7-20-2009

Risk factors of type 2 diabetes and cardiovascular diseases among Jamaican adolescents

Sheila C. Barrett

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DOI: 10.25148/etd.FI14050445

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FLORIDA INTERNATIONAL UNIVERSITY

Miami, Florida

RISK FACTORS OF TYPE 2 DIABETES AND CARDIOVASCULAR DISEASES
AMONG JAMAICAN ADOLESCENTS

A dissertation submitted in partial fulfillment of the

requirements for the degree of

DOCTOR OF PHILOSOPHY

in

DIETETICS AND NUTRITION

by

Sheila C. Barrett

2009

To: Dean Fernando M. Treviño
R.Stempel College of Public Health and Social Work

This dissertation, written by Sheila C. Barrett, and entitled Risk Factors of Type 2 Diabetes and Cardiovascular Diseases among Jamaican Adolescents, having been approved in respect to style and intellectual content, is referred to you for judgment.

We have read this dissertation and recommend that it be approved.

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University Graduate School

Florida International University, 2009

DEDICATION

The study is dedicated to the memory of my mother, Olive Barrett who died of diabetes complications, my father, Ivan Barrett who later followed with ischemic heart disease. The pain of losing my parents prompted this research to help bring awareness to others.

ACKNOWLEDGMENTS

I wish to thank my committee members for their support during the preparation and compilation of this study. I appreciate their time, effort and guidance throughout the process. Special gratitude to Dr. Paulette Johnson for her help and patience with the statistical analyses, Dr. Adriana Campa, for her suggestions in methodology, Dr. Marcia Magnus and Dr. Dalip Ragoobirsingh for their scrutiny of the proposal. To my major professor, Dr. Fatma Huffman, thank you for your faith in my ability to complete this study. Her gentleness, encouragement, guidance, financial planning and assistance helped me to meet the deadlines and requirements for completion of this study. Thanks to the University Graduate School, FIU for awarding me the Dissertation Year Fellowship during my final year of the study.

Special thanks to the workers of the Heart Foundation of Jamaica, the Diabetes Association of Jamaica, and the Central Medical Laboratory, who performed the blood analyses. To the Jamaican Ministry of Education and Ministry of Health officials who sanctioned the collection of data. To the principals and contact persons in all ten schools who accommodated us for the data collection. To the study subjects who willingly participated and made this project possible.

To my family members here in the USA and in Jamaica who supported me during this challenging process. I am extremely grateful to my sisters, Cheryl and Heather Barrett in Jamaica who worked tirelessly to organize this study for me and made follow-up calls to ensure the smooth success of the project. To Francine White who assisted me throughout the data collection and to my nephews who took time out from their school activities to accompany me on data collection days. Your help is greatly appreciated.

ABSTRACT OF THE DISSERTATION
RISK FACTORS OF TYPE 2 DIABETES AND CARDIOVASCULAR
DISEASES AMONG JAMAICAN ADOLESCENTS

by

Sheila C. Barrett

Florida International University, 2009

Miami, Florida

Professor Fatma Huffman, Major Professor

Purpose: The purpose of the study was to examine Jamaican adolescents in a school setting, for risk factors of type 2 diabetes mellitus (T2DM) and cardiovascular diseases (CVDs).

Methods: A descriptive epidemiological cross-sectional study of 276 Jamaican adolescents (112 males and 164 females) ages 14-19 years (15.6 ± 1.2), randomly selected from grades 9-12 from ten high schools on the island. Thirteen risk factors were examined. Risk factors were compared with BMI levels and demographics. A sub-study validated finger prick testing of fasting blood glucose, total cholesterol, and HbA1c versus venous testing in 59 subjects.

Results: Prevalence of overweight was 33.0% ($n=91$) with mean BMI of 23.74 ± 7.74 .

Approximately 66.7% of subjects reported ≥ 3 risk factors. The number of T2DM and CVDs risk factors increased for subjects with BMI above 25. One third of the overweight subjects were classified with the metabolic syndrome. High BMI was associated with high waist circumference ($r = .767$, $p < .01$), high waist-to-hip ratio

($r = .180$, $p < .01$), presence of Acanthosis Nigricans ($r = .657$, $p < .01$), high total cholesterol ($r = .158$, $p < .01$), family history of T2DM ($r = .157$, $p < .01$), and hypertension ($r = .422$, $p < .01$). Regression analyses significantly predicted gender and physical activity ($p < .001$), and total number of risk factors for T2DM and CVDs ($p < .001$). Paired samples t-tests revealed no significant differences between methods of testing for TC and HbA1c ($p < .01$) but not for FBG ($p > .05$). Percentage bias for the methods of blood testing met the reference standards for fasting blood glucose but not for total cholesterol and HbA1c. Bland Altman tests of agreement between the two methods indicated good agreement for all three tests.

Conclusion: Jamaican adolescents are at high risk for T2DM and CVDs as seen in other study populations. Effective programs to prevent T2DM and CVDs are needed. Family history of diseases, anthropometric measures, and gender identified more subjects at risk than did the biochemical measures. Comparison between finger prick and venous blood methods suggested that finger prick is an adequate method to screen for risk factors in children and adolescents.

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GLOSSARY

Acanthosis Nigricans	A skin disorder manifested by velvety light-brown to black marks around the neck, axilla, knuckles, elbows and is associated with obesity and insulin resistance.
Body Mass Index	A crude estimate of body fat calculated by dividing a person's weight by their height (weight (kg)/height (m ²))
Fasting Blood Glucose	Measurement of the amount of sugar in whole blood and is taken at least 8 hours after eating, useful in diagnosing diabetes.
Fasting Plasma Glucose	Measurement of the amount of sugar in plasma and is taken at least 8 hours after eating, the preferred glucose measurement for the diagnosis of diabetes.
Glycated Hemoglobin	A form of hemoglobin (HbA1c) that remains bound to the glucose molecule used to identify the average plasma glucose concentration over a prolonged period (120 days) lifespan of the RBCs.
Hypertension	Elevated high blood pressure defined by both above normal levels of diastolic and systolic blood pressure.
Insulin Resistance	A medical condition in which the body cells do not respond effectively to effects of insulin; a key feature of type 2 diabetes.
Macronutrients	Dietary fat, protein and carbohydrates, referred to as "macro" due to the large amounts needed by the body.
Metabolic Syndrome	A combination of associated cardiovascular risk factors to include central adiposity, high fasting plasma glucose, hypertension, high levels of LDL-C and low HDL-C cholesterol. Presence of any three components constitutes the metabolic syndrome.
Obesity	Is a medical condition associated with excessive accumulation of body fat. Determined by BMI > 30 kg/m ²
Overweight	A state of health with having more body fat than is considered healthy (20% above normal body weight for height).

Physical Activity	Activity that is intended for improving or maintaining physical fitness and health.
Type 2 Diabetes	A health condition formerly associated with age, but now found in younger age group. Associated with obesity, and insulin resistance, and is more common in ethnic minority groups.
Total Cholesterol	The combination of all measurement of all types of cholesterol in the blood.
Waist Circumference	A measurement of the waist taken around the abdomen. Fatty deposits around the waist indicate increased health risks. Waist circumference of 102 cm (40 inches) in men and 88 cm (35 inches) in women suggest increased health risks.
Waist-to-Hip Ratio	Waist measurement divided by the hip circumference. Healthy Waist-to-hip-ratio is <1.0 for men and < .8 for women.

LIST OF ABBREVIATIONS

AN	Acanthosis Nigricans
ACSM	American College of Sports Medicine
AMDR	Acceptable Macronutrient Distribution Ranges
BMI	Body Mass Index
BMR	Basal Metabolic Rate
CDC	Center for Disease Control and Prevention
CVD	Cardiovascular Disease
ECG	Electrocardiogram
FAO	Food and Agricultural Organization
GDP	Gross Domestic Product
HDL-C	High Density Lipoprotein Cholesterol
IOTF	International Obesity Task Force
IR	Insulin Resistance
LDL-C	Low density Lipoprotein Cholesterol
MET	Metabolic Equivalent
METS	Metabolic Syndrome
NCEP	National Cholesterol Education Program
NHES	National Health Examination Survey
NHANES	National Health and Nutrition Examination Survey
PA	Physical Activity
PAQ-C	Physical Activity Questionnaire for Children
SES	Socio economic status

TC	Total Cholesterol
TG	Triglycerides
T2DM	Type 2 diabetes mellitus
USDHHS	United States Department of Health and Human Services
WHO	World Health Organization

CHAPTER I

INTRODUCTION

Statement of the Problem

The prevalence of Type 2 diabetes mellitus (T2DM) in children and adolescents with its complications and premature mortality is increasing and presents a major public health challenge. Type 2 diabetes mellitus is among the cluster of cardiovascular diseases (CVDs) risk factors such as obesity, hypertension, and dyslipidemia, known as the “Metabolic Syndrome” (METs) and is considered the seventh leading cause of death in the developing world (Sacks, Bruns, & Goldstein et al., 2005). Once thought to relate only to adults, T2DM is now increasingly found in children and adolescents (Daniels, 2006; Choudbury, 2005, Reinehr, 2005).

Health conditions such as heart attack and strokes are chronic, start in childhood, and take decades to present as overt conditions (Daniels, 2006; Wyatt, Winter, & Dubbert et al., 2006). Being obese during childhood, adolescence and young adulthood may accelerate these conditions (Daniels, 2006; Choudbury, 2005).

Most of the data on childhood obesity and related health complications were collected in the developed countries. As lifestyles change in the developing world to pattern that of the developed countries, there is need for research among this population. This study investigated the prevalence of risk factors for T2DM and CVDs among Jamaican adolescents ages 14-19 years. The study was undertaken to help raise awareness of the presence of risk factors such as overweight and obesity, family history of chronic nutrition-related diseases, decreased physical activity, and poor dietary intakes among this population. A secondary aim was to validate a screening method for testing

blood values of fasting blood glucose (FBG), total cholesterol (TC), and glycated hemoglobin (HbA1c) which can be used in a school setting, with easier testing for, and faster feedback than traditional clinical setting.

Significance of the Study

The study is significant because with data it will be possible to track trends, provide the rationale for the implementation of programs that can help in the prevention of chronic diseases, help to provide a healthier future generation for the workforce, save on healthcare costs, and provide a better quality of life for Jamaicans.

The growing prevalence of T2DM and CVDs is associated with the growing rates of obesity. Type 2 diabetes mellitus in minority American children over ten years old now accounts for 8-45% of new cases of diabetes (ADA, 2005). Approximately 60 percent of overweight American children also have hypertension, hyperinsulinemia, and/or hyperlipidemia (Freedman, Dietz, Srinivasan et al, 1999). The prevalence rate of obesity (BMI exceeding the 95th percentile) among US children ages 12- 19 years has increased by 10% over a twenty year period. That is, adolescent obesity has increased from 5% in 1980 to 15.5% in 2000 in the USA (Bloomgarden, 2004). Therefore, the proposed study is significant for a number of reasons; it is an unprecedented assessment of risk factors of T2DM and CVDs among Jamaican adolescents.

There is no documented research on T2DM in Jamaican children and adolescents despite the current interest and prevalence shown in children from other countries. Screening for T2DM is necessary since the onset of T2DM occurs 4-7 years before clinical diagnoses (Sacks et al., 2005). Second, research on childhood obesity in the

developing world is sparse and this will add to the body of literature on childhood obesity in the developing world. The rate of obesity is expected to pattern that of the US since the diets have become more similar to US foods with high levels of imported refined grains, oils, and other high energy-dense foods. Third, it will provide baseline data so that trends can be examined retrospectively. In addition, this study will help to rejuvenate interest in preventive health care that can be accessed more readily and economically at the school level without overburdening the already strapped healthcare system.

In the 1960s-70s when the health concerns were that of childhood infectious diseases such as measles, smallpox, chicken pox and tuberculosis, the Jamaican government took more active role in the health of school children. Children were targeted and immunized within the school system. Now that the focus has shifted to non-communicable diseases such as T2DM and CVDs, there is need for government based primary prevention programs that target school children for these health conditions.

Reduction of health care costs is important to countries such as Jamaica with low Gross National Product (GNP) and which are overburdened with high healthcare costs. Total health expenditure in Jamaica was J\$9.1 billion in 1993-1994 and represented up to 8.9 % of the Gross Domestic Product (GDP) at that time (Lalta, 1995). Due to massive devaluation of the Jamaican currency, Jamaica's GDP was US\$8.9 billion in 2004 with GDP per capita income of US\$3,350.00 (Jamaica Facts and Figures, 2005). More recent reports showed that Jamaica spends approximately 6% of GDP on the treatment of diabetes and hypertension (PAHO, 2008). Early screening for risk factors of T2DM and CVDs is needed to help reduce health care costs.

The numbers of persons without health insurance in Jamaica is not documented but the percentage without insurance is expected to be even higher than in a developed country. Up to 11.4% of children in the USA had no health insurance in 2003 (“Center on Budget and Policy Priorities,” 2004). In Jamaica, about 15% of persons who have health insurance purchased private health insurance (Lalta, 1995). Many persons pay out of pocket for health care with approximately 54% doing so in 1993-94. It is likely that even if parents are aware of the risks of overweight and obesity, they are unable to solicit proper healthcare with no medical insurance to help offset the costs.

US based research indicated strong associations with being overweight during childhood and adolescence with insulin resistance (IR), dyslipidemia, and elevated blood pressure in young adulthood (Gungor & Arslanian, 2002; Steinberger, Moran, Hong et al., 2001; & Daniels, 2001; Daniels, 2006; Choudbury, 2005; Reinehr, 2005). This epidemiological study identified adolescents at risk to T2DM and CVDs. It is an unprecedented study which examined Jamaican adolescents on thirteen risk factors for T2DM and CVDs. Identification of these risk factors can help plan early preventive programs for this population.

Background and Significance

Recent research shows an increasing global prevalence of T2DM in children and adolescents due to a concurrent rise in the prevalence of obesity (Reinehr, 2005). Further, childhood obesity is closely associated with IR in early adulthood (Steinberger, et al., 2001). Other factors such as ethnicity, gender and family history of disease have been associated with the development of T2DM.

A study of 167 obese US adolescents revealed a prevalence of 4% of T2DM, all cases reported were among Hispanics and Blacks (Sinha, Fisch, & Teague et al, 2002). Earlier studies (Rosenbloom, Joe, & Young et al., 1999) indicated that girls were 1.7 times more likely to develop T2DM than boys. Research shows that over two-thirds of children with T2DM have at least one parent with T2DM (ADA, 2000). Other studies also revealed higher prevalence of T2DM among females than males and among minority groups compared to Caucasians (Rosenbloom, et. al, 1999, McKnight-Menci, Sababu, & Kelly et al, 2005).

Type 2 diabetes mellitus is found in up to 45% of new cases of diabetes in children and adolescents at health centers in the US, which serve large numbers of African American, Mexican American and Native American youths (ADA, 2000, ADA, 2005, Bavdekar, Yajnik, & Fall et al, 1999; Berry, Sheshan, & Heschel et al, 2004). Detection of the early signs of T2DM and CVDs is needed to help in the prevention of these and other related medical conditions. Type 2 diabetes mellitus in children and adolescents relates to obesity and features of the metabolic syndrome (METS) such as hyperinsulemia, hypertension, & dyslipidemia. Other associated indicators include polycystic ovarian syndrome (PCOS) and Acanthosis Nigricans (AN). It is difficult to diagnose T2DM in adolescents since there are few symptoms such as mild polyuria and polydipsia which tend to appear around mid to late puberty (Reinehr, 2005). Screening is recommended for children over age 10 years and at any age if the child is overweight and has two other risk factors. Other risk factors include family history of T2DM, race/ethnicity, and signs of IR. The presence of Acanthosis Nigricans (AN) (a dark line around the neck) is a sign of IR and when present, it is easily detectable and needs to be

considered as an additional risk factor. It is further recommended that screening for T2DM be carried out every two years (Sacks, al., 2002).

Cardiovascular diseases are manifested in the middle or older years. However, the development usually starts in the earlier years and progresses to clinically significant lesions in young adulthood (Gungor, & Arslanian, 2005; Steinberger & Daniels, 2003). Research has shown that the fatty streaks associated with atherosclerosis were found in the aortas of children as young as three years old (McGillis-Bindler, & Bruya, 2000). Other studies indicated that about 60% of overweight American children also had hypertension, hyperinsulinemia, and/or hyperlipidemia (Freedman, et al., 1999).

This research was conducted on a group of Jamaican adolescents since the epidemiological transition is underway in Jamaica among adults. The prevalence rate of obesity among Jamaican women was 25% and twice that of the men. Up to 51% of deaths in the Caribbean region during the late 1990s related to diabetes, cancer, and cardiovascular diseases [The Caribbean Commission on Health and Development (CCHD) 2005 Report]. The increase in obesity among the adult population was attributed to excessive consumption of foods, wrong food choices, and low physical activity. Similar trends were expected among Jamaican adolescents. Information on Jamaican adolescents is needed to estimate the future barriers to addressing lifestyle diseases for this country of limited health resources.

Research Purpose

Testing for risk factors of T2DM in children and adolescents is necessary since earlier research indicated that “the presence of T2DM in one-third of the minority

children with T2DM, and the majority of Caucasian children with T2DM was detected in the absence of symptoms” (Reinehr, 2005). The Centers for Disease Control (CDC) in the USA recommended early screening for children over 10 years who present with any clinical signs of the metabolic syndrome (central obesity, raised blood pressure, raised triglycerides, low HDL-C, and fasting hyperglycemia), family history of T2DM, those who are members of particular ethnic group at risk (Asians, Hispanics, Indians and African Americans), and if they are extremely obese with BMI of $> 30 \text{ kg/m}^2$ and fall in the $> 95^{\text{th}}$ percentile (Reinehr, 2005; Singh, Shaw, & Zimmet, 2004). Although research is lacking on Jamaican adolescents, it was hypothesized that Jamaican adolescents, the majority of whom, are of African descent (91%), mixed ethnicities (7%), Indian (1%) and others (1%) (Jamaica Facts and Figures, 2005) will share the same dynamics as observed by the other ethnic groups in other countries.

The proposed study involved screening for overweight and obesity and lifestyle factors, such as physical activity levels and diet that may increase the risk of T2DM and CVDs among 276 randomly selected Jamaican adolescents in ten high schools in Jamaica. In addition, blood samples were tested for fasting blood glucose (FBG), total cholesterol (TC), and glycated hemoglobin (HbA1c) using a finger prick method. This assessment is easy to apply in the school setting and offers fast feedback. The finger prick can be used as a screening tool to identify those students in need of further follow-up, and is an inexpensive and less invasive data collection tool when compared to venipuncture, a more involved and invasive screening method, more appropriate for a clinical setting. A sub-sample of 59 randomly selected students from the larger study group was tested using venipuncture for the same blood parameters. Testing of this sub-

sample was used to validate the finger prick method versus venous blood testing to determine if the former can be used for effective screening of risk factors for T2DM and CVDs in a school setting. Other data that were collected included anthropometric measures such as weight, height, body mass index (BMI), waist circumference (WC), waist-to-hip ratio (WHR), demographic data, blood pressure (BP), presence of Acanthosis Nigricans (AN), dietary intakes of energy and macronutrients, physical activity (PA) levels, family history of overweight and obesity, T2DM, and CVDs.

Specific Aims

The main aim of this study was to examine Jamaican adolescents, ages 14-19 years for risk factors of T2DM and CVDs. Specific aims were to:

1. determine the prevalence of risk factors for T2DM and CVDs among Jamaican adolescents.
2. identify the dietary, family history and physical activity levels which contribute to the risk factors for T2DM and CVDs in Jamaican adolescents.
3. characterize the frequency and cluster of risk factors for T2DM and CVDs, such as diet, family history of T2DM (first degree relative with diabetes), CVDs, obesity (BMI > 95th percentile), hypertension, high-risk ethnic groups (Blacks and Indians), high levels of HbA1c and FBG, and low physical activity levels among Jamaican adolescents.
4. compare blood samples of FBG, TC, and HbA1c using finger prick method with that of venipuncture to ascertain if the former can serve as a surrogate for the gold standard of venipuncture.

Table 1

Research Questions, Objectives and Hypotheses

Research Questions	Objectives	Hypotheses
1. What is the relationship between ethnic background, gender, place of residence, and income and the risk factors for T2DM and CVDs among Jamaican adolescents?	1. To determine the prevalence of the risk factors of T2DM and CVDs (FBG, HbA1c, TC, systolic and diastolic blood pressure, BMI, WC, WHR, positive family history of T2DM, CVDs, and overweight, AN, PA, and dietary intakes of macronutrients) and the relationships between the risk factors for T2DM and CVDs and ethnicity (Blacks, Indians, Mixed) gender (male and female), place of residence (rural, urban) and income among Jamaican adolescents.	<p>1. Ethnicity, gender, place of residence, and income will be positively associated with the number of risk factors for T2DM and CVDs (high levels of FBG, HbA1c, TC, BP, waist circumference, WHR, and presence of AN, low PA, and family history of overweight, CVDs, and T2DM) and with each individual risk factor.</p> <p>1a. Blacks will report greater number of risk factors for T2DM and CVDs than Indians and those of mixed ethnicities.</p> <p>1b. Jamaican female adolescents will have a greater number of risk factors for T2DM than males.</p> <p>1c. Jamaican male overweight and obese adolescents will have a greater number of risk factors for CVDs than their female obese and non-obese counterparts.</p> <p>1d. Jamaican adolescents who live in urban areas will have greater number of risk factors for T2DM and CVDs than their rural counterparts.</p> <p>1e. Jamaican adolescents from lower income families will present with more risk factors for T2DM and CVDs than those from higher income families.</p>

Research Questions	Objectives	Hypotheses
2. What is the prevalence of risk factors for developing T2DM and CVDs among Jamaican adolescents?	2. To determine the frequency, cluster, and associations of the risk factors of T2DM and CVDs in Jamaican adolescents using measures such as FBG, HbA1c, TC, systolic and diastolic blood pressure, BMI, WC, WHR, positive family history of T2DM, CVDs, and overweight, AN, PA levels, and dietary intakes of macronutrients.	<p>2. Overweight and obese Jamaican adolescents will have higher levels of at least one of the following risk factors: high FBG, HbA1c, TC, BP, WC, WHR, and presence of AN, low PA, and family history of overweight, CVDs, and T2DM, than those with normal or low BMI.</p> <p>2a. Waist circumference and WHR of Jamaican adolescents will be positively associated with the risk factors for T2DM and CVDs (high FBG, HbA1c, TC, BP, subjects' BMI, and presence of AN, low PA, and family history of overweight, CVDs, and T2DM), and with each individual risk factor.</p> <p>2b. Jamaican adolescents with family history of obesity (parents' BMI) will present with > BMI than those without family history of obesity as determined by anthropometric measures of adolescents and self-reported data of parents/family.</p> <p>2c. Energy intakes of Jamaican adolescents will be positively correlated with the total number of risk factors for T2DM and CVDs (high levels of FBG, HbA1c, TC, BP, parents' BMI, waist circumference, WHR, and presence of AN, low PA, and family history of CVDs, and T2DM) and with each individual risk factor.</p>

Research Questions	Objectives	Hypotheses
		<p>2d. Intakes of complex and refined carbohydrates of Jamaican adolescents will be positively associated with the total number of risk factors for T2DM and CVDs (high levels of FBG, HbA1c, TC, BP, waist circumference, WHR, and presence of AN, low PA, and family history of overweight, CVDs, and T2DM) and with each individual risk factor.</p> <p>2e. Total fiber intake (g) of Jamaican adolescents will be negatively associated with the total number of risk factors for T2DM and CVDs (high levels of FBG, HbA1c, TC, BP, waist circumference, WHR, and presence of AN, low PA, and family history of overweight, CVDs, and T2DM) and with each individual risk factor.</p> <p>2f. Intakes of saturated and unsaturated fat, and intake of omega-3 and omega-6 fatty acids of Jamaican adolescents will be associated with the total number of risk factors for T2DM and CVDs (high levels of FBG, HbA1c, TC, BP, waist circumference, WHR, and presence of AN, low PA, and family history of overweight, CVDs, and T2DM) and with each individual risk factor.</p>

Research Questions	Objectives	Hypotheses
3. Is there a relationship between blood parameters such as glucose, TC, and HbA1c measured by finger prick method and the same measures using venipuncture?	3.To compare the results of blood parameters using finger prick techniques with that of venipuncture to determine if there is a relationship between the two methods and determine if the finger prick method can be used instead of venipuncture in the early screening of T2DM and cardiovascular diseases.	3. There will be no significant differences between, FBG, TC, and HbA1c measured by finger prick and venipuncture methods.

Risk Factors for T2DM and CVDs

Childhood obesity and overweight are strong predictors of T2DM and CVDs, the prevalence of which has sharply increased globally within the past two decades (Rubenstein, 2005; James, Leach, & Kalamara et al, 2001). Obesity is defined as “an excess of body fat mass exceeding 20% of total body weight.” The World Health Organization (WHO) estimated that over one billion adults in the world are overweight with 300 million being clinically obese that is, BMI over 20% of ideal weight for height (WHO, 2003). Of significance is the rising prevalence in adolescents since obesity affects morbidity and mortality in young adulthood (Rubenstein, 2005). The growing prevalence of obesity and related chronic diseases that originated in the industrialized countries have now become diseases of the developing countries, many of which are still fighting infectious childhood diseases (Prentice, 2006; Nugent, 2006; Popkin, 2001). Data on obesity in the developing world are sparse, however Delpeuch & Maire, (1997)

estimated that over 30% of people in Latin America, the Caribbean, the Middle East, and Northern Africa are overweight.

Overweight varies by race and ethnicity, place of residence (rural or urban) and gender (male /female). Data from US based studies revealed that up to 14% non-Hispanic whites, 21% non-Hispanic blacks, and 23% Mexican American adolescents are overweight (McKnight-Menci et al, 2005). Place of residence is a predictor of overweight as more people move from rural to urban areas and adapt to urban lifestyles. According to the Food and Agricultural Organization (FAO, 2006) up to 50% of the world's population now live in urban areas. The change from a rural to urban lifestyle increases the risk for obesity with a corresponding increase in the intakes of high energy-dense foods, and reduced physical activity (Popkins, 2001; Prentice, 2006). In Jamaica, 52% of the population lives in urban areas and are mostly centered in four of the fourteen parishes; Kingston, St. Andrew, St. Catherine and St. James (STATIN, 2001). The first three of these parishes were targeted for this research.

Data on gender differences vary with some studies indicating that more Indian boys (17.8%) than girls (15.8%) in India, ages 14-19 years are overweight (Ramachandran, 2004). Other studies indicated that obesity is more prevalent in women worldwide partly due to their constant exposure to a domestic environment and easy access to food (James et al, 2001). In a study on obesity and overweight in Jamaican children, more girls than boys, ages 10-15 years were found to be obese (Gaskin & Walker, 2003).

Obesity is linked to T2DM and CVDs. Type 2 diabetes mellitus is a metabolic disease characterized by glucose intolerance and IR often associated with obesity

(McKnight-Menci, et al., 2005). The disease might go unnoticed for years while the increased hyperglycemia damages vital organs (McKnight-Menci, et al, 2005). Further, T2DM results in “a gradual increase in insulin resistance associated with a decline of insulin secretion with fasting hyperglycemia” (Marcovecchio, Mohn, & Chiarelli, 2005). T2DM in children is mostly linked to obesity, sedentary lifestyle, puberty, race, ethnicity, features of insulin resistance, family history of T2DM, being female, and perinatal factors (Marcovecchio et al, 2005; Berry, Urban, & Grey, 2006).

There is a strong association between the incidence of T2DM and overweight/obesity. Type 2 diabetes mellitus accounts for up to 85% of all cases of diabetes. Of this percentage, approximately 95% of individuals with T2DM are overweight or obese (WHO, 2003). Once considered an adult-onset disease until the late 1970s, T2DM is now commonly seen in younger populations especially among adolescents and minorities (Fagot-Campagna, 2000; McClain, Srinivassan, & Chen, et al, 2000). Up to 8-45% of newly diagnosed cases of T2DM in children over 10 years occur among American ethnic minorities (ADA, 2005). Type 2 diabetes mellitus is now accepted to run parallel to the increasing rates of obesity and is spreading to the developing countries (Gungor, & Arslanian, 2002). It is estimated that by the year 2025, most cases of T2DM will come from India, and the Middle Eastern countries, with large increases expected from China, Latin America and the Caribbean and the rest of Asia (WHO, 2003).

The prevalence of CVDs is increasing in the lesser developed countries. Approximately 80% of all cases of CVDs now occur in the developing countries (Nugent, 2006). Up to 17% of deaths in the developing countries were attributed to CVDs in 2000

(Nugent, 2006). Data on heart diseases in Jamaica indicated that of 15,511 ECGs performed in 2004, 23.1% had abnormalities; out of 44,127 persons who had their blood pressure checked, 68.3% had readings above the normal range (Heart Foundation of Jamaica, 2006). These screenings were carried out by the Supermarket Screening Program (SSP) of the Heart Foundation of Jamaica and involved only screening of adults.

Increased rates of obesity are seen even in countries with low GDP such as Pakistan and Nigeria that now face significant risks from obesity and high cholesterol leading to cardiovascular diseases (Nugent, 2006). Although Jamaica has a per capita GDP of US\$3,350.00 (Jamaica Facts and Figures, 2005), the country may still experience a high prevalence of obesity and overweight. Despite the low per capita income of Jamaicans, there is evidence of overweight among the adult population. Of the 15,511 adults who had their weight checked in the SSP, 35.3% were overweight, 23.4% obese, and 2% were morbidly obese. According to Nugent (2006) “the health-related problems of overweight and obesity now widen the health disparities between rich and poor and add extra burden on the health care systems of the developing countries which are considered the most vulnerable victims of non-communicable disease related to obesity.” Obesity poses economic strain on the already stressed economy of a nation.

The present study determined whether Jamaican adolescents were at risk for T2DM and CVDs and examined the relationship between obesity and type 2 diabetes mellitus and risks of cardiovascular diseases in this age group. The International Obesity Task Force (IOTF) suggested using the BMI for weight and height (kg/m^2) as a reasonable measure of obesity in children and adolescence and was used as a benchmark for determining overweight and obesity among the Jamaican population studied.

T2DM and Obesity among Adolescents

The WHO estimated that globally, at least 171 million people suffer from T2DM and predicted that by the year 2030 this number will double (WHO, 2006). This increase is expected from the present population therefore research is needed to help prevent the spread of T2DM. Type 2 diabetes mellitus is most common in developed countries where its prevalence is concomitant to the rising rates of obesity. However, the trend is fast growing in the developing world due to urbanization and lifestyle changes, and most importantly the adaptation of a Western diet and lifestyles (Prentice, 2006; Monteiro Conde, Liu, et al, 2004; Popkin, 2001; Martorell, Khan, & Hughes et al, 1998). Research shows that diabetes in the English-Speaking Caribbean is on the rise and is projected to continue rising (Hennis, & Fraser, 2004). According to Hennis & Fraser (2004) the increasing rate of diabetes in the Caribbean mirrors that of Western acculturation as seen in Africa and is associated with the rise in obesity.

Most of the research on type 2 diabetes in children and adolescents has been done in the western world. However, reports from countries such as Japan, Taiwan and India indicated that type 2 diabetes in children and adolescents is on the rise (Singh, et al., 2004). Howdle & Wilkin (2001) stated that “the number of adolescents with T2DM has increased ten-fold over the past ten years.” The rapid rise of T2DM among children was first reported in the Pima Indian population in Arizona where diabetes in adolescents increased by 54% between 1980s and 1990s (Dabelea, Hanson, & Bennett et al., 1998; Nesmith, 2001). Despite the scarcity of research on T2DM in children of the developing world, there have been reports of childhood diabetes in countries such as Saudi Arabia, Libya, India, Bangladesh, Mexico, Thailand, and Argentina. In the past,

most of these cases related to type1 diabetes, but countries such as Japan and Taiwan are now reporting increasing rates of T2DM in children (Singh et al., 2004). This chronic disease is expected to rise with a 5-6% increase between 2003-2005. The greatest increase is expected from the developing countries, especially India (Singh et al, 2004).

Obesity and T2DM in Jamaican Adolescents

Research on diabetes in Jamaica does not focus on the younger age groups despite the fact that some studies (Daniels, 2006; Choudbury, 2005, Reinehr, 2005) have shown increasing prevalence of obesity and related T2DM among younger age groups in other countries. Currently Jamaica's population consists of approximately 1% Indian origin and 91% of African ancestry with approximately 28% of the population being between the ages of 10-24 years, most of whom live in the rural areas (National Center for Youth Development, Ministry of Education, Youth and Culture, Jamaica, 2002). Research indicated that;

1. pediatric T2DM is on the rise worldwide (Daniels, 2006; Sacks et al., 2002; Choudbury, 2005).
2. most of the new cases will be comprised of those of Indian origin (Ramchandaran, 2004), one of the Jamaican minorities.
3. African ancestry is a major risk factor for T2DM in studies conducted in the USA, (ADA, 2005; Berry et al., 2004), and those of African ancestry comprise the majority in Jamaica.

This research examined the risk factors for diabetes among adolescents of these two ethnic groups in Jamaica.

In a 1995 survey of 2,109 Jamaicans 15 years and older, it was reported that “Jamaica has a point prevalence of diabetes of 17.9% according to WHO criteria and 1.7% had impaired glucose tolerance (IGT)” (Ragoobirsingh, Lewis-Fuller & Morrison, 1995). Of this sample, 48% of the total diabetes prevalence comprised newly diagnosed cases. Diagnosis of diabetes or IGT was based on WHO criteria (fasting blood glucose (FBG) of ≥ 6.7 mmol/l or a 2 hour postprandial reading of 11.1 mmol/l) which represents diabetes, and FBG < 6.7 mmol/l and a 2 hour postprandial reading of between 6.7 –11.1 mmol/l indicated the presence of IGT) (Ragoobirsingh, et al., 1995). In this study, 24.6% of the total participants and 2.6% of those diagnosed with diabetes fell in the age group 15-24 years which provided limited but enlightening information on diabetes in adolescents. No data on ethnic differences were reported. Gender differences although not significantly correlated with diabetes, showed more females (54.3%) than males (45.7%) had diabetes. Other factors that correlated positively with the prevalence of diabetes in this sample included advanced age (20.3% of sample 75 years and over had diabetes), lower level of education, truncal (abdominal) obesity, family history of diabetes, history of alcohol consumption, and multiple parity. Gender, place of residence, birth weight, and cigarette smoking were negatively correlated with diabetes (Ragoobirsingh et al, 1995). In this survey no distinction was made between type 1 and type 2 diabetes mellitus, or was there any mention of the relationship between obesity and other risk factors of diabetes. Some of these findings were corroborated by McKeigue, Shah, & Marmot (1991) in Afro-Caribbean men living in Britain.

The current study was the first of its kind to screen Jamaican adolescents at risk of obesity, T2DM, and other nutrition and lifestyle-related health complications. The study

also determined whether fasting finger prick testing of capillary whole blood for fasting blood glucose (FBG), total cholesterol (TC), and glycated hemoglobin (HbA1c) could be used as a surrogate for the gold standard of venipuncture for early screening of risk factors for diabetes and cardiovascular disease in a school setting. The study adds to the body of literature on T2DM in adolescents in the developing countries. The information furnished by this study will help to forecast the future burden of life-style diseases in Jamaica and for planning the allocation of scarce public health resources.

Relationship of Obesity to T2DM and CVDs

Excess body fat, abdominal and subcutaneous fat are associated with insulin resistance (IR), a key feature of T2DM (Vickram, Tandon, Misra et al, 2005). Obesity strongly predicts T2DM in children and in one study was shown to occur mainly in Indian, Pakistani and Middle Eastern children in the United Kingdom (Vickram et al, 2005). Further, body weight is strongly associated with insulin resistance. Higher BMI is associated with hyperinsulinemia and insulin resistance (Ford, Williamson, & Liu, 1997). Insulin resistance refers to “reduced responsiveness of peripheral tissues to insulin due to a reduction in the number and function of insulin receptors” (Ford et al., 1997). Further, hyperinsulinemia results when the body’s resistance to insulin causes more insulin to be produced by the pancreas (Steinberger & Daniels, 2003). Obesity is also associated with increased insulin production by pancreatic beta cells. The relationship between obesity and insulin resistance “may be due to the duration and extent of the obesity leading to further deterioration in glucose homeostasis when β cells

become impaired, resulting in reduced insulin production leading to diabetes” (Ford et al, 1997).

It has been suggested that “obesity accompanied by elevated free fatty acids may increase hepatic glucose production and impact insulin resistance of target cells leading to non-insulin dependent diabetes mellitus (NIDDM) or T2DM” (Reaven, 1988). Further support on obesity and insulin resistance comes from Ramachandran (2004) who stated that “insulin resistance is one of the major etiological factors for diabetes, and the risk association of obesity with diabetes is greatly mediated through insulin resistance.”

Other research showed serum insulin levels to be positively correlated with BMI, LDL-C, glucose, triglycerides, systolic and diastolic blood pressure according to the Bogalusa Heart Study. Negative correlations were found for insulin levels and HDL-C in this study (Bao, Srinivasan, & Berenson, 1996).

The risk conferred by obesity to the development of diabetes is more than 40 times higher in obese women in comparison to those who are not obese (Ramachandran, 2004). In a 2002 World Health Report, up to 5% of diabetes, and 21% of ischemic heart disease cases were attributable to BMI above 21 kg/m² (WHO, 2003). The relationship between obesity and hypertension, high cholesterol and diabetes is so strong that researchers now advocate that a diagnosis of obesity can serve as a surrogate for these conditions without the need for blood testing (Nugent, 2006).

Although mortality from cardiovascular diseases has decreased since the 1970s, it is still the main cause of death in the Western World (Health Survey for England, 1999). Data from the Health Survey for England on the Health of Ethnic Minority Groups revealed that some ethnic minority groups appear to be more prone to ischemic heart

diseases than others. Immigrant men born in the Indian sub-continent had higher mortality than those from the Caribbean. Cerebrovascular disease ranks next to ischemic heart disease as a major cause of death for these same two groups with Black Caribbean men twice as likely to die from strokes, than native men in England and Wales ("Health Survey for England," 1999). In this survey, subjects were classified as having CVD if they had any of these conditions- angina, heart attack, stroke, heart murmur, irregular heart rhythm, high blood pressure or diabetes as confirmed by a nurse or doctor. Despite having lower prevalence of angina, both Black Caribbean men (7.8%) and women (7.9%) had higher prevalence of diabetes than the other minority ethnic groups (Indian Men = 7.7%; Irish men = 4.2%; Indian women = 4.7%; Irish women = 2.4%).

