analysis designed to identify characteristics affecting the cardiovascular health of South Asian children living in Canada, urban and rural India. However for the purposes of this thesis project the investigation will focus on South Asian children residing in Canada. Our project sites are located in Vancouver, British Columbia and Hamilton, Ontario. Recruitment was concentrated in Surrey, British Columbia and Brampton, Ontario due to the large population of South Asian individuals residing in these cities as defined by census.

3.1.1. Hypothesis

Primary Hypothesis

There is a positive relationship between SSB consumption and z-BMI in South Asian children after adjusting for confounders (age, sex, socioeconomic status, total physical activity, dietary score and acculturation).

Secondary Hypothesis

There is a positive between SSB consumption and:

- waist circumference
- waist to height ratio

after adjustment for confounders. Additionally, specific categories of beverages (ex. soft drinks, fruit juices, milk) will be correlated to a higher BMI in South Asian children.

3.1.2. Specific Aims

The aims of this research are to investigate the relationship between SSB consumption and BMI in South Asian children. The children will undergo comprehensive interviews to gather information about lifestyle characteristics and anthropometric measurements to assess their risk of obesity.

3.1.3. Study Population

A total of 363 South Asian children were screened for study eligibility. For the purposes of this investigation, South Asian is defined as a person with exclusive ancestry in Bangladesh, India, Nepal, Pakistan and Sri Lanka. Ethnicity will be self-reported by parent/guardians of children participating in the study.

3.1.4. Inclusion and Exclusion Criteria

Inclusion Criteria

- Children entering or enrolled in grades two and three in public schools (age range six-nine years old, depending on date of birth)
- Parents and/or children must be able to communicate in English
- Parental consent and child assent is required prior to assessment

Exclusion Criteria

- Unable to provide consent

3.2. Method of Assessments

3.2.1. Recruitment Strategy

Children were recruited through community based recruitment strategies. Recruitment began by contacting elementary schools with high enrolments of South Asian children. This information was made available by contacting the respective school boards participating in the research study. Individual packages containing letters with a description of the RICH LEGACY study and consent forms were sent to parent/guardians of grade two and three children enrolled in participating elementary schools. Additionally, information booths were arranged one hour prior and after school hours to recruit parents and children on a monthly basis at various elementary schools. An effective recruitment strategy included information sessions for parents during weekday evenings – potentially corresponding with other school events (i.e. parent teacher interviews, student showcase nights, etc.).

The study was also marketed to the South Asian community by advertising at community centres (i.e. libraries), places of worship and South Asian festivals. Advertisements were placed in South Asian newspapers and broadcasted on local television stations. The majority of community recruitment was accomplished through health fairs at places of worship (i.e. Sikh and Hindu temples) and South Asian festivals (i.e. Vaisakhi). Research assistants fluent in Punjabi and Hindi were present to avoid language barriers during recruitment. These health fairs were held in partnership with the Heart and Stroke Foundation, which began a campaign- “Our Health is our Wealth” - to raise awareness of hypertension and CVD in the South Asian community. During the health fairs our research team simultaneously recruited and volunteered to provide free cardiovascular risk profile assessments. Interested families provided their contact information. Therefore these health fairs were beneficial to raise community awareness of the prevalence of CVD and reaching out to families interested in participating in the RICH LEGACY study that may have not seen previous study advertisements.

In addition, a Community Advisory Committee (CAC) was created due to the essential support of the community required for recruitment. The committee consisted of

health professionals and prominent individuals from the South Asian community. The committee provided advice on recruitment strategies, aided in study promotion and provided community access to key organizations. The CAC is also in place to help disseminate the results of the study into the South Asian community.

3.2.2. Data Collection

Our research team contacted families that provided contact information through community health fairs and evening information sessions via telephone. The research assistant scheduled an appointment for assessment if the children met the eligibility criteria. Children were assessed in a place of convenience in their community (i.e., community centres, places of worship) during evenings or weekends and were asked to bring a parent/guardian to complete the assessment. As an incentive for parents we provided a health report outlining the results from the child's assessment (Appendix I). A book was provided as a gift for the children at the end of their assessment.

A trained research assistant administered the questionnaires in the language preferred by the families to avoid bias introduced from translation. Questionnaires were administered to ensure accurate and thorough responses. Research assistants were trained through simulator sessions and retrained if variation from the coordinator was unacceptable.

Each assessment included a standardized questionnaire (Appendix II) that took approximately one hour to complete. Standardized questionnaires were used to assess the child's background, medical history, nutrition, physical activity levels and anthropometric data. Questions were asked to parent(s) and child, however if there is a discrepancy in the answers provided the child's answers were not used. The child's answer was prioritized for questions evaluating opinions on healthy behaviours or body image satisfaction. Socio-economic status was assessed using parental education. A food frequency questionnaire (FFQ) assessed the intake of a variety of foods and beverages. Beverages included were: regular soft drinks, diet soft drinks and fruit juices. The food frequency questionnaire was adapted from the INTERHEART FFQ (78), which was shown to predict MI in an international study including adults of South Asian and

European descent. A dietary risk score (DRS) was generated from the FFQ (79). An additional (secondary) beverage questionnaire was adapted from Action Schools BC and was tailored to be culturally relevant (80). The activity questionnaire gathered information concerning physical activity.

The physical examination includes: height, weight (for BMI calculation), waist circumference, and blood pressure. Height was measured using a portable stadiometer without footwear rounded to the nearest 0.1 cm. Individuals were asked to take a deep breath before measures are taken. Weight was measured using the Tanita Ironman body composition monitor, with minimal clothing and footwear removed. BMI was calculated from weight in kilograms divided by height in meters squared. Waist circumference measurement was recorded in centimetres and measures were taken with no or minimal clothing using a measuring tape. Waist circumference was recorded as the average of two measures taken halfway between the lower rib margin and the iliac crest against the skin following normal exhalation. Waist circumference was categorized as $\geq 90^{\text{th}}$ and $< 90^{\text{th}}$ percentile after adjusting for age and sex. Blood pressure was assessed using the Omron HEM-711DLX blood pressure monitor with a child or adult sized cuff (depending on child's arm girth) placed on the left arm. Children were seated for the entire length of the blood pressure assessment; three measures were taken over a six-minute period with the average being recorded. Blood pressure z-scores and percentiles were calculated and adjusted for age and sex. Children between 90-95th percentile were categorized as pre-hypertensive and $> 95^{\text{th}}$ percentile were categorized as hypertensive.

3.2.3. Assessment of Sugar-Sweetened Beverage Intake

As previously mentioned, the RICH LEGACY FFQ (primary questionnaire) provides a broad overview of the weekly frequency of soft drink, fruit juice intake and diet beverages. For the analysis, SSB refers to the inclusive intake of soft drinks and fruit juices. A secondary questionnaire was included to assess more specific categories of SSBs and to determine serving size intake as well. This questionnaire was administered to the Vancouver cohort to further investigate beverage consumption patterns and

trends. Categories included in the secondary questionnaire include: milk based drinks (ex. chai tea, hot chocolate), soft drinks (regular/diet), 100% fruit juice and other drinks (e.g., sports drinks, fruit cocktails, Slurpees).

3.2.4. Ethical Considerations

A total of three consent and assent forms (Appendix I) were drafted according to guidelines set by Simon Fraser University Research Ethics board. Consent and assent was obtained from parents/guardians and children, respectively, prior to beginning of assessments. Each family was provided with a copy of the consent and assent forms for their personal records. Research assistants fluent in Hindi and Punjabi were present during assessments to ensure language barriers were not an issue in obtaining informed consent.

Consent was also obtained from each respective school district. After consent was obtained from the school districts, our research team invited principals from various schools to participate in the study. The community centres and places of worship did not require formal consent to be obtained for use of their facilities. Our research team approached various community centres and places of worship willing to participate in the study. These venues did not require formal consent however we established a consensual agreement for continual use of their facilities for our research purposes.

All information provided by parents and child was entered into a confidential and secured database. Each child was assigned a study identification number. All forms and results were labelled with study identification numbers and no personal identifiers to ensure confidentiality. Only the principal investigators, project coordinators and research assistants involved in the study have access to the complete study records.

3.2.5. Direct Role in Study

My direct role in the RICH LEGACY study involved duties such as:

- Acting as the community liaison to build and maintain connections with community centers, temples and elementary schools

- Recruitment of study participants from the community
- Scheduling and performing assessments with study participants
- Designing and implementation of the secondary beverage questionnaire
- Training new research assistants to complete assessments

Chapter 4. Analysis

4.1.1. Sample Size Determination

A sample size of convenience comprised of 300 children was set based on feasibility for this study. Standard deviations were calculated from preliminary data of 193 children. Based on the standard deviation for the frequency of SSB intake of 1.00 (units) and 1.35 for z-BMI, with power set to 80% and alpha set to 0.05, the detectable difference was found to be 0.22. This represents the increase in z-BMI for every one unit increase in SSB consumption. Smaller differences can be obtained if the sample size is increased.

4.1.2. Statistical analysis

Descriptive and demographic data were stratified by sex, location and weight class. Normally distributed continuous data are presented as means and standard deviations. If the data are not normally distributed the variables were log transformed and displayed as median and interquartile ranges. Categorical data were presented as counts and frequencies. Independent t-tests and ANOVAs were performed on continuous variables and Pearson Chi-square tests for categorical variables. Percentiles and standardized scores were calculated for waist circumference, systolic and diastolic blood pressure, respectively, after adjustment for age and sex (81). For study purposes, a p-value less than or equivalent to 0.05 represents statistical significance.