In this survey, individuals of both sexes and all minority ethnic groups classified with CVDs also had BMI > 25 kg/m² ("Health Survey for England," 1999). The observed prevalence for overweight and obesity was higher for Indian and Bangladeshi women when adjusted for age. The prevalence of raised total cholesterol (> 6.5 mmol/l) was higher for persons with CVDs than those without. The risk ratio for CVDs was higher for Indian and Pakistani women and Chinese men. The risk ratios for prevalence of angina for Black Caribbean men and women were 1.9 and 2.2 respectively. High blood pressure ($\geq 140/90$ mmHg) was also higher among individuals with CVDs.

CHAPTER II

REVIEW OF LITERATURE

Recent research shows an increasing global prevalence of T2DM in children and adolescents due to the rising prevalence of obesity (Reinehr, 2005). Overweight is associated with T2DM, CVDs, hypertension, dyslipidemia and insulin resistance. These health conditions of obesity were once thought to relate only to adults but are now increasingly found in children and adolescents. Many of these conditions such as heart attack and strokes are chronic and present physiological changes during childhood. They take decades to present as overt diseases and threaten to shorten the life span by as much as 5 years (Daniels, 2006; Wyatt et al., 2006). Being obese during childhood, adolescence and young adulthood may accelerate these conditions (Daniels, 2006; Choudbury, 2005).

Detection of the early signs of T2DM and CVDs is needed to help in the prevention of these and other related medical conditions. Other studies indicated that about 60 percent of overweight US children also have hypertension, hyperinsulinemia, and/or hyperlipidemia (Freedman et al., 1999). Research is needed on the Jamaican adolescents since it is expected they will share similar characteristics to adolescents in the USA and other countries. Data from this study will help to guide interventions to reduce the risk of morbidity and mortality among the Jamaican population, and the tremendous cost of these life-style diseases for a resource-limited country.

Type 2 Diabetes Mellitus (T2DM)

Type 2 diabetes mellitus (T2DM), is often called adult-onset or obesity related diabetes although it is now commonly seen in children and adolescents. Type 2 diabetes mellitus is characterized by the body tissues being resistant to insulin. It is the most common form of diabetes and is highly prevalent in adults in the developing world. The majority of cases of T2DM are seen in obese persons or those who reported history of obesity at the time of diagnosis. Type 2 diabetes mellitus can occur at any age but is usually diagnosed after age 30 years. Causes of T2DM include defects in both the secretion and action of insulin. With T2DM, there are normal levels of endogenous insulin but levels are inadequate to overcome concomitant insulin resistance. Insulin resistance (IR) occurs when there is a decrease in tissue sensitivity or responsiveness to insulin leading to hyperglycemia (Mahan & Escott-Stump, 1996).

Three possible causes of T2DM have been suggested; 1) an abnormal pattern of insulin secretion that can be inadequate or excessive; 2) decreased uptake of insulin at the cellular level resulting in increased elevation in postprandial glucose levels related to a defect in a receptor or post-receptor in the cells; and 3) poor release of glucose from the liver early in the morning which results in elevation in fasting glucose levels. These three defects then lead to a continued state of hyperglycemia which further compounds the problems of insulin resistance and secretion (Mahan, & Escott-Stump, 1996).

Although impaired glucose tolerance (IGT) is not a diagnosis for diabetes, people with IGT eventually develop diabetes mellitus. IGT is manifested by higher than normal blood glucose. Early screening for IGT can help to prevent T2DM (Mahan, & Escott-Stump, 1996). Most cases of T2DM can be treated with medications but lifestyle

changes can help to manage the disease. Screening is therefore necessary so that early detection can help to prevent complications such as cardiovascular diseases, chronic renal failure, retinal damage and possibly blindness, nerve damage, erectile dysfunction, gangrene, and risk of amputations. Other factors such as smoking, hypertension, elevated cholesterol, obesity, and lack of regular exercise can worsen the effects of diabetes (Mahan, & Escott-Stump, 1996).

Recognizing T2DM in Children

Detection of T2DM in children is even more problematic than in adults. Type 2 diabetes mellitus in children is sometimes misdiagnosed as there are cases of children with T2DM who present with diabetic ketoacidosis (DKA), a condition associated with type I diabetes. Studies indicated that up to 42% of African American children and 30% Hispanic children with type 2 diabetes also presented with DKA (Pinhas-Hamiel, Dolan & Zetler, 1997). However, diabetes in children and adolescents can be easily recognized by the presence of Acanthosis Nigricans (AN) in the absence of DKA (Scott, Smith, Craddock et al., 1997). Acanthosis Nigricans is reported to occur in 60-90% of young people with type 2 diabetes (Scott, et al., 1997). The presence of AN (manifested by a dark ring around the neck) is a sign of insulin resistance (IR) and is commonly seen in Native Americans (40%), African Americans (13%) and Hispanics (6%) (Tajima, 2002; Stuart, Driscoll, & Lindquist et al., 1998). The presence of AN alone is not conclusive for determining the presence of insulin resistance or hyperinsulinemia, neither does the presence of AN in minority groups. In a study by Nguyen, Keil, & Russell et al. (2001), approximately one-third of the obese children with hyperinsulinemia also had AN among

all ethnicities. One study shows that BMI is a better marker than the presence of AN for detecting IR (Hirschler, Aranda, & Oneto, et al, 2002). The presence of AN is likely to correlate with BMI (Hirschler et al., 2002). Therefore, we used different indices for determining T2DM in our population such as measures of BMI, FBG, HbA1c and the presence of AN.

According to the American Diabetes Association (ADA) 2005, 8-45% of minority children above 10 years who have diabetes are diagnosed with type 2 diabetes (Berry et al., 2006). With the increase in numbers of children diagnosed with type 2 diabetes, it is imperative that primary prevention aims at delaying its development by reducing overweight among children (Berry et al., 2006). Those children who are already diagnosed with pre-diabetes should be monitored to prevent further development to diabetes. It is also important to control the disease to prevent further complications such as hypertension, hyperlipidemia, and cardiovascular diseases (Rosenbloom & Silverstein, 2003).

Obesity and Cardiovascular Diseases

Obesity has been cited as “a risk factor for coronary heart disease, ventricular dysfunction, congestive heart failure, stroke, and cardiac arrhythmias” (Klein, Burke, Bray et al, 2004). Obesity increases mortality from CVDs and deaths from CVDs are directly related to increase in BMI. Persons with BMI > 35 kg/m² are 2-3 times more likely than lean persons with lower BMI (18.5- 24.9 kg/m²) to die from CVDs (Calderon, Boyne, & Bennett, et al, 2004). The authors further stated that “overweight in adolescent

is associated with a 130% increased risk of CVDs mortality during adulthood” (Calderon et al., 2004).

Although CVDs do not manifest until adulthood, studies have shown that the atherosclerotic process begins early in life (Berenson, Wattigney, Bao et al., 1995; Berenson, Srinivasan, Bao et al., 1998; Chen, Bao, Begum, et al., 2000). Overweight in children has been linked to “increased rates of hypertension, hyperlipidemia, T2DM, and early atherosclerotic lesions” (Calderon, Yucha, & Schaffer, 2005). Increase in body weight results in increased blood pressure (Calderon et al, 2004). More compelling evidence on overweight and risk of CVDs comes from Hoffman, Kromboud, & de Lezene (1988) who found strong associations between morbidity and mortality from adults who were overweight as adolescents.

Obesity and hypertension are strongly linked to adult age, however, there is growing evidence that hypertension also occurs among younger age groups (Sorof, Poffenbarger, & Bernard, et al., 2002). The majority of children over six years of age who have hypertension also have a family history of hypertension, and are usually overweight. Along with hypertension are other medical conditions such as kidney diseases and disorders of the endocrine system or abnormalities of the blood vessels. Other factors are inadequate physical activity, poor diet, and poor stress management. Hypertension is a major risk factor for stroke and heart attacks. Overtime, high blood pressure can damage vital body organs such as the kidney, brain and heart, therefore early detection is necessary.

To classify as hypertensive, an individual must have persistently elevated systolic and/diastolic arterial BP of 140/90 mmHg or more if they are over 15 years old. BP

measurements are usually spontaneous and vary greatly. It is suggested that BP be taken after 10 minutes of quiet rest. If the first reading of BP is greater than 120/80mm Hg or if the difference between two readings is > than 5mm Hg further readings should be taken. Hypertension is diagnosed based on more than one reading. Readings must be taken on different occasions and separated by one to two weeks.

Several epidemiological studies have found that BP was significantly higher for children with higher BMI. Obese adolescents were more likely to have three times greater prevalence of hypertension than their non-obese counterparts (Sorof et al., 2002). It is difficult to determine a cut-off point for hypertension among children since BP continues to rise from infancy to about age 18. Therefore, BP for children and adolescents is determined by plotting each individual's height on standard age-adjusted growth curves to determine a height percentile. The height percentile, age and gender are then used to ascertain the 90th and 95th percentiles for BP. These tables of percentiles are available from the 1996 National High Blood Pressure Education Program Working Group on Hypertension Control in Children and Adolescents. Children who plot below the 90th percentile for height, age and gender are considered to have normal BP. Children who plot between 90-95th percentile are classified as having "pre-hypertension" which is likely to develop into hypertension. Children whose systolic or diastolic BP plots higher than the 95th percentile for age, gender, and height measurements, are classified as hypertensive. Three measurements of systolic and diastolic BP higher than the 95th percentile are needed to classify one as hypertensive since BP varies with emotions, activity level, medications, and stress (Collins, Peto, & McMahon, 1990). Adolescents with BP > 120/80 mmHg are considered to be pre-hypertensive. For 17 year olds, the

95th percentile is close to 140/90mm Hg which is the cut-off point for adults. Use of the height percentiles for determining hypertension can be misleading for younger age groups. Organizations such as the American Academy of Pediatrics (AAP), American Heart Association (AHA), and the American Medical Association (AMA) “recommend routine screening of adolescents and children during preventive visits since up to 28% of children have secondary hypertension for which early detection may be beneficial.”

Determinants of Cardiovascular Risks

Research indicated that atherosclerosis began in childhood (McGillis-Bindler, & Bruya, 2000; Steinberger et al., 2003; Gungor, & Arslanian, 2005). Therefore, testing for cholesterol in children can help to prevent later development of CVDs. It was recommended that “children should be tested for cholesterol levels if a parent or grandparent had atherosclerosis at or before age 55, the parent or grandparent suffered a heart attack, or showed other signs of artery disease at or before age 55, or if a parent has a blood cholesterol level over 240 mg/dL” (NCEP, 1995). Subjects with T2DM tend to have low HDL-C and high levels of triglycerides. The American Dietetic Association recommended lowering LDL and total cholesterol as well as monitoring blood pressure for persons with diabetes. Screening for high cholesterol, low HDL-C and high triglycerides is needed in the early prevention of T2DM.

Cholesterol guidelines for children were set by the National Cholesterol Education Project sponsored by the National Heart, Lung and Blood Institute. A desirable blood lipid profile for an adult is $TC < 200$ mg/dl and $HDL-C \geq 35$ mg/dl. For children, cholesterol level less than 175 mg/dL was recommended. LDL-C is not easily

measured by laboratory methods but can be calculated. LDL-C and TC are highly correlated. Therefore, TC levels are used to detect LDL-C. Measurement of a complete lipid profile includes TC, LDL-C, HDL-C and triglycerides (TG). Measures of LDL-C can be determined by measuring TC, TG and HDL-C. Total cholesterol can be measured in a non-fasting state. However, TG must be measured after a 12 hour fast to allow time for the chylomicrons to clear. LDL-C is calculated using the Friedwald formula:

$$\text{LDL-C} = (\text{TC}) - (\text{HDL-C}) - (\text{TG}/5)$$

Where LDL-C = low-density lipoproteins cholesterol; TC = total cholesterol; HDL-C = high density lipoprotein cholesterol; and TG = triglycerides. Use of this calculation is best done when TG levels are less than 400 mg/dl. A desirable lipoprotein profile for children would then be $\text{TC} \leq 170 \text{ mg/dl}$; $\text{LDL-C} \leq 100 \text{ mg/dl}$; and $\text{HDL-C} \geq 60 \text{ mg/dl}$ (NCEP, 1993). A child's LDL-C should be checked if the child has a TC of 170 mg/dL or greater. Triglycerides are also measured when the LDL-C is checked. TG levels less than 200 mg/dL are considered normal (Mahan, & Escott-Stump, 1996).

Definition of Overweight and Obesity

An adult is considered overweight if the BMI is 25.0 kg/m^2 or more, and obese if the BMI is $\geq 30 \text{ kg/m}^2$. BMI is defined as the weight in kilograms divided by the square of the height in meters (kg/m^2). BMI is generally considered a crude estimate of body fat. BMI as an assessment of measuring obesity in adults has been internationally accepted and correlated well with body fat $r = .7 \text{ --} .8$ (Epstein & Higgins, 1992). Different indices have been used to determine obesity in children and include the recommendations of the International Obesity Task Force (IOTF) which suggests using the BMI for weight

and height (kg/m^2) as a reasonable measure of obesity in children and adolescents. The IOTF further stated that the standards used for grading obesity such as grade I and grade II for BMI of 25 and 30 respectively should be used (Dietz & Bellizzi, 1999). Other measures include the NHANES which uses $>$ the 85th percentile as a cut-off point for obesity. Countries in Asia and Latin America tend to use a cut-off point of $>120\%$ of weight for height (Dietz & Bellizzi, 1999). In 1995 the WHO accepted that the new normal adult range for BMI should be changed from 20.0 to 18.5-24.9 kg/m^2 (James et al., 2001).

Differences in prevalence of obesity vary among countries based on the index used to measure obesity. For example, in Argentina when the NHANES 85th percentile was used, the prevalence of obesity appeared to more than double when compared to the $>120\%$ of weight for height (Guillaume, 1999). A comparison of the 85th percentile cut-off point for BMI for three countries; Australia, United States and the United Kingdom, revealed an overlap between the BMI for children ages 7-15 years between Australia and the United States while the United Kingdom data were slightly lower. The BMI seem to be more widely accepted for measuring obesity in children but the cut-off percentile varies from 85th-97th percentile. The use of skin-fold thickness and weight for height are also used in some countries (Guillaume, 1999). The use of central adiposity is not considered suitable since morbidity and mortality in obese children and adolescence have not been well documented (Guillaume, 1999).

Adult BMI varies among ethnic and national groups. The same might be true of adolescents in different countries and of different ethnicities. A WHO Report (2003) found adult mean BMI levels of 22-23 kg/m^2 in Africa and Asia when compared to levels

of 25-27 kg/m² which is common in North America, Europe, some Latin American countries, North Africa, and Pacific Island countries (WHO, 2003). Globally there appears to be an upward shift in BMI levels with corresponding greater risk for high blood pressure, diabetes, and heart disease at an earlier age. Over-nutrition and increased BMI is accompanied by underweight and decreased BMI in some countries. A BMI of < 18.5 kg/m² is considered underweight and can have debilitating health effects. See Table 2 for The WHO standard classification of obesity and risk of co-morbidities

Table 2

WHO Classification of Obesity and Risk of Co-Morbidities

	BMI Kg/m ²	Risk of Co- morbidities
Underweight	< 18.5	Low
Normal BMI	18.5-24.9	Average
Overweight		
Pre-obese	25.0-29.9	Increased
Obesity class I	30.0-34.9	Moderate
Obesity class II	35.0-39.9	Severe
Obesity class III	≥ 40	Very severe

There is concern among Asian investigators over the higher BMI cut-off point for obesity since research has shown a high prevalence of diabetes and hypertension at lower BMI for this group (James et al., 2001). As a result, they have suggested using a cut-off point for obesity of BMI 25 kg/m² and an upper limit for normal of 22.9 kg/m². Support for this lower BMI limit comes from Ramachandran (2004) who argued that the association between BMI and glucose intolerance is as high as in any other population

despite having lower BMI. For example, studies have shown that for urban Indian population a BMI of $> 23 \text{ kg/m}^2$ increased the risk for diabetes for both males and females (Snehalatha, Viswanathan, & Ramachandran, 2003). In other words, a BMI of $< 23 \text{ kg/m}^2$ is considered healthy for Asian Indians. Consequently, the WHO has established a BMI of $18.5\text{-}22.0 \text{ kg/m}^2$ to be healthy for this population. Healthy BMI among other ethnic groups is $18.5\text{-}24.9$. This ethnic difference in nationality-related BMI is significant to this study, since Jamaica's population comprises up to 1% Indians, and data from Trinidad revealed a higher mortality rate of diabetes among Indo-Trinidadians when compared to other populations. It is likely that a cut-off point of 24.9 for a healthy BMI among Jamaican Indians may result in misclassification of risk of overweight among this group.

One study of 306 Jamaican children assessed obesity using the IOTF BMI cut-off point for obesity and measures of skin-fold and examined children at age 7-8 and at follow up later at age 11-12. It was found that BMI correlated better with other indices for adiposity among the older age group. Establishing a suitable BMI for children has been a concern of many researchers due to differences in pubertal age. For this population, pubertal age was set at 11-12 years (Gaskin & Walker, 2003). Results indicated an increase in overweight from 3.5% - 9.5% over the follow-up period. The BMI had low sensitivity to identify children $> 85^{\text{th}}$ percentile when the IOTF cut-off point for BMI was used.

In the Jamaican study, Gaskin & Walker (2003) showed that other measures of adiposity such as TSF and SF had higher sensitivity, however, 14-30% of the children were misclassified. The specificity for BMI was high. In general, girls were fatter than

boys. It was concluded that children identified for overweight using the IOTF BMI cut-off point are likely to have high body fatness. In another study, testing the adequacy of the BMI cut-off point for children found that use of BMI 95th percentile as cut-off point for children had high sensitivity (88%) and high specificity (94%). However, when lower percentiles were compared using the ROC (receiver operator characteristic) analyses, results indicated that lower cut-offs improved sensitivity with no loss in specificity (Reilly, Dorosty, & Emmett, 2000).

Dietz & Bellizzi, (1999) suggested that “a BMI above the 95th percentile may be a more specific measure to identify children and adolescents with increased body fat.” What was needed was a mid-point sensitivity and specificity study using the 85th and 95th percentiles. An IOTF conference proposed “a BMI above the 85th percentile as a cut-off for overweight and above the 95th percentile as an index for determining obese adolescents” (Dietz & Bellizzi, 1999). These results are significant to this study which aims at identifying overweight and obesity in Jamaican adolescents and examining them for risks of T2DM and CVDs.

Prevalence of Overweight and Obesity

For US children, the rates of overweight and obesity increased from 4% in 1982 to 13% in 1999 (Headley et al., 2004), and reached 16% in 2001 (Kumanyika, Jeffrey, Morabia, et al., 2002). Approximately 25% white children and 33% African American and Hispanic children were overweight. Roughly 59% US adults have BMI > 30 and consequently are at risk to chronic diseases. Research indicated that “26% of obese people have hypertension, 80% present with type 2 diabetes, 70% have cardiovascular

diseases related to obesity, 42% breast and colon cancer diagnosed among obese persons, and 30% gall bladder surgery are related to obesity” (Kumanyika, et al., 2002). It is estimated that globally over 22 million children are overweight (Kumanyika, et al., 2002). Data from the developing world indicated that approximately 18% of Indian children ages 13-18 years were overweight (Ramchandaran et al, 2003) due to decreasing physical activity, and higher socio-economic status (SES). Thailand showed an increase of overweight from 12.2% to 15.6% over a two-year period among the 6-12 year olds (Kumanyika et al., 2002). In Latin America, studies were based on younger children 1-5 years but the prevalence of obesity has increased by 56% between 1985 and 1995 (Kumanyika et al., 2002).

Causes of Obesity

Obesity has a multiplicity of causes. Fundamentally, weight gain results when the energy intakes exceed energy expenditure. According to the US Surgeon General, up to 300,000 deaths per year occur from sedentary activities and unhealthy dietary habits. Diet, inactivity and increased television viewing have been attributed to the rising prevalence of overweight and obesity among children (Nelson, Carpenter, & Chiasson, 2004). Other factors that influence obesity are family history of obesity, type of work, level of physical activity, race and environment. Recent evidence points to the influence of the fast food industry and their competitive marketing strategies to super-size their meals (Schlosser, 2001). Portion sizes in a typical fast food restaurant for one of their combination meals may be able to provide all the calories needed for one day.

The increasing rates of overweight and obesity have also been attributed to changes in diet and consumption patterns. In the US, children are exposed to a wide variety of processed and refined carbohydrate foods. In addition to increased consumption of sodas over milk, children in industrialized countries have access to more meats and high fat foods than children in the developing world. The fast food industry tends to market to the tastes of children who put the pressure on parents to purchase these foods over home-made foods (Schlosser, 2001).

Changes in lifestyle patterns with more mothers working outside the homes leave families with less time to prepare foods and consequently drive the success of the fast food industry. The response is to increase the numbers of fast food restaurants and the portion sizes to outsell competitors. The increase in portion sizes or “super-sizing” is concomitant with the increase rates of obesity among the US population (Schlosser, 2001). The fast food industry has expanded its business to many developing countries with the same marketing strategies aimed at children, and where local families equate the ability to purchase fast foods with affluence. Schlosser (2001) alluded to the growing rate of obesity in Asian countries to the expansion of the fast food industry in those countries. Reports from national data sets in the US indicated increase in consumption of sodas, pasta, salty snacks, juice and sugar-and sweetened beverages among the US population (Smickilas-Wright, Nielson, & Popkin, 2003)

Along with the increase in portion sizes, physical activity has been declining among children. There have been reports on a link between the amount of time children spent watching television and/ or videos and obesity (Crespo Smith, & Troiano et al., 2002; Certain & Khan, 2002; Dennison, Erb, & Jenkins, 2002; Christakis; Ebel, & Rivera

et al, 2004). Research on physical activity and just how much is adequate is sparse, but there is some evidence that children are not sufficiently active physically (Crespo et al, 2002; Dennison et al., 2002; Dowda, Ainsworth, & Addy et al., 2001; Gortmaker, Must, & Sobol et al., 1996). The US Surgeon General has recommended that “all individuals over two years old engage in moderate physical activity for at least 30 minutes per day” (Welk & Wood, 2000).

Ethnicity, Overweight and Obesity

With regards to ethnicity and overweight, Black girls 5-17 years are generally heavier (3 kg) and taller (2-3 cm) than their White counterparts (Dwyer et al., 2000; Krosnick, 2000). When adjusted for height, Black girls remained relatively heavier than White girls. The National Growth and Health Study (NGHS) of girls 9-10 years old living in Virginia, California, Ohio, and Washington, DC (Kimm Barton, & Obarzanek et al., 2001) showed that Black girls had significantly higher BMI, skinfold measures, and blood pressure compared to their White counterparts. Dwyer et al (2000) examined data from the Child and Adolescent Trial for Cardiovascular Health (CATCH) survey, which was designed to measure the effectiveness of home versus school education programs to reduce cardiovascular risks among elementary school children. The study found that more Blacks (38%) than Whites (25%) were overweight.

Using the CATCH data, NHANES I (1971-1974), NHANES III (1991-1994), and the Bogalusa Heart Study (1991-1994), Dwyer et al. (2000) found that overweight was more prevalent among Blacks, Mexican Americans, and American Indian children compared to White children using weight percentiles for age and sex. Among the Pima

Indians, the rate of overweight is considered to be the highest in the world with 50% of males and females having more than 95th percentile of BMI (Krosnick, 2000). American Indian children 5-18 years old fall above the 85th percentile BMI for age and sex (Broussard, Sugarman, & Bachman-Carter et al., 1995). These studies on higher rates of obesity in Blacks and Indians are of particular importance, since Jamaica's population is comprised mainly of Blacks (91%) followed by mixed ethnicities (7%) and Indians (1%).

Measuring Obesity in Children

Research showed that “one in four overweight children is already showing signs of type 2 diabetes (impaired glucose intolerance), with 60% already having one risk factor for heart disease” (Freedman, et al., 1999). However, it is difficult to measure obesity in children and adolescents since the timing and onset of puberty varies making it harder to set cut-off points (Singh et al., 2004; Hardy, Harrell & Bell, 2004). Further, there is contradiction over the International Obesity Task Force (IOTF) and the World Health Organization (WHO) definitions for screening obesity among younger populations since these cut-off points were determined from populations from developed countries and do not represent the developing world.

The terms “overweight,” and “at risk of overweight” have been suggested by the Centers for Disease Control (CDC) instead of “obesity” when referring to children and adolescents (American Obesity Association, 2006). However, the use of percentiles is suggested by The American Obesity Association with a BMI above the 85th percentile for overweight and above 95th percentile for obesity. The 95th percentile corresponds to the adult BMI of 30 kg/m² which indicates obesity, whereas, the 85th percentile corresponds

to a BMI of 25 kg/m² which indicates overweight. The CDC suggests two levels of overweight; “children > 95th BMI percentile for age and gender are considered overweight, and those > BMI 85th percentile are considered at risk for overweight.”

The BMI for children is usually referred to as “BMI for age.” The CDC suggests applying percentiles after the BMI has been calculated based on weight and height. Percentiles are suggested since they help to indicate the relative position of the child’s BMI in relation to other children of the same age and sex (American Obesity Association, 2006). Age and gender are considered significant when determining cut-off points for children and adolescents since the amount of body fat changes with age. Girls tend to have more body fat than boys. See table 3 for the CDC BMI for age percentile.

Table 3

BMI for Gender and Age Percentile

Weight status category	Percentile range
Underweight	Less than the 5 th percentile
Healthy weight	5 th percentile up to the 85 th percentile
At risk of overweight	85 th to less than the 95 th percentile
Overweight	Equal to or greater than the 95 th percentile

Source: CDC, Department of Health and Human Services, 2006

Measures used to determine childhood overweight must take into account developmental periods in children’s lives when the BMI rises because of the growth spurts such as at age 4-6 and again during puberty (Dietz, 1997). In this study, adolescents ages 14–19 will be used.

Central Adiposity and Obesity

It is becoming increasingly recognized that BMI might not be the best way of assessing overweight and obesity. The higher prevalence of diabetes among Indians may be related to their tendency to deposit fat in the abdominal area despite having lower BMI. Similar to higher BMI, abdominal fat or central adiposity is closely associated with hyperinsulinemia and insulin resistance (Ramachandran, 2004). According to Ramachandran (2004), “visceral fat increases the risk of diabetes and hyperlipidemia by favoring insulin resistance.” Studies done in India on non-diabetic Indians revealed that insulin resistance was associated with subcutaneous fat. It is theorized that “increased risk posed by intra-abdominal fat for diabetes and other metabolic diseases may be related to the higher number of fat cells in the abdominal adipose tissue, higher blood flow, increased receptors for cortisol and testosterone and greater catecholamine – induced lipolysis in comparison to subcutaneous adipose tissue” (Ramachandran, 2004).

The researcher further pointed out that there is increased influx of non-esterified fatty acids to the liver of abdominally obese individuals that may be related to the increase of insulin resistance and susceptibility to the metabolic syndrome. Arguments in support of upper body adiposity and relation to insulin resistance came from a study comparing non-diabetic Asian Indians and Mexican Americans (Ramachandran, Snehalatha, & Viswanathan, et al., 1997). In this study, the Asian Indians had lower BMI than the Mexican Americans, but had greater upper body adiposity as measured by waist-to-hip ratio which explains the high insulin resistance among Asian Indians despite having lower BMI.

Some risk factors associated with central adiposity include glucose intolerance, hyperinsulinemia, hypertriglyceridemia, and hypertension (Ramachandran, 2004). These are also risk factors for cardiovascular diseases. Earlier studies on central adiposity and insulin resistance indicated that in Asian Indians a 0.04 unit increase in waist to hip ratio (WHR) resulted in a four-fold increase in diabetes (20% in Asians compared to 5% in Europeans), also Indians had significantly higher post-glucose insulin levels (41 Aμ/ml vs. 19 Aμ/ml) higher triglycerides and lower HDL than Europeans (McKeigue, et al., 1991). Further support on central adiposity, a risk factor for CVDs, T2DM, and hypertension comes from the International Task Force on Obesity (IOTF) which stated that “populations with low BMI such as Asians tend to have high levels of abdominal fat and are particularly prone to CVDs, T2DM and hypertension” (IOTF, 2006). Gopalan (1998) in a study on Asian Indians found that up to 20% of subjects, although not overweight, had central obesity, putting them at risk to CVDs, T2DM and hypertension.

Since central adiposity poses a risk for diabetes and insulin resistance, cut-off values have been determined for waist circumference, (WC) of 85 cm for men and 80 cm for women) and waist-to-hip ratio (WHR) of 0.89 and 0.81 for men and women respectively (Ramachandran, 2004). The use of WC instead of WHR has been recommended as an index of central adiposity since it shows an interaction with general adiposity at lower levels of BMI. In this study, waist circumference, WHR, and BMI were used to determine those at risk for T2DM and CVDs. See table 4 for gender-specific waist circumference for increased risk associated with metabolic complications in Caucasians.

Table 4

Waist Circumference and Obesity-Associated Metabolic Complications

Gender	Risk of obesity-related metabolic complications	
	Increased	Substantially Increased
Male	≥ 94 cm	≥ 102 cm
Female	≥ 80 cm	≥ 88 cm

Clustering of Risk Factors for T2DM and CVDs

Obesity in childhood and adolescence is associated with a number of clinical manifestations. The most common obesity-associated problems (dyslipidemias, and hyperinsulinemia) are found in more than half of the overweight children and adolescents. Research has shown that “up to 60% of overweight children had at least one cardiovascular risk factor such as high cholesterol, elevated insulin levels, and hypertension compared to 10% of children with healthy weight who had at least one risk factor”(Freedman, et al, 1999). Freedman et al. (1999) also found that up to 25% of overweight children had two or more risk factors. Overweight children and adolescents may have increased risks of morbidity and mortality in adulthood regardless of their adult weight status (Deckelbaum & Williams, 2001). Research has shown that about one third of all severely obese adults were overweight as children (Whitaker, Wright, Seidel, et al., 1997).

The United States Surgeon General’s Report (US Department of Health and Human Services, 2006) stated that “overweight adolescents have a 70% chance of becoming overweight or obese adults. This risk of becoming obese is 80% if one or more

parents are overweight or obese. Obese adults are at increased risk of overall mortality and death from cardiovascular diseases, cancer, diabetes, and digestive diseases.” The WHO has coined the term “metabolic syndrome” to represent the existence of T2DM and cardiovascular diseases because the two seem to go together (Weis, 2005). To receive a diagnosis of the metabolic syndrome, an individual must have at least three of five criteria: 1) elevated blood pressure, 2) high triglyceride level, 3) low HDL-cholesterol, 4) high fasting glucose and 5) central obesity (NCEP and ATP III Panel, 2006). This syndrome affects approximately 25% of US adults and predisposes one to atherosclerosis and diabetes (Weis, 2005). This syndrome may be present in about 30% of obese adolescents (Weis, 2005).

Health, Social, and Economic Costs of Obesity

Obesity threatens to reverse the remarkable changes of medical science of the 20th century by decreasing life expectancy with its accompanying health-related problems of T2DM and CVDs (Daniels, 2006; Siepel, 2005). Obesity shortens the life span. Research on years of life lost due to obesity, shows that, White males lose 13 years, Black males 20 years, White females lose 8 years and Black females lose 5 years (Fountaine, Redden, & Wang et al., 2003). Further support on years of life lost due to obesity comes from Murray & Lopez (1994) in an Australian study. The authors found that the burden of disease associated with obesity and overweight increases in men 55-64 years and in women over age 55 years. After adjusting for confounding factors such as physical activity, this study still showed that in both sexes over 4% of total disability and life years lost were attributable to obesity and overweight. Death resulting from obesity

is fast approaching that caused by smoking (Allison, Fountaine, & Manson et al, 1999). Obesity has been found to increase the risk of diabetes. Ford et al. (1997) found that for every kilogram in weight increase, the risk for diabetes increases by 4.5%.

Researchers have found that unhealthy weight gain increases the risk of heart disease in both men and women (Galanis, Harris, & Sharp et al., 1998). It is estimated that “a gain of 10-20 pounds increases the risk of coronary heart disease to 1.25 and 1.6 times in women and men respectively” (Willet, Manson, Stampfer et al., 1995; & Galanis, et al., 1998). As weight gain increases, the risks become greater. For example, increase of 22 pounds or over for men, and 44 pounds for women increase the risk of coronary heart disease to 1.75 and 2.65 respectively (Willet, et al., 1995; Galanis, et al., 1998). Some health risks associated with obesity among others, include premature death, heart disease, type 2 diabetes, stroke, sleep apnea, asthma, breathing problems, cancer (endometrial, colon, kidney, gallbladder and post-menopausal breast cancer), high blood cholesterol, menstrual irregularities, hirsutism (growth of excess body and facial hair), stress, incontinence, increased surgical risk, and depression (National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), 1996).

In addition to the physical and health problems associated with obesity, psychological and social consequences are also associated with obesity. For example, obese adolescents have lower college acceptance rates, lower desirability to employers, prospective attainment of lower social class, and increased risk for body dissatisfaction. Obese persons are usually stigmatized and discriminated against (Siepel, 2005). They experience low self-image, depression, anxiety, and overall lower quality of life than those with healthy weights.

Obesity poses an economic burden on countries and governments through direct medical costs for hospital care, physician's services, medications, and indirect costs associated with obesity. Indirectly, costs due to obesity were calculated by looking at loss of productivity due to premature deaths, and restricted labor activities (Wolf & Colditz, 1998). Using data from the 1988-1994 National Health Interview Survey (NHIS), Wolf and Colditz (1998) estimated that the economic cost of obesity in 1995 was \$99.2 billion. Of this amount, \$51.64 billion was attributed to medical cost, more than half of which went towards treating diabetes. Substantial amounts were also spent on treating coronary heart disease (\$16.97 billion). In terms of indirect cost which is arrived at by extrapolating from labor days lost from premature deaths, disability and excess absenteeism, Wolf and Colditz (1998) found that up to \$46.56 billion were lost in indirect costs of obesity. Further support on the economic cost of obesity comes from Tucker (1998) who indicated that obese employees were 1.74 times more likely to be absent from work than those with healthy weights. The economic cost of obesity was estimated to increase from US\$99.2 billion in 1995 to \$117 billion in 2000. Most of these obesity-related costs are associated with type 2 diabetes, coronary heart diseases, and hypertension (Wolf & Colditz, 1998). Although the current study did not calculate the economic cost of obesity and obesity-related health conditions, an understanding of the medical costs associated with obesity, is helpful in planning programs for the prevention of T2DM and CVD; conditions related to obesity.

Acanthosis Nigricans, Obesity, Type 2 Diabetes, and Cardiovascular Diseases

Acanthosis Nigricans is manifested by dark, raised skin in areas such as the axilla, neck, knuckles, elbows, and knees and is believed to result from hyperinsulinemia.

Acanthosis Nigricans is manifested by a darkening of the skin, velvety plaques of body folds and is most commonly seen around the neckline or in the axilla in children who have greater body weight and fat mass, higher serum insulin levels and lower insulin sensitivity (McGillis-Bindler, & Bruya, 2005, Burke, Hale, & Hazuda et al., 1999).

Acanthosis Nigricans is becoming more prevalent among obese patients and those with type 2 diabetes mellitus (Burke et al., 1999). Subjects with AN were also at risk for atherosclerotic cardiovascular diseases (Katz, & Feldman, 2006).

The presence of AN is a marker for the risk factor of hyperinsulinemia.

Hyperinsulinemia leads to binding of insulin-like growth factor (IGF) receptors on keratinocytes and fibroblasts and ultimately hyperplasia of the skin (Cruz, & Hud, 1992).

It is believed that obesity underlies this insulin resistance. High fasting blood insulin levels confirm the presence of hyperinsulinemia. Persons with hyperinsulinemia are often able to maintain glucose homeostasis despite the presence of insulin resistance.

They exhibit normal blood glucose despite the presence of T2DM especially in individuals over age 40. Therefore testing of blood insulin levels may help to improve the condition. Hyperinsulinemia with normal blood glucose is an indicator of pre-diabetes.

Insulin resistance (IR), that is, resistance to insulin mediated glucose disposal, is present in T2DM and has been linked to cardiovascular diseases (Reaven, 1988; Laakso, 1996; Stern, 1996). Reaven, (1988) postulated that IR may underlie other disorders such

as hypertension, dyslipidemia, (high triglyceride and low HDL levels), impaired glucose tolerance, and coronary heart disease. There has been an association with diabetes mellitus and atherosclerotic cardiovascular disease, therefore, control of blood glucose can help to control coronary and carotid disease (Reaven, 1988). Obesity causes insulin resistance which is associated with AN (Reaven, 1988), therefore intervention is needed to correct the weight loss and provide dietary measures to help correct the problems. Exercise and improved diet can help to lower insulin levels and can improve AN.

Obesity and Physical Activity, and Relationship to T2DM and CVDs

Physical activity “differs from exercise and refers to any movement produced by muscular contractions that burn extra calories” (Harvard School of Public Health, 2006). Individuals who live a sedentary lifestyle are more likely to become overweight and develop chronic diseases. Some benefits of physical activities according to the US Surgeon General’s Report are; improved longer and healthier life, protection from heart diseases and its precursors (high blood pressure and high cholesterol), protection against certain cancers, prevention or control of type 2 diabetes and control weight among other benefits.” Earlier research found a positive association between glycemic control (HbA1c) and aerobic fitness or reported physical activity among children with type 1 diabetes (Sackey & Jefferson, 1996; & Horgan, 2005). However, very little is known about the impact of regular exercise on metabolic control in adolescents with type 2 diabetes. Studies have shown improvement in high-density lipoprotein levels and endothelial function in obese insulin-resistant adolescents (Kelly, Wetzseteon, Kaiser, et al., 2004).

Simple exercise such as walking briskly for 20 minutes per day can help reduce the chances of having a heart attack or stroke, developing diabetes or dying prematurely. At least 30 minutes of moderate intensity physical activity is recommended each day by the CDC, US Surgeon General, and the American College of Sports Medicine (Pate, Pratt, & Blair, 1995). The CDC estimates that physically active persons can help to cut the direct medical costs in the US by as much as \$70 billion yearly (Pratt, Marcera & Wang, 2000).

Measurement of physical activity is more accurately done by Physical Activity Questionnaires (PAQs) which cover day-day individual activities, inexpensive, requires little labor, and are useful in epidemiological studies. These recorded activities are then measured in terms of energy expenditure. The energy costs of physical activities are then expressed in metabolic equivalents (MET) units (Kwan, Woo, & Kwok, 2004). One Met is estimated to be 3.5 ml/min/kg resting oxygen consumption ($VO_{2\text{ resting}}$) for all age and gender groups unlike the BMR which closely resembles the MET but varies by age and gender. The CDC and American College of Sports Medicine (ACSM) have compiled a comprehensive list of physical activities based on level of intensity of such activities.

Obesity, T2DM, CVDs, and Food Intake

The macronutrient composition of the diet and relation to diabetes, CVDs and obesity is widely studied. In general, the types of fats consumed rather than the amount (g) shows health risks compared to health benefits. Saturated fats are associated with CVDs whereas intakes of types of fatty acids such as the omega-3 fatty acids seem to have a protective property (Hu, 2000; Howard, 2000; Mayer-Davis, 2000). Research is

lacking on the relationship between the consumption of dietary fat and T2DM, but fats contribute to obesity which is a major risk factor of T2DM (Hu, 2000). Arguments in favor of carbohydrates and T2DM relate to the glycemic index of the food eaten. Types of carbohydrates with low ability to raise blood glucose levels are recommended in the prevention of T2DM.

Research has shown that dietary fiber and its relation to glycemic load may have a beneficial effect on CVDs (Hu, 2000; Pereira & Liu, 2005). The association between dietary fiber and glycemic load and effects on CVDs was stronger among overweight individuals than non-overweight (Pereira & Liu, 2005). Consumption of whole grain has also been associated with reduced risk of CVDs among men and women (Loke, 2005; Liu, 2002; Gross, Li, & Ford et al., 2004). Epidemiological studies have shown that diets rich in high-fiber grains lower the risk of CVDs and T2DM (Liu, 2002; Salmeron, Manson, & Stampfer et al., 1997). Women who consumed foods with high glycemic load (GL) and had low cereal fiber intake were found to be 2.3 times more likely to develop T2DM (Salmeron et al., 1997). Intakes of refined carbohydrates have been associated with CVDs since carbohydrates induce hypertriglyceridemia by enhancing hepatic synthesis of very low density lipoproteins (VLDL) and reducing lipoprotein lipase activity (Liu et al., 2001)

Increased consumption of refined carbohydrates is associated with increased rates of T2DM in the USA (Gross, et al., 2004). In a study comparing the USDA per capita nutrient consumption of USA residents between 1907-1997 with the CDC's prevalence of T2DM, significant correlations were found between changes in T2DM and changes in dietary fat ($r = .84, p < .001$), carbohydrates ($r = .55, p < .001$), protein ($r = .71, p < .001$),

fiber ($r = -.16$, $p < .001$), corn syrup ($r = .83$, $p < .001$) and total energy ($r = .75$, $p < .001$). The authors concluded that ‘increased intakes of refined carbohydrates (corn syrup) along with decrease in fiber intake paralleled the upward trend in diabetes prevalence’ (Gross et al., 2004).

Consumption of macronutrient is important to this study in relation to their association with overweight and consequently to BMI which are also risk factors of T2DM and CVDs. Excess energy intake leading to overweight may be related to low intakes of fiber. High intake of fibers reduced energy intake by decreasing energy density and also enhanced satiety (Howarth, Terry & Huang et al., 2005; Howarth, Saltzman & Roberts, 2001; Yao & Roberts, 2001). High fiber intake also correlated with low fat, low energy density and low glycemic index (Howarth, et al., 2001).

Comparison of Finger Prick versus Venous Blood Testing

Differences have been noted between whole blood capillary glucose and venous plasma glucose with values for capillary whole blood being higher than venous blood. The concentration of water is approximately 11% higher in plasma than whole blood therefore glucose concentrations in plasma are 11% lower than whole blood (Sacks et al., 2002). Despite these limitations of capillary whole blood, they are useful in making quick diagnoses for persons who would normally have to be sent to a laboratory. An advantage of this method is it allows immediate feedback to the patient when tests are performed on location. The test is also less costly than laboratory testing. The cost of treating diabetes due to its debilitating conditions from hypoglycemia and ketoacidosis and CVDs for US residents was estimated at US\$98 billion in 1992 (Sacks,

et al., 2002). Further, in one US based study, FBG was shown to be comparable with FPG in diagnosing T2DM among 40-69 year olds without known diabetes. Of the 1,028 persons screened, diabetes was confirmed in 22 by FBG or FPG and 14 were confirmed by both the FBG and FPG (Sandbaek, Lauritzen, Borch-Johnsen et al., 2005). The prevalence of confirmed diabetes was lower (2.1%) compared to 3.3% for unconfirmed diabetes in this study (Sandbaek, et al., 2005).

Variability between blood glucose measured using self-monitoring devices and laboratory testing of plasma glucose showing a difference of less than 20% between capillary blood glucose and simultaneous venous FPG levels at FBG levels > 4.2 mmol/L have been noted (Sacks et al., 2002). The International Federation of Clinical Chemistry (IFCC) recommended that all blood glucose monitoring systems should give a comparable plasma result. On an average, results that are referenced to plasma should be approximately 11% lower than results referenced to whole blood (D'Orazio, Burnett, & Fogh-Andersen et al., 2005). The Accu Chek Advantage used in this study aligns closely with this 11% recommendation (Roche Diagnostics, New Zealand).

Total Cholesterol (TC)

Cardiovascular diseases are the leading cause of death in the world. Early monitoring of cholesterol can help to reduce the global burden of treating CVDs. Development of CVDs usually starts in the earlier years and progresses to clinically significant lesions in young adulthood (Gungor, & Arslanian, 2005; Steinberger et al., 2003). Cholesterol testing in children and adolescents is needed since fatty streaks associated with atherosclerosis are now found in the aortas of children as young as three

years old (McGillis-Bindler, & Bruya, 2000). High cholesterol levels have been associated with premature CVDs (Frick, Elso, & Haspa et al. 1987; Brensike, Levy, & Kelsey et al., 1984). High-density lipoproteins (HDLs) are associated with protection against heart diseases whereas low-density lipoproteins (LDLs) are considered risk factors for the development of chronic diseases (NCEP, 1995). Subjects with type 2 diabetes tend to have low HDL-C and high levels of triglycerides. The ADA recommends lowering LDL and total cholesterol as well as monitoring blood pressure for persons with diabetes. Cholesterol screening is recommended and many screening tests are now performed in physicians' offices or clinics.

Earlier research showed that point-of-care testing for TC shows lower precision than standardized laboratory testing but may be used in "resource-poor settings" (Rotchford, Machattie & Gills, 2002). Measurement of TC alone is not as accurate as using the TC/HDL-C ratio. Also capillary testing of TC is not as accurate as venous testing (Dipeolu, 2006). Research shows that EDTA anti-coagulated venous plasma measurements are approximately 3% lower than yields from venous serum measurements. Therefore, the NCEP advises adding 3% to venous plasma results to allow for comparisons with NCEP cutoffs (Greenland, Bowley, & Melklejohn et al., 1990).

Studies which compared capillary versus venous testing of TC (Bowden, Kingery & Rust, 2004; Kafonek, Donovan, & Lovejoy, 1992; Costanza, Wolf & James et al., 2005) showed conflicting results. Use of capillary whole blood classified more subjects as low risk for TC compared to venous method (Bowden et al, 2004). Whereas Kafonek et al. (1992) found similar results for lipids measured by finger prick and venous blood

samples, another study (Costanza et al., 2005) found small bias between venous and capillary whole blood samples of TC.

Glycated Hemoglobin

Hemoglobin is the oxygen-carrying pigment that gives blood its red color. Approximately 90% of the hemoglobin is classified as hemoglobin A. The “A” stands for adult type. One chemical component accounts for 92% of the hemoglobin and the remaining 8% is further divided into four components called A1c, A1b, A1a1, and A1a2. Hemoglobin A1c (HbA1c) is a minor component to which the glucose molecule is bound. HbA1c is also called glycated hemoglobin or glucosylated hemoglobin.

The purpose of the HbA1c test is to determine how much glucose remains on the hemoglobin molecule and which helps to determine the plasma glucose concentration over time. The principle is based on the 120 day life-span of the red blood cells. During this time the glucose molecule binds to the hemoglobin and forms glycated hemoglobin. Once the hemoglobin becomes glycated it remains glycated. Therefore a build-up of glycated hemoglobin within the cells reflects the average level of glucose to which the cell has been exposed for its life-span. The level of HbA1c is proportional to the average blood glucose concentration during the three months period.

The Diabetes Control and Complications Trial (DCCT) and the United Kingdom Prospective Diabetes Study (UKPD) provided reference values for HbA1c. The DCCT study involved 1,400 persons with type 1 diabetes conducted between 1983-1993. After 6.5 years, persons in the intensive treatment group (monitored glucose 3-4 times daily, used insulin pump or injections) attained an average HbA1c of 7.3% while those in the

conventional therapy group was 9.1%. In the UKPDS study of 4500 persons with type 2 diabetes those treated with a diet regimen had HbA1c levels of 7.9% compared to the intensive regimen with 7.0% (Nakamoto, 2006).

Achievement of a 6.5% reading for HbA1c indicated blood glucose that is under control. It is possible to have normal HbA1c > 8% and have blood glucose of 120mg/dL if the blood glucose is tested once per day. However, at other times of the day the blood glucose may be above 120mg/dL. It must be noted that to every 1% increase of HbA1c there is a 35 mg/dL or 1.95 mmol/L increase in mean plasma glucose.

Lower finger prick values of HbA1c compared to venous blood were found in 147 diabetic patients age 18 years and older tested at two family practice centers which routinely use HbA1c analysis at an outside laboratory for venipuncture samples. The aim of the study was to determine if same-day-visit testing of HbA1c (using capillary blood finger prick samples) could be used in these health care centers for more efficient patient care and improved diabetes management (Schwartz, Monsur & Bartoces et al., 2005).

In another study of 333 outpatients screened for diabetes mellitus using HbA1c measures, fasting plasma glucose and a two hour post-load oral glucose tolerance test, HbA1c had sensitivity of 60% compared to FPG and OGTT with 52% and 40.0% respectively and specificities of 90.9, 98.7 and 99.4 percent for the three measures. The predictive values for a positive diagnosis were 34.9%, 76.5% and 83.3% for the three tests (Simon, Coignet, Thibault et al., 1985). Specificity refers to “the proportion of people without the disease who have a negative test result and sensitivity means the proportion of people with the disease who have a positive test result.” The results indicated that HbA1c had higher sensitivity, but lower specificity than the FPG and OGTT. From a

public health point of view tests with high specificity and predictive values are better than those with high sensitivity but poor specificity (Simon, et al., 1985).

The normal HbA1c range for a healthy person is 4 – 5.9%. The International Diabetes Federation and American College of Endocrinology recommends that HbA1c values below 6.5% whereas the American Diabetes Association extends this range to 7%. Ranges above 7% represent poor glucose control (Nakamota, 2006).

Summary

Obesity is the main risk factor for T2DM and CVDs in children and adolescents and a predictor of adult obesity. As the prevalence of pediatric obesity increases around the world in developed and developing countries, the burden of life-style diseases is expected to increase, overburdening the public health systems in countries with limited health resources. More information is needed on the risk factors for these diseases to assist in the development of effective programs to prevent the morbidity and mortality related to obesity, T2DM, and CVDs, and to identify preventable risk factors early in children and adolescents, such as high BMI, socio-economic factors, high BP, presence of AN, dietary distortions, and low physical activity. A suitable and economical method of blood testing is needed for a resource-poor country such as Jamaica. Finger prick versus venous testing was performed. The literature shows conflicting results for finger prick versus venous testing (the gold standard), however, few studies showed comparable results for both method. Using the information presented in this chapter, this study was designed to assess these critical emergent problems.

Table 5

Summary of Literature on T2DM and CVDs among Adolescents

Reference	Areas Assessed	Population	Main Findings	Suggestions/Future Needs
Headley et al., 2004	Prevalence of obesity among US children and adolescents	Survey of 4018 children, Data from NHANES 1999-2000 and 4258 children in 2001-2002	Increase in overweight among children and adolescents was 15.0% in children 6 -19 years in 1999 -2000 and 16.5 % in 2001-2002.	Identify prevalence of overweight to aid future planning for prevention and intervention for the Jamaican adolescent group.
Gungor et al., 2005	Obesity and related chronic diseases	Clinical study of 20 adolescents with T2DM, 22 normal weight and 20 obese adolescents as controls.	Pulse wave velocity (PWV) higher in subjects with T2DM and the overweight group. PWV significantly correlated with glucose, HbA1c, BMI, IR and C-reactive protein. Overweight subjects are at higher risk to CVDs than normal weight counterparts	Based on results of US adolescents at risk for T2DM and CVDs, similar findings are expected among the Jamaican adolescent population. Identify risk factors of this population.

T2DM = type 2 diabetes

PWV= Pulse Wave Velocity

CVDs= cardiovascular diseases

NHANES = National Health and Nutrition Education Survey

IR = Insulin resistance

Reference	Areas Assessed	Population	Main Findings	Suggestions/Future Needs
Borders et al., 2006	Gender specific disparities in obesity by place of residence, SES, ethnicity	Survey data from the 2003 Behavioral Risk Factor Surveillance System (BRFSS) for the State of Texas.	Hispanic or Black females were more at risk for obesity. Females with high household income were less at risk to obesity. Subjects in rural areas were more at risk for obesity ($p < .001$).	Policies and programs needed to target males and females residing in rural areas. Collect research evidence on these demographics for the Jamaican population.
Seidell et al., 2001	Comparison of WC and WHR as measures of adiposity and risk for CVDs.	313 men and 382 women in Quebec > 18 years.	Large WC associated with high LDL-C in women. Lower correlations of the risk factors for BMI than for WC and WHR.	Identify similar trends in the Jamaican population for future planning to reduce overweight and obesity and lower WC.
Kobaissi et al., 2004	Overweight, AN and IR as risk factors for T2DM among children.	131 overweight Hispanic children ages 8-13 years.	AN is an independent predictor of IR in overweight Hispanic children, but BMI remains the primary determinant of IR.	Conduct study on AN and IR in this population. No evidence of this been done before in that group. Education needed on prevention of AN and improving IR.

SES = Socio-economic status
IR = Insulin resistance
PA = physical activity

AN = Acanthosis Nigricans
WHR = waist-to-hip ratio
BMI = Body mass index

WC = waist circumference
CVDS = cardiovascular disease
LDL-C = low density lipoprotein

Reference	Areas Assessed	Population	Main Findings	Suggestions/Future Needs
Gaskin & Walker, 2003	Adiposity in Jamaican children	306 inner city children ages 7-12 years, Kingston, Jamaica.	Children identified as overweight using IOTF standard of classification. Girls were significantly more overweight.	Identification of the T2DM and CVDs risks associated overweight. Interventions to increase PA and reduce weight.
Ragoobirsingh et al., 1995	Diabetes prevalence in Jamaica	2109 subjects ages 15 years and over.	Jamaica has 17. 9% diabetes prevalence according to WHO criteria. 2.6% of 15-24 year olds diagnosed with diabetes. Obesity and family history of diabetes positively correlated with prevalence of diabetes.	Need for screening among younger age groups. Interventions to reduce risk for T2DM especially aimed at females.
Ichinohe et al., 2005	Prevalence of obesity and lifestyle factors in Jamaica	2000 Jamaican adults average age 32.5± 18.4 for females and 31.7± 19.2 for males.	Jamaican adult females were significantly more overweight (p <.001) and exercised less than the adult males. Lower prevalence of obesity associated with higher educational level in females.	Identify risks among the adolescent group to encourage healthier lifestyle practices to reduce the burden of chronic diseases in later years.

T2DM = type 2 diabetes

IOTF = International Obesity Task Force

WHO = World Health Organization

Reference	Areas Assessed	Population	Main Findings	Suggestions/Future Needs
Pan & Pratt, 2008	Metabolic syndrome & association w/ PA and diet	4,450 US children and adolescents ages 12-19 years.	Prevalence of 3.5 % METS. Males significantly more at risk to the METS than females ($p < .001$). METS was 16 times higher among overweight adolescents with BMI $\geq 95^{\text{th}}$ percentile.	Identification of the METS among Jamaican adolescents using a modified version of the NCEP ATTP III guidelines. Data can be used to plan interventions to increase PA, reduce weight, and select healthy food choices.
Weis et al., 2004	Obesity and the METS in children and adolescents.	439 obese, 31 overweight, and 20 non-obese children and adolescents ages 4-20 years.	Prevalence of METS increased with severity of obesity. Obese subjects were 1.5 times more likely to be classified with the METS.	Assessment of the risk factors for the METS among overweight Jamaican adolescents. Interventions needed to reduce biomarkers of T2DM and CVDs which are found in children and adolescents.

METS = metabolic syndrome

CVDS = cardiovascular disease

NCEP = National Cholesterol Education Program

BMI = body mass index

PA = physical activity

ATTP III = Adult Treatment Panel III

T2DM = type 2 diabetes

Reference	Areas Assessed	Population	Main Findings	Suggestions/Future Needs
Rotchford et al., 2002	Reliability of capillary testing of HbA1c in resource poor settings	239 African diabetic patients	Capillary testing of HbA1c had high specificity (97.1%) and high correlations with venous blood testing. Capillary glucose recommended for resource poor settings. HbA1c testing possible without prior fasting.	Need for a method of blood testing which is affordable and cost effective and suitable for the adolescent population and can be carried out in a school setting.
Kafonek et al., 2002	Comparison of finger prick TC with venous TC.	83 subjects	Biologic variations of lipids were similar in finger prick versus venous testing.	Use finger prick TC as a screening tool but not for diagnosis.
Sandbaek et al., 2005	Comparison of capillary and venous FBG.	2051 adults 40-69 years without known diabetes were invited for screening.	50% accepted screening by POC versus laboratory standard. Presence of diabetes accurately confirmed by both capillary and plasma glucose in 22 (1.8%) of those screened.	Evaluation of FBG needed in the adolescent group. Validation of finger prick method among the adolescent population in a school setting.
HbA1c = glycated hemoglobin POC = Point-of-care		TC = total cholesterol FBG = Fasting blood glucose		

CHAPTER III

METHODS AND DESIGN

Research Design

The study was a non-experimental descriptive epidemiological study design which involved screening for risk factors of type 2 diabetes (T2DM) and cardiovascular diseases (CVDs) such as overweight and obesity, high levels of fasting blood glucose (FBG), glycated hemoglobin (HbA1c), total cholesterol (TC), blood pressure (BP), waist circumference (WC), waist to hip ratio (WHR), presence of Acanthosis Nigricans (AN), low physical activity (PA) levels, family history of overweight, T2DM, CVDs, and poor dietary intake of 276 adolescent students in selected high schools in Jamaica. A sub-sample of 59 randomly selected students was examined to compare capillary whole blood versus venous blood samples of FBG, HbA1c, and TC in the validation of the finger prick method for early screening of risk factors for T2DM and CVDs in a school setting.

Study Population

The study population comprised of students ages 14-19 years from the (rural and urban) secondary schools on the island of Jamaica. Approximately 28% of Jamaicans fall within the age group of 10 -24 years, with 50% living in the rural areas, and with more youths living in rural than urban areas (National Center for Youth Development, Ministry of Education, Youth and Culture, Jamaica, 2002).

Research has shown a preponderance of evidence that more Jamaican females than males were overweight (Gaskin & Walker, 2003; Ichinohe, Mita, Saito et al., 2005). Data on school enrollment in Jamaica shows that up to age 16 years about equal numbers

of males and females are enrolled in secondary schools but females predominate after age 16 (National Center for Youth Development, Ministry of Education, Youth and Culture, Jamaica, 2002).

All ethnicities were included since research has also shown that the prevalence of T2DM was higher among ethnic minorities (African Americans, Native Americans, Hispanics (Siepel, 2005; McKnight-Menci et al., 2005) in US based research. Another study showed increasing incidence of both obesity and T2DM among Asian children (Vikram, et al., 2005) and since Jamaica's population consists of approximately 91% Blacks of African and 1% of East Indian ancestry, the same dynamics are expected in this study population. Inter-racial marriages are also common and it is likely that the sample will also comprise mixed ethnicities. Data on Jamaica's population show a presence of 7% being of mixed ethnicities (Jamaica Facts and Figures, 2006). Most of the Indian population lives in the parishes of Westmoreland, Clarendon, and St Mary. The parish of Clarendon was selected to obtain a proportionate representation of this ethnic group.

Approximately 100% of children under the age of 14 years and 83% of children aged 15-16 years are enrolled in a school in Jamaica. It is also reported that up to 95% of children progress to secondary schools (National Center Youth Development, Ministry of Education, Youth and Culture, Jamaica, 2002). Therefore it was likely to find a representative sample from the secondary school population by selecting students from the different parishes.

Recruitment and Sampling

Subjects were selected through purposive and stratified sampling from the 14 parishes on the island. The fourteen parishes were grouped into six main regions for administrative purposes by the Ministry of Education, Youth, and Culture. Of the six main regions, regions one, two, and six were selected to give a representative sampling for ethnicities, rural and urban locations and socio-economic status (SES). Region one consisted of the parishes of Kingston, St. Andrew, and part of St. Thomas. This region hosts the major urban areas of the island with Kingston being the island's capital city. The parish of St. Thomas and parts of St. Andrew however classified as rural areas. Region two consisted of St. Mary, Portland and parts of St. Thomas which classified as rural areas. Region six consisted of the parishes of Clarendon and St. Catherine and included both rural and urban locations.

Three regions were selected through cluster sampling based on ethnicity, SES, rural/urban location, and cost-effectiveness in accessing these schools. A list of all schools within each parish was made using the Ministry of Education's publication on school profiles. This list of secondary schools was further stratified by school type (traditional and non-traditional). Representations of all income levels and SES were ascertained by selecting the traditional high schools which typically cater to the middle and upper class families, and by having representation from the other new high and comprehensive high schools in the surrounding areas. Schools were then randomly selected from each parish and school type by placing the names of all traditional high schools in that parish in a hat and drawing one school. The non-traditional high school was selected in a similar manner. Two schools were randomly selected for each of the

five parishes chosen to represent the two school types making a total of 10 schools. See Table 6 for the breakdown of the population by regions, parishes, school type and location. Selection of study subjects by regions, parishes, school type and location represented the following sub-groups; gender (male, female), ethnicity (Blacks, Indians, Mixed), SES (high, medium, low) and location (rural, urban).

Table 6

Breakdown of Population by Regions, Parishes, School Type and Location (N=300)

Regions	Parishes	School Type	Location	Subjects
1	Kingston	Traditional	Urban	30
		Non-Traditional	Urban	30
	St. Andrew	Traditional	Urban	30
		Non-Traditional	Urban	30
2	St. Thomas	Traditional	Rural	30
		Non-Traditional	Rural	30
6	Clarendon	Traditional	Rural	30
		Non-Traditional	Rural	30
	St. Catherine	Traditional	Urban	30
		Non-Traditional	Rural	30

Subjects were selected from grade levels (9-11) to represent the age group 14-19 years. Thirty students from each of the ten schools were selected. A list of all students in

grades 9-12 was obtained from the principal of each school. The students were stratified by grade level and gender and each student assigned a number. Students were then selected from each grade level/gender within each school by randomly selecting five numbers per grade and gender and matching those numbers to the names on the list.

Sixty subjects were also randomly selected from the original sample of 300 for validation of venipuncture screening. This selection was done by assigning an ID number to each of the 300 students. The numbers were entered into Microsoft Excel and 6 ID numbers were randomly selected from each school making a total of 60.

Inclusion Criteria

The study included Jamaican adolescent ages 14-19 years who attended secondary schools on the island. Only those students whose parents gave written consent and who themselves signed an assent form were included in the study. Both normal and overweight adolescents were included in the study. Only subjects who weighed over 110 lbs and were in apparently good health had their blood drawn by venipuncture.

Exclusion Criteria

Subjects were excluded from the study if they were on medications known to alter blood pressure, glucose or lipid metabolism, and if they had known eating disorders.

Calculation of Sample Size

Correlations, chi square tests, multiple and logistic regressions were carried out for hypotheses testing. Using a multiple linear regression with six predictor variables for

risk factors of T2DM and CVDS, a sample size of 300 was sufficient to yield 99 percent power to detect an R squared of .10 versus 0 using an F-test with a significance level of .05 (Faul, & Erdfelder, 1992).

The following formula was used to calculate the 95 percent confidence interval for proportion of overweight Jamaican adolescents. The increase in childhood T2DM is linked to the growing rates of obesity among children and adolescents (Daniels, 2006; Choudbury, 2005; Reinehr, 2005; Steinberger et al., 2001) and T2DM is among the cluster of cardiovascular disease (CVDs) risk factors such as hypertension, and dyslipidemia (Sacks, et al., 2002). Gaskin and Walker (2003) surveyed 306 Jamaican children aged 7-8 and again at follow-up 11-12 years old in comparing different standards for determining overweight among Jamaican children. Results indicated an increase in overweight from 3.5% - to 9.5% over the follow-up period. Therefore, a projected proportion of overweight of 10% among Jamaican adolescents, ages 14-19 years was used in calculating sample size.

$$n = \frac{z^2 \times p(1-p)}{m^2}$$

n = required sample size

z = 1.96 (standard normal value for 95 % CI)

p = estimated prevalence of overweight (10% or 0.10)

m = margin of error at 5% (standard value of 0.05)

$$n = \frac{1.96^2 \times .10(1-.10)}{0.05^2} = 138$$

The sample size of 138 was adequate for a research design that uses simple random sample selection. However, in this study, cluster sampling technique was used to ensure adequate representation of ethnicity, rural and urban locations and SES. To correct for

the difference due to design effect, the sample was multiplied by 2 (FAO, 1990; Magnani, 1997 & UNICEF, 1995):

$$n = 138 \times 2 = 276.$$

To allow for errors in recording or other contingencies, a further 5% of the sample was added;

$$n = 276 \times .05 = 13.8$$

The sample size was $276 + 14 = 290$. To allow for attrition the researcher added a further 10 study subjects making a total sample size of $300/10 = 30$ students per school. The total sample size for the study was therefore estimated at $N = 300$. That was, 30 students from each of the ten schools.

For the comparison testing of finger prick capillary whole blood and fasting venous plasma (hypothesis three) 60 students were randomly selected from the main study population. The power analysis using estimates of variances and effect sizes derived from similar studies (Tamborlane, 2005; Schwartz et al., 2005; McGillis-Bindler & Bruya, 2005) indicated that a sample size of 45 was sufficient to detect differences of a medium effect size ($d = .5$) (Cohen, 1988) between finger prick blood parameters (blood glucose, HbA1c and TC) and venipuncture technique for the same variables to yield 90% power with significance level of .05 for a two-sided paired samples t-test. However, 60 students were recruited, six from each of the ten schools to allow for attrition.

McGillis-Bindler & Bruya, (2005), identified children at risk for overweight, cardiovascular diseases, and type 2 diabetes, compared finger prick capillary whole blood to the “gold standard” of fasting serum values for glucose and lipoprotein levels.

Correlations were found only for HDL-C ($r = .591$, $p = .003$) and triglycerides ($r = .534$,

$p = .010$) when comparisons were made between the non-fasting finger prick method and fasting venipuncture method. They selected 23 subjects from a sample of 111 to give 80% power for a one tailed test to detect a difference of 5% in the correlation analyses (McGillis-Bindler & Bruya et al., 2005).

Tamborlane et al. (2004) compared finger prick HbA1c levels of 200 type 1 diabetic children aged 7-17 years assayed by a Point-of Care (POC) instrument, the DCA 2000, with the DCCT/EDIC central laboratory assay and found a strong correlation between the DCA and the DCCT/EDIC ($r = 0.94$, $p < 0.001$). However, the DCA HbA1c levels were significantly higher than the DCCT/EDIC central laboratory values with a mean difference of 0.2%, $p < .001$ (95 % CI of 0.14 to 0.23).

Procedure

The study was conducted with the approval of the Institutional Review Board, Florida International University, and the Jamaican Ministry of Education, Youth, and Culture, and the Ministry of Health and Environmental Control (Appendices A-C). The principals in the selected schools were contacted for their school's consent to participate and to gain access to selecting students (Appendix D). The researcher visited each of the ten randomly selected schools and obtained written permission from the principals. On this visit, a Contact Person (CP) was selected to include the school nurse, guidance counselor or the senior nutrition teacher. Written consent of the CP was obtained on that visit (Appendix E). The selected CP in each school was briefed on the study protocol.

After obtaining permission from the principals and CPs, the researcher began to recruit students from each grade level. Students were stratified by grade level and gender

and five names randomly selected per grade level. The researcher explained the study to the student and asked them to take the combined consent/assent forms (Appendix A) home for their parent's signature. Students whose parents have consented were asked to sign the assent form (Appendix A) after the study was explained to them. Contact persons were responsible for organizing the students on data collection days and called the students the night before to remind them of the overnight fast. The demographic and socioeconomic questionnaire (Appendix F) was self-administered on data collection day and questionnaires returned to the researcher on the same day.

Finger prick blood collection was performed by workers of the Mobile Unit of the Heart Foundation of Jamaica (Appendix G), and the Diabetes Association of Jamaica (Appendix H). Venous blood draws were taken by the phlebotomist of the Central Medical Laboratory, Kingston (Appendix I). Anthropometric measures, BP, and physical examination for Acanthosis Nigricans were obtained by the school nurse and the researcher. The entire data collection lasted for three weeks by targeting one school per day.

Workers of the Heart Foundation of Jamaica performed the finger prick tests for TC and FBG. Students were pricked a second time by a worker from the Diabetes Association of Jamaica who conducted the finger prick tests for HbA1c only on all 276 subjects. The phlebotomist of the Central Medical Laboratory accompanied the research team to collect venous blood samples and test for HbA1c, TC, and FPG. Venous blood samples were stored and taken back to the laboratory in Kingston for testing on the same day. All 60 samples were tested at the same laboratory using standard laboratory

procedures for testing TC (chemistry dry slide technology), FPG (hexokinase method), and HbA1c (boronate- affinity HPLC method).

Students were instructed to complete a 12 hour fast before the blood collection. On each test day students reported to the “sick bay” where they were interviewed to determine if they had fasted the night before. Those students who were not fasting were not used in the study. Weights, heights, waist, and hip circumference were measured by the researcher and the CP. Six randomly pre-selected students from each school had their blood samples taken by the phlebotomist of the Central Medical Laboratory using venipuncture. The phlebotomist prepared the blood for testing and transported it to the laboratory where analysis was performed within 24 hours.

After completion of dietary intakes, physical activity questionnaire, anthropometric measures, examination for AN, demographic data and two measures of blood parameters, each subject was given a monetary incentive of US\$5.00 along with other tokens of appreciation. Tokens included donations of daily planners, notebooks, pens, pencils, pocket-sized hand lotion, toothpaste, rubber stress balls, T-shirts, and sun-visors. Those who participated in the comparison study were given an additional US\$5.00 after completing the venipuncture. Students were served a continental breakfast of fruit juice/fruit plate, choice of sandwiches, danish/muffins, after blood collection to prevent possible hypoglycemic episodes (Appendix J for Study Protocol).

Pilot Testing of Instruments

All instruments were pilot tested in a high school that was not part of the sample schools but similar to the study schools. Informed consent (Appendices KI-III) was obtained for pilot testing of instruments. Instruments for measuring AN (Appendix L), and PA (Appendix M) have been used and reliability determined in previous studies (Burke et al, 1999; Crocker, Bailey, & Faulkner et al., 1997). In one study comparing physical activities of 84 children ages 9-15 years using the Physical Activity Questionnaire for Children (PAQ-C), Crocker, et al (1997) found acceptable levels of test-re-test reliability for both males ($r = .75$) and females ($r = .82$). The scale developed by Burke et al., (1999) for determining locations and severity of AN has been successfully used in other studies among Mexican Americans. The scale had good replicability ($k > .68$) for measuring the severity and location of AN on the neck region (Burke et al., 1999). The demographic questionnaire (Appendix F) and food recall (Appendix N) were developed by the researcher and were tested and validated before being administered. These instruments were tested among a similar sample of 40 students from a high school not included in the study.

Data Collection and Description of Instruments

Demographic, Anthropometric, Medical Data, Physical Activity and Dietary Intakes

Specific demographic and anthropometric data from subjects were collected at each selected school. Demographic data included gender, age, race/ethnicity, parents' occupation, place of residence, parent's income and educational level, family history of diabetes, obesity, and cardiovascular disease (Appendix F).

Anthropometric

Anthropometric data such as weight, height, waist and hip circumferences were collected and recorded by the researcher and CP for each subject at each selected school (Appendix O). Students were weighed using the Professional Medical Beam Balance scale (Health-O-Meter, model 402EXP) with weight capacity of 220 kg and 450 lbs and weight graduations of 100 grams and 4 ounces respectively. Weights were measured in kg. The height rod with increments in cm as well as inches with height range of 24” to 84” in 1/8 “ increments and 60 cm to 213 cm in 1 mm increments was used. Subjects were weighed in their school uniforms and were asked to remove their shoes before weighing. Weights were recorded to the nearest 0.1 kg. The scale was disinfected and recalibrated after each use and the process repeated. Heights were taken using a stadiometer and recorded in centimeters. Subjects were asked to stand straight with weight evenly distributed on both feet, feet together with arms at the sides. Subjects were asked to look straight ahead. The headpiece was lowered to touch the head and lightly compress the hair. Heights were measured to the nearest 0.5 cm.

BMI was calculated as weight (kg) divided by height (m^2). Although BMI cut-off points vary among different ethnic groups for the same level of body fat, research has shown that an increase in T2DM and CVDs is linked to increase BMI (Singh, et al., 2004). Research indicated that 85% of children with T2DM were overweight (BMI > 85th percentile) or obese (BMI > 95th percentile). Body mass index as determined by the International Obesity Task Force (IOTF) for the following categories were used to classify subjects as normal weight ($18.5 \leq \text{BMI} \leq 24.9$), overweight ($25.0 \leq \text{BMI} \leq 29.9$), and obese (BMI ≥ 30). Among the obese category, subjects were further classified as

class I (BMI ≥ 30.0 -34.9), class II (BMI ≥ 35 -39.9) and Class III (BMI > 40) obese. The data collected in this section was used primarily to describe the study population as well as factored in the logistic regression analyses. BMI was coded as follows for descriptive purposes;

- 1 = Underweight (BMI ≤ 18.5)
- 2= Normal Weight (18.5 $\leq$ BMI ≤ 24.9)
- 3= Overweight (25.0 $\leq$ BMI ≤ 29.9)
- 4= Class I Obesity (BMI ≥ 30 -34.9)
- 5 = Class II Obesity (BMI ≥ 35.0 -39.9)
- 6 = Class III Obesity (BMI ≥ 40.0)

For the logistic regression, BMI was coded as 1 = risk (BMI ≥ 25), and 0 = no risk (BMI < 25). Actual BMI of study subjects and self-reported BMI equivalents from silhouettes (Appendix P) were used for correlating BMI with family history of overweight and obesity.

Family history of obesity based on BMI percentages was measured using a scale of 1-9 silhouettes for both males and females. The scale of 1-9 corresponded to BMI percentages (Appendix P) for equivalent BMI. A scale of 5 and above represented overweight and obesity. This scale was developed by Bulik, Wade, Heath et al. (2001) and was successfully used to determine obesity among 16,728 female and 11,366 male Caucasians ages 18-100 years. Results using receiver operating curves (ROC) indicated that these figures effectively classified individuals as obese or thin (Bulik et al., 2001). A reliability check for self-reported BMI data using scale and compared to actual BMI

measures of 181 women and 160 men revealed high correlations between actual BMI and self-reported BMI for men $r = .90$ and women $r = .94$ (Bulik et al., 2001).

The scale was pilot tested on a group of 37 Jamaican adolescents ages 14 -19 years in one high school. Pilot study results found significant correlations between actual BMI for subjects and perceived BMI using the silhouettes ($r = .45$, $p < .05$). The scale was also used to identify family history of obesity by having students circle the silhouette they thought most closely resembled their mother and father. Results of the pilot study indicated strong correlation between the subjects perceived BMI (from silhouettes) and subject's perceived BMI of their father ($r = .46$, $p = .008$). No correlation was found between subject's actual BMI and their perceived BMI of their father. However, significance was found for subject's actual BMI and their perception of their mother's BMI ($r = .40$, $p < .01$). Subjects' mean BMI for perceived and actual BMI were 24.1 kg/m^2 and 23.7 kg/m^2 respectively. Actual BMI measurements of study subjects classified 11 or 29 % of the sample as overweight ($\text{BMI} \geq 25 \text{ kg/m}^2$) compared to 12 or 32% for perceived (self-reported) BMI. Based on pilot tests results the silhouettes were included in the main study. Family history of overweight/obesity was determined as $\text{BMI} \geq 25 \text{ kg/m}^2$ and $\text{BMI} \geq 30 \text{ kg/m}^2$ if one parent was overweight or obese respectively. In the present study data were coded as 0 = no family history of overweight/obesity and 1 = family history of overweight/obesity.

Measuring Central Adiposity

Excess abdominal fat is more resistant to the action of insulin which in turn increases the risk for CVDs, T2DM and hypertension. In a study of Asian Indians, up to

20% of subjects although not overweight, had central obesity putting them at risk for CVDs, T2DM and hypertension (Gopalan, 1998). Central adiposity poses a risk for diabetes and insulin resistance. Cut-off values of waist circumference (WC) of 85 cm and 80 cm with WHR of 0.89 and 0.81 for men and women respectively are recommended (Ramachandran, 2004).

In this study, both waist circumference and BMI were used to determine those at risk for T2DM and CVDS. Waist circumference of ≥ 94 cm and ≥ 80 cm shows increased risk of obesity-associated metabolic complications for adult Caucasian males and females, ≥ 102 cm and ≥ 88 cm shows substantial risks for both males and females respectively (Ramachandran, 2004).

Waist circumference was measured by placing a non-stretchable tape around the waist at the region of the navel for males and between the bottom of the rib and top of the hip bone for females. Subjects were asked to stand erect with abdomen relaxed, arms at the side and feet together. The participants were asked to breathe normally then the measurements were taken at the end of the normal expiration. Measurements were recorded to the nearest 0.1 cm. Waist circumference was coded as a categorical variable:

- 0 = normal (< 94 cm and < 80 for males and females)
- 1 = ≥ 94 cm and ≥ 80 cm for adult males and females), increased risk for T2DM and CVDs.
- 2 = ≥ 102 cm and ≥ 88 cm for males and females), substantial risk for T2DM and CVDs

Waist circumference was classified as 1 = risk for WC ≥ 94 cm and ≥ 80 cm for males and females, and ≥ 102 cm and ≥ 88 cm, and 0 = no risk for WC < 94 cm and < 80 for males and females.

Hip measurements were taken at the tip of the hip bone in males and at the widest point of the hip and buttocks of the females. Measurements were recorded to the nearest 0.1 centimeter. To arrive at the waist-to-hip ratio, the waist circumference was divided by the hip circumference. A healthy waist-to-hip ratio for female is 0.8 and below and for males 1.0 or below (Dalton, Cameron & Shaw et al., 2003). People with more weight around the waist face more health risks than those who carry the weight around the hip (Dalton et al., 2003). Waist-to-hip ratio was coded as:

- 0 = healthy WHR < 0.8 for females, and < 1.0 for males.
- 1 = increased risk for CVDs > 0.85 for females and > 1.0 for males.

Waist circumference and WHR have been found to be associated with both CVDs and T2DM in adults. However, data on adolescents are needed. In one study of 11,247 Australians aged > 25 years examined for cardiovascular disease risks by using waist circumference, waist-hip ratio and BMI, WHR had the strongest relationship with T2DM, dyslipidemia (women only) and hypertension. Strong associations were found for BMI and hypertension in women and for T2DM in men. WHR had a strong relationship with CVDs risk factors before adjustment for age (Dalton et al., 2003).