The primary hypothesis was addressed by performing a bivariate correlation to analyze the relationship between measures of obesity and SSB intake. A secondary aim was to investigate the relationship of diet beverages with measures of obesity. Measures of obesity include z-BMI, waist circumference and waist to height ratios. The main dependent variable under investigation, SSB and diet beverage intake was log

transformed to provide a normal distribution. Data from the RICH LEGACY questionnaire was used to assess SSB intake in terms of frequency per day. Multiple linear regressions were performed to further analyze the data for correlations. Regression models were adjusted for age and sex however additional co-variates were considered in the regression models: total physical activity, dietary risk score and socio-economic status and acculturation. The additional co-variates had little effect on the analysis therefore were excluded from the final models. Underweight children were also excluded from the final models.

Beverage data from the secondary survey was used to address the secondary hypothesis. The secondary beverage data was stratified into normal and overweight/obese weight categories; underweight children were treated as outliers and excluded from analysis. Consumption of SSB intake is represented as millilitres per day. Non-parametric tests were performed to differentiate consumption patterns between normal vs. overweight/obese children. Multiple linear regression models were used to identify which beverage categories are correlated to obesity. Each model was adjusted for age and sex.

Chapter 5. Results

5.1. Demographic and Descriptive Characteristics

Table 2 contains a summary of demographic, lifestyle and anthropometric characteristics of the study population stratified by location. A total of 363 apparently healthy South Asian children were recruited. In the Hamilton cohort, 83.2% of children had at least one parent that acquired post secondary education compared to 69.3% of parents from the Vancouver cohort ($p=0.003$). In addition, children from the Hamilton cohort displayed a higher acculturation score than participants from the Vancouver cohort (Hamilton: 67.7 ± 7.8 , Vancouver: 65.7 ± 7.9 ; $p=0.024$); a higher acculturation score is associated with a higher degree of westernization. The diet of participants was evaluated based on a dietary score that assesses the overall quality of the diet. Children from Hamilton had a healthier diet than the Vancouver cohort (Hamilton: 24.1 ± 7.4 , Vancouver: 21.2 ± 7.9 ; $p= 0.001$). However daily physical activity was higher in the Vancouver cohort in comparison to the Hamilton cohort (Vancouver: 48 ± 20 minutes, Hamilton: 40 ± 33 minutes; $p= 0.02$).

Both cities had similar rates of overweight and obese children ($p=0.49$, $p=0.92$, respectively). The percentage of children with waist circumference above the 90th percentile was similar across Hamilton and Vancouver (15% vs. 13%). Overall, children had lower BMI in the Hamilton cohort ($p=0.03$). Vancouver had a higher percentage of children classified as pre-hypertensive (21% vs. 10%) and hypertensive (25% vs. 10%) than Hamilton.

Table 2. Demographic and descriptive characteristics of study population stratified by location (n=363)

Variables	Hamilton (n=262)	Vancouver (n=101)	p
Age (years)	7.8 ± 0.6	8.3 ± 0.9	< 0.001
Female (%)	49	51	0.54
Education			
One parent attends post-secondary (%)	83	69	0.003
Both parents attend at least primary/secondary (%)	60	38	< 0.001
Diet score	24 ± 7	21 ± 8	0.001
SSB ¹ consumption (frequency/day)	1.1 ± 0.7	1.1 ± 0.9	0.53
Daily physical activity (minutes)	40 ± 33	48 ± 20	0.02
Daily leisure time (minutes)	1334 ± 617	1276 ± 664	0.43
Acculturation score	68 ± 8	66 ± 7	0.02
BMI	17 ± 3	17 ± 3	
z-BMI	0.4 ± 1.4	0.4 ± 1.5	
% Overweight	20	19	0.99
% Obese	15	17	0.62
WC (cm)	58.9 ± 8.3	58.7 ± 9.1	0.910
WC > 90 th percentile* (%)	15	13	0.62
Height (cm)	129.4 ± 6.5	132.0 ± 8.2	0.001
Weight (kg)	28.4 ± 6.5	30.5 ± 9.2	0.007
SBP (mmHg)	106 ± 10	114 ± 10	
SBP z-scores*	0.58 ± 0.90	1.25 ± 0.85	< 0.001
DBP (mmHg)	64 ± 8	69 ± 7	
DBP z-scores*	0.41 ± 0.75	0.81 ± 0.61	< 0.001
Pre-hypertension (%)	10	21	< 0.001

Hypertension (%)	10	25	< 0.001
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¹SSB: sugar-sweetened beverages; WC: waist circumference; SBP: systolic blood pressure; DBP: diastolic blood pressure *WC percentiles and blood pressure z-scores calculated by adjusting for age and sex

Table 3. represents the demographics and anthropometric characteristics stratified by weight class. Underweight children were younger than normal, overweight and obese children (underweight: 7.7 ± 0.8 , normal: 7.8 ± 0.6 years old, overweight: 8.0 ± 0.8 years old, obese: 8.0 ± 0.8 years old; Table 3). There were no major differences in diet across children from different BMI classifications ($p=0.98$). Anthropometric measures varied across BMI classifications. Waist circumference was highest in the obese category after adjustment of age and sex (obese: 64%, overweight: 18%, normal: 1%, underweight: 0%). The height and weight was greatest in the obese cohort with a decreasing trend in overweight children and further reduction in normal weight children (Obese: $134.5\text{cm} \pm 7.6\text{cm}$, $38.8\text{kg} \pm 7.3\text{kg}$, overweight: $130.7\text{cm} \pm 6.1\text{cm}$, $60.7\text{kg} \pm 5.3\text{kg}$, normal: $128.1\text{cm} \pm 6.4\text{cm}$, $24.3\text{kg} \pm 3.1\text{kg}$; $p<0.001$ for height and weight, respectively). Systolic and diastolic blood pressure was highest in obese children and lowest in underweight children, after adjustment for age and sex. Hypertension was observed in approximately 42% of obese children with blood pressure values above the 95th percentile; 20% of overweight children were affected compared to 5% of normal weight and 8% of underweight children.

Table 3. Demographic and descriptive characteristics of study population stratified by BMI status (n=363)

Variables	Underweight (n=13)	Normal (n=220)	Overweight (n=73)	Obese (n=56)	p
Age (years)	7.7 ± 0.8	7.8 ± 0.6	8.1 ± 0.8	7.9 ± 0.8	0.011
Female (%)	46	52	54	42	0.24
Education					
One parent attends post-secondary (%)	53	82	82	71	0.07
Both parents attend at least primary/secondary (%)	0	55	63	46	0.001
Diet score	22 ± 5	23 ± 8	23 ± 8	24 ± 8	0.98
SSB ¹ consumption (frequency/day)	1.1 ± 0.7	1.1 ± 0.7	1.2 ± 0.7	1.2 ± 1.0	0.61
Daily physical activity (minutes)	31 ± 12	41 ± 31	46 ± 28	45 ± 31	0.44
Daily leisure time (minutes)	996 ± 598	1342 ± 639	1317 ± 632	1301 ± 601	0.94
Acculturation score	67 ± 7.5	67 ± 8.3	67 ± 7.0	67 ± 7.1	0.69
BMI (kg/m ²)	13 ± 0.4	15 ± 1	19 ± 1	22 ± 0.1	
z-BMI	-2.5 ± 0.4	-0.3 ± 0.8	1.4 ± 0.3	2.6 ± 0.6	< 0.001
WC ¹ (cm)	48.1 ± 3.0	55.2 ± 4.7	64.4 ± 5.7	72.2 ± 6.1	< 0.001
WC > 90 th percentile* (%)	0	1	18	64	< 0.001
Height (cm)	126.2 ± 7.3	128.1 ± 6.2	133.6 ± 6.1	135.3 ± 8.4	< 0.001
Weight (kg)	20.5 ± 2.5	25.1 ± 3.3	33.2 ± 5.4	40.3 ± 7.9	< 0.001
SBP (mmHg)	102 ± 10	105 ± 8	113 ± 10	119 ± 11	
SBP z-scores*	0.25 ± 1.0	0.47 ± 0.76	1.1 ± 0.87	1.6 ± 0.98	< 0.001
DBP (mmHg)	68 ± 8	63 ± 7	68 ± 7	72 ± 8	

DBP z-scores*	0.11 ± 0.75	0.32 ± 4.5	0.82 ± 0.78	1.0 ± 0.73	< 0.001
Pre-hypertension (%)	8	7	23	25	< 0.001
Hypertension (%)	8	5	20	42	< 0.001

¹SSB: sugar-sweetened beverages; WC: waist circumference; SBP: systolic blood pressure; DBP: diastolic blood pressure *WC percentiles and blood pressure z-scores calculated by adjusting for age and sex

The demographics did not differ significantly between boys and girls (Table 4). Boys had more daily leisure time than girls (Boys: 1388 ± 601 minutes, Girls: 1246 ± 652 minutes; p=0.03). Lifestyle characteristics such as: physical activity, diet and SSB consumption were similar for both genders (p=0.27, p=0.28, p=0.21 respectively). The percentage of obese children was slightly higher in boys than girls (27% vs. 19%, respectively) however similar percentage of boys and girls were found to have a waist circumference over the 90th percentile (14% across both). Height, weight and blood pressure did not differ significantly across genders.

Table 4. Demographic and descriptive characteristics of study population stratified by gender (n=363)

Variables	Boys (n=182)	Girls (n=181)	p
Age (years)	7.9 ± 0.7	7.9 ± 0.7	0.35
Education			
One parent attends post-secondary (%)	81	77	0.35
Both parents attend at least primary/secondary (%)	54	52	0.72
Diet score	23 ± 7	21 ± 8	0.28
SSB ¹ consumption (frequency/day)	1.2 ± 0.9	1.1 ± 0.7	0.21
Daily physical activity (minutes)	44 ± 28	41 ± 31	0.27
Daily leisure time (minutes)	1388 ± 601	1246 ± 652	0.03
Acculturation score	67 ± 7.2	67 ± 8.5	0.29
BMI (kg/m ²)	17 ± 3	17 ± 2	
% Overweight	18	22	0.35
% Obese	19	12	0.04
z-BMI	0.46 ± 1.5	0.35 ± 1.3	0.48
WC ¹ (cm)	59.1 ± 8.2	58.2 ± 8.8	0.30
WC > 90 ^h percentile* (%)	14	14	0.98
Height (cm)	131.2 ± 7.3	130.1 ± 6.9	0.27
Weight (kg)	29.1 ± 7.7	29.1 ± 7.0	0.37
SBP (mmHg)	109 ± 11	107 ± 10	
SBP z-score	0.79 ± 0.94	0.74 ± 0.94	0.95
DBP (mmHg)	65 ± 8	65 ± 8	
DBP z-score	0.46 ± 0.77	0.57 ± 0.69	0.25
Pre-hypertension (%)	12	14	0.59
Hypertension (%)	16	12	0.49

¹SSB: sugar-sweetened beverages; WC: waist circumference; SBP: systolic blood pressure; DBP: diastolic blood pressure *WC percentiles and blood pressure z-scores calculated by adjusting for age and sex

5.2. Primary Analysis

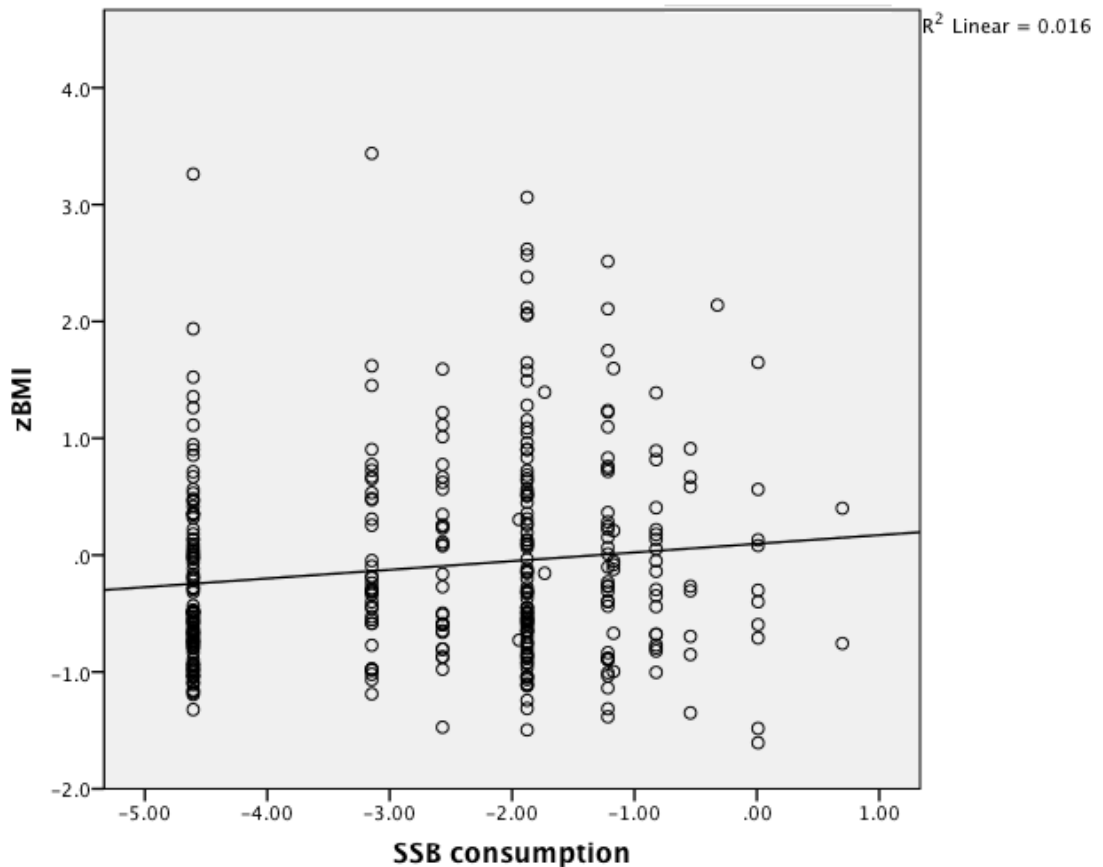


Figure 4. Bivariate correlation between total SSB consumption/day (SSB units are on log scale; x=0 equivalent to 1 unit of SSB consumption) and zBMI ($R^2=0.016$, $p=0.46$)

There was no correlation between total SSB and zBMI (Figure 4) or with WC and waist to height ratio (data not shown). When adjusted for age and sex there was a significant association observed between SSB and zBMI ($p=0.02$); this association was not observed with diet beverages ($p=0.43$). In the adjusted models, WC and waist

circumference to height ratios were not associated with neither SSBs nor diet soft drinks (table 5).

Table 5. Regression models adjusted for age and sex using anthropometric measures as dependent variables

Outcome	SSB		Diet beverages	
	Beta	p	Beta	p
zBMI	0.03	0.02	-0.04	0.43
Waist circumference	0.05	0.35	-0.04	0.46
Waist:height	0.01	0.86	-0.42	0.43

5.3. Secondary Analysis

Table 6 summarizes the secondary beverage data collected in the Vancouver cohort. There was no correlation between zBMI and total beverage ($p=0.65$), SSB ($p=0.54$; data not shown). However overall beverage consumption was approximately 100 mL greater in normal weight children ($p=0.39$). There were no differences in milk consumption ($p=0.59$), soft drinks ($p=0.82$), 100% fruit juices ($p=0.09$) and fruit juices/other drinks ($p=0.52$) detected between normal and overweight/obese children. There was no association observed between waist circumference and waist to height ratios with total beverage or SSB intake (data not shown).

Table 6. Beverage intake in Vancouver population (n=36)

Beverages (mL/day)	Normal (n=26)	Overweight/Obese (n=10)	p
Milk	498 ± 382	401 ± 254	0.59
Soft drinks	49 ± 83	42 ± 55	0.82
100% fruit juice	118 ± 111	49 ± 62	0.09
Fruit juice/other drinks	55 ± 112	81 ± 105	0.52

Total beverage consumption	789 ± 86	691 ± 138	0.39
Total SSB consumption	172 ± 215	230 ± 234	0.50

Chapter 6. Discussion

6.1. Summary of Major Findings

Patterns over the past three to four decades have shown a close parallel between the rise in added sugar intake and the global childhood obesity epidemic. SSBs are the primary source of added sugar intake in the diets of North American children. A large number of observational studies have reported the positive association between SSB consumption and long-term weight gain. A rising amount of experimental studies and interventions have investigated the potential effects of SSB consumption as a risk factor of obesity. The added sugars in these beverages contribute to weight gain through an increase in caloric load - considered as extraneous calories - as they provide no nutritional value or satiation. Recent literature has reported there are disparities observed in the intake patterns of minority children living in North America (64, 82). Anand *et al.* (83) demonstrated South Asian individuals are disproportionately affected by increased abdominal obesity and adverse metabolic risk factors. This study aimed to investigate SSB consumption in South Asian children living in Canada and its potential relationship to obesity.

The major findings from the study include a positive association between zBMI and SSB consumption; however there were no correlations with other measures of obesity (WC and waist to height ratio). Further analysis of the intake of various beverage categories demonstrated consumption did not differ between normal and overweight/obese children. Milk was the highest consumed beverage compared to soft drinks, fruit juices (100% and artificial) and other drinks in all weight categories.

6.2. Demographic and Descriptive Characteristics

Notable differences in demographics of children living in Hamilton and Vancouver were observed. The percentage of families that had at least one parent with a formal post-secondary education was higher in Hamilton than Vancouver. Parental education was used as an indicator of socioeconomic status (84). Previous studies have demonstrated children from lower SES families are at higher risk of being overweight or obese however this effect was not observed; the prevalence of overweight and obesity was similar in both cities. Despite these similarities, children from Hamilton had a healthier diet score and lower levels of physical activity than the Vancouver cohort. This is consistent with existing evidence that children from high SES backgrounds - especially in urban settings - tend to have better nutritional intake and lower rates of physical activity (38).