In another study of 313 men and 382 women in Canada, waist and hip circumferences were also found to have effects on cardiovascular disease risk factors. Both men and women with large waist circumference had significantly lower HDL cholesterol concentrations ($p < .05$) and high fasting triacylglycerol, insulin and glucose

concentrations ($p < .01$). A large waist circumference was associated with high LDL-C and BP for women only and with low HDL and high glucose in men ($p < .05$). Both high triacylglycerol and insulin concentrations were found in men and women ($p < .05$) (Seidell, Perusse, Jean-Pierre et al., 2001). Waist circumference and WHR measurements are also significant for T2DM patients since T2DM is largely associated with obesity. Studies have shown that patients with T2DM have higher WHR than non-diabetics (Seidell, Han, Feskens, et al., 1997).

Blood Analysis

Capillary blood samples were tested by the workers from the Heart Foundation of Jamaica for glucose and total cholesterol. HbA1c samples were tested by a Diabetes Association of Jamaica worker. Students reported to the “sick-bay” in each school, were interviewed and then tested. Sixty randomly selected students from the larger study population had their blood drawn by venipuncture by the phlebotomist of the Central Medical Laboratory. Venous blood samples were prepared and transported to the laboratory in Kingston for analysis.

Blood Glucose

In this study both fasting blood glucose (FBG) and fasting plasma glucose (FPG) were measured on the same day. Fasting blood glucose was measured using the Accu Chek Advantage Blood Glucose Monitor (Roche Diagnostics of New Zealand) for the finger prick method. With this procedure, blood glucose concentrations were measured with a small amount (4 μ L) of capillary whole blood taken from the fingertip. Capillary

blood was obtained by using a sterile lancet to prick the finger. The blood was applied directly to the reagent strip. Successive drops of blood were taken for measuring TC at that moment. One drop of capillary blood was applied to the test strip and placed in the glucose monitor. The instrument uses biosensors to generate a current. The size of the current indicates the amount of glucose present in the blood. Test time for the FBG was about 15 seconds and results were available immediately. The results were entered on the data sheet (Appendix O) immediately.

Validity and accuracy of Accu Chek Advantage Blood Glucose Monitor (Roche Diagnostics of New Zealand) has been determined in a number of studies. In a study which evaluated the variability of results between point-of-care (POC) testing glucose meters using fresh whole blood and the central laboratory analyzer, the Accu Chek group of glucose monitors showed the lowest bias but there were considerable differences between laboratory methods and the other glucose meters (Khan, Vasquez, Gray, et al., 2006). Successive glucose meter readings agreed well when testing hypoglycemia, but readings with differences greater than 10% occurred more than 61% of the time in the hyperglycemic values and 20% occurred 57% of the time in the hypoglycemic range using the Accu Chek Advantage when compared to the central laboratory values (Khan, et al., 2006).

Accuracy and precision of this instrument was also tested in an Australian study using capillary blood samples from 49 diabetic patients attending a clinic (Cohen, Boyle, Delaney et al., 2005). Blood samples were evaluated using five glucose meters and compared with a reference; the YSI Glucose Analyzer (Yellow Springs Instruments, Ohio, USA). Coefficient of variation was calculated to determine precision. Coefficient

of variation (CV) ranged from 2.8 to 5.5% and were close to the values given by the manufacturers, except for the Accu Chek Advantage (Roche). Coefficient of variation for the Accu Chek Advantage ranged from 3.64 to 2.62% in this study compared to the manufacturers listed variability of < 3.1%. Of the five glucose meters tested, only one (CareSens) from Australian met the ADA (Australian Dietetic Association) recommendation of < 5% bias (deviation from reference). In this study, bias ranged from 4.0 to 15.5% (Cohen, et al., 2005). Most meter readings were higher than the reference device with the Accu Chek being 0.6 mmol/L higher than the reference (Cohen, et al., 2005).

Since blood glucose varies throughout the day in response to meals and exercise, in this study measures were taken after a 12-hour fast and first thing as the students arrived at school. Both finger prick and venipuncture were carried out at the same time to reduce variations in glucose concentrations. Whole blood from capillary was used for the finger prick method and plasma for the venipuncture.

For the venipuncture, the phlebotomist accompanied the researcher to each school and collected these samples before anthropometric measures and other data were collected. To prevent glucose variability due to glycolysis, the sample was treated with a glycolysis inhibitor sodium fluoride (2.5 mg fluoride/mL of blood) to slow glycolysis. This process may take up to 2 hours to stop glycolysis. If the sample is not tested early the blood samples can show a 5-7% decrease in glucose values (Nichols, 2006). After treating with a glycolysis inhibitor, samples were set on ice for transportation to the laboratory. Glucose concentrations in whole blood usually become stable after four hours and can be kept for 72 hours at room temperature if an inhibitor such as fluoride is

used (Chan, Swaminathan, & Cockran, 1989). Four hours were sufficient time to transport the samples from each school back to the laboratory in Kingston for testing.

For the venous method, a small sample of blood (3 mL) was obtained from the basilic and cephalic veins at the antecubital fossa. that is, the area inside the bend of the elbow where the veins are very superficial and close to the skin. Analysis of venous blood was done using the COBAS MIRA Plus Analyzer (Roche Diagnostics) using the Glucose Hexokinase Liquid Reagent (Roche Diagnostics). The principle is based on a modification of Slein (1963) enzymatic testing using hexokinase and glucose-6-phosphate-dehydrogenase to catalyze the reaction. Results were referenced to the FDA method for measuring blood glucose.

Differences have been noted between whole blood and plasma glucose levels. Whole blood levels are 12 to 15% lower than plasma glucose because of less water content in RBCs compared to plasma (Nichols, 2006). After a fast, venous blood is approximately 2 to 5 mg/dL lower than capillary glucose due to glucose absorption and cellular metabolism. Capillary glucose can be 20 to 70 mg/dL higher than venous blood samples after a meal because of post-prandial effects of insulin on cellular uptake and metabolism ((Nichols, 2006). Therefore all blood samples were taken after an overnight fast of 12 hours.

Fasting plasma glucose (FPG) was classified based on the most current ADA criteria (ADA, 2005). Blood glucose levels included continuous as well as categorical values. Categorical values were coded as 0-2 to represent the following cut-off points. However, categories 1 and 2 were combined and treated as at risk for T2DM.

- 0 = Normal (fasting glucose = FPG <100mg/dL
- 1 = Impaired fasting glucose (IFG) (FPG ≥100mg/dL and <126 mg/dl)
- 2 = Diabetes (FPG ≥126mg/dL).

The ADA recommends three criteria for diagnosis of diabetes mellitus which include 1) checking for symptoms such as polyuria, polydipsia, unexplained weight loss, and a casual plasma glucose concentration > 200 mg/dL, 2) fasting plasma glucose > 126 mg/dL, and 3) two-hour postload glucose > 200 mg/dL performed during an oral glucose tolerance test (OGTT) using a glucose load of 75 g of anhydrous glucose dissolved in water (James, 2006). Reference intervals for glucose concentrations in healthy children range from 3.3-5.6 mmol/L (60-100mg/dL) and for adults it is 4.1-5.9 mmol/L (74-106 mg/dL) (Sacks, 1999). However, the ADA criteria was used in this study for diagnosing diabetes rather than these reference intervals

Total Cholesterol (TC)

Capillary testing of total cholesterol was carried out by the workers of the Heart Foundation of Jamaica using the Accutrend GCT Cholesterol Monitor (Roche, Diagnostics, Mannheim, Germany). Measurement of TC in this study used enzymatic methods (cholesterol esterase). Cholesterol esters are cleaved by the cholesterol esterase to form free fatty acids and cholesterol. The products are further oxidized by cholesterol oxidase in the presence of peroxidase to form a red substance called quinoneamine. The instrument measured the intensity of the reaction color using “reflectance photometry” and then calculated TC using a lot specific algorithm. The result was displayed in mg/dL or mmol/L. The instrument measured a range of TC of 150-300 mg/dL (3.88-7.76

mmol/L). Manufacturer's precision of the instrument for measuring TC is stated as < 5% and for accuracy $\pm 5\%$. Results are available in 3 minutes and uses only one drop of blood for testing.

Research is lacking on the reliability of the Accutrend GCT in the testing of total cholesterol. However, reliability of the Accutrend GCT was tested for TG and showed that coefficient variations for different capillary TG concentrations were 3.3% for high TG and 5.3% for low TG (Moses, Calvert, & Storlien, 1996). When compared to plasma TG concentrations, the Accutrend GCT capillary measures of TG had a strong correlation ($r = 0.94$) (Moses et al., 1996).

Point-of-care tests are to be validated for accuracy and precision. Accuracy refers to the agreement between the monitor and standardized laboratory test on the same parameters, whereas, precision refers to the reproducibility of these tests (Taylor & Lopez, 2004). Guidelines for accuracy and precision of these instruments are determined by the NCEP and CDC. The NCEP recommends a coefficient of variation between laboratory testing and the monitor to be $\leq 3\%$. Average bias (precision) according to the CDC should not be greater than $\pm 3\%$.

Both venous and capillary blood samples were tested and compared in the present study. Earlier research indicated high positive bias for fingerstick plasma capillary testing of TC versus venous serum testing. In one study (Greenland et al., 1990) cholesterol concentrations in fingerstick derived plasma were consistently higher and gave a positive bias of 3.6% which means this method alone would classify subjects at risk when they are not. Cutoff points for cholesterol by the National Cholesterol Education Program (NCEP) refer to venous serum samples.

Cholesterol guidelines for children as set by the National Cholesterol Education Project, sponsored by the National Heart, Lung and Blood Institute, suggested a desirable blood lipid profile for children. Cholesterol level less than 175 mg/dL was recommended for children. Compared to adults, the ATPIII panel suggested TC < 200 mg/dL as desirable, 200 mg/dL as borderline high, and ≥ 240 mg/dL as high. Total cholesterol was coded as 0-2 to represent the following categories;

0 = Normal (TC < 170 mg/dL)

1 = Borderline (TC 170-200 mg/dL)

2 = Abnormal (TC > 200 mg/dL)

Total cholesterol was further coded as 1 = risk (TC > 170mg/dL) and 0 = no risk (TC < 170 mg/dL) for statistical analyses.

Methodology for Testing Total Cholesterol

A small drop of blood which was applied directly to the testing strip in the Accutrend GCT Cholesterol Monitor analyzer, immediately after the finger was pricked for the FBG blood sample. The technology used for testing TC with point-of-care testing monitors involves the use of a cholesterol esterase which hydrolyzes cholesterol esters (Taylor & Lopez, 2004). Hydrogen peroxide is produced when cholesterol oxidases oxidize the cholesterol. Readings are made due to color differences produced when the hydrogen peroxide further reacts with a substrate in the presence of peroxidase. A light is reflected off the test strips due to the color change. The monitor converts the reading into a cholesterol level and displays the reading. It is the height of the color peak which indicates the amount of hydrogen peroxide and consequently the amount of cholesterol

from the sample (Taylor & Lopez, 2004). The venous sample was taken by the phlebotomist of the Central Medical Laboratory on the same day and taken back to Kingston for analysis using standard laboratory procedure. Venous samples were tested using the VITROS 350 analyzer which used a chemistry dry slide technology for measuring lipid profiles.

Glycated Hemoglobin

In this study HbA1c was measured by both finger prick and venous blood samples. Comparisons were made to determine the variability of these methods and to determine if there were significant differences between HbA1c as measured by both methods. Finger prick method is cheaper than laboratory testing especially among people with no health insurance as expected in the Jamaican population.

In a comparison testing HbA1c was measured in the same day visit with two laboratory methods, HbA1c values were consistently lower for the capillary blood samples. The aim of the study was to determine if same-day-visit testing of HbA1c (using capillary blood finger prick samples) could be used in these health care centers for more efficient patient care and improved diabetes management (Schwartz et al., 2005).

The normal HbA1c range for a healthy person is 4 – 5.9%. The International Diabetes Federation and American College of Endocrinology recommends that HbA1c values below 6.5% whereas the American Diabetes Association extends this range to 7%. Ranges above 7% represent poor glucose control (Nakamota, 2006). In this study, the International Diabetes Federation guidelines of < 6.5 % will be used as the cut-off point

for normal levels of HbA1c. For statistical analyses HbA1c measures were coded as dichotomous values to represent the following;

- 0 = $\leq 6.5\%$ for normal
- 1 = $> 6.5\%$ poor glucose control.

The present study assessed HbA1c, the standard method of assessing long-term glycemic control which gives the glycemic history of the subject over the past three months. Measurement of HbA1c is needed in diabetic control since glucose irreversibly binds or glyicates with red blood cell hemoglobin, therefore more glucose equates to more binding. Current guidelines recommend HbA1c values below 7.0. HbA1c values increasing from 5.0 to 7.0 in non-diabetics, have been associated with increased risks of CVDs (Shankar, Klein, & Moss, 2007). The International Federation for Diabetes and the World Health Organization have not agreed to the use of HbA1c only in the diagnosis of T2DM, however studies show that when used with other measures such as FPG and BMI, HbA1c is effective for screening (Norberg, Eriksson, Lindahl et al., 2006).

In this study HbA1c was measured using the Nycocard manufactured by Axis-Shield. The blood was drawn into a short micro-pipette by finger prick and dropped into a pre-dispensed test tube where it was mixed with blue borate buffer reagent and left for three minutes. The machine is equipped with a timer to indicate when to pick up the tube and give it a spin. After spinning, 25 microliters of the mixed solution were drawn with an automatic pipette. This sample was then expelled into a mixing well where it was absorbed by a filter paper membrane. The filter soaked up the reagent within seconds, the pipette was changed, and 25 microL of wash solution delivered to the mixing well.

After this was absorbed, the Nycocard pen read the HbA1c and displayed the result on the LCD screen (Nycocard Diabetes Screening).

The Nycocard is Diabetes Control and Complications Trial (DCCT) calibrated and used up to 5 microliters of blood from finger prick or venipuncture which made it ideal for use with children and adolescents. The results were available within four minutes and measures were reported as one standardized HbA1c value. Measurements for HbA1c using fasting venous samples were carried out using standardized laboratory procedure (boronate affinity HPLC) which is DCCT corrected.

Measurement of venous HbA1c samples was carried out using the PDQ Plus Analyzer from Primus Corporation which is certified by National Glycohemoglobin Standardization Program, USA. This equipment used high-performance boronate affinity chromatography to separate glycated hemoglobin. The hemoglobin fractions were then monitored by light absorption at 413 nano meters (nm). Results were available within two minutes.

Blood Pressure (BP)

Research indicated that up to 17-32% of adolescents with T2DM have hypertension (Fagot-Campagna, Pettitt, & Engelgau, 2000). According to a Pan American Health Organization (PAHO) 2008 Report, hypertension is the number one risk factor for death in the region. In another study of Pima Indians ages 5-19 years, 85% were obese, 14% had hypertension and 30% had dyslipidemia (Fagot-Campagna et al., 2000).

The researcher measured blood pressure using a sphygmomanometer. Students were allowed to rest for five minutes before the measurements were taken. An average of two readings was used in the analysis. Blood pressure exceeding the 95th percentile for height, age and sex were used to define the diagnosis of hypertension. The height percentile, age and sex were used to ascertain the 90th and 95th percentiles for BP (Appendices Q and R). Adolescents who plotted below the 90th percentile for height, age, and gender were considered to have normal BP. Adolescents who plotted between 90-95th percentile were classified as having “pre-hypertension” which means they are at risk to developing hypertension. Subjects whose systolic or diastolic BP plotted higher than the 95th percentile for age, gender, and height measurements were classified as hypertensive and referred to follow-up. For 17-19 year olds, the 95th percentile which is close to 140/90mm Hg, the cut-off point for adults, was used to classify subjects as hypertensive. The American Academy of Pediatrics (AAP), American Heart Association (AHA), and the American Medical Association (AMA) recommended routine screening of adolescents and children during preventive visits since up to 28% of children have secondary hypertension for which early detection may be beneficial. Blood pressure was coded as 0-2 to represent the following;

- 0 = Normal (BP < 90th percentile for height, age and gender)
- 1 = pre-hypertensive, (BP between the 90-95th percentile for height age, and gender)
- 2 = hypertensive (BP higher than the 95th percentile for age, gender and height).

Pre-hypertensive and hypertensive measures were further collapsed into two categories wherein 1 = risk (BP > 90th percentile) and 0 = no risk (BP < 90th percentile) for analyses purposes.

Acanthosis Nigricans (AN)

The researcher examined each subject for the presence of Acanthosis Nigricans (AN), a dark, raised skin in areas such as the axilla, neck, knuckles, and knees which is believed to result from hyperinsulinemia. Acanthosis Nigricans is manifested by a darkening of the skin, velvety plaques of body folds and is most commonly seen around the neckline or in the axilla in children who have greater body weight and fat mass, higher serum insulin levels and lower insulin sensitivity (McGillis-Bindler & Bruya, 2005; Burke et al., 1999). Examination of AN was significant to the study since AN is becoming more prevalent among obese patients and those with type 2 diabetes (Burke et al., 1999). Subjects with AN were also at risk for atherosclerotic cardiovascular diseases (Katz & Feldman, 2006).

The presence of AN is a marker for the risk factor of hyperinsulinemia. Hyperinsulinemia leads to binding of insulin-like growth factor (IGF) receptors on keratinocytes and fibroblasts and ultimately hyperplasia of the skin (Cruz, 1992). Acanthosis Nigricans is associated with hyperinsulinemia, which is a consequence of insulin resistance often associated with obesity (Burke et al., 1999; McGillis-Bindler & Bruya, 2005). Acanthosis Nigricans has been reported in 60-90 % of young people with T2DM (Scott, et al., 1997) and is a physical marker for insulin resistance and appears to be more prevalent in some ethnic groups (Tajima, 2002; Stuart, et al., 1998).

In this study a quantitative scale (Appendix K) which measured the severity as well as locations for AN was used. The scale includes six AN measures; neck, axilla, neck texture, knuckles, elbows and knees to determine the presence or absence of AN as well as the severity (Appendix L). However, it was not convenient to measure AN on the axilla in the current study. A quantitative scale ranging from 0-4 was used to determine the severity of AN on the neck wherein 0 = absent, 1 = present, 2= mild, 3= moderate and 4 =severe. For the neck texture a scale of 0-3 wherein 0 = smooth to the touch, 1= rough to touch, 2 = coarse with raised skin, and 3 = extremely coarse and clearly visible. For the knuckles, elbows and knees, a qualitative scale using the terms “present or absent” was used (Appendix L). Acanthosis Nigricans easily resembles psoriasis but can be differentiated because unlike psoriasis, the plaques of AN do not present with inflammation. For the regression analyses, presence of AN only on the neck was used and coded as present = 1, and absent = 0. Descriptive statistics such as means and frequencies were used to determine the severity and other locations of AN.

Burke et al. (1999) in a study of 406 participants examined for AN using the same scale as in this study. The neck, axilla, elbows, knuckles and knees were examined by two independent observers. Results showed high inter-observer concordance and k statistics of the scale. The scale was found to have high inter-observer reliability ($k > .68$) and correlated well with insulin resistance (IR) and BMI among Mexican Americans (Burke, et. al., 2001). Only the neck region had high k statistics and the researchers excluded the other areas from their analyses. A k statistic that is $> .75$ is considered excellent reproducibility and $.4 < k < .75$ represents good reproducibility (Burke et al., 2001). In our study, data were collapsed for analysis in the logistic regressions using

presence (1) or absence (0) of AN for the neck only. However, descriptive statistics were also used to determine the severity of AN in this population.

Physical Activity (PA)

Research has shown that children need up to 60 minutes of exercise per day (Klein et al., 2004). Physical activity has been shown to increase insulin sensitivity in children (Schmitz, Jacobs, Hong, et al., 2002). This increased insulin sensitivity is seen among obese children undergoing regular exercise then it decreases when they revert to a sedentary life style (Schmitz, et al., 2002). Obesity and dietary factors have been shown to affect the metabolic response to exercise, for example, high- fat feeding reduces the growth hormone response to exercise (Cappon, Ipp, Brasel, et al., 1993). Earlier studies indicated that a change to a sedentary lifestyle similar to the effects of Westernization on Australian Aborigines resulted in increased life-style–related chronic diseases such as T2DM, premature CVDc, dyslipidemia, hypertension and hyperinsulinemia (O’Dea, White, & Sinclair, 1998), therefore, low physical activity was considered a risk factor for T2DM and CVDs.

In our study, physical activity was measured by using the Physical Activity Questionnaire for Older Children (PAQ-C). The PAQ-C is a self-administered 7-day recall measure which assessed general physical activity levels during the school year (Appendix M). The instrument consisted of 9 questions that assessed activity levels at different times of the day including school and out of school activities. Each question has five responses and was scored from 1-5 where 1 = inactive (student does not participate in that particular activity at all), 2 = low activity level (activity is performed 1-2 times in

the past seven days), 3= moderately active (activity is performed 3-4 times in the past seven days, 4= active (activity is performed 5-6 times in the past seven days, 5 = very active (activity is performed > 7 times in the past seven days). An average of all 9 items was taken to determine the activity level of the child.

With this method, each item has an equal weight in the final score (Welk, & Wood, 2000). A limitation in using this instrument was that all items are equally scored and no level of physical activity was graded in terms of amount of energy spent doing the activity, nor the amount of time spent on each activity (Welk, & Wood, 2000). However, it gave an idea of which children were active or inactive, and created a profile for the times of day to help identify when they were least active, so implementation programs can address the activity levels at those times.

Despite these limitations, the PAQ-C has been successfully used with children in grades four and higher and from ages 9-15. Crocker et al. (1997) examined the feasibility of using this measure of physical activity among children. Results indicated that the instrument had acceptable item and test score characteristics in item distribution, and was determined to have good internal consistency. Using a sample of 84 children ages 9-15 years Crocker et al. (1997) found acceptable levels of test-re-test reliability for both males ($r = .75$) and females ($r = .82$).

The PAQ-C instrument examined activities for the week, and included such activities at recess, in PE class, lunch (apart from eating), after school. It is simple and easy to read for this age group. All 276 study subjects were asked to complete the PAQ-C and return it to the researcher or CP in their school. This activity took less than 10 minutes. For the regression analyses, activity level was coded as;

- 0 = physical activities performed more than 2 times per week (no risk).
- 1 = activities performed less than 2 times per week (risk).

Dietary Intakes

Dietary intakes were measured by questioning each student on all the food and beverages they consumed for the past 24 hour, the amounts, methods of preparation and location were recorded by the researcher (Appendix N). Data were used to determine associations between fiber intake, types of carbohydrates (refined and complex) and types of dietary fat on risk factors for T2DM and CVDs among Jamaican adolescents. The 24-hour recall is one of the most common methods used in surveys. Its limitations include the reliance on self-reports and memory problems (Forshee, 2004). Also individuals may not be truthful in their reports. Recalling portion sizes is also a problem with the 24 hour recall. In this study each student was interviewed face to face by the researcher who recorded their information in a booklet (Appendix N).

The researcher used the United States Department of Agriculture (USDA) multiple-pass method of collecting food intake data. This method employed a five-step approach to ensure accurate and complete recall of food intake, and reduced the respondent's burden. The method is also available in an automated computer version but for this study, the researcher used the five steps verbally to record the data (Appendix N). The five steps are described below:

1. The researcher asked the subjects to tell her all the foods and beverages he/she consumed for the previous day and recorded these in a booklet (Appendix N).

2. The researcher probed for foods that are normally forgotten such as those eaten between meals.
3. The researcher asked subjects about the time, eating occasion and location where these foods were eaten.
4. The researcher asked the subject to describe in detail the amounts eaten, methods of preparation such as fried or grilled, and to describe the type of food. For example what type of bread (whole wheat as against white bread). The researcher showed subjects pictures of estimates of foods in cups and their equivalents in ounces to determine the amounts of foods eaten
5. The researcher probed for any item that the subject might have left out in step one.

The USDA multi-pass method of data collection has been used in many other studies to include the National Health and Examination Survey, and the WWEIA (What We Eat In America) surveys. In a smaller study, this method effectively assessed food intakes of obese and non-obese women in the US (Conway, Ingwersen, & Vinyard et al., 2003). In a study of 49 women aged 21-65 years with BMI ranging from 20- 40 kg/m², the multiple pass method effectively assessed mean energy intake within 10% of mean actual intake when compared to the previous day. In that study, women overestimated their energy and carbohydrate intakes by 8-10%. However, no significant differences were found between mean actual and recalled intakes of energy and the macronutrients among the obese group. Normal weight and overweight women significantly ($p < .01$) overestimated their energy, protein and carbohydrate intakes (Conway, et al., 2003).

In another study comparing observed food intake at a facility with the multiple – pass method conducted via telephone the following day, Conway, et al. (2004) found no significant differences between actual and re-called intakes of energy (3294 ± 111 and 3541 ± 124 kcal/day). No significant differences were found for the individual macronutrients. Forty-two men ranging from age 21 to 65 with BMI of 21-39 kg/m² participated in that study. The energy intake of both obese and non-obese men significantly correlated with estimated energy requirements ($r = .57$, $p < .05$). It was concluded that the multiple-pass method of food intake collection can be used successfully to assess intakes of energy, and macronutrients regardless of BMI status.

Comparison of a 24 hour recall against three days of re-call was pilot tested prior to this study to determine if the 24 hour recall represented habitual macronutrient intakes. Strong correlations were found for energy (kcal) ($r = .494$, $p < .002$) and carbohydrate (g) ($r = .427$, $p < .008$) intakes between the 24 hour recall and the three days recall in the pilot study. Therefore the 24-hour recall for macronutrient intakes was used in this study. Approximately 10 minutes per student were used in collecting the 24 hour recall in the pilot study which revealed that students ate similar items and with very little variety.

Data on macronutrients intakes in our study were analyzed using the USDA National Nutrient Database for Standard Reference (USDA, Agricultural Research Service, 2005). Cultural food items not found in the USDA National Nutrient Database for Standard Reference were analyzed using the Food Composition Tables, Caribbean Food and Nutrition Institute. Analysis of food intake concentrated mainly on the macronutrients since research has shown a marked transition in the diets of people of the developing world (Popkin, 2001). It was expected that the diets of Jamaicans pattern

included the high fat, high energy-dense foods of Western countries which had an increase in animal foods, added sugars, increased fat consumption, and a decrease in cereal and fiber intake (Popkin, 2001). In many developing countries more than 30 percent of the total energy now comes from fat (Popkin, 2001). Dietary results were analyzed for individual macronutrients (g), energy (kcal), types of carbohydrates (complex and refined) and fats (saturated and unsaturated), and fiber (g). Macronutrient intakes including energy (kcal), total g intakes for carbohydrates (refined and complex), fiber, fat, types of fat (saturated and monounsaturated fats) were measured using continuous variables and factored into correlation analyses.

Data Analyses

Statistical analyses were performed using SPSS version 17.0 (SPSS Inc., Chicago, IL, USA). Data analyses included descriptive statistics such as means, standard deviations, frequencies and percentages for demographic characteristics of the population and risk prevalence of the risk factors for T2DM and CVDs. The data analyses included testing for the risk factors of T2DM and CVDs using logistic and multiple linear regressions for determining the associations with the demographic and environmental variables (hypotheses 1a-e). Risk factors were coded as 1 = risk, and 0 = no risk, and for predicting relationships with WC and WHR and the other risk factors (hypothesis 2a). Cross-tabulations, Chi square and Odds Ratios were used to compare the risk factors by BMI. Other statistical analyses included Pearson Correlations for diet and individual risk factors of T2DM and CVDs (hypotheses 2c-f), between WC and the other risk factors, and between WHR and other individual risk factors of T2DM and CVDs. Spearman

Correlation was used to determine the relationship between family history of obesity and subject obesity. The Holm's Sequential Bonferroni Method was applied to control for type 1 error for all analyses. A type 1 error occurs when the null hypothesis is rejected and it is actually true resulting in a false positive classification (Holms, 1979).

For hypothesis number three which compared the two methods of blood testing, analyses included Pearson Correlation, a paired samples t-test, testing for percentage bias to control for random error, and the Bland Altman Plot to determine agreement between the two methods of testing. This statistic compared the two methods (finger prick and venipuncture) which assessed the same parameters (TC, FBG, HbA1c). The limit of agreement was set at 2 SD above and below the mean difference (Altman, Bland, 1983; & Bland, Altman, 1986). The Bland Altman Plot graphed the difference between the two methods of testing by removing the variation between subjects and leaving the measurement error which indicated the difference was normally distributed. Mean differences close to zero with scores reflecting narrow CI suggested good agreement between the two methods.

Sensitivity and specificity were calculated to determine the validity of the methods of blood testing. Sensitivity refers to the proportion of subjects who are correctly classified as having a disease condition. A test having greater sensitivity is less likely to misclassify an individual with a negative result (Monsen, 1993). Specificity measures the proportion of people without the disease or condition who test negative. The "greater the specificity of a test, the less likely that a positive test will misclassify a person." For this reason, higher specificity is preferred in public health research. These calculations were done using the following contingency table:

		Test Result	
		Positive	Negative
Yes		A	b
No		C	d

$$\text{Sensitivity} = \frac{a}{a+b}$$

$$\text{Specificity} = \frac{d}{c+d}$$

Percentage bias was calculated to control for random error (chance). A precise measure is one which is reproducible. Since the same instruments were used repeatedly on the subjects, we tested within-instrument-reproducibility. To determine the percentage bias of the two methods of blood testing the following formula was used:

$$\frac{\text{finger prick reading} - \text{laboratory value}}{\text{laboratory value}} \times 100$$

Glucose analysis was compared for analytical imprecision of $\leq 3.3\%$, $\leq 2.5\%$ for bias and $\leq 7.9\%$ for total error (Sacks, et al., 2005). The National Cholesterol Education Program recommendation of a 3% CV for bias for determining total cholesterol concentration (NCEP, 1990; & NCEP, 1995) was used for comparing percentage bias of TC. Precision for HbA1c of $<3\%$, and 2-3% for established physiological limits and

3-4% for the National Glycohemoglobin Standardization Program (Schwartz et al., 2005) were used.

Research Questions

1. What is the relationship between ethnic background, gender, place of residence, and income and the risk factors for T2DM and CVDs among Jamaican adolescents?
2. What is the prevalence of risk factors for developing T2DM and CVDs among Jamaican adolescents?
3. Is there a relationship between blood parameters such as FBG, TC, and HbA1c measured by finger prick method and the same measures using venipuncture?

Objectives of the Study

1. To determine the prevalence of the risk factors of T2DM and CVDs (FBG, HbA1c, TC, systolic and diastolic blood pressure, BMI, WC, WHR, positive family history of T2DM, CVDs, and overweight, AN, PA, and dietary intakes of macronutrients) and the relationships between the risk factors for T2DM and CVDs and ethnicity (Blacks, Indians, Mixed); gender (male and female); place of residence (rural, urban); and income among Jamaican adolescents
2. To determine the frequency, cluster, and associations of the risk factors of T2DM and CVDs in Jamaican adolescents using measures such as FBG, HbA1c, TC, systolic and diastolic blood pressure, BMI, WC, WHR, positive family history of T2DM, CVDs, and overweight, AN, PA levels, and dietary intakes of macronutrients.

3. To compare the results of blood parameters using finger prick techniques with that of venipuncture to determine if there is a relationship between the two methods and determine if the finger prick method can be used instead of venipuncture in the early screening of T2DM and cardiovascular diseases.

Table 7

Statistical Analyses

Hypotheses	Types of Variables	Statistics
1. Ethnicity, gender, place of residence, and income will be positively associated with the number of risk factors for T2DM and CVDs (high levels of FBG, HbA1c, TC, BP, waist circumference, WHR, and presence of AN, low PA, and family history of overweight, CVDs, and T2DM) and with each individual risk factor.	Exposure: Ethnicity, gender, income, and place of residence	Multiple regression analyses predicting the total number of risk factors and individual continuous –valued risk factors.
1a. Blacks will report greater number of risk factors for T2DM and CVDs than Indians and those of mixed ethnicities.	Outcomes: Total number of risk factors and each individual risk factor for T2DM and CVDs.	Logistic regression analyses to determine associations between the demographic risk factors and the individual dichotomous –valued risk factors.
1b. Jamaican female adolescents will have a greater number of risk factors for T2DM than males.		Holm's Sequential Bonferroni Method
1c. Jamaican male overweight and obese adolescents will have a greater number of risk factors for CVDs than their female obese and lean counterparts.		Odds ratios
1d. Jamaican adolescents who live in urban areas will have greater number of risk factors for T2DM and CVDs than their rural counterparts.		
1e. Jamaican adolescents from lower income families will present with more risk factors for T2DM and CVDs than those from higher income families.		

Hypotheses	Types of Variables	Statistics
2. Overweight and obese Jamaican adolescents will report high levels of at least one of the following risk factors: FBG, HbA1c, TC, BP, waist circumference, WHR, and presence of AN, low PA, and family history of overweight, CVDs, and T2DM.	<p>Exposure: BMI</p> <p>Categories (normal, overweight, obese).</p> <p>Outcomes:</p> <p>Categorical variables; BP and family history of T2DM and CVDs, AN, and PA.</p> <p>Continuous Variables: FBG, HbA1c, TC, Parents' BMI, Waist Circumference, WHR, and total number of risk factors.</p>	<p>Chi square tests.</p> <p>Odds ratios</p> <p>Logistic regression analyses to determine associations between BMI and various combinations of risk factors.</p> <p>Holm's Sequential Bonferroni Method</p>
2a. Waist circumference and WHR for Jamaican adolescents will be positively associated with the total number of risk factors for T2DM and CVDs (high FBG, HbA1c, TC, BP, subjects' BMI, and presence of AN, and low PA, and family history of overweight, CVDs, and T2DM, and with each individual risk factor.	<p>Exposure: Waist Circumference and WHR</p> <p>Outcomes:</p> <p>Categorical variables; BP and family history of T2DM and CVDs, AN, and PA.</p> <p>Continuous variables: FBG, HbA1c, TC, subjects' BMI, Parents' BMI, some family history of CVDs, and T2DM, and total number of risk factors.</p>	<p>Pearson Correlations of WC and WHR with the total number of risk factors and with each individual risk factor for T2DM and CVDs.</p> <p>Holm's Sequential Bonferroni Method.</p>

Hypotheses	Types of Variables	Statistics
2b. Jamaican adolescents with family history of obesity (parents' BMI) will present with > BMI than those without family history of obesity as determined by anthropometric measures and self-reported data.	Exposure: Parents' BMI based on scale of 1-9 silhouettes corrected to BMI equivalents. Outcome: Actual BMI of subjects.	Spearman Correlations between parents' BMI and subjects' BMI
2c. Energy intakes of Jamaican adolescents will be positively associated with the total number of risk factors for T2DM and CVDs (high levels of FBG, HbA1c, TC, BP, waist circumference, WHR, and presence of AN, low PA, and family history of overweight, CVDs, and T2DM) and with each individual risk factor.	Exposure: Energy intakes (total calories from fat, protein and carbohydrates) Outcome: Categorical variables; BP and family history of T2DM and CVDs, AN, and PA. Continuous variables: FBG, HbA1c, TC, subjects' BMI, Parents' BMI, some family history of CVDs, and T2DM, and total number of risk factors.	Pearson Correlations of energy intake with the total number of risk factors and with each individual risk factor for T2DM and CVDs. Holm's Sequential Bonferroni Method

Hypotheses	Types of Variables	Statistics
2d. Intakes of complex and refined carbohydrates of Jamaican adolescents will be positively associated with the total number of risk factors for T2DM and CVDs (high levels of FBG, HbA1c, TC, BP, waist circumference, WHR, and presence of AN, low PA, and family history of overweight, CVDs, and T2DM) and with each individual risk factor.	<p>Exposure: Carbohydrates intakes (g) (complex and refined).</p> <p>Outcome: Categorical variables; BP and family history of T2DM and CVDs, AN, and PA.</p> <p>Continuous variables: FBG, HbA1c, TC, subjects' BMI, Parents' BMI, some family history of CVDs, and T2DM, and total number of risk factors.</p>	<p>Pearson Correlations of complex and refined carbohydrate intakes (g) with the total number of risk factors and with each individual risk factor for T2DM and CVDs.</p> <p>Holm's Sequential Bonferroni Method</p>
2e. Total fiber intake (g) of Jamaican adolescents will be negatively associated with the total number of risk factors for T2DM and CVDs (high levels of FBG, HbA1c, TC, BP, waist circumference, WHR, and presence of AN, low PA, and family history of overweight, CVDs, and T2DM) and with each individual risk factor.	<p>Exposure: fiber intake (g)</p> <p>Outcome: Categorical variables; BP and family history of T2DM and CVDs, AN, and PA.</p> <p>Continuous variables: FBG, HbA1c, TC, subjects' BMI, Parents' BMI, some family history of CVDs, and T2DM, and total number of risk factors.</p>	<p>Pearson Correlations of fiber intake (g) with the total number of risk factors and with each individual risk factor for T2DM and CVDs</p> <p>Holm's Sequential Bonferroni Method</p>

Hypotheses	Types of Variables	Statistics
2f. Intake of saturated and unsaturated fat, and intake of omega-3 and omega-6 fatty acids of Jamaican adolescents will be associated with the total number of risk factors for T2DM and CVDs (high levels of FBG, HbA1c, TC, BP, waist circumference, WHR, and presence of AN, low PA, and family history of overweight, CVDs, and T2DM) and with each individual risk factor.	<p>Exposure: % caloric intake of fat (Saturated, unsaturated).</p> <p>Outcome: Categorical variables; BP and family history of T2DM and CVDs, AN, and PA.</p> <p>Continuous variables: FBG, HbA1c, TC, subjects' BMI, Parents' BMI, some family history of CVDs, and T2DM, and total number of risk factors.</p>	<p>Pearson Correlations of gram intakes of saturated and unsaturated fat with the total number of risk factors and with each individual risk factor for T2DM and CVDs.</p> <p>Holm's Sequential Bonferroni Method</p>
3. There will be no significant differences between FBG, TC, and HbA1c measured by finger prick and venipuncture methods.	<p>Dependent: FBG, TC and HbA1c, outcomes for each variable.</p> <p>Independent: Methods of blood testing.</p>	<p>Two-sided paired sample t-test ($\alpha = 0.05$) for mean differences between the finger prick and venipuncture samples.</p> <p>Pearson correlations.</p> <p>Bland-Altman plot for agreement between the two methods of blood testing, sensitivity and specificity for validation of the tests, and percentage bias for random error.</p>

Data Monitoring and Safety

Protection against Potential Risk

The study was conducted with the permission of Institutional Review Board of Florida International University, the principals of each selected school and the parents of randomly selected students. Participants were informed that they have the right to withdraw from the study at any time. The participants were given a copy of the consent form and the other filed away at Florida International University in locked cabinets. Study subjects were informed of the purpose of the study, which was to examine Jamaican adolescents for risk of type 2 diabetes and cardiovascular diseases to determine if they are prone to diabetes and cardiovascular disease as seen in younger populations in other countries.

Participants were informed that the study consisted of two parts (screening and a randomly selected group of students) to participate in a smaller study for validation of the methods and they may be asked to participate in both parts. All students were screened for T2DM and CVDs disease risks using finger prick method for determining non-fasting blood glucose levels, TC, and HbA1c. Other measures included blood pressure, presence of AN, anthropometric data such as weight, height, waist circumference, WHR, demographic data, family history of obesity, diabetes, cardiovascular disease, dietary intakes, and physical activity levels.

Confidentiality of personal information and medical data was maintained by the researcher. Only investigators who were directly involved in this study had access to personal information and participants identity were not revealed in any publication from this study. Further confidentiality was maintained by identification of subjects by

personal identification numbers (PIN) only. Personal identification numbers were assigned from 01-300. The assigned identification numbers linking to subjects were known only to the researcher and kept safely in locked cabinets.

Benefits to Study Subjects.

Since adolescents are prone to obesity and obesity is associated with increased risks for T2DM and CVDs, this study was timely and provided much needed insight into planning intervention programs and encouraged early screening of adolescents to prevent these chronic diseases among this population. Subjects were given a free screening for T2DM and CVDs risks, had their food intakes analyzed, their BMI determined, their level of physical activity assessed and their risk of two debilitating chronic diseases determined. In addition, subjects were given a small compensation for their effort.

Quality Control

To ensure consistency with the study protocol, students were asked to complete a 12-hour fast before data collection. The researcher questioned the students if they have fasted. Those who have not fasted before blood testing were not tested. To allow for attrition, up to 5% more subjects than needed to give 80% power were recruited. High risk subjects were reported to the school nurse as part of the IRB agreement, for follow-up and discussion with the parents. Each school was given a digital scale and a blood pressure monitor by the researcher to help in the continued monitoring of adolescents' weights and blood pressure.

Anthropometric data such as weight and height were taken in a secluded room to allow for privacy of the subjects. Weights were taken in light clothing with shoes removed. Scale was disinfected after each use to prevent contamination and recalibrated at intervals. Examinations for AN were done by the school nurse and researcher in a private room (sick bay). All laboratory testing was done by the Central Medical Laboratory in Kingston to reduce variability among laboratory methods. Similarly, all finger prick tests were taken by the health team from the Heart Foundation of Jamaica using the Accu Chek Advantage for FBG and the Accutrend GCT for testing TC. All HbA1c finger prick tests were performed by the worker from Diabetes Association of Jamaica using the same equipment, the Nycocard manufactured by Axis-Shield.

Summary of Methods

Based on the evidence that obesity is related to T2DM, CVDs, and that these health conditions are increasing in adolescents, the present study screened for overweight and obesity, and lifestyle factors such as diet and physical activity levels among 276 randomly selected Jamaican adolescents in ten high schools in Jamaica. In addition, biochemical indices such as FBG, TC, and HbA1c were compared using finger prick and venous methods of 60 randomly selected students from the larger study group. Testing of this sub-sample was done to determine the validity of the finger prick method.

Anthropometric measures such as weight, height, body mass index, demographic data, blood pressure, presence or absence of Acanthosis Nigricans (AN), dietary intakes, physical activity levels, family history of overweight and obesity, T2DM, and cardiovascular diseases were also collected.

CHAPTER IV

RESULTS

Jamaican adolescents were studied for the presence of risk factors for T2DM and CVDs. Thirteen risk factors were examined to include subjects' body mass index (BMI), waist circumference (WC), waist-to-hip ratio (WHR), fasting blood glucose (FBG), total cholesterol (TC), glycated hemoglobin (HbA1c), blood pressure (BP), physical activity (PA), food intakes, family history of obesity, type 2 diabetes (T2DM) and cardiovascular diseases (CVDs), and presence of Acanthosis Nigricans (AN). Variables such as gender (male, female), ethnicity, (Blacks, non-Blacks), place of residence (rural, urban), and income levels (low, high) were examined to determine how each related to the risk factors of T2DM and CVDs. Additionally, data were collected on a sub-sample of Jamaican adolescents to compare the methods of blood testing (finger prick versus venipuncture) for screening at field conditions.

Demographic Characteristics

Of the 300 students who were recruited, 276 participated in the study (112 males and 164 females). Mean age was 15.6 ± 1.18 years. Of the 24 non-participants, 4 did not return the parental consent forms, 17 were absent due to an incessant rain experienced during the time of data collection (students were unavoidably absent), and 3 were removed from the data set due to incomplete data. Table 8 shows the demographic make-up of the sample.

The final sample included more females (N=164, 59.4%) than males (N=112, 40.6 %). Subjects were predominantly Black (78.2%) as expected since up to 91% of the island's population is Black. Only 11 (4.0%) of the participants were Indians. Of the Indian subjects, the majority (9) were females aged 14-16 years and were drawn from the rural schools. The mixed ethnic group comprised 17.0% (N=47) of the sample.

More subjects from the non-traditional (N=142, 51.4%) than the traditional (N=134, 48.6%) high schools participated in the study. Types of schools were used as a measure of SES. Typically, the traditional schools offer a more academic program and catered to the middle and upper class students. The majority of the sample were in the 16 year age group (N=82, 29.7%) followed by 15 (N=71, 25.7%) and 14 (N=61, 22.1%). A total of 136 (49.3%) rural and 140 (50.7%) urban subjects participated in the study.

Table 8

Demographic Characteristics of the Study Population (N=276)

Variables	n	%
Gender		
Male	112	40.6
Female	164	59.4
Ethnicity		
Black	216	78.2
Indian	11	4.0
Chinese	1	0.4
Caucasian	1	0.4
Mixed	47	17.0
School-Type		
Traditional	134	48.6
Non-traditional	142	51.4
Age (years)		
(Mean 15.6 ± 1.2)		
14	61	22.1
15	71	25.7
16	82	29.7
17	45	16.3
18	16	5.8
19	1	0.4
Place of Residence		
Urban	140	50.7
Rural	136	49.3
Grade level		
9	71	25.7
10	78	28.3
11	104	37.7
12	23	8.3

General Description of the Risk Factors

Anthropometric Measures

Table 9 shows frequencies, means, and standard deviations for the anthropometric measures. Heights ranged from 120 cm to 197 cm (168.2 ± 9.4). Weights ranged from 30 kg to 160 kg (67.3 ± 22.2). The overall mean BMI of the study population was 23.8 ± 7.7 and ranged from 12.9 to 50.8. More than one-third (42.4%) of the subjects had normal mean BMI (20.90 ± 1.76), 24.6% of the sample were underweight with mean BMI of 16.72 ± 1.30 , and 14.9% were overweight (BMI= 27.32 ± 1.38), 50 (18.1%) were obese; class I obese (n = 20, BMI = 32.34 ± 1.69), class II obese (n = 19, BMI = 36.83 ± 0.98), and class II obese (n = 11, BMI = 46.21 ± 8.43). When overweight and obese subjects were combined, 33.0 % (BMI = 35.67 ± 3.12) of the sample was classified as overweight putting them at risk for T2DM and CVDs.

Waist circumferences ranged from 55.0 cm to 129 cm (79.1 ± 14.3). Hip measurements ranged from 68 cm to 152 cm (97.7 ± 14.7). Measures of waist circumference classified n = 197 (71.3%) of the adolescents as not at risk for T2DM and CVDs, n = 29 (10.5%) had increased risk (≥ 94 cm and ≥ 80 cm for males and females) respectively, and n = 50 (18.1%) had substantial risk (≥ 102 cm and ≥ 88 cm for males and females). Overall, 28.6% of the sample had high WC which classified them at risk for CVDs or T2DM. Most of the sample (n = 255, 92.3%) fell within the normal range for a healthy WHR (<1.0 and $<.85$ for males and females) respectively. Measures of WHR classified only n = 21(7.6%) subjects at risk for T2DM and CVDs with WHR ≥ 1.0 and $\geq .85$ for males and females respectively.

Table 9
Anthropometric Measures of Study Subjects (N=276)

Risk Factors	n	Mean $\pm$ SD %
BMI		23.76 $\pm$ 7.72
Underweight (<18.5)	68	24.6
Normal (18.5-24.9)	117	42.4
Overweight (25.0-29.9)	41	14.9
Obese ($\geq$ 30)	50	18.1
Height (cm)		168.2 $\pm$ 9.4
Weight (kg)		67.3 $\pm$ 22.2
Waist Circumference		79.06 $\pm$ 14.2
Normal (< 94 cm M, < 80 cm F)	197	71.4
Increased risk ($\geq$ 94 cm M, $\geq$ 80 cm F)	29	10.5
Substantial risk ($\geq$ 102 cm M, $\geq$ 88 cm F)	50	18.1
Waist to Hip Ratio		0.80 $\pm$ 0.06
Healthy (<.85 for F, < 1.0 for M)	255	92.4
Increased risk ($\geq$.85 for F, $\geq$ 1.0 for M)	21	7.6

F = female M = male BMI = Body Mass Index

Table 10 shows the frequencies, means and standard deviations of selected risk factor indicators (FBG, TC, HbA1c, and BP) for CVDs and T2DM determined by finger prick measures. 39 (14.1%) of the sample was classified at risk with impaired fasting glucose (IFG) that is, FBG $\geq$ 100 and FBG <126 mg/dL and 3 (1.1%) classified as diabetic with FBG greater than 126 mg/dL. The total number of subjects classified at risk for T2DM because of high FBG was n = 42 (15.2%).

Most of the sample (n= 250, 90.6%) had normal TC levels with TC less than 170 mg/dL according to the National Cholesterol Education Program (NCEP) guidelines for children. However, 8.3% of the sample was classified at risk for CVDs with TC of 170 - 200 mg/dL (borderline). Only three participants had high levels of TC (TC > 200 mg/dL). For statistical analyses, subjects considered at risk for high TC included those with borderline as well as high levels of TC making a total of n = 26 (9.4%).

The majority of the sample (n = 202, 73.2%) were classified as having normal levels (< 6.5%) of HbA1c. Results indicated that FBG classified fewer subjects at risk for T2DM than measures of HbA1c (n = 42, 15.2% and n = 74, 26.8%) respectively. Finger prick measures of TC classified 9.4% of the subjects at risk for T2DM and CVDs as compared to FBG (15.2%) and HbA1c (26.8%).

Blood pressure was classified as normal, pre-hypertensive and hypertensive based on the NCEP guidelines which classify children and adolescents taking into account height, gender and age percentiles (Appendices Q and R). Mean systolic and diastolic BP (mm/Hg) were 116.8 ± 16.2 and 69.9 ± 10.9 respectively. The majority of the sample (n = 205, 74.3%) was classified as having normal BP which placed them in the < 90th percentile according to their age, gender, and height percentile with measures of systolic and diastolic blood pressure. Twenty-four subjects (8.7%) were classified as pre-hypertensive (between the 90th and 95th percentile), and n = 47 (17.0%) were classified as hypertensive (above the 95th percentile). For statistical analyses, subjects who classified in the 90-95th and above the 95th percentile were pooled and classified at risk for high BP (n = 71, 25.7%).

Table 10

Biochemical Risk Factors of CVDs and T2DM (N=276)

Risk Factors	n	%	Mean $\pm$ SD
Fasting Blood Glucose (mg/dL)			91.21 $\pm$ 10.53
Normal FBG (<100)	234	84.8	
IFG (100-126)	39	14.1	
Diabetes (>126)	3	1.1	
Total Cholesterol (mg/dL)			143.0 $\pm$ 21.32
Normal (<170)	250	90.6	
Borderline (170-200)	23	8.3	
Above normal (>200)	3	1.1	
HbA1c (%)			6.09 $\pm$ 1.33
Normal ($\leq$ 6.5)	202	73.2	
Above normal (> 6.5)	74	26.8	
Blood Pressure (mmHg)			
Systolic			116.8 $\pm$ 16.23
Diastolic			69.9 $\pm$ 10.90
Normal < 90 th Percentile	205	74.3	
Pre-hypertensive (90 th -95 th Percentile)	24	8.7	
Hypertensive (> 95 th Percentile)	47	17.0	

IFG=Impaired fasting glucose.

Physical Activity

Physical activity was measured using the Physical Activity Questionnaire for Children (PAQ-C) (Appendix M) which examined activities in and out of school and on weekends. The scale has nine items all rated equally on a five point likert type scale which ranged from no activity to more than 7 times per week. Each question had five responses and was scored from 1-5 where 1 = inactive (student did not participate in that particular activity at all), 2 = low activity level (activity was performed 1-2 times in the past seven days), 3= moderately active (activity was performed 3-4 times in the past seven days, 4= active (activity was performed 5-6 times in the past seven days, 5 = very

active (activity was performed > 7 times in the past seven days). An average of all 9 items was taken to determine the activity level of the subject. The mean physical activity score was 2.2 ± 0.6 (Table 11) which indicated that subjects participated in physical activities on an average of 1-2 times per week. Low physical activity level was based on an average of two or less times of PA per week. The majority of the subjects ($n = 169$, 61.2%) participated in physical activities more than two times per week compared to 107 (38.8%) who participated in physical activities two times or less per week.

Table 11

Physical Activity, Family History of T2DM, CVDS, and Obesity (N=276)

Risk Factors	n	%	Mean $\pm$ SD
Physical Activity			2.20 $\pm$ 0.60
Low (PA $\leq$ 2 x/wk)	107	38.8	
High (PA > 2 x/wk)	169	61.2	
Family History T2DM			
Yes	145	52.5	
No	131	47.5	
Family History CVDS			
Yes	82	29.7	
No	194	70.3	
Family History Overweight			
Yes	181	65.6	
No	95	34.4	

Other measures of physical activity included number of hours per week spent on watching television and playing computer games (Appendix F). Results ranged from 0 to

84 hours per week (10.7 ± 13.5) for watching television. Thirty-one subjects (11.2%) did not watch television, reportedly they had none. Hours spent on playing computer games ranged from 0 to 60 hours per week (5.9 ± 10.3). Over one third ($n=106$, 38.4%) of the sample did not play computer games.

When asked if they considered themselves to be physically active, the majority of the subjects said yes ($n = 211$, 76.4%) and 6 (2.2%) of the subjects did not respond. However, when they rated themselves on the PAQ-C (Appendix M), only 61.2% were physically active.

Table 11 showed that more of the subjects had parents with T2DM ($n = 144$, 52.5%) than CVDs ($n = 82$, 29.7%). Family history of overweight and obesity was determined if either parent had BMI ≥ 25.0 which represented a scale of 5 to 9 on the silhouettes. Results indicated that about two thirds of the sample (65.6%) reported family history of overweight and obesity.

Presence of Acanthosis Nigricans (AN)

The presence of AN was determined by examining the neck, knuckles, elbows and knees of each subject. The instrument used for determining the presence of AN was developed and used by Burke et al (1999) and comprised different scales for measuring the presence or absence of AN on the neck, elbows, knuckles, and knees (Appendix L). The scale also measured the severity of the condition on the neck and axilla. However, in this study, presence of AN on the axilla was not evaluated. Acanthosis Nigricans is easily recognized by lines of pigmentation on the neck. Therefore, grading of AN was done using pictures which represented the severity of physical signs on the neck

(Appendix L). For analysis purposes, presence of AN was determined with the neck measures only (Table 12). Acanthosis Nigricans on the neck was graded from 1-4 in severity with grade 1 representing a thin visible line on the neck; grade 2 = 1-2 cm, grade 3 = 2-3 cm, and grade four >3 cm in width (Acanthosis Nigricans: The Education and Screening Program ANTES).

Table 12
Presence and Severity of Acanthosis Nigricans (AN) (N=276)

Scale	n	%
Presence of AN on neck		
Present	122	44.2
Absent	154	55.8
Neck Texture		
1 smooth	50	41.0
2 rough	30	24.6
3 coarse	35	28.7
4 extremely coarse	7	5.7
Knuckles		
Present	47	17.0
Absent	229	83.0
Elbows		
Present	41	14.9
Absent	235	85.1

Up to 122 (44.2%) of the adolescents had physical signs of AN as observed on the neck region. Further examination of neck texture revealed that 50 (41%) had visible signs of AN, however, the neck texture was smooth to the touch (grade one). Thirty subjects (24.6%) had visible signs of AN on the neck with a texture that was just rough to

the touch (grade two), 35 (28.7%) had grade three AN which represents coarse texture with signs that were highly visible, and 7 (5.7%) had severe (extremely coarse) AN (grade 4 $\geq$ 3 cm in width).

Total Number of Risk Factors for T2DM and CVDs

A total of thirteen risk factors were examined. Twelve were coded into risk versus no risk categories and analyzed with logistic regressions. Food intake values were analyzed for total energy and individual macronutrients and their relationship to the risk factors of T2DM and CVDs using Pearson Correlations. For each of the twelve risk factors used in the logistic regressions, 1 represented risk and 0 represented no risk. The following cut-off points were used as at risk for each risk factor: BMI $\geq$ 25, waist circumference (WC $\geq$ 94 cm and $\geq$ 80 cm for males and females), waist-to-hip ratio (WHR $<$ 1.0 and $<$.85 for males and females) respectively, fasting blood glucose (FBG $\geq$ 100 mg/dL), total cholesterol (TC $\geq$ 170 mg/dL), glycated hemoglobin (HbA1c $>$ 6.5%), blood pressure (BP $>$ 90th percentile), physical activity (PA $\leq$ 2 times/week), positive family history of overweight, type 2 diabetes (T2DM) and cardiovascular disease (CVDs), and presence of Acanthosis Nigricans (AN) on the neck.

Table 13 shows that 66.7% of adolescents had three or more risk factors present (3.78 ± 2.32). Twelve risk factors were included in the analysis. Results showed the presence of risk factors ranged from 0-10 with one Black, male, rural participant reporting ten out of twelve risk factors for CVDs and/or T2DM. Twelve subjects reported zero risk factors for T2DM and CVDs and 36 reported only one risk factor. No one reported 11 or 12 risk factors.

Table 13

Number of Risk Factors¹ for CVDs and/or T2DM (N=276)

Number of Risk Factors	n	%	Cumulative %
0	12	4.3	4.3
1	36	13.0	17.4
2	45	16.3	33.7
3	44	15.9	49.6
4	47	17.0	66.7
5	30	10.9	77.5
6	22	8.0	85.5
7	16	5.8	91.3
8	13	4.7	96.0
9	10	3.6	99.6
10	1	0.4	100.0

Risk factors were coded as 1 = risk and 0 = no risk based on cut-off points for each risk factor. ¹Risk factors present ranged from 0-10. Mean number of risk factors = 3.78 ± 2.32

Figure 1 shows a comparison of overweight and obese subjects with normal weight subjects and the distribution of the risk factors. Twelve risk factors were coded and factored into the comparison. The number of risk factors present ranged from 0-10. The sample consisted of more normal weight (n = 185, 67%) than overweight and obese (n = 91, 33.0%) subjects. Sixteen percent (n = 45) of the normal weight subjects reported 2 risk factors compared to one overweight subject who reported two risk factors for T2DM and CVDs. As the number of risk factors increased to five or more, more overweight and obese subjects reported greater numbers of risk factors than their non-obese counterparts. Cross-tabulation of the number of risk factors with BMI levels

revealed that of the 91 subjects with high BMI, 98% (n = 90) had more than 3 risk factors compared to 46% (93 out of 185) of the subjects with normal BMI who reported three or more risk factors for T2DM and CVDs.

Figure1. Comparison of Overweight and Normal Weight Subjects by Number of Reported Risk Factors for T2DM and CVDs

Number of Risk Factors and Metabolic Syndrome

The metabolic syndrome (METS) is a cluster of risk factors which include abdominal adiposity, dyslipidemia, impaired glucose tolerance and high blood pressure (Li & Ford, 2007). Metabolic syndrome is determined by the presence of three or more selected risk factors. According to the National Cholesterol Education Program (NCEP) Adult Treatment Panel III in the USA (2006), presence of any three of the five components of CVDs risk to include central obesity, high blood pressure, high

triglycerides, low HDL-C, and fasting hyperglycemia constitute the METS. In the current study comparison was made using five selected risk factors; HbA1c, FBG, TC, BP, and central adiposity (high WC) to determine the presence of metabolic syndrome.

High FBG (>100 mg/dL) according to the ADA (2005) guidelines, and HbA1c $> 6.5\%$ based on the International Federation of Diabetes (Nakamota, 2006) were used as surrogates for hyperglycemia and subsequent risk for T2DM. Adult standards of WC ≥ 94 cm and ≥ 80 cm for males and females respectively were used for determining central adiposity. The NCEP guidelines for children and adolescents of BP $\geq 90^{\text{th}}$ percentile based on age, height percentile and gender along with TC ≥ 170 mg/dL were considered at risk for CVD. BMI was classified using the International Obesity Task Force (IOTF) standard classification where BMI of ≥ 25 indicated overweight.

A cross comparison of these five risk factors and BMI indicated that 31 (34.1%) of the subjects with high BMI had 3 or more of these five selected risk factors compared to 7 (3.78%) subjects with normal BMI who also had three or more risk factors. Overall, one third of the overweight subjects were classified as having metabolic syndrome with 3 or more of the five selected risk factors. When normal weight and overweight subjects were combined, 13.7% of the overall sample had three or more of the five selected risk factors.

Results Relating to Hypotheses Testing

Results of Hypothesis One

Hypothesis one stated that gender, ethnicity, place of residence, and income would be positively associated with the number of risk factors for T2DM and CVDs

(high levels of FBG, HbA1c, TC, BP, parents' BMI, waist circumference, WHR, and presence of AN, low PA, and family history of CVDs, and T2DM) and with each individual risk factor. Logistic regression analyses (Table 14) showed significance for all four demographic variables and certain risk factors ($p < .05$).

Gender predicted FBG ($p = .040$), WC ($p = .041$), AN ($p = .013$), PA ($p < .001$), family history of CVDs ($p = .030$), and total number of risk factors ($p = .010$). Males had significantly higher FBG compared to females. However, females were more at risk for high WC, low PA, presence of AN, family history of CVDs, and higher numbers of risk factors. Ethnicity was significant only for predicting family history of T2DM ($p = .019$) with more Blacks ($n = 103$, 71.5%) reporting family history of T2DM compared to non-Blacks ($n = 41$, 28.5%). Place of residence significantly predicted BMI ($p = .018$), WC ($p = .021$), PA ($p = .032$), and family history of obesity ($p = .01$). Urban subjects had significantly higher BMI, higher PA and higher WC, but lower family history of overweight/obesity.

Household income was significant for predicting TC ($p = .039$), family history of CVDs ($p = .016$), and family history of obesity ($p = .014$) (Table 14). Subjects from lower income families had significantly higher levels of TC compared to subjects from higher income families. Subjects from the higher income group reported significantly more family history of CVDs and overweight/obesity. However, when controlled for type 1 error using the Holm's Sequential Bonferroni Method, based on the large numbers of tests performed, results were significant only for gender and PA in the logistic regression. Of the number of subjects who were at risk for low PA, a higher percentage of females

(n =79, 48.2%) were physically inactive than males (n = 28, 25.0%). Females were significantly more at risk for low physical activity than males, $p < .001$ (OR 2.7, 95% CI 1.6 to 4.76).

Gender was also significant for the total number of risk factors ($p = .010$) in the multiple regression. An equal number (6) of male and female reported zero risk factors. Similarly, 18 males and females reported one risk factor, and slightly higher number of males (25 vs. 20) reported two risk factors for T2DM and CVDs. Females dominated as the number of risk factors increased from 3 to 9. However, one male reported 10 risk factors. Cross-tabulation of gender and number of risk factors showed more females (n = 120, 73.2%) had ≥ 3 risk factors compared to males (n = 63, 52.25%).

Table 14

Relationships among Gender, Ethnicity, Place of Residence, Income and Risk Factors of T2DM and CVDs

Risk Factors	Model P value	Gender (Male)			Ethnicity (Non-Black)		
		OR	95% CI	P value	OR	95% CI	P value
High FBG	.332	2.01	1.03-3.93	.040	0.86	0.37-2.0	.729
High TC	.036	0.61	0.25-1.5	.281	0.36	.07-1.45	.141
High BMI	.100	0.64	0.37-1.09	.101	1.03	0.55-1.93	.917
High WC	.043	0.56	0.32-0.97	.041	0.88	0.46-1.69	.708
Presence of AN	.080	0.53	0.32-0.87	.013	0.66	0.36-1.21	.175
Low PA	<.001	0.36	0.21-0.62	< .001*	1.20	0.66-2.25	.536
¹ Family history T2DM	.007	0.70	0.43-1.1	.163	2.09	1.13-3.9	.019
¹ Family history CVDs	.003	0.53	0.30-0.94	.030	1.68	0.90-3.1	.100
¹ Family history Obesity	.014	1.05	0.64-1.78	.844	0.62	0.34-1.16	.133
Total # of risk Factors			$\beta = -.16$	.010*		$\beta = .02$	.765

¹ represents positive family history of disease. Regression model used for total number of risk factors.

*considered significant after controlling for type 1 error.

Table 14 (cont'd)

Relationships among Gender Ethnicity, Place of Residence, Income and Risk Factors of T2DM and CVDs

Risk Factors	Model P value	Place of Residence (Urban)			Household Income (Low)		
		OR	95% CI	P value	OR	95% CI	P value
High FBG	.332	0.81	.42-1.6	.555	0.92	.53-2.21	.829
High TC	.036	1.20	0.52-2.78	.674	3.70	1.06-12.8	.039
High BMI	.100	1.87	1.1-3.14	.018	1.03	0.58-1.76	.955
High WC	.043	1.90	1.1-3.2	.021	0.79	0.45-1.37	.398
Presence of AN	.080	0.88	0.54-1.44	.618	0.04	0.56-1.59	.817
Low PA	<.001	0.57	0.35-0.95	.032	1.10	0.66-1.98	.633
¹ Family history T2DM	.007	1.20	0.78-2.08	.329	0.60	0.35-1.02	.057
¹ Family history CVDs	.003	0.77	0.45-1.3	.342	0.51	0.29-0.88	.016
¹ Family history Obesity	.014	0.54	0.32-0.90	.019	0.49	0.27-0.87	.014
Total # of risk Factors			$\beta = -.02$	.684		$\beta = -.08$	.191

¹ represents positive family history of disease.

Hypothesis Two: Predicting Risk Factors of T2DM and CVDs

It was hypothesized that overweight and obese Jamaican adolescents would have at least one of the following risk factors for T2DM and CVDs: high FBG, HbA1c, TC, BP, WC, WHR, and presence of AN, low PA, family history of obesity (Parent's BMI), CVDs, and T2DM. Cross-tabulation of BMI on each of the individual risk factors of T2DM and CVDs (Table 15) and chi square analyses revealed significant results for WC (OR= 119.20, $p < .001$), presence of AN (OR =28.45, $p < .001$), WHR (OR =7.70, $p < .001$), TC (OR= 5.50, $p < .001$), BP (OR = 4.60, $p < .001$), and family history of T2DM (OR= 2.83, $p < .001$). In all cases overweight/obese subjects were more likely to be at risk for T2DM and CVDs. Fasting blood glucose ($p = .076$), HbA1c ($p = .062$), physical activity ($p = .850$), and family history of CVDs ($p = .554$) were not significant predictors of BMI. Family history of obesity (OR = 1.89, $p = .031$), was not significant when using the Holm's Sequential Bonferroni Method to control for type one error but was significant at the .05 level of significance.

Waist Circumference, AN, WHR, TC, BP, and family history of T2DM were the most prevalent significant risk factors of T2DM and CVDs for overweight and obese subjects. Overweight/obese subjects were 119 times more likely to have higher WC than their underweight/normal weight counterparts. They were 28 times more likely to present with AN as observed on the neck region.

Table 15

Cross-tabulations and Odd Ratios of Individual Risk Factors with BMI Classifications (N= 276)

Risk Factors	Underweight/ Normal (n= 185) BMI < 25		Overweight/ Obese (n = 91) BMI ≥ 25		OR	95% CI	P value
	N	%	n	%			
Fasting Blood Glucose (≥100mg/dL)	23	12.4	19	20.9	1.86	0.95-3.6	.076
Total Cholesterol (≥170mg/dL)	8	4.3	18	19.8	5.50	2.3-13.1	<.001*
HbA1c (> 6.5%)	43	23.2	31	34.1	1.71	0.98-2.9	.062
Blood Pressure (≥ 90 th Percentile)	29	15.7	42	46.2	4.60	2.6-8.2	<.001*
Waist Circumference (≥ 94 cm male, ≥ 80 cm female)	7	3.8	75	82.4	119.20	47.1-30.1	<.001*
Waist-to-hip Ratio (≥ 1 male, ≥.85 female)	5	2.7	16	17.6	7.70	2.7-21.7	<.001*
Presence of Acanthosis Nigricans	41	22.2	81	89.0	28.45	13.5-59.8	<.001*
Low Physical Activity (≤ 2 x/week)	71	38.4	36	39.6	1.05	0.63-1.7	.850
Family History of T2DM	82	44.3	63	69.2	2.83	1.67-4.8	<.001*
Family History of CVDs	55	29.2	27	29.6	0.99	0.58-1.7	.554
Family History of Obesity	113	61.1	68	74.7	1.89	1.1-3.3	.031

* Significant using Holm's Sequential Bonferroni Method, overall $\alpha = .05$

Overweight and obese subjects were 7.7 times more likely to have high WHR, 5.5 times more likely to have high TC, and 4.6 times more likely to have high BP than their underweight and normal weight counterparts. Overweight and obese subjects reported more family history of T2DM, and were 2.8 times more likely to have family history of T2DM (Table 15).

Logistic Regression of the Relationship between BMI and the Risk Factors of T2DM and CVDs

Two logistic regression models were estimated; one with WC and the other with WHR since the variables were highly correlated with each other. The regression model (Table 16) which included waist-to-hip-ratio, revealed significant results for AN (OR =22.80, 95% CI = 9.8-52.8, $p < .001$), WHR (OR= 9.10, 95 % CI = 2.2-37.6, $p < .001$), TC (OR= 5.30, 95% CI = 1.5-18.9, $p < .01$), and family history of T2DM (OR= 3.70, 95% CI = 1.7-8.1, $p < .001$). With this model, the highest odds of being overweight or obese related to the presence of AN. Subjects with Acanthosis Nigricans were 22.8 times more likely to be overweight/obese. Subjects with high WHR were 9.1 times more likely to be overweight/obese than those with lower WHR. Subjects with high TC (>170 mg/dL) were 5.3 times more likely to be overweight or obese. Similarly, subjects with family history of T2DM were more likely (3.7 times) to be overweight/obese.

When waist circumference was factored into the regression model, significance was found only for waist circumference (OR =53.2, 95 % CI = 17.54 -161.1, $p < .001$), and presence of AN (OR = 4.8, 95% CI = 1.7- 13.9, $p < .01$).

Table 16

Logistic Regression Analysis of BMI with Risk Factors for T2DM and CVDs (N= 276)

Risk Factors	With Waist Circumference ¹			With Waist-to-Hip Ratio ²		
	OR	95 %CI	p value	OR	95 %CI	p value
Fasting Blood Glucose ($\geq 100\text{mg/dL}$)	1.20	0.35-4.2	.754	1.20	.46-2.8	.764
Total Cholesterol ($\geq 170\text{mg/dL}$)	2.80	0.62-12.9	.182	5.30	1.5-18.9	.009*
HbA1c ($>6.5\%$)	1.70	0.62-4.76	.332	1.0	0.44-2.4	.971
Blood Pressure ($\geq 90^{\text{th}}$ Percentile)	2.20	0.78-6.3	.137	2.90	1.3-6.3	.010
Waist Circumference (≥ 94 cm male, ≥ 80 cm female)	53.20	17.54-161.1	$<.001^*$	-	-	-
Waist-to-hip Ratio (≥ 1 male, $\geq .85$ female)	-	-	-	9.10	2.2-37.6	$<.001^*$
Presence of AN	4.80	17-13.9	.003*	22.80	9.8-52.8	$<.001^*$
Physical Activity (≤ 2 x/week)	.80	0.31-2.9	.731	0.83	0.39-1.7	.614
Family History of T2DM	3.20	1.2-8.5	.024	3.70	1.7-8.1	$<.001^*$
Family History of CVDs	.50	.15-1.42	.175	0.55	0.24-1.3	.174
Family History of Obesity	1.40	0.49-4.2	.510	1.30	0.57-2.9	.542

* Significant using Holm's Sequential Bonferroni Method, overall $\alpha = .05$ for each regression using WC and WHR¹ Model χ^2 (10, N=276) = 219.66, $p < .001$ ² Model χ^2 (10, N=276) = 157.46, $p < .001$

Overweight or obese subjects were 53 times more likely to have high WC than their underweight or normal weight counterparts. Overweight or obese subjects were 4.8 times more likely to have AN than their underweight or normal weight counterparts. A comparison of both models revealed that the presence of AN was the strongest predictor of high BMI in the two logistic regressions after WC or WHR (Table 16).

Relationship between WC and WHR and Risk for T2DM and CVDs

Hypothesis 2a stated that waist circumference (WC) and waist-to-hip ratio (WHR) would be associated with the risk factors of T2DM and CVDs. Waist Circumference $\geq$ 94 cm for males and $\geq$ 80 cm for females increased the risk for T2DM and CVDs in adults (Ramchandaran, 2004). Waist-to-hip ratios of 1.0 for males and 0.85 for females or above were used to determine those at risk for T2DM and CVDs. Measures of WC ranged from 55-129 cm for females and 60-118 cm for males. The mean WC was 82.5 cm for males and 76.7 cm for females. High WC classified $n=79$ (28.6%) of the study subjects at risk for T2DM and CVDs compared to WHR $n=21$ (7.6%) (Table 9). Table 17 shows Pearson Correlation coefficients for WC, WHR and the risk factors of T2DM and CVDs.

Waist circumference positively correlated with BMI ($r=.77$, $p<.001$), total number of risk factors ($r=.66$, $p<.001$), BP ($r=.39$, $p<.001$), and weakly but significantly correlated with FBG ($r=.17$, $p=.014$), family history of obesity ($r=.16$, $p=.008$), TC ($r=.14$, $p=.018$), and family history of T2DM ($r=-.13$, $p=.027$). However, when controlled for type one error using the Holm's Sequential Bonferroni Method, these weak correlations were no longer considered significant.

There were positive correlations for WHR and physical activity ($r = .22$, $p < .001$), BMI ($r = .16$, $p = .009$), and total number of risk factors ($r = .16$, $p = .008$). Larger WC was associated with higher BMI, higher BP, higher FBG, more risk factors, and positive family history of obesity. High WHR was associated with low physical activities, higher BMI, and more risk factors for T2DM and CVDs.

Table 17

Relationship between WC and WHR to Risk Factors of T2DM and CVDs (N=276)

Risk Factors	Waist Circumference		Waist To Hip Ratio	
	r	p value	r	p value
Fasting Blood Glucose (mg/dL)	.17	.004*	.15	.011
HbA1c (%)	.04	.543	.02	.790
Total Cholesterol (mg/dL)	.14	.018**	.06	.348
Blood Pressure (percentile)	.39	<.001*	.07	.242
BMI	.77	<.001*	.16	.009*
Acanthosis Nigricans (AN)	.59	<.001*	.08	.171
Physical Activity	.06	.359	.22	<.001*
Family history of T2DM	-.13	.027**	.01	.897
Family history of CVDs	.02	.764	.01	.931
Family history of Obesity	.16	.008*	.01	.937
Total # of risk factors	.66	<.001*	.16	.008*

* Significant using Holm's Sequential Bonferroni Method, overall $\alpha = .05$ for each set of correlations. Note. AN, PA, family history of T2DM, CVDs, and obesity were coded as 0 = no risk, 1 = risk. ** no longer significant after controlling for type one error.

Relationship between Family History of Obesity and Subjects' Obesity

Hypothesis 2b stated that subjects with family history of obesity would be obese. Family history of obesity was determined by asking students to identify a figure from the silhouettes (Appendix P) using a scale of 1 to 9 which represented 9 levels of BMI categories for both mother and father of the subjects. Scales of 5 and 6 were considered overweight and 7 to 9 represented obesity. Scales were converted to actual BMI levels (Appendix P) and used in the descriptive comparison of parents and subjects' BMI (Figure 2). Subject's BMI was determined by actual measurements of height and weight.

Figure 2 shows comparison of subjects' and parents' BMI. Results revealed that there were more overweight and obese mothers ($n = 140$, 52.4%) than fathers ($n = 121$, 47.5%). There were higher percentages of fathers (52.5%) than children (42.4%) and mothers (43.4%) in the normal weight category. There were some underweight mothers ($n = 11$, 4.2%) but no father was reported as underweight. Fathers were not classified as underweight since the cut-off BMI value for underweight was 18.5 and the lowest scale for males represented a BMI of 19.3. Results showed a higher percentage of children (18.1%) than mothers (11.6%) and fathers (11.8%) in the obese category.

Figure 2. Comparison of Subjects' and Parents' BMI

Family history of obesity was determined if one parent had BMI ≥ 25 . This was coded using categorical variable of 1 for family history and 0 for no family history of obesity. Table 18 and figure 2 show the means, standard deviations and correlations of subjects' and family BMI. Spearman's correlation showed a weak but significant association between family history of obesity and subjects' obesity ($r = .19, p < .001$). Positive weak correlations were found between mother and child's BMI ($r = .15, p < .05$), and between father and child's BMI ($r = .19, p < .001$). Mean BMIs were 23.8 ± 7.7 for subjects, 23.8 ± 6.5 for mothers, and 23.1 ± 7.4 for fathers (Table 18). A detailed comparison of BMI categories for subject and parents (Appendix S) was performed.

Results showed that overweight and obese parents were likely to have children who were also overweight and obese.

Table 18

Spearman Correlations of Subjects' and Parents' BMI (N=276)

Variables	n	Mean $\pm$ SD	r	P value
Subjects' BMI ^a	276	23.8 $\pm$ 7.7		
Mothers' BMI ^b	267	24.8 $\pm$ 6.5	.15 ^{ab}	.020*
Fathers' BMI ^c	255	23.1 $\pm$ 7.4	.19 ^{ac}	.001*
Family History of Obesity ^d			.19 ^{ad}	.001*

Comparison of subjects BMI and family history of obesity coded as 0 = risk and 1 = no risk.

Macronutrient Intakes

Food intakes were measured by a 24-hour recall using the USDA Multiple Pass method. A 24-hour food recall was considered adequate for testing food intakes as demonstrated by the pilot study conducted with a similar population. The pilot study examined the relationship between macronutrient intakes using 24 hour recall compared to 48 and 72 hour recalls. Paired samples t-tests were used to determine if there were significant differences between macronutrient intakes for the 24 hour period compared to 48 and 24 compared to 72 hours. There were no significant differences in gram intakes of carbohydrates (221 $\pm$ 102) for 24 hour recall compared to 48 hours (224.6 $\pm$ 91.8) and between the 24 hour recall and 72 hours of food recall (243 $\pm$ 85.7) ($p > .05$). Comparison of fat (g) intakes showed no significant differences between 24, 48 and 72 hours ($p > .05$).