Analysis of children in various weight classes demonstrated no differences in demographic characteristics (diet scores, physical activity or SSB consumption) though there were differences among physical characteristics. Obese children had the highest scores of blood pressure, WC, height and weight and these values subsequently decreased in overweight and furthermore in normal and underweight weight children. These trends are illustrative of the clinical consequences observed in overweight and obese children (45). A higher BMI is strongly correlated to adverse health outcomes such as higher blood pressure and increased adiposity (45). In addition a significant portion of obese children were found to have a WC above the 90th percentile. In children a higher WC is associated with a higher risk of obesity and is a risk factor of metabolic syndrome (85).

Overall there were gender differences observed in the time spent in leisure activities. Leisure time was assessed using TV time, computer/video game usage and time spent on academics. Boys were found to spend more time engaged in daily leisure activities than girls. A study investigating the leisure activities of 120 children aged 5-13 years old demonstrated similar findings. In addition the study suggests gender disparities exist in the activities children choose to spend their leisure time engaged in (86). Jayalakshmi *et al.* (87) reported sedentary individuals tend to display higher blood

pressure and are at an increased risk of weight gain. Although there were no significant differences in anthropometric measures and blood pressure in the study sample the increased time in leisure activity suggests boys may be at higher risk of obesity than girls.

6.3. Sugar-Sweetened Beverage Analysis

6.3.1. Primary Analysis

The increasing prevalence of childhood obesity is suspected to be due to a combination of environmental and social factors relating to diet and physical activity. Of these factors, SSBs have been scrutinized as a large contributor to weight gain. Overall, SSB consumption was related exclusively to zBMI, not WC or waist to height ratio. BMI is the most common measure used to estimate body size in children and adults. It is used as the primary indicator of obesity due to its cost-effectiveness and convenience in field research.

Waist circumference and waist to height ratios have been suggested as alternatives to measuring adiposity due to their association with cardio metabolic risk factors and visceral fat (88). However, neither WC nor waist to height ratios were associated with obesity. WC has been well studied as a predictor of obesity; it is an accurate measure of central adiposity in comparison to BMI, which is a relative ratio of overall body size. WC is not widely used due to the lack of robust comparison standards and guidelines among children and adolescents. In addition, development of visceral adipose tissue is prevalent during early adolescence therefore WC measurements in the population under study may not be appropriate due to their younger age (89).

Other cross-sectional studies evaluated fat mass measured by dual-energy X-ray absorptiometry (DEXA) as the primary outcome method of assessment. Fat mass is another accurate predictor of obesity however not frequently used due to its high cost and inconvenience. One longitudinal study reported SSB consumption increased over time in children aged 8-18 years old however there was no significant relationship

between consumption and fat mass (90). Johnson *et al.* (91) reported no significant findings in a cross-sectional study investigating the relationship between SSB consumption and fatness in 5-7 year old children.

Previous research indicates minority populations tend to have higher SSB consumption in comparison to Caucasian populations. Wang *et al.* (2008) performed an analysis of the National Health and Nutrition Examination Survey (NHANES) data from 1988-1994 and 1999-2004 to examine racial differences in beverages consumption. For all age groups, the increase in SSB consumption was highest in minority populations – black and Mexican American children – in comparison to white populations (62). To date, there is limited evidence of the specific dietary practices, including beverage consumption patterns, of South Asian children living in Canada. A recent study conducted by Lesser *et al.* (92) investigated the dietary patterns of 209 South Asian adult immigrants. The results reported positive dietary practices, such as consumption of fruits and vegetables, along with the adoption of unhealthy dietary practices, such as an increase in fast foods and consumption of SSBs (93). Since children tend to emulate the dietary patterns established by their parents, it is likely similar patterns may be observed in South Asian children.

The present study is among the first to demonstrate a correlation between SSB consumption and obesity in South Asian children. Due to the cross-sectional nature of this investigation it is difficult to identify causal factors. Research suggests ethnicity may influence the risk of obesity in children at a physiological level as there is ample evidence in adults to demonstrate this effect. Due to limited research studying the effect of SSB beverage consumption on obesity in South Asian children comparative data is extrapolated from investigations including minority populations that have been well studied. Children from other minority populations tend to display similar cardio metabolic risk factors, such as the adverse distribution of visceral adipose tissue, observed in South Asians in comparison to white populations (94). A recent randomized controlled trial tested a two year intervention aimed at reducing SSB intake in children. Among Hispanic children, the difference in BMI between the experimental and control group was significant at one year and during follow up. The same effect was not observed in non-

Hispanic children (95). The same authors conducted a re-analysis of a previous 19-month intervention that reported positive association between SSB consumption and change in BMI (57). After re-analysis of the data to include effect modification by ethnic group, reduction of SSB intake showed strong associations to reduction in BMI in Hispanic children; this effect was not significant in non-Hispanic children (95). These findings suggest ethnicity may influence susceptibility but whether they are generalizable to South Asians – or other minority groups - requires further investigation.

The physiological mechanisms of weight gain due to intake of excess sugars are less understood. The prevailing theory of weight gain suggests energy consumed in the form of a liquid carbohydrates provides less satiety and micronutrients than energy consumed from solid carbohydrates (96). Numerous studies have established that when an individual increases their consumption of liquid carbohydrates they do not concomitantly reduce their solid food consumption (97-99). This was demonstrated in a study where the consumption of soda - equivalent of 1180 kilojoules per day - resulted in significantly greater weight gain than did consumption of an isocaloric solid carbohydrate load (100). Additional studies reported results consistent with these findings (101, 102).

The high amounts of sugars and high fructose corn syrup (HFCS) in SSBs have been shown to induce rapid spikes in blood glucose and insulin levels (103). Consumption of large volumes of SSBs contributes to a high dietary glycemic load (GL). High GL diets are thought to promote weight gain due to the high postprandial insulin response, which stimulates uptake of glucose by tissues. This produces a rapid fall in blood glucose concentrations thought to induce a hunger response. The loss of metabolic fuel leads to compensatory overeating as the body attempts to restore energy homeostasis (104).

There is growing evidence to suggest consumption of fructose, a component found in equal amounts in sucrose and HFCS, may induce adverse metabolic effects that contribute to obesity. From a physiological perspective, the metabolism of fructose and glucose are different; fructose is preferentially metabolized by the liver leading to fat deposition, hepatic de novo lipogenesis and insulin resistance (105). In a study of overweight and obese adults, a diet providing 25% of energy intake from fructose-

sweetened beverages resulted in significantly higher visceral adipose volume compared to a group that had glucose in place of fructose (106). Therefore drinks sweetened with higher amounts of fructose may pose an even greater threat to visceral fat deposition, eventually leading to weight gain.

Diet beverages were included in the analysis to observe its potential effects on obesity in South Asian children. Current theories state replacing SSBs with diet beverages may lead to overall decrease in energy intake and assist in weight management. Two observational studies demonstrated diet beverage consumption led to weight reduction in individuals with high BMI or those from minority groups (95, 107). The results of this study do not provide conclusive evidence to support this theory. This effect may not be witnessed demographic because consumption in the study cohort may be low. Dietary guidelines do not recommended consumption of diet beverages as part of a daily balanced diet in children (108). The majority of randomized control trials to demonstrate statistically significant results are conducted in adolescents and may not be clinically meaningful given their modest effect on weight and body fat reduction (70).

6.3.2. Secondary Analysis

A secondary analysis focused on identifying specific beverage consumption trends and patterns observed in the Vancouver population. Preliminary analysis revealed there was no relationship between SSB consumption and zBMI. Failure to detect significance may be due to lack of power in the subset population used for this analysis.

There were no significant differences in the types of beverages consumed between normal and overweight/obese children. High consumption of SSBs was expected in overweight/obese children, not normal weight children. Due to the biased nature of self-report data, the overweight/obese children may have underreported their levels of fruit juice and other sugared beverage consumption. A cross-sectional analysis of 12 648 children demonstrated overweight/obese participants aged 7-10 years old reported consuming fewer calories than their normal weight peers (109). The discrepancy in data observed between normal weight and obese children may not depict

an accurate reflection of their true dietary intake therefore may have influenced the results of the overall study.

The secondary beverage questionnaire was tailored to be able to detect specific beverages and consumption patterns that are culturally relevant to South Asians. The questionnaire captured additional data about sugars added to beverages, such as milk as it is a common dietary practice in South Asian culture. Milk consumption in children is necessary to provide the essential nutrients such as calcium, protein, vitamin B-12 and D required for growth and development. There was higher intake of milk beverages than soft drinks, 100% fruit juice, fruit juice/other drinks in both weight categories; however there were no significant differences observed in the consumption of milk between normal weight and overweight/obese children. Milk consumption has been known to have a protective effect against obesity due to its subsequent decreased intake of SSBs (56). The results do not provide conclusive evidence for the protective effect of milk against obesity. Certain types of milk, such as reduced fat milk provide less calories and fat than whole milk however is linked to a higher BMI in children due to decreased satiation (110).

6.4. Implications

It is imperative to understand how environment, social differences from Westernized culture and native cultural customs may impact the health of South Asian children. The school setting has been considered an ideal setting to introduce PA and dietary changes for all children regardless of their ethnic or socioeconomic background. School-based policies aimed at targeting healthy behaviours have reported reduced intake of SSBs (63, 111, 112). Introducing such policies aimed at targeting the reduction of specific beverages with high consumption in South Asian children could prove to be effective.