Mean fat (g) intakes were 47.6 ± 23.3 , 57.4 ± 51.0 , and 54.4 ± 37.3 for the 24, 48 and 72 hours respectively. Protein (g) intakes over the same periods were 60.8 ± 35.8 , 69.6 ± 48.8 , and 68.6 ± 35.12 respectively and no significant differences were found ($p > .05$). Fiber (g) intakes showed no significant differences ($p > .05$) for the 24 hour (5.35 ± 3.93), to 48 hours (14.24 ± 47.45) and 24 hour to 72 hours (11.66 ± 31.72). Total kilocalorie intakes showed no significant differences for 24 hours compared to 48 and 24 to 72 hours of food intakes ($p > .05$). Mean kilocalorie intakes were 1564.04 ± 664.83 , 1649.22 ± 543.67 and 1640.29 ± 531.48 for the same time periods. Results of the pilot test indicated that one 24 hour recall of Jamaican adolescents was an acceptable measure of their usual dietary intake of calories, fiber, and macronutrients. No statistically significant differences were noted when comparing 24 hour dietary recall to 48 and 24 hour to 72 hours diet recalls for the select diet parameters.

The relationship between the individual macronutrients, total kilocalories, and fat types were examined. Table 19 shows mean (g) intakes of macronutrients by meals. Overall, food intakes fell within normal ranges for the Acceptable Macronutrient Distribution Ranges (AMDR); for the Dietary Reference Intakes; for the USA and Canada (USDA Dietary Reference Intake, 2002) for all three macronutrients (Table 19). AMDR for carbohydrates is 45-65 % and mean intake of this sample was 58.1%. Recommended fiber intake for 14-18 year old males and females are 38g/d and 26g/d respectively. Overall mean intake of fiber was 14.4 ± 9.6 . According to the Food and Nutrition Board, Institute of Medicine, National Academies (USDA Dietary Reference Intake, 2002) sugar intake should not be more than 25% of total energy intake.

Percentage sugar intake was 15.8% which fell within the recommended limit. The AMDR for fat is 20-35% whereas the mean of percentage fat intake in this study was 27.9%. The AMDR for protein is 10-35% and mean percentage intake was 15.5% which was within the recommended range for proteins. Intakes of saturated fats were within the normal range. Recommended saturated fat intake is 7-10% and the mean was reported as 8.3%. However, intakes of unsaturated fats were below the recommended ranges in this sample. Recommended intake of monounsaturated fat is 10-15% and the reported mean was 9.2%; and polyunsaturated fat intake is 10-35% and the mean intake was 5.5% for this sample.

In general, the total kilocalorie intake for 14-18 year olds according to the US and Canadian Dietary Reference Intakes is 2368 kcals/d. However, the mean kilocalorie intake of the adolescent in this study was 1850.4 ± 869 . Lunch provided the most kilocalories of the day (647.7 ± 397 kcals). A total of 81 (29.3%) participants missed or skipped breakfast. Fiber intake was low at all three meals with an overall mean daily intake of 14.4 ± 9.6 . Intakes of refined sugars were highest at the lunch meal (30.8 ± 33.3 g) due to the high percentage of carbonated and other beverages that the adolescents had with their lunch meal.

Intakes of omega-3 fatty acids and trans fats were low. A total of 210 (76%) subjects reported eating foods containing omega-3 fatty acids but at very low intakes compared to 95 who reported consuming foods containing omega-6 fatty acids. Adequate Intake for omega-6 is 5-10% of daily energy intakes and for omega-3 fatty acids it is 0.6-1.2%. In this sample intakes of both fatty acids were negligible 1.1 g and 0.4 g respectively.

Table 19
Caloric and Macronutrient Intakes Estimated by 24-hour Recall (N=276)

Energy and Nutrient Intakes	Mean $\pm$ SD				
	Breakfast	Lunch	Dinner	Snack	24 hour
Total kcals	319.6 $\pm$ 332.4	647.7 $\pm$ 396.8	593.0 $\pm$ 371.4	289.7 $\pm$ 407.0	1850.05 $\pm$ 869.9
Total carbohydrate(g)	59.8 $\pm$ 41.8	94.6 $\pm$ 58.9	88.5 $\pm$ 69.9	42.7 $\pm$ 60.9	268.5 $\pm$ 130.7
Fiber (g)	3.0 $\pm$ 3.7	3.6 $\pm$ 3.2	5.8 $\pm$ 6.5	1.8 $\pm$ 2.9	14.2 $\pm$ 9.7
Sugar (g)	11.4 $\pm$ 14.6	30.9 $\pm$ 33.3	11.6 $\pm$ 17.0	18.5 $\pm$ 34.2	72.4 $\pm$ 59.3
Starch (g)	26.6 $\pm$ 33.8	46.6 $\pm$ 39.3	66.8 $\pm$ 51.1	18.5 $\pm$ 27.0	158.5 $\pm$ 90.7
Protein (g)	11.4 $\pm$ 13.6	25.7 $\pm$ 22.0	28.3 $\pm$ 19.2	6.2 $\pm$ 12.2	71.6 $\pm$ 37.8
Total fats (g)	12.6 $\pm$ 15.9	18.3 $\pm$ 14.2	14.9 $\pm$ 16.1	11.4 $\pm$ 16.4	57.3 $\pm$ 35.7
Saturated Fats (g)	3.6 $\pm$ 4.3	5.7 $\pm$ 4.6	3.4 $\pm$ 3.2	4.5 $\pm$ 7.9	17.1 $\pm$ 11.9
Monounsaturated Fats (g)	4.7 $\pm$ 6.7	6.1 $\pm$ 6.2	5.3 $\pm$ 6.5	2.8 $\pm$ 5.3	18.9 $\pm$ 13.5
Polyunsaturated Fats (g)	2.9 $\pm$ 4.9	3.2 $\pm$ 3.4	3.8 $\pm$ 5.5	1.4 $\pm$ 2.9	11.3 $\pm$ 9.5
Omega-3 FA (g)	0.07 $\pm$ 0.7	0.1 $\pm$ 0.8	0.2 $\pm$ 1.1	0 $\pm$ 0	0.3 $\pm$ 1.5
Omega-6 FA (g)	0.09 $\pm$ 0.7	0.1 $\pm$ 0.8	0.2 $\pm$ 1.0	0.03 $\pm$ 0.4	0.4 $\pm$ 1.5
Transfats (g)	0.03 $\pm$ 0.1	0.1 $\pm$ 0.8	0.2 $\pm$ 1.1	0.03 $\pm$ 0.0	0.2 $\pm$ 1.1
Cholesterol (mg)	64.5 $\pm$ 108.4	59.1 $\pm$ 74.2	75.7 $\pm$ 106.6	10.4 $\pm$ 25.8	139.6 $\pm$ 133.9

Only 60 subjects reported consuming foods which contained trans fatty acids at very low levels. Mean cholesterol intake (139.6 ± 133.9) was lower than the suggested 300 mg/d with 263 (95.3%) of the subjects reported consuming foods with cholesterol (Table 19).

Correlations of Macronutrients and Risk Factors of T2DM and CVDs

Correlations for the macronutrients and the risk factors of T2DM and CVDs were performed. Results indicated significant correlations for some of the risk factors of T2DM and CVDs at the .05 level of significance (Appendices T, U, and V). Although the correlations were significant, none reached moderate effect size ($r = .3$) (Cohen, 1988). Consideration was given to the high numbers of risk factors and macronutrients that were compared in our analyses. Therefore, the Holm's Sequential Bonferroni Method (Holm's, 1979) was applied to reduce type 1 error.

Hypothesis 2c to 2f examined the correlations between macronutrient (g) intakes and the twelve risk factors studied. It was expected that higher intakes of refined carbohydrates, total fat, types of fats, and total kilocalories would positively correlate with high BMI, WC, and presence of AN. Variables were weakly correlated ranging from $-.18$ between WC and total fat to $.10$ between PA and total carbohydrate. After controlling for type 1 error, significance was found only between WC and total fat intakes ($r = -.18$, $p = .003$) and between the presence of AN and fiber intakes ($r = -.18$, $p = .003$). Lower intakes of fats were associated with higher WC, and lower fiber intake was associated with presence of AN. The risk factors of T2DM and CVDs and types of fats consumed (Appendix V) were not significant after controlling for type 1 error.

Results of Hypothesis 3

Hypothesis three stated that there would be no significant differences between FBG, TC, and HbA1c measured by finger prick and venous blood samples. Sixty of the original 276 subjects were randomly selected prior to data collection for participating in the methods of blood testing. One subject was removed from this sub-study sample due to incomplete data set needed for the study. The power analysis using estimates of variances and effect sizes derived from similar studies (Tamborlane, 2005; Schwartz, et al., 2005; McGillis-Bindler & Bruya, 2005) indicated that a sample size of 45 was sufficient to detect differences of a medium effect size ($d = .5$) (Cohen, 1988) between finger prick blood parameters (blood glucose, HbA1c and TC) and venipuncture technique to yield 90% power with significance level of .05 for a two-sided paired samples t-test. Table 20 shows the demographic characteristics of the sub-study sample of size 59.

The sub-study sample consisted of almost equal numbers of subjects by school type, and location. More females ($n = 35$, 59.3 %) than males ($n = 24$, 40.7 %) were randomly selected from all four grade levels (9-12) with the majority (40.7 %) falling in grade eleven. The mean age was 15.6 ± 1.19 years which is identical to the main study sample mean (15.6 ± 1.18). Majority of the subjects ($n = 21$, 35.6%) were in the 16 year age group. The sample consisted of mostly Blacks (81.4%). Sub-study sample was representative of the main study sample.

Table 20

Demographic Characteristics of Sub-Study Sample (n =59)

Variables	n	%
Gender		
Male	24	40.7
Female	35	59.3
Location		
Urban	30	50.8
Rural	29	49.2
School-type		
Traditional	29	49.2
Non-Traditional	30	50.8
Grade level		
9	15	25.4
10	16	27.1
11	24	40.7
12	4	6.8
Age (years)(15.6±1.2)		
14	15	25.4
15	10	16.9
16	21	35.6
17	10	16.9
18	3	5.2
Ethnicity		
Blacks	48	81.4
Non-Blacks	11	18.6

Table 21 describes the results of selected risk factors for the sub-study sample and the main study group. The sub-study sample was randomly chosen, descriptive data show a higher percentage of subjects from the sub-study sample (13.6%) were at risk for high TC than those from the main study (9.4%). Similar results were found for FBG. Approximately 15% of subjects from the main study were at risk for high FBG compared

to 25.4% from the sub-study sample. Results for HbA1c showed that a higher percentage of subjects from the main study (26.8%) had high HbA1c compared to the sub-study sample (22.0%). There were no significant differences between the risk factors for the main sample and the sub-study sample which indicated the sub-study sample was representative.

Table 21

Comparison of Sample to Sub-Study Sample: Blood Measures

Risk Factors	Main Study (N = 276)			Sub-study (n = 59)		
	Finger Prick			Venipuncture		
	n	%	Mean $\pm$ SD	n	%	Mean $\pm$ SD
TC (mg/dL)			143.0 $\pm$ 21.32			145.85 $\pm$ 21.61
Normal (< 170)	250	90.6		51	86.4	
Borderline ($\geq$ 170 < 200)	23	8.3		7	11.9	
Above Normal (> 200)	3	1.1		1	1.7	
FBG (mg/dL)			91.21 $\pm$ 10.53			95.24 $\pm$ 10.27
Normal (< 100)	234	84.8		46	78.0	
IFG ($\geq$ 100 < 126)	39	14.1		12	20.3	
Diabetes (> 126)	3	1.1		1	5.1	
HbA1c (%)			6.09 $\pm$ 1.33			5.40 $\pm$.81
Normal ($\leq$ 6.5)	202	73.2		46	78.0	
Above Normal (> 6.5)	74	26.8		13	22.0	

FBG = Fasting Blood Glucose

TC = Total Cholesterol

HbA1c = Glycated Hemoglobin

Table 22 shows the frequency and Pearson correlations for finger prick versus venipuncture measures for FBG, TC and HbA1c. Finger prick and venous TC were highly correlated ($r = .80$, $p = .001$). Correlations for FBG approached moderate size effect ($r = .28$, $p = .032$), whereas, HbA1c measure by both methods of blood testing were weakly and not significantly correlated ($r = .23$, $p = .079$).

Table 22

Frequency and Correlations of FBG, TC and HbA1c (n= 59)

Variables	Finger prick		Venous		r	p value
	n	%	n	%		
FBG (mg/dL)					.28	.032*
Normal (>100)	46	78.0	41	69.5		
IFG(100-126)	12	20.3	17	28.8		
Diabetes (>126)	1	1.7	1	1.7		
TC (mg/dL)					.80	.001*
Normal (<170)	51	86.4	41	69.5		
Borderline (170-200)	7	11.9	12	20.3		
Above normal (>200)	1	1.7	6	10.2		
HbA1c (%)					.23	.079
Normal (≤ 6.5)	46	78.0	54	91.5		
Above normal (> 6.5)	13	22.0	5	8.5		

*p < 0.05 considered significant

FBG= fasting blood glucose

TC= total cholesterol

HbA1c= glycated hemoglobin

Table 23 revealed significant differences for finger prick and venous testing for TC

(p <.001) and HbA1c (p <.001), but not for FBG (p =.185) using paired samples t-test

Table 23

Paired Samples t-test for FBG, TC, and HbA1c (n=59)

Variables	Finger prick	Venous	Mean Difference		
	Mean± SD			95% CI	p value
FBG (mg/dL)	92.88± 11.97	95.23±10.27	-2.35±13.45	-5.85, 1.15	.185
TC (mg/dL)	145.85± 21.6	157.93±30.0	-12.07±18.3	-16.85, -7.30	.001
HbA1c (%)	6.08± 1.49	5.40± 0.81	0.67±1.5	0.27, 1.10	.001

p < 0.05 considered significant

FBG= fasting blood glucose TC= total cholesterol HbA1c = glycated hemoglobin

Comparison of Finger Prick and Venous Blood Testing for Fasting Blood Glucose

Fasting blood glucose (FBG) values ranged from 64.8 mg/dL to 149.4 mg/dL for finger prick and 77.4 mg/dL to 126.0 mg/dL for venous blood samples. There were two outliers for finger prick FBG compared to one for venous FBG (Appendix W). Finger prick testing of FBG overestimated subjects in the normal blood glucose range whereas venous method classified more subjects with Impaired Fasting Glucose (IFG) than finger prick method (Figure 3). Both methods of testing found only one subject with FBG >126 mg/dL. Finger prick testing of FBG was less sensitive than venous testing (33.3 %) in classifying subjects with above normal FBG, and had high specificity (82.9%). Both methods of testing correctly classified subject with diabetes.

Figure 3: Comparison of Finger Prick and Venous Fasting Blood Glucose

Pearson correlation of finger prick and venous FBG was significant ($r = .28$, $p = .032$), and further testing of FBG using paired samples t-test (Table 23) showed that the means were not significantly different ($p = .185$) which indicated that the mean level for finger prick testing of FBG was close to venous FBG. For one method to substitute for another there should be agreement between the two methods, therefore further comparison of finger prick and venous FBG was done using the Bland Altman Plot.

Bland Altman Plot of Agreement for Fasting Blood Glucose

The Bland Altman Plot (Altman, Bland, 1983; & Bland, Altman, 1986) measured the degree of agreement between two clinical methods. The plot consisted of the difference between the methods plotted against their mean. Correlation coefficients commonly used to compare clinical methods do not necessarily show good agreement

between the two methods. If the range of values is wide the correlation coefficient will be greater than if it is narrow (Bland & Altman, 1999). Investigators tend to compare the two measures using the whole range of values which inevitably gives a high correlation. Figure 4 shows the complete range of values for FBG for finger prick and venous samples. The majority of the scores fell along the line which invariably gives a high correlation. A test of significance is completely different from test of agreement since data with poor agreement can also give high correlations (Bland & Altman, 1999).

Figure 4. Comparison of Fasting Blood Glucose by Finger Prick and Venous Method (n =59)

Figure 5 plots the difference between each capillary whole blood sample for FBG and each corresponding venous sample against the mean of the two samples. Good agreement indicates that the majority of the scores will fall within ± 2 SD from the mean (Bland & Altman, 1999). The majority of scores for FBG fell within the ± 2 SD from the mean. Only two scores were above +2SD and only one below -2SD. Based on paired samples t-test, and the Bland Altman Plot for agreement between methods of blood testing, finger prick testing of FBG appeared to be a good measure for early screening of risk factors for T2DM and CVDS in this sample.

Figure 5. Bland Altman Plot for Finger Prick and Venous Method FBG (n=59)

Comparison of Finger Prick and Venous Blood Testing for Total Cholesterol

Total cholesterol values ranged from 123.52 to 203.6 mg/dL for finger prick and 96.5 to 235.46 mg/dL for venous blood samples. Strong positive correlation was found between the two measures of TC ($r = .80$, $p < .001$). However, further comparison using

paired samples t-test showed that TC measured using finger prick and venous blood methods were significantly different with a mean difference of -12.07 ± 18.3 , $p < .001$ (95% CI = -16.85 to -7.6). Figure 6 showed that venous blood testing identified more subjects with borderline high TC than finger prick. Venous blood testing also identified more subjects with above normal TC than did finger prick.

Finger prick TC had specificity of 100 % and sensitivity of 16.7%. Results indicated that subjects without high TC were correctly classified by the finger prick method. Finger prick TC shows high specificity and high correlations between both methods of testing ($r = .80$, $p < .001$).

Figure 6. Comparison of Finger Prick and Venous Method TC (n = 59)

The differences between each capillary whole blood sample for TC and each corresponding venous blood sample against their means in the Bland Altman Plot

(Figure 7) shows that the majority of the scores fell within $\pm 2SD$ which indicated good agreement between the finger prick whole blood capillary samples and venous blood samples for TC. There were no outliers for TC using box plots (Appendix X) however, when the scores were standardized for the Bland Altman Plot there were two outliers one above $+3SD$ and two below $-2SD$ (Figure 7).

Since the majority of scores were a minimum of 123.52 mg/dL many of the Z scores fell on a straight line in the Bland Altman Plot. Correlation and Bland Altman indicated that finger prick testing of TC may be suitable for screening of risk factors for T2DM and CVDs.

Figure 7. Bland Altman Plot for Finger Prick and Venous TC (n=59)

Comparison of Finger Prick and Venous Blood Measures for Glycated Hemoglobin (HbA1c)

HbA1c values for finger prick blood ranged from 4.20 to 14.0 and for venous blood 4.0 to 7.80. Finger prick compared to venous blood testing for HbA1c classified more subjects at risk for T2DM than the venous blood testing (22.0% vs. 8.5%).

Comparison of HbA1c by both finger prick and venous blood measures (Table 22) showed a weak and insignificant correlation ($r = .23$, $p = .079$). When further tested by paired samples t-test (Table 23), results were significantly different with a mean difference of 0.67 ± 1.5 , $p < .001$ (95% CI 0.27 - 1.07). Figure 8 shows a comparison of HbA1c by the two measures. Finger prick measures of HbA1c revealed low sensitivity (20.0%), and had high specificity (77.8%) compared to venous blood testing in classifying subjects at risk for high HbA1c.

Figure 8. Comparison of Finger Prick and Venous HbA1c (n= 59)

Figure 9 shows the difference between each finger prick blood sample for HbA1c and venous blood sample in a Bland Altman Plot. The majority of scores fell within $\pm 2SD$, with only two outliers for HbA1c below the $-2SD$ in the Bland Altman Plot (Figure 9). Closer examination of the data using box plots (Appendix Y) revealed that there were many outliers for HbA1c for both methods, but more so for the finger prick method. Despite showing good agreement in the Bland Altman Plot between finger prick and venous blood testing of HbA1c, there was a weak correlation between the two measures. Similarly, paired samples t-test showed significant differences in means between the two measures. Therefore, finger prick testing of HbA1c may be used with caution in identifying subjects at risk for T2DM in the early screening of adolescents.

Figure 9. Bland Altman Plot for Finger Prick and Venous HbA1c (n= 59)

Calculation of Percentage Bias

Comparison of finger prick testing with laboratory standards are expected to meet specific standards of variation. The percentage bias of the two methods of blood testing was calculated using the following formula;

$$\frac{\text{finger prick reading} - \text{laboratory value}}{\text{laboratory value}} \times 100$$

Glucose analysis should have analytical imprecision of $\leq 3.3\%$, $\leq \pm 2.5\%$ for bias and $\leq 7.9\%$ for total error (Sacks, 2005). Percentage bias was -2.4% for blood levels of $100\text{--}126\text{ mg/dL}$ which represented above normal levels of fasting blood glucose (FBG) and met the reference standards of $\leq \pm 2.5\%$ for analytical imprecision (Sacks, 2005). Results for TC were compared with The National Cholesterol Education Program recommendations of $\pm 3\%$ bias for determining total cholesterol concentration (Alberti et al., 2005; NCEP, ATP III, 2001). Results from our study revealed percentage bias of -7.6% for TC which was below the reference standard of $\pm 3\%$. Precision for HbA1c should be $< 3\%$, and $2\text{--}3\%$ for established physiological limits and $3\text{--}4\%$ for the National Glycohemoglobin Standardization Program (Schwartz et al., 2005). Results indicated a percentage bias of 12.6% which exceeded all of the reference standards.

Summary of Validation Study

Of the three risk measures tested by finger prick testing, FBG appeared to be most suitable for the early screening of adolescents in the school setting since there was no significant difference between the finger prick and venous measures and the Bland Altman Plot showed good agreement between the means of both methods of blood

testing. Despite the significant differences seen for finger prick and venous testing of TC and HbA1c, the Bland Altman Plot showed good agreement for these variables which suggested they may be used with caution in the early screening of adolescents for risk factors of T2DM and CVDS in a school setting.

Summary of Research Findings

Table 24 summarized the main findings of the three hypotheses. Hypothesis one examined the relationship between the risk factors of T2DM and CVDs and the demographic characteristics of the study subjects. Hypothesis two investigated the frequency and cluster of the risk factors. Hypothesis three validated the methods of blood testing.

Table 24

Summary of Research Findings

Hypotheses	Findings	Interpretations
1. Ethnicity, gender, place of residence, and income will be positively associated with the number of risk factors for T2DM and CVDs (high levels of FBG, HbA1c, TC, BP, parents' BMI, waist circumference, WHR, and presence of AN, low PA, and family history of CVDs, and T2DM) and with each individual risk factor.	<p>Ethnicity significantly predicted family history of T2DM (OR=2.1, $p = .019$) in the logistic regression at the .05 level of significance.</p> <p>Gender significantly predicted PA ($p < .001$) in the logistic regression, and total number of risk factors ($\beta = -.16$, $p = .010$) in the multiple regression. Females were less physically active than males (OR = .36, $p < .001$).</p>	<p>Hypothesis partially accepted. Significance was found only for gender and PA and total number of risk factors after controlling for type 1 error using Holm's Sequential Bonferroni method. Females reported greater numbers of risk factors than males. Females were 2.7 times more likely to be physically inactive than males.</p>
1a. Blacks will report greater number of risk factors for T2DM and CVDs than Indians and those of mixed ethnicities.	Ethnicity predicted family history of T2DM only (OR=2.1, $p = .019$) at the .05 level of significance.	Ethnicity was not significant for total number of risk factors. Blacks reported more family history of T2DM. When controlled for type 1 error using Holm's Sequential Bonferroni method, ethnicity was no longer considered significant for family history of T2DM.

Hypotheses	Findings	Interpretations
1b. Jamaican female adolescents will have a greater number of risk factors for T2DM than males.	Gender was significant for total number of risk factors ($\beta = -.16$, $p = .010$) at the .05 level of significance in the multiple regression.	Hypothesis accepted for gender and total number of risk factors. Females reported greater numbers of risk factors than males.
1c. Jamaican male overweight and obese adolescents will have a greater number of risk factors for CVDs than their female obese and lean counterparts.	Gender significantly predicted FBG (OR=2.01, $p = .040$), WC (OR=0.56, $p = .041$), AN (OR=0.53, $p = .013$), PA (OR = .36, $p < .001$), and total number of risk factors ($\beta = -.16$, $p = .010$) at the .05 level of significance.	Hypothesis partially accepted. Males had higher FBG than females but females had higher WC, higher numbers of risk factors, presence of AN and were less physically active than males.
1d. Jamaican adolescents who live in urban areas will have greater number of risk factors for T2DM and CVDs than their rural counterparts.	Place of residence significantly predicted BMI (OR=1.87, $p = .018$), WC (OR=1.9, $p = .021$), PA (OR=.88, $p = .032$), and family history of obesity (OR=0.54, $p = .019$) at the .05 level of significance.	Hypothesis not accepted after controlling for type 1 error using Holm's Sequential Bonferroni method. Urban and rural subjects are equally subject to the risk factors for T2DM and CVDs.
1e. Jamaican adolescents from lower income families will present with more risk factors for T2DM and CVDs than those from higher income families.	Income significantly predicted TC (OR=3.7, $p = .039$), family history of CVDs (OR=0.51, $p = .016$), and family history of obesity (OR=0.49, $p = .014$) at the .05 level of significance.	Hypothesis not accepted after controlling for type 1 error using Holm's Sequential Bonferroni method. Jamaican adolescents are at risk for T2DM and CVDs regardless of family income levels.

Hypotheses	Findings	Interpretations
2. Overweight and obese Jamaican adolescents will have high levels of at least one of the following risk factors: FBG, HbA1c, TC, BP, waist circumference, WHR, and presence of AN, low PA, and family history of overweight, CVDs, and T2DM.	<p>Risk factors ranged from 0-10 (3.8 ± 2.3). Overall, 66.7% of normal and overweight subjects had ≥ 3 risk factors. 98% of overweight and obese adolescents had ≥ 3 risk factors.</p> <p>High BMI significantly increased the risks of: AN (OR=22.8, $p < .001$), WHR (OR= 9.1, $p < .001$), TC (OR= 5.30, $p = .009$), family history of T2DM (OR=3.70, $p = .001$), and WC (OR=53.2, $p < .001$).</p>	<p>Hypothesis accepted.</p> <p>Overweight and obese adolescents had more risk factors for T2DM compared to normal weight counterparts.</p> <p>Adolescents with high BMI were more likely to have presence of AN, high WHR, high WC, high TC, and family history of T2DM.</p>
2a. Waist circumference and WHR for Jamaican adolescents will be positively associated with the risk factors for T2DM and CVDs (high FBG, HbA1c, TC, BP, subjects' BMI, and presence of AN, and low PA, and family history of overweight, CVDs, and T2DM, and with each individual risk factor.	<p>WC identified more subjects at risk of T2DM and CVDs (28.6%) compared to WHR (7.6%). WC positively correlated w/ BMI ($r = .77$, $p = .001$), total number of risk factors ($r = .66$, $p = .001$), AN ($r = .59$, $p < .001$), BP ($r = .39$, $p = .001$), FBG ($r = .17$, $p = .004$), and family history of obesity ($r = .16$, $p = .008$). WHR positively associated w/ total number of risk factors ($r = .16$, $p = .008$) BMI ($r = .16$, $p = .009$) and FBG ($r = .15$, $p = .011$).</p>	<p>Hypothesis accepted. WC and WHR positively correlated with the individual risk factors and total number of risk factors.</p> <p>Subjects with high WC also had higher numbers of risk factors compared to those with high WHR, when tested by Pearson Correlations.</p>

Hypotheses	Findings	Interpretations
2b. Jamaican adolescents with family history of obesity (parents' BMI) will present with > BMI than those without family history of obesity as determined by anthropometric measures of adolescents and self-reported data of parents/family.	66% of parents were overweight /obese. Correlation found b/w father & subjects BMI ($r = .19$, $p < .01$) mother and subject ($r = .15$, $p = .020$) There were more obese adolescents (18.1%) than mothers (11.6%), and father (11.8%).	Hypothesis accepted. Family history of obesity related to child's obesity - subjects whose parents were overweight/obese had high BMI.
2c. Energy intakes of Jamaican adolescents will be positively associated with the total number of risk factors for T2DM and CVDs and with each individual risk factor.	Macronutrient intakes were within the AMDR ranges. Total fat intake correlated w/ WC ($r = -.18$, $p = .003$).	Hypothesis not accepted. After controlling for type 1 error, significance found only for WC and total fat.
2d. Intakes of complex and refined carbohydrates of Jamaican adolescents will be positively associated with the total number of risk factors for T2DM and CVDs (high levels of FBG, HbA1c, TC, BP, waist circumference, WHR, and presence of AN, low PA, and family history of overweight, CVDs, and T2DM) and with each individual risk factor.	Complex carbohydrates negatively correlated w/ AN ($r = -.15$, $p = .011$), and total number of risk factors ($r = -.13$, $p = .030$), and positively w/ PA ($r = .13$, $p = .026$). Intakes of refined carbohydrates had negative correlations w/ BMI ($r = -.14$, $p = .020$) and PA ($r = -.13$, $p = .029$).	Complex carbohydrates correlated w/ more risk factors than refined sugars at the .05 level. Hypothesis not accepted. Intakes of refined sugars and the risk factors were not significant using Holm's Sequential Bonferroni method.

Hypotheses	Findings	Interpretations
2e. Total fiber intake (g) of Jamaican adolescents will be negatively associated with the total number of risk factors for T2DM and CVDs and with each individual risk factor.	Fiber intakes negatively correlated w/ BMI ($r = -.15$, $p = .015$), WC ($r = -.15$, $p = .012$), family history of obesity ($r = -.17$, $p = .005$), AN ($r = -.18$, $p = .003$), and total number of risk factors ($r = -.14$, $p = .017$).	Hypothesis not accepted. Significance found only for AN and fiber intake using Holm's Sequential Bonferroni method. High intakes of fiber were associated with absence of AN.
2f. Intakes of saturated and unsaturated fat, and intake of omega-3 and omega-6 fatty acids of Jamaican adolescents will be associated with the total number of risk factors for T2DM and CVDs and with each individual risk factor	Intakes of saturated fats negatively correlated w/ WC ($r = -.16$, $p = .007$), and AN ($r = -.17$, $p = .006$). Monounsaturated fats were positively associated w/ HbA1c ($r = .13$, $p = .032$), and negatively w/ WC ($r = -.15$, $p = .013$), and AN ($r = -.17$, $p = .005$). Polyunsaturated fats were positively associated w/ HbA1c ($r = .13$, $p = .031$), and negatively with BMI ($r = -.12$, $p = .043$), WC ($r = -.13$, $p = .028$), and AN ($r = -.15$, $p = .011$).	Hypothesis not accepted. There were no significant associations with the types of fats and the risk factors of T2DM and CVDs after controlling for type 1 error using Holm's Sequential Bonferroni method. Intakes of omega-3 and omega-6 fatty acids were negligible in this population. No significant correlations found between the individual risk factors and omega-3 or omega-6 fatty acids or cholesterol intakes.
3. There will be no significant differences between FBG, TC, and HbA1c measured by finger prick and venipuncture methods.	Paired samples t-tests showed no significance for Finger prick FBG and venous blood FPG ($p = .185$), but Finger prick TC and HbA1c were significantly different from venous blood samples ($p = .001$).	Hypothesis accepted for FBG but not for TC and HbA1c when tested for significance. Good agreement in the Bland Altman Plot indicated all three tests can be used for screening of high school adolescents in this sample.

CHAPTER V

DISCUSSION

Type 2 diabetes mellitus (T2DM) is increasing among younger populations in the US (Sacks et al., 2002; Daniels, 2006; Choudbury: 2005 & Reinehr, 2005). This increase has been linked to the growing rates of obesity. Obesity is further linked to the development of cardiovascular diseases (CVDs). We predicted similar findings among the Jamaican adolescent population. In one nationwide survey, 25% of Jamaican adolescents were found to be overweight (“The Jamaican Daily Gleaner”, 2007). Despite the growing rates of obesity and T2DM among adolescents in other countries, research is lacking on Jamaican adolescents who are expected to share similar characteristics. Additionally, there is no documented study on risk factors of T2DM among Jamaican adolescents. Our study examined if Jamaican adolescents are at risk for T2DM and CVDs as found in similar populations in the resource-rich countries. Socio-demographic characteristics of this population and the prevalence of 13 risk factors for T2DM and CVDs were described and their associations were analyzed.

General Description of the Study Subjects

The recruitment and sampling process successfully obtained sufficient numbers of subjects to fit the selection criteria set in the study for place of residence (rural, urban), gender and socio-economic status (SES). We were unable to recruit sufficient numbers from the different ethnic groups due to the representative random selection process that was followed. A quota non-probability sampling method would have ensured adequate sample size from all other ethnically diverse groups but would not have allowed for

randomization and for our sample to be representative of the general population. The use of schools as the research site allowed for easy access to study subjects. Moreover, data collection on all thirteen risk factors was completed in one day at each of the ten schools. The easy access to study subjects and methods of data collection also allowed completion of pilot testing of the instruments, recruitment, and data collection in one year.

Gender was important to our study since earlier research showed that females are more likely to have T2DM and males tend to be more at risk for CVDs. Our final sample included more females than males. This discrepancy occurred among the higher grade levels (11-12) with more females (60) than males (43) and also by the “no shows” on data collection days. In the upper grade levels more females tend to dominate since this is the time the students prepare for the advanced level subjects for external examinations and for entry to tertiary institutions. Typically more females than males would stay on for further schooling at this level. This trend continues into tertiary level with more females than males attending university (Miller, 1986). Students were needed from these upper grades to include the age group 18-19 years since our study dictated inclusion of subjects ages 14-19 years.

Gender and ethnicity were considered significant to this study since research has shown gender and ethnic differences for many of the risk factors for T2DM and CVDs. For example, in previous studies, more adolescent females than males were obese and adolescent females were 1.7 times more likely to develop T2DM than males (Rosenbloom, et al, 1999; McKnight-Menci et al, 2005). Our study found only 3 subjects with fasting blood glucose (FBG) values >126 mg/dL which suggested the presence of diabetes. These students were referred for further follow-up. Our one-time measure of

fasting blood glucose is not conclusive for diagnosing diabetes among our study sample. Unlike earlier studies which showed more adolescent girls than boys to be at risk for T2DM, adolescent boys were two times more likely to have high FBG compared to adolescent girls in our study. Gaskin & Walker (2003) found significantly higher ($p < .01$) BMI among Jamaican girls ($18.01 \pm 3.34 \text{ kg/m}^2$) than boys ($17.15 \pm 2.55 \text{ kg/m}^2$) ages 10-12 years. We found slightly higher BMI for females (24.4 ± 8.2) compared to males (22.76 ± 6.8) in our study but this was not statistically significant. Research also indicated that adolescent males tend to have more abdominal fat than total fat mass. Abdominal fat correlated better with the metabolic risk factors of CVDs than total fat (Moreno, Pineda, & Rodriguez et al., 2002). In another study, adult males were shown to be more at risk for CVDs than females (England Health Survey for Ethnic Minority Groups, 1999). Fat cells associated with obesity resists insulin therefore sugar tends to remain elevated in the blood. Weight reduction and consequent lowering of BMI improves insulin sensitivity and may prevent or delay the onset of T2DM in at-risk adolescents.

More Blacks participated in this study than other ethnic groups present which was expected since up to 91% of the island's population is Black. Research has shown that globally the highest rate of T2DM is predicted to come from India (WHO, 2003 & Singh et al, 2004). However, in this study only 3.9% of the sample was Indians, consistent with their representation in the general population. The majority of the Indians were females aged 14-16 years and were drawn from the rural schools. The mixed ethnic group comprised 17% of the sample and was predominantly from the traditional high schools.

There was an almost even distribution of this mixed group among urban and rural locations and were from the age groups 14-18 years.

It was not surprising to find a higher percentage of the “mixed ethnicity” in our sample than the Indians since overall, the islands’ population comprises 7% of the mixed ethnicities compared to 1% Indians (Statistical Institute of Jamaica, Census, 2000) and there are a number of inter-racial marriages among Blacks and Indians. In some cases, mixed group represented more than two ethnic groups; some of the subjects reported being from Black, Indian, and Caucasian ethnicities. For analyses purposes, ethnicity was grouped as Blacks and Non- Blacks: Indians, Chinese, Caucasian and those of mixed ethnicities.

School-type was used to represent socio economic status (SES) since the traditional schools typically cater to the upper and middle class students. There were few more subjects from the non-traditional compared to traditional high schools. This difference can be accounted for by the number of no-shows since the four subjects who failed to return the consent forms were from a traditional high school. One traditional high school accounted for eight (4 did not return the signed parental consent form, and 4 were absent on the day of data collection) out of the twenty-four no shows. The three study subjects who were excluded from the study for incomplete data were also from a traditional high school.

The majority of the sample fell in the 16 year old age group. Although equal numbers of subjects were sought by place of residence (rural, urban) more urban than rural subjects participated in the study, again, a consequence of the representation of the sample. Lower participation was a result of the heavy rains which prevented rural

students from attending school on data collection day. Our sample was representative of Jamaican adolescents with predominantly more Blacks and females, almost equal numbers of rural and urban adolescents and more subjects from the non-traditional high schools.

Anthropometric Measures

Body mass index (BMI) and other anthropometric measures were of interest to our study since research shows that individuals with higher BMI, WC and WHR are at risk for T2DM and CVDs. Determining BMI was important for our study since previous studies from large population groups indicated that obesity increased the risk of mortality from CVDs. Subjects with BMI $>35 \text{ kg/m}^2$ are 2-3 times more likely than lean persons with lower BMI ($18.5\text{--}24.9 \text{ kg/m}^2$) to die from CVDs (Calderon et al, 2004).

Overweight in adolescent is associated with a 130 % increased risk of CVDs mortality during adulthood (Calderon et al, 2004). Still, other studies show that increased BMI is a risk factor for T2DM (Reinher, 2005, & Steinberger et al., 2001). In another study, overweight in children and adolescents strongly predicted increased risks of morbidity and mortality in adulthood regardless of their adult weight status (Deckelbaum & Williams, 2001).

Our findings indicated that overweight in Jamaican adolescents was twice the prevalence rate of overweight adolescents in the USA. The prevalence rate of obesity (BMI exceeding the 95th percentile) among US children aged 12- 19 years was estimated at 15.5% in 2000 (Bloomgarden, 2004). We found that 33% of our sample was overweight by the same standard. The percentage of overweight adolescents in the

present study was above the estimated 25% of the Jamaican Ministry of Health Report (“Jamaican Daily Gleaner,” 2007). These results indicated a growing percentage of adolescents becoming overweight. There is a need for preventive programs which target weight control. These programs can be implemented within the Jamaican school system.

Almost 25% of our sample was classified as underweight. This finding on underweight is similar to earlier research which indicated that over-nutrition and under-nutrition go hand-in-hand in some resource-poor countries (Popkins, 2001; Prentice, 2006). It was not surprising to find underweight children and adolescents with their overweight mothers in the developing world. The presence of more overweight mothers may be due to more domestic lifestyles of women compared to children who are engaged in more activities outside of the home. Typically, women in the developing world are responsible for preparing the family’s meals which gives them more access to food than the rest of the family. It is likely that non-working mothers would be more overweight than their children. Further analysis of employment status of mothers and overweight is suggested. These findings are important to Jamaican health workers who can target programs for adolescents. Further research is needed on the dietary and other factors which contribute to the underweight among the Jamaican adolescents.

More females than males had BMI in the overweight range ($\text{BMI} > 25 \text{ kg/m}^2$). There were higher percentages of subjects ages 14-16 with BMI in the overweight range compared to the 17-19 year olds (11.6% vs. 2.9%) respectively. This may be related to pubertal development. However, we did not measure pubertal stages. Nevertheless, our results on the prevalence of overweight among younger adolescents indicated that measures are needed to stop the spread of this health condition which will lead to T2DM

and CVDs in the later years. It further supports the need for early screening for risk factors of T2DM and CVDs among high school students.

Results of our study on BMI, gender, and age are similar to previous findings of Gaskin & Walker (2003). Jamaican girls had significantly higher ($p<.01$) BMI compared to boys in the 10-12 year group. Similarly, another study found more obese Jamaican adult females compared to males (Ichinohe, et al., 2005). As supported by other literature (Popkins, 2001; Prentice, 2006), a higher percentage of urban compared to rural adolescents were overweight in our study. Earlier research shows a shift towards the consumption of more high-fat and high-calorie foods, and decreased physical activity among urban than rural children. These findings are crucial to health administrators who can plan and implement preventive programs to target weight control among Jamaican adolescents.

Physical Activity

Earlier research showed that decreased physical activity (PA) and time spent watching television were linked to childhood obesity (Crespo et al, 2002; Certain et al, 2001; Dennison et al, 2002; & Christakis et al, 2004). In the current study, subjects spent approximately 10 hours per week watching television or an average of 1.4 hours per day and up to 5.9 hours per week playing computer games. Research is lacking on just how much physical activity is needed among children and adolescents to prevent obesity. However, others have found that children are not sufficiently physically active (Crespo et al, 2002; Dennison et al, 2002; Dowda et al, 2001 & Gortmaker et al, 1996). Approximately 30 minutes of physical activity per day is recommended by the US

Surgeon General for people over two years (Welk & Wood, 2000). A limitation of our study was that the Physical Activity Questionnaire used for Children (PAQ-C) did not measure the amount of time spent on each activity but gave an indication of how often and what types of activities they were more likely to be engaged in. However, despite this limitation, data on frequency and types of activities may be used to plan intervention programs to increase PA among adolescents.

A number of studies have shown the benefits of PA in the prevention of T2DM, CVDs, and hypertension (Pan, Li, & Hu, 1997; Leon, 1997; & Tuomilehto, Lindstrom, & Erickson et al., 2001). Results from these earlier studies indicated that inactivity was closely related to chronic non-communicable diseases. Physical activity was measured in the current study since it was expected that low PA levels would be related to risk factors associated with T2DM and CVDs. PA was found to be significant only for gender in this study when tested by logistic regression. Males were more physically active compared to females. Adolescent males may have more leisure time compared to females. It is part of the Jamaican culture to assign more household chores to the females leaving them with less time for the kinds of physical activities measured by the PAQ-C. Although data are lacking on PA and risk of T2DM and CVDs among Jamaican adolescents, previous research on Jamaican adults showed a similar trend with more females than males being physically inactive (Ichinohe, et al., 2005). Early intervention is needed to target more involvement in PA among Jamaican adolescent girls since there is research evidence of more Jamaican adult females being physically inactive.

It was expected that PA would predict BMI. However, PA was not a significant factor for BMI in our study ($p=.850$). The majority of the subjects reported PA more than

two times per week which classified them as being physically active. Also, the kinds of activities listed on the scale are typical activities for Jamaican adolescents. These activities varied from skipping, walking, riding and bicycling which are common activities especially among rural Jamaican children. Therefore we expected more rural than urban adolescents to be physically active. A better measure of the relation between PA and BMI would have been to determine the amount of time and energy spent on each activity. Despite some significance found for PA and risk factors at the .05 level of significance, when we controlled for type 1 error, significance was found only between PA and gender. Nevertheless, findings on PA from this study are significant since it provides preliminary data for further comparisons.

Our findings on PA are supported and refuted by other studies. Earlier research found a positive correlation between being female, urban resident and distance walked or cycled to school each day (Sjolie and Thuen, 2002). Border, Rohrer, & Cardarelli (2006) found significant differences between PA and place of residence with adult males and females in non-metropolitan (rural) areas having higher odds of obesity than their metropolitan (urban) counterparts. These studies were conducted on an older population than ours. It is expected that with low PA, female adolescents in our study also face the risk of T2DM and CVDs in later years. More research is needed on physical activity and risk factors of T2DM and CVDs of Jamaican adolescents and lifestyle factors that may lend itself to increased risk of chronic diseases.

Presence of Acanthosis Nigricans (AN)

This study was unprecedented in the examination of Jamaican adolescents for the presence of AN. The presence of AN was easily determined by the dark line around the neck, axilla, knees, elbows (Scott et al., 1997). For statistical analysis, presence of AN was determined by the neck measures only in our study. Over forty percent of our sample had AN on the neck area. There was no conclusive evidence that these subjects had T2DM, but the presence of AN is considered a risk factor for T2DM perhaps in later years as indicative of metabolic syndrome (Kong, Williams, & Smith et al., 2007). The ease and low cost of screening for AN are helpful in identifying at risk populations and in planning programs for the prevention of T2DM.

Previous research have found that the presence of AN is an independent risk factor for T2DM since AN is associated with hyperinsulinemia and high BMI (Kong, et al., 2007; Kobaissi, Weigensberg, Ball et al, 2004). One third of our sample had high BMI. The presence of AN in our study was strongly related to high BMI which is also a risk factor for T2DM and CVDs. Subjects with AN were 28 times more likely to have high BMI than those without AN. We further found a strong correlation between the presence of AN and BMI ($r=.633$, $p=.001$). Unlike other studies (Kong et al., 2007 & Kobaisi et al., 2004) we did not measure hyperinsuleinemia. Hyperinsulinemia results in insulin resistance (IR) and is related to high BMI. The one-time only finger prick method of testing FBG used in this study could not allow for us to measure IR. Insulin resistance is commonly measured by homeostatic model assessment (HOMA) which uses fasting plasma glucose and insulin concentrations to determine indices of insulin sensitivity and secretion (Tripathy, Almgren, & Tuomi et al, 2004).

The presence of AN is closely related to high BMI and other risk factors of T2DM. A more recent study (Kong et al, 2007) examined 1133 US children ages 7-19 for AN and the risk factors for T2DM such as family history of T2DM, hypertension, and overweight/obesity. They found that AN was present in 17% of the children and adolescent in their sample. Another study of 131 obese children (BMI of 28.4 ± 5.5) ages 7-13 found that up to 73% of the children had AN (Kobaissi, et al, 2004). Findings of overweight associated with AN in children and adolescents are significant. Acanthosis Nigricans is easy to detect and this can guide programs for targeting at risk adolescents to prevent T2DM and CVDs at an earlier age before symptoms develop, thereby reducing the rates of morbidity and mortality in later years.

The association between AN, ethnicity and T2DM was strong in other studies (Fagot-Campagna et al., 2000; & Stuart et al., 1998). The presence of AN is a physical marker for insulin resistance (IR) which is common among minority ethnic groups in the USA. Up to 40% of Native Americans, 13% of African Americans and 6% of Hispanics with IR also had AN (Tajima, 2002; Fagot-Campagna et al.2000; & Stuart et al, 1998). In the absence of IR, BMI remains a strong indicator of AN. Three studies (Nguyen et al., 2001; Hirschler, et al., 2002 & Kobaissi, et al., 2004) found closer relationships between AN and BMI when compared to AN and hyperinsulinemia and IR. Only 35% of the obese children with hyperinsulinemia also had AN despite ethnicity (Nguyen et al., 2001). Kobaissi, et al. (2004) found that BMI was a better indicator of AN than IR among Hispanic children and adolescents. Therefore we consider our findings on the relationship between BMI and AN to be a strong indicator of the risk of T2DM among the population we studied.

Overall, our study found 44% of the subjects had AN, 15% had elevated levels of FBG, and 33% were found to be overweight which are strong indicators for the development of T2DM and CVDs in later years. Kobaissi et al. (2004) found higher presence of AN (73%) compared to our study (44%) however, in their study subjects had higher mean BMI than in our study. Although AN was significantly correlated with some variables (WC, WHR, and fiber intake) in this study, the presence of AN alone was not conclusive for predicting the presence of diabetes since IR was not measured. Kong et al (2007) suggested that AN is an independent risk factor for T2DM and that individuals with AN are likely to present with multiple risk factors for T2DM. These data can be used to guide further research on the presence of AN and the specific risk factors for T2DM among Jamaican adolescents.

Socio-Demographic Characteristics and Risk Factors of T2DM and CVDs

We hypothesized that ethnicity (Blacks, non-Blacks), gender (male, female), place of residence (rural, urban), and income (high , low) would be positively associated with the risk factors for T2DM and CVDs based on earlier research findings (WHO, 2003; Singh et al, 2004; Rosenbloom, 1999; McKnight-Menci et al, 2005 & Moreno et al., 2002). Ethnicity was grouped as Blacks and non-Blacks in our study. The latter included Indians, Chinese, Caucasian, and subjects of mixed ethnicities. Gender, ethnicity, place of residence, and income predicted some of the risk factors of T2DM and CVDs in the logistic regression at the .05 level of significance. However, after controlling for type 1 error, we found significance only for gender and PA. Males were more physically active than females in this study.

We hypothesized that females would have greater number of risk factors for T2DM than males since other studies indicated that female adolescents were 1.7 times more likely to develop T2DM than males (Rosenbloom, et al., 1999; McKnight-Menci et al., 2005). Our hypothesis was partially accepted since gender significantly predicted only PA in the logistic regression with adolescent males being more physically active than females. However, females had significantly more risk factors than males in the multiple regression. Our findings on gender and number of risk factors are similar to earlier studies on gender and risk of T2DM (Rosenbloom, et al., 1999, McKnight-Menci et al., 2005).

We hypothesized that Black Jamaican adolescents would have greater number of risk factors for T2DM and CVDs than Indians and those of mixed ethnicities since results from US based studies indicated that more Blacks than Whites were at risk for T2DM (Sinha, et al., 2002; ADA, 2000; ADA, 2005; Bavdekar et al, 1999; Berry et al., 2004; & Kimm, et al., 2001). When controlled for type 1 error, ethnicity did not predict any of the risk factors in the logistic regression. However, cross-tabulation of the risk factors related to the METS (HbA1c, FBG, TC, WC and BP) among ethnic groups indicated that a higher percentage of non-Blacks classified with the METS (had ≥ 3 risk factors) compared to Blacks in our study.

We predicted that place of residence (urban, rural) would be significantly related to the risk factors of T2DM and CVDs. Specifically, more urban adolescents would have greater number of risk factors for T2DM and CVDs than their rural counterparts due to their decreased PA levels, and higher intakes of energy-dense foods (Popkins, 2001;

Prentice, 2005). However, we found no significant association with place of residence and the risk factors for T2DM and CVDs after controlling for type 1 error.

It was hypothesized that subjects from the lower income group would have greater number of risk factors for T2DM and CVDs as reported by other studies (Drewnoski & Darmon, 2005a; Drewnoski & Darmon, 2005b; Drewnowski, 2007; Monteiro, et al., 2004; Blakely, Hales, Kieft et al., 2004; Cooper, Cutler, Desvigne et al., 2000). Income was a significant predictor of TC, family history of obesity, and family history of CVDs at the .05 level of significance in our study but not after controlling for type 1 error. Contrary to expectations, higher TC levels were found in the low income group compared to the high income group which was expected to consume greater amounts of animal foods.

Higher rates of obesity have been found in low-income groups in US based studies (Drewnoski & Darmon, 2005a; Drewnoski & Darmon, 2005b; Drewnowski, 2007). However, we found that subjects from high income group were more likely to report family history of obesity than those from low income group. Similarly, subjects from the high income group reported more family members with family history of CVDs than those from the low income group. Earlier research (Drewnoski, 2007) indicated that the taste and low cost of high fat foods and refined sugars make them more appealing and economical to low income groups.

The lack of significance between income and the risk factors among our study population may be the result of the high cost of foods. Foods that are considered low cost in the US are not the same as in the Jamaican diet. Most of the US low-cost foods when exported to Jamaica become high-cost due to the devaluation of the Jamaican dollar. It is

likely that these foods are affordable mainly to the high income group. The high costs of these foods make them more appealing to individuals with higher incomes, regardless of the association with chronic diseases.

Family history of CVDs was determined if the parent(s) or other family members had been diagnosed by a nurse or doctor for having angina or stroke. Based on these criteria, more family history of CVDs was found among the high income group compared to the low income group. This was not surprising since the high income group reported more family history of obesity which is a risk factor for CVDs. Earlier literature referred to CVD as a “disease of affluence” or “Western disease” since it was mainly found among the high income group (McKeown, 1988; Trowell & Burkett, 1981). Our findings of significantly higher percentage of family history of obesity and CVDs among the high income group appeared to fit this paradigm of disease of affluence. Nevertheless, other studies have shown that among upper-middle income, and high income countries, CVDs risk factors are found mainly among the lowest-income group (Monteira, et al., 2004; Blakely, et al., 2004; Cooper, et al., 2000).

Our findings on income and the risk factors of T2DM and CVDs are significant. Further research is needed on income, food costs, food intakes and relation to T2DM and CVDs of our study population. The findings of effect of gender, ethnicity, place of residence, and income on the risk factors of T2DM and CVDs were confounded by the numbers of risk factors examined.

Risk Factors for T2DM and CVDs

The main aim of our study was to determine if Jamaican adolescents were at risk for T2DM and CVDs as observed in similar populations in other countries. We coded twelve risk factors (FBG, TC, HbA1c, BP, PA, AN, WC, WHR, BMI, family history of T2DM, CVDs and obesity) as present or absent based on current cut-off criteria as described in the methods section. Over two-thirds of our population reported presence of more than three risk factors. However, these risk factors did not relate specifically to the presence of the metabolic syndrome (METS). Therefore we further selected five risk factors which more closely matched the presence of the metabolic syndrome [FBG, TC, HbA1c, BP and central adiposity (high waist circumference)]. We found that 13.7% of the sample presented with three or more of these five selected risk factors. Presence of three or more of these risk factors indicated presence of the METS.

Our five selected risk factors for the METS were based on different criteria and included the suggestions of the WHO's Diabetes Group, and The National Cholesterol Education Program (NCEP) Adult Treatment Panel III in the USA (2006). The WHO Diabetes Group suggested the use of impaired glucose tolerance (IGT) or diabetes, with at least two other risk factors from the following list: raised blood pressure, hypertriglyceridaemia and or low HDL-C, obesity measured by high WHR or high BMI, and microalbuminuria (Alberti & Zimmet, & Shaw 1998). We did not use WHO criteria since we did not measure IGT, and HDL-C. Therefore, we selected risk factors based on The National Cholesterol Education Program (NCEP) Adult Treatment Panel III in the USA (2006) which stated that the presence of any three of the five components of CVDs risk to include central obesity, raised blood pressure, raised triglycerides, low HDL-C,

and fasting hyperglycemia constitute the METS. The METS criteria of the NCEP were closer to our measures of risk factors of T2DM and CVDs. In the present study, high FBG and HbA1c were considered as surrogates for hyperglycemia and subsequent risk for T2DM.

Although in this study IR was not measured, we considered our findings on the presence of the METS adequate. Earlier research pointed to insulin resistance as a causative factor in the METS (Reaven, 1988). However, the role of IR in the METS is still controversial (Alberti, et al., 2005). The International Diabetes Federation suggested that in clinical practice, the presence of impaired glucose is applicable, but all reports on the prevalence of the METS should use only fasting plasma glucose (FPG) of previously diagnosed diabetes when defining hyperglyceridemia (Alberti, et al., 2005). A limitation of our study is that fasting plasma glucose (FPG) was measured only on our sub-study sample of 59 subjects while FBG was used for all 276 participants. As indicated in the results section fasting plasma glucose for the sub-study sample underestimated the number of subjects with normal FPG and overestimated those with high IFG. Further, glucose concentrations in plasma are lower than whole blood since the concentration of water is approximately 11% higher in plasma than the whole blood (Sacks et al., 2002). Fasting blood glucose is likely to overestimate glucose concentrations and is not as reliable as FPG values (Sacks et al., 2002). Finger prick FBG are therefore suitable for screening to be followed by venous FPG testing for diagnosis.

Elevated triglycerides (TG) or the lipid triad which includes high TG, low HDL-C and high LDL-C are indicators of atherogenic dyslipidemia (Li & Ford, 2007). Research indicated that TG appeared to be better indicator of dyslipidemia in defining the

metabolic syndrome in adolescents than the lipid triad (Li & Ford, 2007). A limitation of the present study was that TG was not measured using finger prick method. A complete lipid profile was assessed for the 59 subjects that comprised the sub-study sample and none of these subjects had triglyceride levels > 200 mg/dL. It is likely that the main sample would not have presented with high TG levels since we randomly selected our sub-study sample from the main study sample and paired comparisons were made.

Previous research has shown that up to 60% of overweight children and adolescents had at least one cardiovascular risk factor such as high cholesterol, elevated insulin, and hypertension compared to 10% of those with healthy weight who had at least one risk factor for T2DM and CVDs (Freedman, et al, 1999). Freedman et al (1999) also found that up to 25% of overweight adolescents had two or more risk factors. In general, over two thirds of our sample, overweight or not, had three or more risk factors of T2DM and CVDs.

We further compared risk factors for overweight and underweight/normal weight subjects and found that 98% of our overweight subjects had more than 3 risk factors for T2DM and CVDS compared to 46% for the underweight and normal weight subjects. The number of subjects with 5 or more risk factors greatly increased for subjects with $BMI \geq 25 \text{ kg/m}^2$ compared to those with $BMI < 25 \text{ kg/m}^2$. Our findings on overweight and number of risk factors in adolescents are higher compared to US based studies. Jamaican adolescents may be at higher risk for chronic diseases as compared to their US counterparts.

Risk factors tend to cluster and the presence of more than one risk factor in childhood increases the risk of CVDs in adulthood (Chu, Rimm, & Wang et al., 1998; &

Berenson, Srinivasan, & Bao et al., 1998). Denney-Wilson, Hardy, & Dobbins et al. (2008) found that obese adolescents were more likely to have two or more risk factors for T2DM and CVDs than their non-overweight counterparts. Adolescent males were more likely to have more than one risk factor than adolescent females especially if they were overweight or obese. In the present study, adolescent females reported significantly more risk factors than males, and overweight subjects had more risk factors than their underweight or normal weight counterparts. These findings on overweight are important since obesity during childhood and adolescence persists into adulthood. It is likely that the accompanying risk factors of hypertension, AN, hyperglycemia, and hyperlipidemia will be manifested in the adult years. Primary prevention programs are therefore necessary and may be implemented at the high school level.

Our results indicated that Jamaican adolescents may be at risk for T2DM and CVDs and that the BMI has a direct bearing on the risk factors of T2DM and CVDs. Therefore, measures used to reduce overweight and obesity during childhood and adolescence may help to reduce these risk factors. Simply monitoring subjects' weight through the early screening at the high school level and earlier, may help to reduce other related risk factors of T2DM and CVDs among this population. In view of our findings, we predict that our results of high BMI and presence of the METS will lead to the development of T2DM and CVDs among the young Jamaican population in later years. Preventive measures such as dietary intervention to reduce weight and consumption of saturated fats, increased PA and weight management among adolescents are needed during the school years. These interventions can target school children and adolescents in the school setting and at the national level. Jamaica spends about 6% of GDP on the

treatment of diabetes and hypertension (PAHO Report, 2008). The economic cost of treating diabetes in the USA was estimated at \$174 billion in 2007 (ADA, 2007 <http://www.diabetes.org>). Americans diagnosed with diabetes have medical expenditures that are 2.3 times higher than in the absence of diabetes. What is of concern is that diabetes is highly related to poor nutrition and lifestyle risk factors some of which are modifiable through early screening and interventions.

Waist Circumference and Waist-to-Hip Ratio

The relationship between WC and WHR on the risk factors of T2DM and CVDs were examined since earlier studies showed that central adiposity (high WC and WHR) are associated with CVDs risk factors such as hyperinsulinemia, hypertriglyceridemia and hypertension (Gopalan, 1998, Ramchandaran, 2004). High WC was assessed using the NCEP Adult Treatment Panel III values of ≥ 94 cm and ≥ 80 cm for males and females respectively. These represented North American adult cut-off values for WC. Nevertheless, high WC was significantly related to high FBG, BP, BMI, presence of AN, positive family history of obesity, and the higher total number of risk factors in our study. Higher waist-to-hip ratios (WHR) were significantly associated with high BMI, and low PA. Unlike earlier studies (Gopalan, 1998, Ramchandaran, 2004), we did not measure insulin resistance (IR) or triglycerides. However, we found positive correlations between high WC and high FBG, BP, BMI, and family history of obesity. Our study provides preliminary data for further comparisons of Jamaican adolescents with US counterparts and in the validation of acceptable WC and WHR among Jamaican adolescents.

Interventions aimed at reducing WC and WHR among Jamaican adolescents include the same approaches needed for reduced overweight and include diet planning and increased physical activity. It is likely that Jamaican adolescents do not see themselves as at risk with high WC and WHR since it is culturally accepted to have larger body frames, especially around the hip.

As expected, WC strongly correlated with BMI. However, research indicated that even some individuals with low BMI tend to have high abdominal fat and are prone to T2DM, CVDs and hypertension (IOTF, 2006). In a study of Asian Indians, Gopalan (1998), found that up to 20% of the subjects although not overweight, had central obesity that puts them at risk for CVDs, T2DM, and hypertension. We felt that measuring BMI alone was not sufficient for our study population since BMI is a composite of muscle and body fat and it is likely to find low BMI with high WC and WHR as found in other populations (Ramachandran et al., 1997).

There is conflicting research on WC and BMI as indicators of T2DM and CVDs (Ramachandran et al., 1997; Reaven, 2005). A recent study found that WC predicted T2DM but was not a good predictor of CVDs (Janiszewski, Jansen, and Ross, 2007). Although earlier research indicated that WC highly correlated with IR, the use of WC over BMI is still controversial. Denney-Wilson et al (2008) found that BMI was a better predictor of T2DM and CVDs than WC. Alberti et al. (2005) suggested that as long as BMI is over 30 kg/m², WC does not need to be measured. Despite the conflicting results on the use of WC compared to BMI in determining at risk populations for T2DM and CVDs in previous studies, we concluded that WC may be used to screen Jamaican adolescents since WC is an indicator of abdominal fat whereas a high BMI is a composite

of body fat and muscle. Further, Asian studies indicated that individuals with low BMI had high WC. Waist Circumference appeared to be more strongly associated with other risk factors for T2DM and CVDs than BMI in our sample.

BMI and Family History of Obesity

Obesity is well known to have a strong relation to family history of obesity. The risks of being obese increases by 66% if both parents are obese, and falls to 50% if one parent is obese. If neither parent is obese, the risk of being obese is only 9% (Ponder, Sullivan, & McBath, 2000). We hypothesized that subjects with family history of overweight and obesity would also be overweight and obese. Family history of obesity was measured using a silhouette of body figures. These figures represented various BMI levels for males and females. Adolescents selected the silhouettes that best represented their parents. BMI $> 25 \text{ kg/m}^2$ for mothers and fathers was considered at risk and BMI $< 25 \text{ kg/m}^2$ no risk to create a new variable called family history of obesity by combining BMI $> 25 \text{ kg/m}^2$ of mother and father. Significant correlations were found between family history of obesity and subjects' BMI. Although a smaller percentage of adolescents than parents in our study were overweight, the adolescents were considerably more obese than their parents. In our study, eleven (3.9%) adolescents were classified as morbidly obese based on actual BMI measures.

Findings from our study on Jamaican adolescent on patterns of overweight and obesity are similar to earlier findings from the Heart Foundation of Jamaica Supermarket Screening Program (SSP), with over 30% of adults reported as being overweight and over

20% being obese. The SSP found a small percentage (2%) of morbidly obese adults. There was no report of morbid obesity among the fathers, and only one mother was reported as morbidly obese in our study. Up to 4% of mothers were found to be underweight, compared to 24.6% underweight adolescents in our sample. This relationship between subjects' and parents' overweight/obesity has strong implications of healthcare approaches in the future. Further, the cultural dynamics are important as subjects may not conceive themselves as being at risk for chronic diseases and may not see the need for change. Any intervention therefore needs to address weight reduction in relation to development of chronic diseases.

Family history of obesity is important to the prevention of T2DM and CVDs since children are more likely to become obese if one or more parent is overweight or obese (The United States Surgeon General's Report, US Department of Health and Human Services, 2006) and overweight in children has been shown to transcend into adulthood which increases the risk of T2DM and CVDs (Whitaker et al., 1997; Deckelbaum & Williams, 2001). These findings are significant to dietitians and other health professionals who can tailor programs to address overweight and obesity among the parents. Intervention measures are also needed for adolescents whose parents are overweight or obese since there is a strong relationship between family obesity and obesity in off-springs.

Diet and Nutrient Intakes

In this study, an in-depth analysis of the macronutrients and types of fats was presented because of their association with overweight and the risk factors of T2DM and

CVDs. Food intake data were collected for a 24-hour period using the USDA Multiple Pass Method. This method has been validated in a study of adults ages 21-65 years (Conway, et al., 2003). We pilot tested the macronutrient intakes of 40 Jamaican adolescents and compared 24 hour intakes to 48, and 24 to 72 hours, using The USDA Multiple Pass Method. Analyses revealed no significant differences between 24 and 48 hours, and 72 hour intakes for all macronutrients, fiber and total energy intakes. Thus the 24 hour recall was considered suitable for correctly estimating the usual energy and macronutrient intakes of our population. Intakes of macronutrients and fiber had significant negative correlations with a number of risk factors for T2DM and CVDs and intakes of select nutrients at the .05 level of significance. However, when we controlled for type 1 error we found significant associations only between fiber and AN, and WC and total fat intake.

Intakes of fiber had a significant negative correlation with AN in our study. This is not surprising since earlier epidemiological studies have shown that diets rich in whole grains lower the risk of CVDs and T2DM (Liu, 2002; liu et al., 2000; Salmeron et al., 1997) and the consumption of whole grain cereals has also been associated with reduced risk of CVDs among men and women (Loke, 2005; Liu, 2002; Gross et al., 2004). We expected higher consumption of fiber since the island abounds with tropical fruits and vegetables. However, mean intake of fiber was 14.4 ± 9.6 g/d which is below the Adequate Intake for adolescent males (38 g/d) and females (26 g/d) (Food and Nutrition Board, Institute of Medicine, National Academies, USDA Dietary Reference Intake, 2002).

A limitation of our study may have been the timing of the data collection since it was done within weeks of Hurricane Dean which destroyed fruit trees and vegetables. In

addition, data on fruit and vegetable intakes of Jamaicans are sparse. In a recent report by the Washington representative of the Pan American Health Organization (PAHO, 2008), reference was made to the low intakes of fruits and vegetables as a major risk factor for deaths and disabilities in the region. It would appear that even outside of a natural disaster, the usual intakes of fruits and vegetables of this population are low. Further research is needed on the sources of fiber and relation to absence of AN. Exercise and improved diet can help to lower insulin levels and can improve AN (Reaven, 1988).

Although no significant associations were found for the types of fat in our study, total fat was a composite of all types of fats. We examined the consumption of types of fats since earlier research indicated that the types of fats consumed rather than the amounts are associated with health risks and benefits. Other studies have found that saturated fats are associated with CVDs risks whereas intakes of omega-3 fatty acids seem to have a protective property (Hu, 2000; Howard, 2000; Mayer-Davis, 2000), and that saturated fats increased the severity of CVDs risks (Pan, Liu, & Wang, et al, 1991; Wang, Tam, & Mc Creddie et al, 1994; Hsia, Duncan, & Schob et al, 2000). These studies looked at serum cholesterol, HDL-C, LDL-C and TG and the severity of CVDs using angiographs which were not possible measures for our study, thus a comparison could not be made. We found a significant but weak negative correlation between total fat and WC ($r = -.18$, $p = .003$). Higher WC was associated with lower fat intakes in our study. It is likely that high WC is associated with fat stored from other macronutrients and not necessarily from high dietary intakes of fat per se.

It was expected that Jamaican diets would be high in saturated fats similar to the diets of the resource-rich countries. However, overall fat intakes were within the recommended macronutrient distribution range for saturated fat. The intakes of saturated fats compared to other studies may be due to the higher cost of food items which contain saturated fats (milk, cheese, eggs, meats) for this sample. Examination of the diets for the types of foods consumed and the percentage of calories and from gram amounts of fats present is needed in future studies.

The lack of association between types of fats and other risk factors examined in the current study may be attributed to observation bias. It is likely that subjects reduced, or inadvertently under-reported fat intakes for the purpose of the study. Adolescents were aware that they would be questioned on their food intake on data collection day and they might have eaten low-fat foods. We considered our evaluation of a 24-hour recall of fat intakes suitable based on results of our pilot test. The pilot test revealed no significant differences between fat intakes over a 24 and 48, or 24 and 72 hours. Although there is no evidence that consumption of dietary fat leads to T2DM, high fat intakes contribute to obesity which is a major risk factor of T2DM (Hu, 2000). Further, high fat intake has been shown to increase cholesterol levels which are associated with pre-mature heart disease by increasing CVD risks (Hu, 2000; Howard, 2000; Mayer-Davis, 2000).

No significant correlations were found between the risk factors for T2DM and CVDs and the intakes of omega-3 and omega-6 fatty acids in this study. This may be due to the extremely low intakes of these fatty acids. This was not surprising because it is a common practice for poor Jamaican families to consume meals without any animal products such as eating cabbage with a number of starchy roots instead of having a

meat/fish dish. Data from NHANES III using a single 24 hour recall revealed that 25% of US population reported no EPA and DHA intakes (Wang, Chung, Lichtensin et al., 2004). Similar to the NHANES III study, 76% of our study subjects reported intakes of omega-3 fatty acids though the amounts were small. It must be noted that fish which contains omega-3 fatty acids are mainly from the “oily fish group” with darker colored flesh such as mackerel, herrings and trout. However, intakes of fish in this data set included more white fish (cod, snapper) which lack omega-3 fatty acids. Further, despite the fact that this is an island and we expected it to be abound with seafood, the cost of fish is extremely high and lies outside the reach of many poor Jamaican families.

Overall, intakes of all macronutrients fell within the Average Macronutrient Dietary Range (AMDR) for American and Canadian diets despite findings of high BMI in this sample. Usual intakes of macronutrients might have been reduced the day before the data collection. Further research is needed on the appropriateness of the AMDR ranges for fats. The highest intake of saturated fat was provided by the lunch meal which was consumed at school. Research is needed on the overall diet quality and the relationship with physical activity and the factors for T2DM and CVDs in Jamaican adolescents.

Comparison of Finger Prick vs Venous Blood

Earlier studies examined capillary whole blood versus venous blood as a quick method of making early diagnoses for patients in emergency care. Using finger prick for testing blood samples for FBG, TC, and HbA1c is easier to perform, less invasive, requires very little training, and provides quick feedback. In this study, the two methods

were compared to determine if capillary blood testing of FBG, TC, and HbA1c could be used as a substitute for venous testing in detecting risks of T2DM and CVDs among adolescents on site and in the school setting. For finger prick testing to be used instead of venous blood samples, there should be good agreement between the two methods, and the results should meet specific standards of variability between finger prick and the reference standards. Further, validation of these tests requires high sensitivity and specificity. High sensitivity indicated that the tests correctly identified the proportion of persons who tested positive. TC had the highest sensitivity followed by FBG, and HbA1c. The high correlations of finger prick and venous TC were evidence of the ability of finger prick TC to identify subjects at risk.

In our study significant mean differences were found between finger prick and venous methods of testing for TC and HbA1c ($p = .001$) but not for FBG ($p = .185$) when tested by paired sample t-test. However, correlation was strong for TC ($r = .80$, $p < .001$). The Bland Altman plot indicated good agreement for all three tests with 95% or more of the scores falling within $\pm 2SDs$. Good agreement between both methods indicated that finger prick testing may be used as a surrogate in the early screening for risk factors of T2DM and CVDs among Jamaican adolescents.

Comparison of capillary FBG and venous FPG in our study shows conflicting results with earlier studies. Funk, Chan, & Lutz (2001) found poor correlation for FBG between capillary and venous blood samples of healthy volunteers. Other studies on critically ill patients' venous blood samples were found to be more accurate than capillary blood (Sylvan, Pokorny, & English, 1995; & Thomas, Gough, & Benson, 1994).

In our study, no significant difference was found between capillary and venous blood testing of FBG in healthy adolescents.

Sacks et al. (2002) found 20% variability between capillary blood glucose (measured by self-monitoring devices such as the Acu Chek Advantage used in this study) and venous FPG at levels of $>4.2\text{mmol/L}$. The variability of 20% did not meet the ADA's standard of variability between both methods being $<5\%$. However, whole blood levels of 100-126mg/dL representing above normal levels of FBG showed a percentage bias of -2.4% between whole blood and plasma samples in the current study. Therefore results for variability between the two methods of testing FBG in our study met the most recent ADA standard (ADA, 1994) recommendation of $<5\%$.

The International Federation of Clinical Chemistry recommended that blood glucose levels referenced to plasma should be approximately 11% higher than those referenced to whole blood (D'Orazio et al., 2005). Further studies are needed to compare these methods to determine variability of results. Our study did not allow for repeatability of the blood tests and this one-time measurement may not be adequate to determine variability between the methods of blood testing.

Studies have shown lower precision with finger prick testing for TC as compared to standardized laboratory testing (Dipeolu, 2006). Other studies, (Kafonek, 1992; Costanza et al., 2005) found that biological variations of TC, TG, HDL-C, and LDL-C were the same for venous and capillary testing. The current study revealed that finger-prick blood TC was significantly different from venous blood but showed good agreement between the two methods of testing in the Bland Altman Plot.

Our study did not meet the standard requirements for percentage bias between methods of blood testing for TC. Therefore finger prick testing of TC was considered to be suitable for early screening but was not recommended for making clinical decisions. Differences between methods of blood testing of TC might have related to dilution of interstitial fluid in the finger prick samples giving a lower cholesterol concentration since the subjects underwent three finger prick tests in quick succession on the same day. Despite these discrepancies, we believe our tests for TC is suitable as a preliminary screening among our study population.

A limitation of the study was the measurement of TC only. HDL-C, LDL-C or TG was not measured. Measurement of a complete lipid profile would have been ideal but the instrument for measuring finger prick TC could not be used to measure TG or HDL-C. Previous studies show that people with T2DM have abnormal lipid profiles with elevated LDL-C, TG and decreased HDL-C levels which put them at risk for CVDs (Assmann, Cullen & Schulte, 2002). Another study showed that treatment to increase HDL-C levels was found to be more effective than lowering LDL-C levels in patients with T2DM (Windler, 2005) since HDL-C returns cholesterol to the liver for excretion via bile. The Joint British Societies Guidelines (JBS) suggested that in the absence of HDL-C measures, total cholesterol value should be used alone on the same scale and the value taken as one (Dipeolu, 2006). Comparison of a complete lipid profile was not possible for this sample since we could not measure a complete lipid profile by finger prick testing. Although earlier studies recommended a complete lipid profile for clinical diagnosis, we consider the measures of TC to be useful. Lowering TC and increasing HDL-C is the recommended treatment for patients with abnormal lipid profiles and risk

of CVDs. Similar to our findings, Dipeolu, (2006) found that capillary testing is easy to perform and less costly than venous testing however, it has lower specificity and sensitivity.

Our study was unprecedented in its examination of finger prick testing for HbA1c among Jamaican adolescents. We found above normal levels of HbA1c by finger prick blood testing compared to venous blood. Higher finger prick values of HbA1c may be due to instrument error. A previous study which compared four commercial point-of-care HbA1c analyzers with laboratory testing found that the Nycocard system had the lowest precision (Hawkins, 2003). In our study, the percentage bias for HbA1c was 12.6% compared to 2-3% for established physiological limits and 3-4% for the National Glycohemoglobin Standardization Program (Sacks, 2005). Another possible explanation for the significant difference between finger prick and venous testing of HbA1c in our sample may be related to the outliers in the finger prick versus venous blood samples when the complete range of values was tested. When the scores were standardized, both finger prick and venous measures showed good agreement between methods of blood testing.

Unlike the higher finger prick HbA1c values compared to venous values found in the present study, Schwartz et al. (2005) in a study of 147 diabetic patients found consistently lower HbA1c results for capillary blood testing than venous blood methods. The study was conducted to determine if same day testing of HbA1c using capillary blood from finger prick samples could be used to improve diabetes care management. Sicard & Taylor (2005), compared finger prick measures of HbA1c with standardized laboratory procedures. The researchers found strong correlations between both methods.

However, similar to Schwartz et al (2005) study, the sample included known diabetics. It is likely that more elevated HbA1c values would be present in known diabetics. The current study excluded previously diagnosed diabetics in the sample. The strength of our study therefore lies in its ability to detect high levels of HbA1c in seemingly healthy volunteers so that early remedial actions can be taken.

Despite the high levels of HbA1c found in our sample, we do not recommend testing of HbA1c solely in diagnosing diabetes among our population. A search of the literature showed there is still no consensus that tests for HbA1c alone are conclusive for a diagnosis of diabetes. The International Federation for Diabetes and the WHO have not agreed on the use of HbA1c only in the diagnosis of diabetes. However, HbA1c, when used with other measures such as FPG and BMI can be effective for screening in this study population which is similar to the findings of Norberg et al., (2006).

Finger prick testing was economical, costing one third that of venous blood laboratory testing for the same measures in this study. Finger prick testing produced results within a few minutes and can be carried out on site in a convenient location such as in the “sick bay” in the school setting. Therefore it is an economical, fast and effective choice for a developing country. Most secondary schools in Jamaica employ a school nurse who can be trained to conduct these tests on site. As supported by the literature, obesity among adolescents is a strong indicator of the development of T2DM and CVDs in later years. Students who are overweight /obese can be further monitored by these finger prick tests in the school setting with the permission of the respective government agencies, and then referred for clinical follow-up as needed. Our results showed that screening of adolescents for high FBG, TC and HbA1c is feasible within a school setting.