There is a need for further investigations to determine the influence of different environments South Asian children are exposed to outside of the school setting. During the assessments, South Asian families frequently reported the importance of gatherings

with family at home and places of worship (Appendix III). This encourages the support for family-based interventions to reduce unhealthy behaviours since social support from families may encourage dietary adherence (113). Places of worship have been identified as a potential venue for intervention due to the access to a wider family unit. This will offer valuable opportunities to provide cultural specific support for the implementation of such family-based interventions. Places of worship - such as Sikh temples, Hindu mandhirs and mosques - are non-for-profit organizations that run their facilities off monetary and food donations by the community and patrons. This tends to lead to an abundance of unhealthy foods and drinks that are readily available for temple patrons. Possible regulations or policies governing the types of foods and drinks accepted and served by places of worship may reduce the access and consumption of SSBs in South Asian children.

6.5. Study Strengths and Limitations

A major strength of the study is the sample size and strong representation of South Asian children in the study sample. There is limited research on the consumption of SSBs in various racial groups in Canadian children. In addition the use of a secondary beverage questionnaire allows for a comprehensive analysis of SSB intake. This will provide a better understanding of the effect of specific beverages on the study outcomes.

One limitation of the study is the cross-sectional nature of the study which uncovers the association between variables without determining the causation. The beverage data contained several limitations as data collected was self-reported therefore may be underreported by children, especially in overweight/obese children. In addition the RICH LEGACY questionnaire was not designed to collect volumetric data of beverage consumption; the “units” of SSB consumption refer only to frequency of intake on a daily basis. Also total energy intake is a strong predictor of obesity however was not included as a co-variate because it was not included in the original study design.

Other limitations include the use of BMI as an indicator of obesity. Caution must be taken when comparing obesity data from various countries due to the differences in methodology when obtaining BMI. A globally accepted definition of childhood obesity does not currently exist. Estimates based off the WHO criteria routinely overestimate BMI whereas the IOTF criteria tend to underestimate BMI classification in comparison to CDC criteria (114). These methodological inconsistencies have made it difficult to classify children into appropriate weight classes and to grasp a true comparative understanding of the global obesity epidemic witnessed in children.

6.6. Knowledge Translation

Knowledge translation is an imperative component of community-based research. Upon the completion of this study, results will be shared with parents and community through information sessions held at participating elementary schools. The CAC will also assist to disseminate the study results within the South Asian community.

6.7. Conclusion and Future Directions

South Asian children and youth are at increased risk of obesity and related CVDs. The information obtained from this study demonstrates there are correlations between SSB consumption and obesity. Future studies should aim to determine if beverage consumption patterns and its observed effect on obesity are ethnic specific. In addition, there is a need to investigate the genetic contribution and to identify metabolic risk factors that may contribute to the increased adiposity witnessed in South Asian children. This will allow public health officials to create and implement culturally tailored interventions and policies to lower rates of obesity affecting South Asian communities located in Canada and worldwide.

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Appendix A: Consent Forms

Faculty of Health Sciences
515 West Hastings Street
Vancouver, BC
V6B 5K3
Telephone: 778-782-7916

RICH LEGACY (Research in International Cardiovascular Health - Lifestyles, Environments and Genetic Attributes in Children and Youth) Study

Parent/Guardian Consent Form

The University and those conducting this project subscribe to the ethical conduct of research and to the protection at all times of the interests, comfort, and safety of participants. This research is being conducted under permission of the Simon Fraser University and Northern Health Authority Research Ethics Boards. This research is supported by the Canadian Institutes of Health Research.

Principal Investigator:

Dr. Scott Lear, Faculty of Health Sciences, Simon Fraser University

Primary Study Contact:

To be determined

Introduction

Your child is being invited to participate in the Research in International Cardiovascular Health - Lifestyles, Environments and Genetic Attributes in Children and Youth Study (RICH LEGACY Study), a community-based research study designed to better understand the behavioural, environmental and genetic determinants of cardiovascular health of children living in diverse settings in Canada and India.

Your child's participation is entirely voluntary, so it is up to you and your child to decide whether or not to take part in this study. Before you decide, it is important for you to understand what the research involves (a form of assent will be provided to your child as well). This consent form will tell you and your child about the study, why the research is being done, what will happen during the study and the possible benefits and/or risks. If you give permission for your child to participate, you will be asked to sign this form. However, your child is still free to decide not to participate and can also withdraw at any time and without giving any reasons for their decision.

RICH Legacy
Consent for Parents/Guardians Version 4.0

Subject Initials: _____
Page 1 of 5

Purpose

The purpose of this research is to identify social, environmental and biological characteristics that are related to heart disease risk factors such as high blood pressure, high blood sugar, obesity and abnormal cholesterol in children. These risk factors are increasing in children throughout the world. As a result, diseases such as diabetes and heart disease are occurring at younger ages. Some research suggests that the environment where children live including their home, neighbourhood and school may contribute to the chance of developing these risk factors for poor health. Our research will identify individual, family, school and community characteristics that are linked with cardiovascular risk factors in 5400 children and youth. We will compare 3 distinct settings: urban Canada, urban India and rural India. This study is an essential step to improving health in different populations whose practices and beliefs may require different solutions.

Who can participate in this study?

Children (boys and girls) of ages 7 and 8, and ages 14 and 15.

What will my child's participation involve?

If your child participates, he/she will be asked to:

1. Complete simple questionnaires about collected on health behaviours including diet, physical activity, smoking and alcohol use. All information will be collected by researchers and will remain confidential.
2. Undergo assessment of blood pressure, body size (height, weight, waist circumference), body fatness (using simple bioelectrical impedance as used in fitness centres) and handgrip strength.
3. Provide a saliva sample for assessment of DNA (to assess hereditary markers for heart disease).

This assessment will take place at or near the school, before or after school, or on the weekend. Seven and eight year old children will have visits booked along with their parent (preferably mother) to help with some of the information in the questionnaires. We anticipate it will take no more than 45 minutes.

A small subset of children (approximately 1 in 5) will be asked to undergo additional measures of factors related to health and heart disease risk consisting of:

1. A fasting blood sample (approximately 1 tablespoon) to measure blood sugar, cholesterol and other heart disease risk markers.
2. Additional questionnaires about family, home and school for the child and the parent (preferably mother) will be completed at this time.
3. A full-body DEXA (dual energy x-ray absorptiometry) scan to assess the amount of total body fat. The DEXA scan uses a very low energy x-ray beam (about one fifth of a plain x-ray) that passes below you as you lay on the bed.
4. Assessment of physical activity using an accelerometer (an iPod sized device that counts movements worn on a waist-band) and by completion of an activity diary for 4 days.

This assessment will be conducted in the Simon Fraser University Surrey Campus. We anticipate it will take no more than two hours including the time for the activity diary.

In addition, we may wish your child (with you for which we have a separate consent form) to participate in group interviews with other children and their parents to discuss the results of the study and ask for input on how our findings may help to improve child heart health in your community. The interviews will last up to 90 minutes and will be tape-recorded.

What are the risks of participation?

Participation in this study involves minimal risk. The blood samples will be obtained by venipuncture- (standard procedure for taking blood) a harmless procedure. The side effects are rare but may include bleeding under the skin (hematoma) or, in extremely rare instances, inflammation of the vein (phlebitis). The total volume of all the blood samples required is less than one tablespoon (<15 mL). The DEXA scan involves exposure to low energy radiation (one fifth of a normal x-ray). The exposure involved in the DEXA scan is less than spending 30 minutes in the sunshine or one day of regular urban living.

What are the costs of participation?

There are no costs to participating in this study.

What are the benefits of participation?

It is possible that your child will not benefit from this study. However, we will provide you and your child a report of your child's blood pressure, body size measures and blood measures (if applicable) with guidance regarding whether the results fall within the desired ranges. All results obtained are for research purposes only and will not be interpreted by a medical doctor as part of the study participation. In the event of significant abnormalities, we will contact you and your child directly.

Who Do I Contact If I have any Questions?

If you have any questions during or after the completion of this study, you may contact the research coordinator or any of the study investigators listed above. Final results and copies of published articles of the study can be received by contacting Dr. Scott Lear at [REDACTED]

If you have any concerns about your rights as a research subject and/or your experiences while participating in this study, contact the principal investigator, Dr. Scott Lear, Simon Fraser University at [REDACTED] or Dr. Hal Weinberg, Director of Research Ethics at Simon Fraser University at [REDACTED]

How will we protect your confidentiality?

Your child's confidentiality will be respected. No information that discloses your child's identity will be released or published without specific consent from you and your child to the disclosure. Ensuring confidentiality is very important to us. Any information that is obtained during this study will be kept confidential to the full extent permitted by the law. We will not need to record your child's name or personal identifiers (ie: date of birth, personal health number) on any study material. Data will be labeled with an anonymous code number and entered into a secure database. Your child will not need to mention their name or any identifying information on the interview. Tape recordings of any interviews will be destroyed after transcribed. Only the research investigator, the study research assistants, and the research coordinator will have access to this data.

Research and medical records identifying your child may be inspected in the presence of the Investigator or his or her designate by representatives of the Research Ethics of Simon Fraser University for the purpose of monitoring the research. However, no records which identify your child by name or initials will be allowed to leave the Investigators' offices.

Printed name of child

Printed name of witness Signature Date

Printed name of principal investigator Signature Date

Printed name of translator (if applicable) Signature Date

Faculty of Health Sciences
515 West Hastings Street
Vancouver, BC
V6B 5K3
Telephone: 778-782-7916

RICH LEGACY (Research in International Cardiovascular Health - Lifestyles, Environments and Genetic Attributes in Children and Youth) Study

Participant Assent Form

You are being invited to be part of a research study. It is up to you if you want to be in this study. No one will make you be part of the study. Even if you agree now to be part of the study, you can change your mind later. No one will be mad if you choose not to be part of this study. We are discussing the study with your parents and you should talk to them about it too. You do not have to be in this study, if you do not want to be.

Why are you doing this study?

We are doing a research study about what makes children's hearts healthy or sick when they are older, especially their habits, their families and schools. A research study is a way to learn more about people.

Why am I being asked to be in the study?

You are being asked to take part in the RICH LEGACY Study, because you live in this area and you are 7 or 8 or 14 or 15 years old which is the age of the children who can participate in this study. Children in Canada and in India are taking part.

What if I have questions?

You can ask questions if you do not understand any part of the study. If you have questions later that you can't think of now, you can talk to me again or you can call me at (study contact number)

If I am in the study what will happen to me?

If you decide that you want to be part of the study, you will be asked to come for a visit in your school where a study worker will take measurements of your blood pressure, body size and hand grip strength all in privacy. You will be asked for a sample of saliva (spit). You will be asked questions about what you eat, how you spend your time and about your health.

You may also be invited to the study clinic for a morning-time blood test (with about a tablespoon of blood) and more questions about your health, the place where you live and go to school. We will ask your parents questions about your family and the place where you live. At this visit, you may have a type of X-ray scan that shows what your body is made up of. You may be asked to wear on your waist a small box the size of an iPod that counts movements for 4 days, and to keep an activity diary.

If you agree, we will contact you again in the future to ask about your health and do some measurements again.

Even after signing this, you can say no to any of these tests or questions if you don't want to do them. you can also drop out of the study.

RICH Legacy
Participant Assent Version 3.0

Page 1 of 2

Can Anything Bad Happen to Me?

You may feel a little pain, feel faint, light headed or dizzy when the blood is taken from your arm with the needle. Also, you might bleed a little when the needle is taken out of your arm or get a small infection if your arm is dirty when the needle is put in.

Will the study help me?

This study may not help you but we will share the results of your measures (such as your weight, blood measures and blood pressure) with you and your parents, which you may find helpful. All other answers you give us will remain between you and the researchers (secret). The information and results of this study may help prevent and treat things that lead to heart disease and diabetes in young people in the future.

You will receive a certificate saying how much time you spent in the study. If you are in high school, this may count as Community Service hours.

Who Will Know I Am in the Study?

Only your parent(s) and the people who are involved in the study will know you are in it. When the study is finished, the study workers will write a report about what was learned. This report will not say my name or that you were in the study. Your parents and you do not have to tell anyone you are in the study if you don't want to.

When Do I Have To Decide?

You have as much time as you want to decide to be part of the study. You have also been asked to discuss my decision with your parents.

Signatures:

If I put my name at the end of this form, it means that I agree to be in the study.

Printed name of subject

Signature

Date

Printed name of guardian/parent

characteristics that are linked with cardiovascular risk factors in 5400 children and youth. We will compare 3 distinct settings: urban Canada, urban India and rural India. This study is an essential step to improving health in different populations whose practices and beliefs may require different solutions.

Who can participate in this study?

Parents of children (boys and girls) of ages 7 and 8, and ages 14 and 15 that are also participating in this study.

What will my participation involve?

We would like your permission to contact you, in case we would like you and your child to participate in group interviews with other children and their parents to discuss the results of the study and ask for input on how our findings may help to improve child heart health in your community. The interviews will last up to 90 minutes and will be tape-recorded.

What are the risks of participation?

Participation in this study involves minimal risk.

What are the costs of participation?

There are no costs to participating in this study.

What are the benefits of participation?

It is possible that you will not benefit from this study. However, your input on the study results and how they may be applied to child heart health may have a beneficial effect on your community.

Who Do I Contact If I have any Questions?

If you have any questions during or after the completion of this study, you may contact the research coordinator or any of the study investigators listed above. Final results and copies of published articles of the study can be received by contacting Dr. Scott Lear at [REDACTED]

If you have any concerns about your rights as a research subject and/or your experiences while participating in this study, contact the principal investigator, Dr. Scott Lear, Simon Fraser University at [REDACTED] or Dr. Hal Weinberg, Director of Research Ethics at Simon Fraser University at [REDACTED]

How will we protect your confidentiality?

Your confidentiality will be respected. No information that discloses your identity will be released or published without your specific consent to the disclosure. Ensuring your confidentiality is very important to us. Any information that is obtained during this study will be kept confidential to the full extent permitted by the law. We will not need to record your name or personal identifiers (ie: date of birth, personal health number) on any study material. Data will be labeled with an anonymous code number and entered into a secure database. You will not need to mention your name or any identifying information on the interview. Tape recordings of any interviews will be destroyed after transcribed. Only the research investigator, the study research assistants, and the research coordinator will have access to this data.

Research and medical records identifying you may be inspected in the presence of the Investigator or his or her designate by representatives of the Research Ethics of Simon Fraser

Appendix B: RICH LEGACY Questionnaire

RICH LEGACY/ODIISEY

Child Step 1

Page 1

Subject ID:
School # Individual #

Subject Initials
F M L

Date of Interview:
year month day

Has the participant consented to step 1 study? No Yes

1. Respondent: Child only Child and Mother Child and Father Child and Guardian

2. Child's name: _____ (if approved otherwise for site's info only)
Given name Last name/ Surname

3. (For India Only) Father's name: _____
Given name Last name/ Surname

4. Age yrs OR DOB:
year month day **Collect DOB first**

5. Sex: Female Male

6. Ethnicity: → (Please refer to facing page for codes)

7. Religion: (Check one only)

Hindu Muslim Christian Sikh
 Buddhist Jain Parsi Other

8. What type of family do you live with? (Check one only)

Single-parent Nuclear Extended (i.e. with grandparents) Joint (i.e. with uncles/aunts etc.)

9. Indicate the number of siblings you have

a) Brothers: b) Sisters:

10. Parents' mother tongue/native language

a) Father: _____

b) Mother: _____

11. Please indicate your parents' main occupation (Refer to facing page for definitions of occupation groups)

a) Father: _____
Group

b) Mother: _____
Group

Subject ID:
School #

Individual #

Subject Initials
F M L

12. Please indicate your parents' highest level of education (Check one only):

a) Father: No formal education (Go to #12b) Primary/Secondary School Trade School College/University Don't Know

i. Highest number of years spent at the level indicated above: Don't Know

b) Mother: No formal education (Go to #13) Primary/Secondary School Trade School College/University Don't Know

i. Highest number of years spent at the level indicated above: Don't Know

13. Have you ever been diagnosed with any of the following by a physician?(Check all that apply)

	No	Yes	Don't Know		No	Yes	Don't Know
a) Diabetes	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	d) Asthma	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b) High blood pressure	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	e) Depression	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
c) High cholesterol	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	f) Attention deficit hyperactivity disorder (ADHD/ADD)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

We would like to ask you about the activities you do on a typical day

14. Sleeping Patterns:

a) What time do you get out of bed in the morning during a school day? : (00:00-23:59)

b) What time do you go to bed at night during a school day? : (00:00-23:59)

c) What time do you get out of bed in the morning during a non-school day? : (00:00-23:59)

d) What time do you go to bed at night during a non-school day? : (00:00-23:59)

e) For how much time do you sleep during the day (i.e. nap) in a week? mins

Subject ID:
School #

Individual #

Subject Initials
F M L

15a) How much time do you spend WORKING outside your home (includes paid and unpaid work such as delivering paper/milk, tending cattle, field work etc.)?

times per week \longrightarrow mins per time
(If 0, go to #16)

b) List the 4 most important activities that you do as part of this work outside home

- i. _____
- ii. _____
- iii. _____
- iv. _____

16. On average how much time do you spend at school each school day? . hrs.
(Refer to facing page)

17a) Currently how do you usually get to and from school? (Check One Only)
(The mode of transportation that is used for the longest duration of time should be recorded) (Refer to facing page)

walk bicycle bus car/auto motorized 2 wheeler small wheel vehicle
(e.g., skateboard, scooter)

b) Distance of school from home: . \longrightarrow km
 mi

c) Time it takes to travel to and from school: min.

18a) Do you do any household work? No \longrightarrow Go to #19 Yes

b) List the most important household activities that you do and how often you do them.

	Times per week	Rough Duration per time
i. _____	<input type="text"/>	<input type="text"/> <input type="text"/> <input type="text"/> min.
ii. _____	<input type="text"/>	<input type="text"/> <input type="text"/> <input type="text"/> min.
iii. _____	<input type="text"/>	<input type="text"/> <input type="text"/> <input type="text"/> min.
iv. _____	<input type="text"/>	<input type="text"/> <input type="text"/> <input type="text"/> min.

Subject ID:
School #

Individual #

Subject Initials
F M L

19. Indicate in the table below the activities that you perform and how often you perform them:
 (Refer to facing page for definitions and examples)

Type of Activity (Over the last 30 days)	Times per week	OR	Times per month	Rough Duration per time
a) Viewing TV	<input type="text"/> <input type="text"/>		<input type="text"/> <input type="text"/>	<input type="text"/> <input type="text"/> <input type="text"/> mins.
b) Videogames/computers/internet (not for homework)	<input type="text"/> <input type="text"/>		<input type="text"/> <input type="text"/>	<input type="text"/> <input type="text"/> <input type="text"/> mins.
c) Homework/tuitions outside school	<input type="text"/> <input type="text"/>		<input type="text"/> <input type="text"/>	<input type="text"/> <input type="text"/> <input type="text"/> mins.
d) Games/sports/exercise in school:				
<input type="checkbox"/> I do not do any games/sports/exercise in school				
OR				
i. _____	<input type="text"/> <input type="text"/>		<input type="text"/> <input type="text"/>	<input type="text"/> <input type="text"/> <input type="text"/> mins.
ii. _____	<input type="text"/> <input type="text"/>		<input type="text"/> <input type="text"/>	<input type="text"/> <input type="text"/> <input type="text"/> mins.
iii. _____	<input type="text"/> <input type="text"/>		<input type="text"/> <input type="text"/>	<input type="text"/> <input type="text"/> <input type="text"/> mins.
e) Major recess/lunch time activity:				
i. _____	<input type="text"/> <input type="text"/>		<input type="text"/> <input type="text"/>	<input type="text"/> <input type="text"/> <input type="text"/> mins.
ii. _____	<input type="text"/> <input type="text"/>		<input type="text"/> <input type="text"/>	<input type="text"/> <input type="text"/> <input type="text"/> mins.
f) Games/sports/exercise outside school:				
<input type="checkbox"/> I do not do any games/sports/exercise outside school				
OR				
i. _____	<input type="text"/> <input type="text"/>		<input type="text"/> <input type="text"/>	<input type="text"/> <input type="text"/> <input type="text"/> mins.
ii. _____	<input type="text"/> <input type="text"/>		<input type="text"/> <input type="text"/>	<input type="text"/> <input type="text"/> <input type="text"/> mins.
iii. _____	<input type="text"/> <input type="text"/>		<input type="text"/> <input type="text"/>	<input type="text"/> <input type="text"/> <input type="text"/> mins.

Subject ID:
School #

Individual #

Subject Initials
F M L

20. How many days per week do you eat breakfast? days

21. How often do you eat food from each of the following groups?

(Refer to facing page for definitions of food groups)

	< 1 per month - never	OR	choose one			# Times
			Monthly	Weekly	Daily	
a) Whole grains breads/cereals	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text"/>
b) Refined breads/rice/pasta and cereals	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text"/>
c) Dairy Products (not milk in tea or coffee)	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text"/>
d) Meat	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text"/>
e) Organ meats	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text"/>
f) Poultry	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text"/>
g) Eggs	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text"/>
h) Fish and seafood	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text"/>
i) Pizza	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text"/>
j) Green leafy vegetables	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text"/>
k) Vegetables, other (raw)	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text"/>
l) Vegetables (cooked)	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text"/>
m) Legumes/nuts/seeds	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text"/>
n) Potatoes, boiled and mashed	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text"/>
o) Pickled food	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text"/>
p) Deep fried food	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text"/>
q) Salty snacks	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text"/>
r) Fruits	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text"/>
s) Ice cream and pudding	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text"/>
t) Desserts and sweet snacks	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text"/>
u) Confectionary, sugars, and syrups	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text"/>
v) Fruit juice and sugared drinks	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text"/>
w) Carbonated beverages (Diet)	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text"/>
x) Carbonated beverages (Non-Diet)	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text"/>
y) Fast food	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text"/>

If either monthly, weekly, or daily is checked, record # of times. —>

Subject ID:
School #

Individual #

Subject Initials
F M L

22. How important is each of the following in making you want to eat healthy foods?

(Refer to facing page for suggested wording of question)

	Not Important	Somewhat Important	Very Important
a) To keep fit and strong	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b) To look good	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
c) To be free from sickness/disease	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
d) To grow well	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
e) To stay mentally alert/study better	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
f) To be energetic	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
g) Other (specify): _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

23. What makes you eat unhealthy foods? (Refer to facing page for suggested wording of question)

	Never	Rarely	Often	Very Often
a) Eating with friends	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b) Eating at home	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
c) Eating at school	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
d) Eating outside	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
e) I like the taste of unhealthy foods	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
f) I am tempted by TV and advertisements	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
g) Parents don't have the time to make healthy foods	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
h) I don't have the time to make, buy or eat healthy foods	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
i) Other (specify): _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

24. How important is it to you to eat healthy foods right now at your age?

Not important Somewhat important Very important

25. How important is it to you to eat healthy foods as you get older?

Not important Somewhat important Very important

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26. How important is each of the following in making you want to be physically active/play sports or outdoor games? (Refer to facing page for suggested wording of question)

	Not Important	Somewhat Important	Very Important
a) To keep fit and strong	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b) To look good	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
c) To be free from sickness/disease	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
d) To grow well	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
e) To stay mentally alert/study better	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
f) To be energetic	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
g) To have fun with friends	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
h) Other (specify): _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

27. What stops you from being more physically active/playing more sports or outdoor games? (Refer to facing page for suggested wording of question)

	Never	Rarely	Often	Very Often
a) I don't have time because of homework	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b) I don't have time because of household work	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
c) I watch TV or go on the computer or play videogames instead	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
d) There is no convenient space nearby (e.g., playground, sports field/court)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
e) It is not safe to play or be physically active outside	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
f) I do not have friends to play or be physically active with	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
g) I am not interested/too lazy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
h) I don't have the energy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
i) It is too tiring	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
j) Bad weather (e.g., too hot, too cold, too rainy/snowy)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
k) My parents or relatives do not like me being physically active/ playing sports or outdoor games	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
l) Other (specify): _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

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28. How important is it to you to be physically active/play sports or outdoor games right now at your age?

- Not important Somewhat important Very important

29. How important is it to you to be physically active/play sports or outdoor games as you get older?

- Not important Somewhat important Very important

30. Acculturation/Westernization (Refer to facing page for instructions)

	Never	Sometimes	Often	Very often/Always	N/A
a) How often do you speak English with your:					
i. Parent(s)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
ii. Siblings	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
iii. Friends	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
b) How often do you speak your mother tongue/ native country's language with your:					
	<input type="checkbox"/> Not asked				
i. Parent(s)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
ii. Siblings	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
iii. Friends	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
c) How often do you watch or listen to English:					
i. TV shows/serials	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
ii. Movies	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
iii. Music	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
d) How often do you watch or listen to the following in your mother tongue/native country's language:					
	<input type="checkbox"/> Not asked				
i. TV shows/serials	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
ii. Movies	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
iii. Music	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
e) How often do you eat Western/Continental food for:					
i. Lunch or dinner (e.g., pizza, hamburgers)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
ii. Snack (e.g., potato chips, cookies)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
iii. Dessert (e.g., cakes, puddings, pastries)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

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Never Sometimes Often Always

f) How often do you eat traditional food from your native country for:

- | | | | | |
|--------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| i. Lunch or dinner | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| ii. Snack | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| iii. Dessert | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

g) How often do you:

- | | | | | |
|---|--------------------------|--------------------------|--------------------------|--------------------------|
| i. Wear Western clothing (e.g., jeans, t-shirts, skirts)? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| ii. Go out to restaurants that serve Western/Continental foods? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| iii. Shop at Western-type stores/shopping mall? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

h) How often do you:

- | | | | | |
|--|--------------------------|--------------------------|--------------------------|--------------------------|
| i. Wear traditional clothing from your native country? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| ii. Go out to restaurants that serve foods from your native country? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| iii. Shop at traditional stores/markets from your native country? | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

i) How often do you attend community gatherings/celebrations? (See facing page for examples)

times per month **OR** times per year **(If 0 go to # 31/32)**

j) How many times is food served at the community gatherings/celebrations you attend?

times per month **OR** times per year

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Complete either **question 31** OR **question 32** below:

For India Only (Question 31)

31. Place of residence

a) Current place of residence: _____
Name of village/town/city

b) Have you always lived in this place? No → Answer i. and ii. below Yes → Go to #33

i. Indicate the number of years you have lived in this place:

ii. Indicate your previous place of residence: _____
Name of village/town/city

For Canada Only (Question 32)

32. Please indicate the code which describes the place of birth and country of ancestry of the following people:
 (Refer to facing page for country codes)

a) Yourself:

Place of birth
<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>

 ↳ If not born in Canada, indicate age at immigration to Canada: years

b) Mother:

c) Father:

	Place of birth	Country of ancestry
d) Maternal Grandmother:	<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>	<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>

e) Maternal Grandfather:	<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>	<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>
--------------------------	---	---

f) Paternal Grandmother:	<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>	<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>
--------------------------	---	---

g) Paternal Grandfather:	<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>	<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>
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33. Circle the picture that shows how YOU look.

Indicate picture number:

For BOYS:

For GIRLS:

Subject ID:
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34. Circle the picture that shows how YOU WANT to look (it can be the same or different).

Indicate picture number:

For BOYS:

For GIRLS:

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CONFIDENTIAL QUESTIONNAIRE

35. Have you experienced any of the following?

- a) Parental Separation/Divorce No Yes
- b) Repeated a grade in school No Yes
- c) Bullying/Violence at school No Yes
- d) Absence from school for multiple consecutive days in the last 12 months (Refer to facing page) No Yes → If Yes, how many days?
- e) Major personal injury or illness requiring hospitalization No Yes
- f) Death/major illness of a household member/sibling/parent No Yes
- g) Violence at home (Refer to facing page) No Yes
 Not asked

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CONFIDENTIAL QUESTIONNAIRE

For 14-15 year Olds Only (Questions 36-37)

36. a) Which best describes your pattern of drinking alcohol?

- Drank alcohol in the past Currently drink alcohol Have never drank alcohol → Go to #37

b) At what age did you start? years

c) How often do you/did you drink alcohol?

- Daily Weekly Monthly

d) Indicate average number of drinks per time:
 (Refer to facing page for approximate size of one "drink")

37. a) Which best describes your history of tobacco use? (Includes smoked and chewed tobacco)

- Formerly used tobacco products Currently use tobacco products Never used tobacco products → Go to #38

b) At what age did you start? years

c) If current, which of the following do you use? (Check all that apply)

Form of Tobacco	Frequency (choose one):			Average # per time
	Daily	Weekly	Monthly	
i. Cigarettes	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text"/> <input type="text"/>
ii. Beedies	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text"/> <input type="text"/>
iii. Pipes/cigars	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text"/> <input type="text"/>
iv. Chewing tobacco (includes tobacco added to paan)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text"/> <input type="text"/>
v. Snuff	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text"/> <input type="text"/>
vi. Sheesha/Water Pipes/Other (specify): _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text"/> <input type="text"/>

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CONFIDENTIAL QUESTIONNAIRE

For All Participants (Question 38)

38. Over the past 12 months, what has been your typical exposure to other people's smoke?
("Exposed" is defined as a minimum of 5 consecutive minutes, during which you inhale other people's smoke)

Select **ONE** only

- None 1-2 times/week 3-6 times/week At least once a day 2-3 times/day 4 or more times/day

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CONFIDENTIAL QUESTIONNAIRE

For 14-15 year old Females Only (Question 39)

39. Have you started menstruation (periods)?

No

Yes

→ At what age did it start?

years

Subject ID:
School #
Individual #Subject
Initials
F M L**For Canada Only (Questions 45-56)** (Refer to facing page for instructions)45. Have you ever had wheezing or whistling in the chest at any time in the past? No → Go to #50 Yes46. Have you had wheezing or whistling in the chest in the past 12 months? No Yes47. How many attacks of wheezing have you had in the past 12 months? None 1 to 3 4 to 12 More than 1248. In the past 12 months, how often has your sleep been disturbed due to wheezing? Never Less than one night per week One or more nights per week49. In the past 12 months has the wheezing ever been severe enough to limit your speech to only one or two words at a time between breaths? No Yes50. Have you ever had asthma? No Yes51. In the past 12 months, has your chest sounded wheezy during or after exercise? No Yes52. In the past 12 months, have you had a dry cough at night, apart from a cough associated with a cold or chest infection? No Yes53. In the past 12 months, have you had a problem with sneezing, or a runny, or blocked nose, when you did not have a cold or flu? No Yes54. Have you ever had hay fever? No Yes55. Have you ever had an itchy rash which was coming and going for at least 6 months? No Yes56. Have you ever had eczema? No Yes

Subject ID: School #

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Subject Initials F M L

40. PHYSICAL MEASURES

Sitting

a) Right arm blood pressure

#1 mmHg → Time : (00:00-23:59)
Systolic Diastolic

#2 mmHg → Time : (00:00-23:59)
Systolic Diastolic

#3 mmHg → Time : (00:00-23:59)
Systolic Diastolic

b) Heart Rate

#1 beats/min

#2 beats/min

#3 beats/min

c) Waist #1 . cm → bare skin minimal clothing (only if refused bare skin)

#2 . cm

d) Weight . kg → minimal clothing full clothing

e) Hip #1 . cm → minimal clothing full clothing

#2 . cm

f) Height . cm (without shoes)

g) Mid right arm circumference: . cm

h) Right arm triceps skinfold: 1. . mm 2. . mm 3. . mm Not Done

41. Grip Strength (Maximal contraction) (Refer to facing page for directions):

a) Non-dominant hand: #1 kg. b) Dominant hand: #1 kg.

#2 kg. #2 kg.

c) Super squeeze: #1 kg.

#2 kg.

Appendix C: Secondary Beverage Questionnaire

RICH LEGACY

Child Questionnaire

Step 1

Subject ID

School				Individual				
!	!	!	!	!	!	!	!	!

Subject Initials

!	!	!
F	M	L

!
!

1. During the past month, on average how often has your child consumed the following drinks? (mark box with an "x", unless otherwise instructed)

	<1 per Month – never	OR	Choose one:			If either monthly, weekly, or daily is checked, record # of times → # Times
			Monthly	Weekly	Daily	
a. Milk products (including soy)	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text"/> <input type="text"/>
b. Hot chocolate (milk-based)	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text"/> <input type="text"/>
c. Tea (milk-based)	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text"/> <input type="text"/>
d. Soft drinks (regular)*	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text"/> <input type="text"/>
e. Soft drinks (diet)*	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text"/> <input type="text"/>
f. 100% fruit juice	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text"/> <input type="text"/>
g. Fruit juice/other drinks	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text"/> <input type="text"/>

2. What is the average serving size of the following drinks? Do you add any extra sugar to any of your drinks?

	# of tps. sugar added to drinks	Serving size (# of mLs/cups)
a. Milk products (including soy)	<input type="text"/> <input type="text"/>	_____
b. Hot chocolate (milk-based)	<input type="text"/> <input type="text"/>	_____
c. Tea (milk-based)	<input type="text"/> <input type="text"/>	_____
d. Soft drinks (regular)	<input type="text"/> <input type="text"/>	_____
e. Soft drinks (diet)	<input type="text"/> <input type="text"/>	_____
f. 100% fruit juice	<input type="text"/> <input type="text"/>	_____
g. Fruit juice/other drinks	<input type="text"/> <input type="text"/>	_____

Appendix D: Participant Report Letter

The Community Health Research Team
 (CoHeaRT)
 Health Sciences
 SIMON FRASER UNIVERSITY

RICH LEGACY
 Rm 2530, 515 West Hastings Street
 Vancouver, BC V6B 5K3
 Telephone: 778-782-7705

Date

Dear,

Thank you for enrolling your daughter, _____ in the **RICH LEGACY Study** (Research in International Cardiovascular Health - Lifestyles, Environments and Genetic Attributes in Children and Youth). We would like to share with you the results of her assessment.

Your child had the following measurements completed on _____ as part of the study. The check mark indicates whether or not your child's current measurement level is at the optimal level for her age group. An explanation of the results are provided on the following page. We may be contacting you in the near future to invite you and your child back to our clinics for an additional assessment. If you have any questions or concerns, please do not hesitate to contact us at (778) 782-7705. Thank you again for helping us learn more about heart health risk factors. The information you are making available to us may lead to programs that can improve the heart health of our children!

Measurement	Results
Weight (kg)	kg
Height (cm)	cm
Hand Grip Strength (kg)	kg

Measurement	Results	At Optimal level %	Not At Optimal level %
Waist Circumference (cm)	cm	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Body Mass Index (kg/M ²)	kg/M ²	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Body Fat %	%	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Systolic Blood Pressure (mm Hg)	mm Hg	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Diastolic Blood Pressure (mm Hg)	mm Hg		

%

EXPLANATION OF THE RESULTS

%

!

1. **Waist Circumference (WC):** provides an indicator of abdominal fat. Too much fat around the waist and upper body is linked to greater risk for diabetes, hypertension and heart disease than fat located more in the hip and thigh area.

%

	Ideal Waist Circumference
Girls 8 yrs.	51.6 to 70.5 cm

2. **Body Mass Index (BMI):** is a measure of a person's weight in relation to their height. A very high BMI may indicate too much body fat and greater risk for diabetes, hypertension and heart disease. A very low Body Mass Index may indicate other health risks.

	Healthy Body Mass Index
Girls 8 yrs.	13.0 to 18.4 kg/m ²

3. **Body Fat Percentage:** the proportion of a person's total body weight that is made up of fat. Body fat is produced in the body, and this may be influenced by diet, exercise and heredity. Some body fat is necessary to maintain life. Too much body fat may be linked to health risks.

%

	Healthy Body Fat Percentage
Girls 8 yrs.	13% to 26%

4. **Blood Pressure (BP):** measures the force of blood against the walls of arteries. Blood pressure is recorded as two numbers—the systolic pressure (as the heart beats) over the diastolic pressure (as the heart relaxes between beats). If the BP is too high on a regular basis, it is putting extra pressure on the arteries and on the heart, and high BP has been linked to higher the risk of health problems in the future. BP should be rechecked by a doctor or nurse if it is out of target only one time.

	Healthy Systolic/Diastolic P.
Girls 8 yrs.	Lower than 108/74

5. **Hand Grip Strength:** is a measure of isometric muscle strength, a measure of physical fitness. Hand grip strength is important for any sport in which the hands are used for catching, throwing or lifting.

%

	Usual Grip Strength
Girls 8 yrs.	5.81 to 14.68 kg