Results of finger prick FBG and TC were more accurately and economically performed when compared to the higher cost of testing for HbA1c among this sample. Further, finger prick testing of HbA1c overestimated the subjects at risk for high HbA1c in our study.

Conclusion

Jamaican adolescents are at risk for T2DM and CVDs similar to other ethnic minority groups in the US. They also tend to have a cluster of risk factors for T2DM and CVDs as seen in other studies. In this study, over 60% of the sample had three or more risk factors for T2DM and CVDs despite their weight status. Over 90 percent of the overweight/obese adolescents reported three or more risk factors of T2DM and CVDs. BMI and WC strongly predicted some of the risk factors for T2DM and CVDs. One third of our sample had BMI ≥ 25 which is twice the percentage of overweight adolescents in the USA. The presence of AN was found in over 40% of the sample and correlated with high BMI as seen in other study populations of adolescents. Macronutrient intakes did not relate to the risk factors of T2DM and CVDs as expected, despite findings of high levels of BMI. Ethnicity, gender, place of residence and income levels were weak predictors of the risk factors of T2DM and CVDs.

Of the three biomarkers tested by finger prick and venous blood, FBG appeared to be most suitable for the early screening of adolescents in the school setting. There was no significant mean difference between the finger prick and venous measures of FBG and the Bland Altman Plot showed good agreement between the means of both methods of blood testing. Despite the significant mean differences found for finger prick and venous

testing of TC and HbA1c, the Bland Altman Plot showed good agreement for these measures which suggested that they may be used with caution in the early screening of adolescents for risk factors of T2DM and CVDs in a school setting.

Finger-prick screening is a suitable method for the developing countries with limited resources. This study showed that early screening can be carried out within the school setting with permission from the respective agencies and the parents. This type of screening can be routinely carried out by the respective Government Ministries. Finger prick screening, in combination with other measures such as BMI, AN, perception of weight status, and WC is a suitable method for the resource poor countries since it is more economical, less time consuming, yields rapid results, and are less feared by adolescents compared to venous blood draws.

Finally, with the increase in cases of diabetes in Jamaican adults, and the rising cost of treating diabetes and its complications, early detection of risk factors during the school years is recommended. Our study showed that anthropometric measures and family history of disease identified more subjects at risk for T2DM and CVDs than did the biomarkers. Therefore intervention studies can be geared at minimizing the risk factors of T2DM and CVDs instead of just treating biochemical indices.

Strengths and Limitations

The study was the first of its kind that examined Jamaican adolescents for a multiplicity of risk factors for T2DM and CVDs. Thirteen risk factors were examined in this study. Prior to this study, no emphasis was placed on evaluating risk factors for T2DM and CVDs in children and adolescents by the agency responsible for diabetes

research in Jamaica; The Diabetes Association of Jamaica. Similarly, the Heart Foundation of Jamaica did not conduct studies involving adolescents. By involving these agencies in the data collection process, they were sensitized to the development and early prevention of these conditions in adolescents and have set a precedent for further research involving this population.

Testing for the presence of AN was a novel part of the study and was new to the agencies and study population involved. Although participants and agency leaders were aware of the physical signs of AN, no one associated this with the risk of T2DM. The study was the first of its kind to analyze the relationship of the risk factors for T2DM and CVDs with nutrient intakes in this population. A comprehensive analysis of nutrient intakes of this population in terms of macronutrient contributions by meal types was presented. Finger prick and venous blood testing for FBG, TC, and HbA1c indicated good agreement between methods of testing which proves that early screening can be carried out within the school system at a minimal cost to parents.

The study which aimed at identifying Jamaican adolescents at risk for T2DM and CVDs may be limited in some areas. First, some of the more common measures for detection of the metabolic syndrome such as insulin resistance (IR) and triglycerides (TG) were not measured due to high cost. It was not feasible to replicate the more expensive laboratory tests. Low cost, accurate measures have been shown to be suitable for screening but not for making diagnoses. TG was measured on the sub-study sample and found to be below 200 mg/dL for all 59 subjects of the sub-sample.

Second, family history of obesity was determined by having students select a silhouette of various BMI levels representing their perceptions of their mothers and

fathers BMI. Validation of this silhouette of the parents by comparing them with actual BMI measures was not done. Third, the scale used to measure PA measured frequency of activities engaged in, but did not measure amount of time spent in physical activity or the amount of energy expended on these activities. For future research, we recommend modification of this tool to make it more accurate and analyzable.

Fourth, our method of data collection for food intake, and timing of the data collection limited our findings. The 24-hour recall might not have adequately represented the true food intakes. Subjects were aware they would be questioned on their food intakes as this might have introduced observer bias. They might have modified their previous day's food intake. Data were collected within weeks of hurricane Dean which destroyed much of the fruits and vegetables and may not have represented the true fiber intakes of this population.

The study did not allow for repeatability in comparing the two methods of blood testing. Agreement between two methods which determines if one can be substituted for another requires good repeatability between both methods. If one method has poor repeatability, then agreement is affected. Although blood samples were collected on the same day, venous samples were taken by one laboratory and finger prick samples by another. However, all venous samples were taken and tested by the same laboratory. Statistical errors were controlled for by selecting a .05 probability level in computing results.

Recommendations

Prevention of chronic diseases such as T2DM and CVDs can greatly reduce healthcare costs for governments in many countries especially in the resource- poor countries, and increase quality of life. Recent reports showed that cases of diabetes have doubled in Jamaica between 1980-2000. Jamaica spends approximately 42 billion dollars annually on the treatment of diabetes and hypertension (PAHO, 2008).

Formerly, a preventive approach for T2DM was to screen individuals over 45 years old (Expert Committee on the Diagnosis and Classification of Diabetes mellitus, 1997). However, more recent research suggests screening children over the age of 10 years for T2DM, if the child is overweight and has two other risk factors (family history, race/ethnicity, and signs of insulin resistance). It is also recommended that screening for T2DM should be carried out every two years (Sacks, et al., 2005). CVDs are not manifested in the early years but there is evidence that the atherosclerotic lesions associated with CVDs in later years begin in early childhood (Gungor et al., 2005; Steinberger et al., 2003) therefore screening of adolescents for risk factors of CVDs is also recommended. Other recommendations from our study include:

- Screening school children for risk factors of T2DM and CVDs bi-annually within the school system. This is manageable since all parties concerned gave their full support to the study. The Ministry of Health and Environmental Control and the Ministry of Education, Youth and Culture did not oppose this screening within the schools. Parents did not object to having their child tested at schools and children were quite willing to undergo testing. Principals and school nurses were supportive and did not object to this type of screening.

- Sensitizing the school nurses to the growing problems of childhood obesity and the related metabolic syndrome. The school nurses can be trained to conduct these finger prick tests with the permission of the Ministry of Health and Environmental Control and the Ministry of Education, Youth, and Culture. Cost of testing can be made part of the cost-sharing efforts in the schools between parents and government subsidies.
- Conducting follow-up testing and monitoring for children and adolescents who are overweight and obese, those who present with grade 3 and 4 for severity of AN on the neck, high WC, FBG, TC, HbA1c levels, pre-hypertension and hypertension. This can be achieved by working with the school nurses and the guidance counselors who will bring this to the attention of the parents. Identification of these risk factors can help in the planning of early intervention to improve the long-term outcomes of these chronic diseases. Simple monitoring of body weight is achievable at no extra cost to the schools.
- Training the school nurses to recognize the physical signs for AN which requires no additional cost to the school or parents.
- Re-introducing physical education to all grades in high schools to reduce the growing rates of overweight and obesity.
- Teaching students about the importance of diet for the prevention of T2DM and CVDs. This can be added to the nutrition curriculum at the high school level. Nutrition needs to be offered as a core so all can benefit from this subject. It is customary for students to select specific subjects at the end of grade nine, and many might not choose food and nutrition for further studies. Therefore, nutrition

knowledge on these chronic, nutrition-related diseases is best introduced at grade nine.

Suggestions for Future Studies

Future studies may require validation of the silhouettes used for determining parents' BMI on a group of parents. Measures of PA need to be more comprehensive since the scale used did not take into account amount of time spent on an activity, amount of energy expended, and with a low cut-off point of two activities per week seem inadequate. The scale classifies students as physically active despite having high BMI.

Repeatability of the methods of blood testing may be carried out and have one laboratory conduct all tests to reduce variation among tests results. Coordination of three different agencies on data collection days was challenging therefore for future studies one agency/laboratory should be used for all blood tests. More accurate testing for determining the presence of the metabolic syndrome, using other indices such as raised LDL-C and TG as recommended by the International Diabetes Federation are to be included instead of TC as was done in this study. Studies indicate that IR is a good indicator of the metabolic syndrome in adolescents and is a strong marker for T2DM. However, IR was not measured in this study.

Our study has set the framework for further studies on nutrition-related chronic diseases among Jamaican adolescents. Based on evidence from this research on the prevalence of risk factors for T2DM and CVDs among Jamaican adolescents, there is need to be develop interventions to prevent risks leading to these costly and fatal chronic diseases.

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APPENDICES

APPENDIX AI CONSENT/ASSENT FORM

FIU

FLORIDA INTERNATIONAL UNIVERSITY
Miami's public research university

IRB Approved
Date: 08/30/07
No: 062807-01

CONSENT/ASSENT TO PARTICIPATE IN A RESEARCH STUDY

Title: Risk Factors of Type 2 Diabetes and Cardiovascular Diseases Among Jamaican Adolescents.

We are requesting your consent and your son/daughter's assent to be in a research study. The investigators of this study are Dr Fatma Huffman, Professor of Florida International University, and Sheila Barrett, doctoral student. The study will evaluate the risk factors that could cause your child to develop type 2 diabetes and cardiovascular diseases later in life. The study will involve screening approximately 360 other adolescents aged 14-19 years who will be selected from ten high schools in five different parishes in Jamaica for risk factors of type 2 diabetes and cardiovascular diseases. The entire study may take up to two hours of your child's time.

Procedure:

If you decide for your child to be a part of the study he/she will be asked to;

- ◆ Complete a 12 hour fast before the day of data collection and report to the sick bay upon arrival at school where he/she will undergo a physical examination by the school nurse who will measure height, weight, body fat percentage, and look for physical signs of Acanthosis Nigricans (a visible dark mark around the neckline which suggests the person may have diabetes).
- ◆ Report to the mobile unit of the Heart Foundation of Jamaica on location at the school to have his/her blood tested using finger prick method. A phlebotomist (an expert in drawing blood) will take a small amount of blood by pricking his/her finger. The blood will be used to determine his/her fasting plasma glucose, HbA1c, and total cholesterol.
- ◆ Report to the Home Economics center in his/her school where he/she will be given a small breakfast after completing the blood test to prevent hypoglycemic event.
- ◆ Complete a questionnaire on past health history, family history of obesity, diabetes and cardiovascular diseases and a physical activity check list.
- ◆ Tell the researcher all the food and drink he/she consumed for the past 24 hours to assess his/her nutrient intake.
- ◆ After completing this blood tests and all questionnaires, he/she will be given a monetary incentive of US\$5.00 for participating in the study.

Possible Risks

The risks associated with this study are minimal. Your child might feel a little discomfort by finger pricking blood collection. With the right procedures for collecting blood, risks of infections are not likely. If any infection occurs, you should report to your child's pediatrician. Your child may also feel some discomfort by revealing information on how much food he/she eats and his/her physical activity levels. Some of the questions may be embarrassing to him/her.

12/05

Robert R. Stempel School of Public Health
Department of Dietetics and Nutrition
11200 S.W. 8th Street, HLS-1 450 • Miami, FL 33199 • Tel: (305) 348-2878 • Fax: (305) 348-1996

Page 17 of 19

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Benefits:

By participating in this study, you and your child will learn about the risk factors of type 2 diabetes and cardiovascular diseases. You and your child will receive the results of his/her blood test, and analysis and calculation of BMI. The research will give us information about Jamaican adolescents who may be at risk to type 2 diabetes and cardiovascular diseases and help us in planning preventive programs that can be made possible through the schools. There is no cost to you and your child to participate in the study.

Right to withdraw from the study:

The participation in the study is voluntary and you have the right to withdraw your child's participation from the study at any time.

Confidentiality:

To protect your child's privacy, all information gathered from him/her will be kept confidential. The information will be identified by a personal identification number (PIN) which will be assigned to him/her by the researcher. No one except Dr Huffman and Miss Barrett will know the name associated with his/her number. The data collected in this research will not be shared with anyone not directly related to the study unless required by law. The results will be presented as a group in all publications and at the general forum and conferences.

If you or your child would like to know more about the research, you can contact Dr Huffman at (305) 348-3788 or Miss Sheila Barrett at (305)408-1890. If either of you feel you were mistreated or you have questions about being in the study you may contact Dr. Patricia Price, the Chairperson of the Florida International University Institutional Review Board, at (305) 348-2618 or (305) 348-2494.

If you have had all your questions answered to your liking and you would like _____ to be in the study, sign below.

(Print Teens Name)

Signature of Parent/Guardian

Date

If you have had all your questions answered to your liking and you would like to be in the study sign below.

Signature of Teen

Date

I have explained the research procedure, subject rights and answered questions asked by the participant. I have offered him/her a copy of this informed consent form.

Signature of Witness

Date

APPENDIX AII

IRB Approval Letter- Main Study

Office of Research Integrity
Research Compliance, MARC 430

MEMORANDUM

To: Sheila Barrett
CC: Dr. Fatma Huffman
File
From: Chris Grayson, CIM, Asst. Director of Research Compliance
Date: August 30, 2007
Proposal Title: Risk Factors Of Type 2 Diabetes And Cardiovascular Diseases Among Jamaican Adolescents.
Approval # 062807-01

The Institutional Review Board of Florida International University has approved your study for the use of human subjects. Your IRB approval date is **June 28, 2007** and this approval will expire on **June 28, 2008**. As a requirement of IRB approval you are required to:

- 1) Provide immediate written notification to the IRB of:
 - Any additions to, or changes in the procedures involving human subjects,
 - Every serious or unusual or unanticipated adverse event as well as problems with the rights or welfare of the human subjects. Confirmation of receipt of serious AE reports must be made with the IRB office.
- 2) Utilize copies of the date stamped consent document(s) for the recruitment of subjects and receive annual renewal of consent documents.
- 3) **Receive annual review and re-approval prior to your expiration date.**

Special Conditions: N/A

Please note your approval number is indicated above. For further information, you may contact the IRB Coordinator by email at irbiacuc@fiu.edu or visit the OSRA – Human Subjects website at www.osra.fiu.edu.

APPENDIX AIII

IRB Renewal Letter

Office of Research Integrity
Research Compliance, MARC 430

MEMORANDUM

To: Sheila Barrett
CC: Dr. Fatma Huffman
File
From: Chris Grayson, CIM, Asst. Director of Research Compliance
Date: June 17, 2008
Proposal Title: Risk Factors Of Type 2 Diabetes And Cardiovascular Diseases Among Jamaican Adolescents.
Approval # 062807-01

The Institutional Review Board of Florida International University has re-approved your study for the use of human subjects. Your IRB approval date is **June 16, 2008** and this approval will expire on **June 16, 2009**. As a requirement of IRB approval you are required to:

- 1) Provide immediate written notification to the IRB of:
 - Any additions to, or changes in the procedures involving human subjects.
 - Every serious or unusual or unanticipated adverse event as well as problems with the rights or welfare of the human subjects. Confirmation of receipt of serious AE reports must be made with the IRB office.
- 2) Utilize copies of the date stamped consent document(s) for the recruitment of subjects and receive annual renewal of consent documents.
- 3) **Receive annual review and re-approval prior to your expiration date.**

Special Conditions: N/A

Please note your approval number is indicated above. For further information, you may contact the IRB Coordinator by email at irbiacuc@fiu.edu or visit the OSRA – Human Subjects website at www.osra.fiu.edu.

APPENDIX BI

Permission Letter- Ministry of Education, Youth and Culture, Jamaica

REPLY OR SUBSEQUENT
REFERENCE TO THIS
COMMUNICATION SHOULD
BE MADE TO THE
PERMANENT SECRETARY
AND THE FOLLOWING
REFERENCE QUOTED:

NO. GS40/017

Ministry of Education, Youth and Culture
2 National Heroes Circle
Kingston 4
Jamaica, West Indies
www.moeYC.gov.jm

September 7, 2006

Ms Sheila Barrett
Graduate Student
Florida International University
Department of Dietetics and Nutrition
University Park, HLS 450
11200 S.W. 8th Street
Miami, FL 33199

Dear Ms Barrett

Reference is made to your letter of September 7, 2006 in which you sought permission to conduct a study, which involves screening children ages 14-19 years for risk factors of Type 2 Diabetes and Cardiovascular Diseases in selected schools drawn from Administrative Regions One and Six.

Kindly be advised that the Ministry has granted permission for you to proceed with this research undertaking with the understanding that confidentiality and anonymity be maintained. However where medical procedures are concerned you need to get the approval from the Ministry of Health and consent from parents.

Best wishes.

Sincerely yours

Jasper Lawrence
Chief Education Officer (actg)

cc: Professor Fatma G. Huffman Ph.D., RD

APPENDIX BII

Permission Letter- Ministry of Education, Youth and Culture, Jamaica

REPLY OR SUBSEQUENT
REFERENCE TO THIS
COMMUNICATION SHOULD
BE MADE TO THE
PERMANENT SECRETARY
AND THE FOLLOWING
REFERENCE QUOTED:

NO. Q540/017

Ministry of Education, Youth and Culture
2 National Heroes Circle
Kingston 4
Jamaica, West Indies
www.moeYC.gov.jm

September 7, 2006

Dear Principal

This serves to introduce Ms. Sheila Barrett a graduate student who is reading for the Doctor of Philosophy Degree in Dietetics and Nutrition, Department of Dietetics and Nutrition, Florida International University. She wishes to conduct a study which involves screening children ages 14-19 years for risk factors of Type 2 Diabetes and Cardiovascular Diseases and as such would also be seeking to involve Home Economics and Science Teachers, School Nurse and Guidance Counsellors (**details of the study is attached**).

Kindly be advised that the Ministry has granted approval for her to proceed with this assignment and your school was selected to be a part of the sample. With this in mind, your cooperation is being solicited in facilitating her as she embarks on this undertaking.

Grateful for your usual support.

Sincerely yours

Jasper Lawrence
Chief Education Officer (actg.)

cc: Mr. Errol Levy, Regional Director, Region 6

Ms. Vilma Blair, Regional Director (actg.), Region 1

Ms. Beryl Jengelle, Regional Director, Region 2

APPENDIX C
Permission Letter- Ministry of Health and Environmental Control, Jamaica

**MINISTRY OF HEALTH
STANDARDS & REGULATION DIVISION
OCEANA COMPLEX
2-4 KING STREET,
KINGSTON, JAMAICA
Tel: (876) 967-1100-9/948-4106 Fax: 967-1629**

ANY REPLY OR SUBSEQUENT REFERENCE
TO THIS COMMUNICATION SHOULD BE
ADDRESSED TO THE PERMANENT SECRETARY
AND THE FOLLOWING REFERENCE QUOTED

Ref #: S&R/R/10

2007 January 04

Professor Fatma G. Huffman Ph.D., RD
Florida International University
Department of Dietetics and Nutrition
University Park, HLS 450
11200 S. W. 8th Street
Miami, Florida 33199
USA

Dear Professor Huffman

Permission for Doctoral Study to be conducted in Selected Schools in Jamaica

Reference is made to a request received from Ms. Shelia Barrett, doctoral student at the Florida International University to conduct her Dissertation Research in adolescents aged 14-19 years for risk factors for Type 2 Diabetes and Cardiovascular Disease in selected schools in Jamaica.

This is to inform you that permission is hereby granted for the study to be conducted in the schools indicated.

Ms. Barrett is to note that permission is granted on condition of adherence of specifications of the Ministries of Education and Health. Subsequent to this permission being granted, Ms. Barrett is expected to submit details of the intended study including the appropriate consent forms for use in the study.

Yours sincerely

Princess Thomas Osbourne (Mrs.)
Director, Standards & Regulation Division

Copy: Ms. Sheila Barrett, Doctoral Student

APPENDIX D

Permission Letter- Principals

August 26, 2007

The Principal,

Dear Sir/Madam,

Your school was randomly selected to participate in a research study conducted by doctoral student, Sheila Barrett and Dr Fatma G. Huffman (major professor) of Florida International University. We are seeking your permission to conduct the research study in your institution. This study is in partial fulfillment for a PhD in Dietetics and Nutrition at Florida International University for Miss Barrett.

The study involves screening children ages 14-19 years for risk factors of type 2 diabetes and cardiovascular diseases. Recent research has shown an increasing trend towards type II diabetes and cardiovascular diseases in younger cohorts of children and adolescents.

If school permission is granted, we will seek further consent from parents, and students to participate in this study. The study will be conducted in two phases; 1) an initial screening for risk factors of type 2 diabetes and cardiovascular disease, and 2) a follow-up study for select students found to be at risk for these health conditions. In phase one students will be asked to a) undergo a physical examination by a nurse, b) have their blood tested using finger prick method, c) keep a 3 day record of all food and drink consumed, d) complete a demographic questionnaire, and e) complete a physical activity checklist. Students will be paid US\$5.00 on completion of all five research activities stated above. Selected students will be invited back for further testing using venipuncture in phase two of the study.

We are also requesting the support of the Home Economics/ Science Teacher/School Nurse /Guidance Counselor in your school to help with data collection for which they will be reimbursed for each student they recruit and who successfully complete all five research activities for the study. Only one teacher per school will be recruited.

I am therefore asking your permission to conduct this study in your school and to suggest the name of a teacher who is willing to help with the data collection. Please give your response by checking the attached form and return in the self-addressed, stamped envelope. Your prompt response will be appreciated. Thank you.

Yours truly,

.....
Sheila C. Barrett
Graduate Student

.....
Fatma G. Huffman Ph. D.
(Major professor)

Robert R. Stempel School of Public Health
Department in Dietetics and Nutrition
11200 S.W. 8th Street, HLS-1 450 • Miami, FL 33199 • Tel: (305) 348-2878 • Fax: (305) 348-1996

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RESPONSE TO REQUEST

I give permission to allow the researcher to conduct this study in my school

☐ Yes

☐ No

.....
Signature

.....
Date

I recommend the following teacher to help with data collection

Name of teacher _____

Telephone _____

Address: _____

Email Address: _____

APPENDIX E

Permission Letter- Contact Persons

August 26, 2007

Dear Sir/Madam,

Your school was randomly selected to participate in a research study conducted by Sheila Barrett and Dr Fatma G. Huffman of Florida International University. This study is in partial fulfillment for a Ph.D. in Dietetics and Nutrition at Florida International University for Ms Barrett.

The study involves screening children ages 14-19 years for risk factors of type 2 diabetes and cardiovascular diseases. If school permission is granted, we will seek further consent from parents, and students to participate in this study. Approximately 360 students from ten high schools in Jamaica will be asked to participate in the study. Students will be randomly selected from grades 9-11 and will include twelve students from each grade level. 60 students from the original sample will be asked to undergo further testing. Recent research has shown an increasing trend towards type 2 diabetes and cardiovascular diseases in young children and adolescents.

Students will be asked to a) undergo a physical examination by a nurse, b) have their blood tested using finger prick method, c) tell the researcher all food and drink consumed for the past 24 hours, d) complete a demographic questionnaire, and e) complete a physical activity checklist. Students will be paid US\$5.00 on completion of all five research activities stated above. Selected students will be invited back for further testing using venipuncture.

You were recommended by your principal to assist in conducting this study. Should you agree to help with this study you will be required to 1) help in recruiting a total of 36 students from grades 9-11, 2) distribute letters of consent to parents, and 3) help in organizing students for blood tests on data collection days. On completion of these research activities you will be given a small stipend for each student who successfully completed all research activities.

Please indicate your consent by signing the attached form and return in the self-addressed, stamped envelope. Your prompt response will be appreciated. Thank you.

Yours truly,

.....
Sheila C. Barrett
(Graduate Student)

.....
Fatma G. Huffman Ph.D., RD.
Major Professor)

Robert R. Stempel School of Public Health
Department in Dietetics and Nutrition
11200 S.W. 8th Street, HLS-1 450 • Miami, FL 33199 • Tel: (305) 348-2878 • Fax: (305) 348-1996

11

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RESPONSE TO REQUEST

I agree to assist with the collection of data for this study in my school

☐ Yes

☐ No

Name of Teacher

Date

Telephone

Address:

Email Address:

APPENDIX F

DEMOGRAPHIC QUESTIONNAIRE FOR ADOLESCENTS

TO BE COMPLETED BY RESEARCHER AND /OR CONTACT PERSON

1. Name of School: _____

2. Place of residence: 1. ☐ Rural 2. ☐ Urban

3. Student: _____ ID #: _____

4. Date of Birth: _____ 5. Age: _____

6. Gender: 1. ☐ Male 2. ☐ Female

7. What is your grade level in school?

1. ☐ Grade 9 2. ☐ Grade 10 3. ☐ Grade 11

8. *Ethnicity*:

1. ☐ Black 2. ☐ Indian 3. ☐ Chinese 4. ☐ Caucasian

5. ☐ Mixed (Please state) _____

9. Do you consider yourself a physically active person? 1. ☐ Yes 2. ☐ No

9b. Approximately, how many hours per week do you spend doing the following?

Sedentary activities? _____ Moderate activities? _____ Vigorous activities? _____

10. Approximately, how many hours per week do you watch TV? _____

11. Approximately, how many hours per week do you spend on the computer or playing video games? _____

12. Do you consider your weight to be

1. ☐ Below Normal 2. ☐ Normal 3. ☐ Above Normal

13. How do you rate your food habits?

1. ☐ Poor 2. ☐ Fair 3. ☐ Good 4. ☐ Excellent

14. Family History of Obesity:

Circle the number from the diagram below that best describes these persons:

1. Mother

1 2 3 4 5 6 7 8 9

2. Father

1 2 3 4 5 6 7 8 9

3. Brother

1 2 3 4 5 6 7 8 9

4. Sister

1 2 3 4 5 6 7 8 9

5. Me

1 2 3 4 5 6 7 8 9

14b. Which of the above figures would you want to look like?

1 2 3 4 5 6 7 8 9

15. Family History of Diabetes

15a. Have you ever been diagnosed with diabetes? 1. ☐ Yes

2. ☐ No

15b. Does anyone in your family have diabetes?

1. ☐ Yes

2. ☐ No

15c. If yes, indicate who;

1. ☐ Mother only

2. ☐ Father only

3. ☐ Both parents

4. ☐ grandparents

5. ☐ Aunt

6. ☐ Uncle

7. ☐ Cousin

16. Family History of Heart Diseases

16a. Have anyone in your family been diagnosed by a nurse or doctor for having angina or stroke? 1. ☐ Yes 2. ☐ No

16b. If yes, indicate who;

1. ☐ Mother only	2. ☐ Father only	3. ☐ Both parents
4. ☐ Grandparents	5. ☐ Uncle	6. ☐ Aunt
7. ☐ Cousin		

16. Mother's Occupation: _____ Father's Occupation: _____

17. Parents' Educational Background

17a. What is the highest level of education for your father?

1. ☐ Primary
2. ☐ Secondary
3. ☐ Diploma
4. ☐ Bachelors Degree
5. ☐ Masters degree
6. ☐ More than a Masters degree

17b. What is the highest level of education for your mother?

1. ☐ Primary
2. ☐ Secondary
3. ☐ Diploma
4. ☐ Bachelors Degree
5. ☐ Masters degree
6. ☐ More than a Masters degree

18. Average Household Income (per month) J\$

1. ☐ 10,000.00 or less
2. ☐ 10,001 20,000
3. ☐ 20,001-30,000
4. ☐ 30,001-40,000
5. ☐ 40,001-50,000
6. ☐ Over 50,000

19. With whom do you live? (Check all that apply).

1. ☐ Mother and father
2. ☐ Mother only
3. ☐ Father only
4. ☐ Grandparents
5. ☐ Sister
6. ☐ Brother
7. ☐ Aunt
8. ☐ Uncle
9. ☐ Other (please state) _____

APPENDIX G

Contract Agreement- Heart Foundation of Jamaica

THE HEART FOUNDATION OF JAMAICA

Founded 1971 by The Lions Club of Kingston

30 BEECHWOOD AVENUE, P.O. BOX 338, KINGSTON 5

TEL: (876) 926-4378, 926-6492, 929-3195 FAX: (876) 754-6441

e-mail: hfj@mail.infochan.com Website: www.heartfoundation.org.jm

Patron
THE RIGHT HONOURABLE
EDWARD ZACCA OJ PC

Honorary Board Members
PROF. EDWIN BESTERMAN
MA MD FRCP FACC
DR. DONALD CHRISTIAN
MD FRCP FACP FACC CD
DR. EDWARD CHUNG
DM FACP FACP FACC
DR. GERRY HUMPHREYS
DR. COLIN MILLER
MR. KEITH SHERVINGTON CD JP
DR. MIKE WOOLING

Chairman
DR. KNOX HAGLEY
CD MB FRCP FRCP FACP FACC FFPHM

Vice Chairman
MR. GEORGE BULLOCK

Secretary/Treasurer
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DIRECTORS

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DR. WENDY GARDNER MBBS, DM
DR. LAMBERT K. INNIS MBBS, FRCA
MR. MICHAEL KING,
ATTORNEY-AT-LAW
MRS. NOELLE LALOR
MS. SHERYLL LOPEZ
RGN CCRN BSCN MED
DR. HAFEEZUL MOHAMMED
BSc (Mc Gill) MBBS, DM (UWI)
FRCP (Lond) FACP FLMI
MRS. STEPHANIE REID MSc
MR. ROBERT RHODEN FCA
PROF. RAINFORD WILKS
MBBS DM MSc FRCP

Executive Director
MRS. DEBORAH CHEN
SRN MPH

September 7, 2006

Florida International University
Department of Dietetics & Nutrition
University Park, HLS 450
11200 S.W. 8th Street
Miami, FL 33199
U S A

Dear Sir/Madam

The Heart Foundation of Jamaica has agreed to support
Miss Sheila Barrett, doctoral student of Florida International
University, in conducting her Dissertation Research.

The study involves testing Jamaican adolescents, aged 14-19 years
for risk factors of Type II Diabetes and Cardiovascular Disease.
The Heart Foundation of Jamaica, through the use of its Mobile
Unit, will facilitate this data collection in ten (10) selected
high schools by conducting the followings tests:

- Fasting Blood Glucose
- Total Cholesterol
- Blood Pressure and
- Body Mass Index

Attached is a copy of the proforma invoice, detailing the cost of these
services.

Yours sincerely

THE HEART FOUNDATION OF JAMAICA

.....
Novelette Dunn, BBA (Hons.), MSc.
Administrative Manager

THE HEART FOUNDATION OF JAMAICA

Founded 1971 by The Lions Club of Kingston

30 BEECHWOOD AVENUE, P.O. BOX 338, KINGSTON 5

TEL: (876) 926-4378, 926-6492, 929-3195 FAX: (876) 754-6441

e-mail: hfj@mail.infochan.com Website: www.heartfoundation.org.jm

Patron
THE RIGHT HONOURABLE
EDWARD ZACCA O.J.P.C.

Honorary Board Members
PROF. EDWIN BESTERMAN
MA MD FRCP FACC
DR. DONALD CHRISTIAN
MD FRCP FACP FACC CD
DR. EDWARD CHUNG
DM FACP FACP FACC
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MR. GEORGE BULLOCK

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DR. LAMBERT K. INNIS MBBS FRCA
MR. MICHAEL KING
ATTORNEY-AT-LAW
MRS. NOELLE LALOR
MS. SHERYLL LOPEZ
RON CCRN BSCN MED
DR. HAFEEZUL MOHAMMED
BSc (Mc Qir) MBBS DM (UWI)
FRCP (Lond.) FACP FLM
MRS. STEPHANIE REID MSc
MR. ROBERT RHODEN FCA
PROF. RAINFORD WILKS
MBBS DM MSc FRCP

Executive Director
MRS. DEBORAH CHEN
SNV MPH

MEMBERS:
World Heart Federation
InterAmerican Heart Foundation

RE: BMI & Blood Pressure checks, Total Cholesterol and Blood sugar
Tests done in 10 schools shown below:

	AMOUNT (\$)
BMI/Blood Pressure -279@\$100=	27,900.00
Total Cholesterol -281@\$400=	112,400.00
Blood Sugar -281@\$300=	84,300.00
Travelling	17,040.00
TOTAL	241,640.00

PAID IN FULL
DATE 19/10/07
RECEIPT No. 222128
223039

APPENDIX H

Contract Agreement- Diabetes Association of Jamaica

**diabetes
association
of jamaica**
Renal Unit (DARU)

1 DOWNER AVENUE, KINGSTON 5 • TELEPHONE: 927-6774

Affiliated Services:

- Downer Pharmacy & Health Supplies
- The Diabetes Centre
- Downer Medical Group
- Eye Care & Laser Services
- Kidney Dialysis

Hon. (Life) President
Dr. the Hon. Errol Morrison
OJ, MD, PhD, FRCP, FACP,
FRSM(UK)
Prof. of Biochemistry
& Endocrinology

Executive Chairman
Lurline Less (Mrs.)
Tel: 876-978-5915
Fax: 876-978-1881
E-mail: diabetesja@kannet.com

Vice Chairman
Executive Director
(Outreach)
Mr. Owen Bernard
Tel: 876-927-9960
Fax: 876-978-1881
E-mail: diabetesja@kannet.com

Secretary
Therina Smith (Miss)

Honorary Consultants
Dr. Knox Hagley
Dr. Hance Persaud
Prof. Everard Banton

Branches Island wide
Kingston & St. Andrew
1 Downer Ave., Kgo. 5
Tel: 927-6774

4 South Street
Paul Bogle Square
Morant Bay, St. Thomas
Tel: 982-1407

2 School Street
Fort Maria, St. Mary
Tel: 994-2515

Smith Road
Port Antonio, Portland
Tel: 353-4481

21 Market Street
Falmouth, Freetown
Tel: 954-5462

Beth Jacob Health Centre
St. Ann's Bay, St. Ann
Tel: 972-2259

Southfield Health centre
St. Elizabeth
Tel: 985-6563

Whitehouse Health Centre
Westmoreland Health Centre
Tel: 963-5210

October 1, 2007

Florida International University
Department of Dietetics & Nutrition
University Park, HLS 450
11200 S.W. 8th Street
Miami, FL 33199
U.S.A.

Dear Sir:

Reference: **Sheila Barrett Dissertation Research**

We are pleased to support the above-mentioned in her research, which involves testing Jamaican adolescents, aged 14-19 years for risk factors of Type II Diabetes and Cardiovascular Diseases.

We will be conducting the following test:

300 Hemoglobin A1c Test, using finger prick method, at a cost of US\$10 each, where the total will be US\$3,000.

For further discussion, I can be contacted on 978-5915.

Yours sincerely,
Diabetes Association of Jamaica

Lurline Less (Mrs.)
EXECUTIVE CHAIRMAN

APPENDIX I

Contract Agreement- Central Medical Laboratory, Kingston, Jamaica

CENTRAL MEDICAL LABORATORIES LTD.

Website: www.centralmedicallabsja.com

August 31st 2007

Miss Sheila Barrett
Florida International University (F.I.U)
Miami
U.S.A.

Dear Miss Barrett,

It was a pleasure hearing from you again and Central Medical Laboratories Ltd. will be awaiting your visit to assist in this very important project you are undertaking.

Listed below is the Updated Quotation for the following tests as requested.

The costs of tests are as follows:

<u>Qty.</u>	<u>Tests</u>	<u>Unit Price</u>	<u>Amount Payable</u>
60	FBS (FPG) }		
	Lipids }	JAS2,400.00	JAS144,000.00
	HbA1c }		

Should you require further information, please do not hesitate to contact the undersigned or Mrs. Denise Ramsay-Thompson, Business Development Manager.

Yours sincerely,

Fay Whitbourne

Fay Whitbourne (Dr.)
Consultant Pathologist

Managing Director: Audrey R.A. Clarke, B.Sc.(Mgmt), EMBA (FIU)
Consultant: Dr. Fay Whitbourne, MB, B.S., D.L.M. (Microbiology)

CORPORATE HEADQUARTERS: 3-5 EUREKA CRES. KINGSTON 5, JA. W.I., TEL: 754-6199-6202 OR 960-4391/2 FAX: 908-4807
MAIN STREET, OCHO RIOS, TEL: 974-2614

APPENDIX JI

STUDY PROTOCOL

7: 00 AM- Six previously randomly selected subjects had their blood taken by venipuncture by the phlebotomist of the Central Medical Laboratory and samples were taken back to Kingston within 4 hours. This activity took place in the sick bay and first thing on data collection day. This group of six were the first to be further examined by the staff of the mobile unit.

7:30 am - Students reported to the sick bay at the school where their names were checked against the list of students made up from the returned consent forms. They were issued an ID card. Students reported to the sick bay as they arrived at school.

Each person conducting an activity wrote their signature on student's ID card as soon as that activity was completed. A school representative (prefect) ushered students from the sick bay in groups of six to the sick bay for blood testing and to then for breakfast.

8:00 am - Students began reporting to the sick bay where the Heart Foundation of Jamaica workers began blood testing. The Heart Foundation worker and worker from Diabetes Association of Jamaica took blood samples by finger prick to measure TC, FBG and HbA1c. The finger was pricked twice to obtain sufficient blood for the three tests.

Students were weighed, had their heights taken, blood pressure measured and waist and hip measured by the Heart Foundation workers and the researcher. Data were entered on form O.

9:00 am First group of students started arriving at a section in the sick bay where they were served a continental breakfast. Students were asked to show their signed ID card indicating that all blood samples (TC, FBG, HbA1c, BP, weight, height, waist and hip circumference) have been taken before they were served a breakfast. Subjects had their ID card checked off after they ate and returned to the sick bay to complete the data collection.

10:00 am After breakfast, students reported back to the sick bay where they were examined by the researcher and school nurse for physical signs of AN. Subjects will answer the demographic and physical activity questionnaires and returned them to the researcher. Researcher checked for completion of questionnaire.

11:00 am- Researcher then conducted the 24 hour recall with each student.

2:00 pm After completion of 24 hour recall, the ID card was collected and checked to determine if all research activity had been completed, students were then given a monetary incentive of US\$5.00 for their time and effort.

APPENDIX JII **RESEARCHER'S CHECKLIST –**

School -----

ID #	Demographic Data	Physical Activity	AN Scale	BP	TC	HbA1c	FBG	Food Record	Amount Paid (\$)
1.									
2.									
3.									
4.									
5.									
6.									
7.									
8.									
9.									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									
21									
22									
23									
24									
25									
26									
27									
28									
29									
30									

Comments:

APPENDIX KI

Permission Letter to Principal for Pilot Study

November 16, 2006

Dear Sir/Madam,

Your school was randomly selected to participate in a pilot research study conducted by doctoral student, Sheila Barrett and Dr Fatma G. Huffman (major professor) of Florida International University. We are seeking your permission to conduct the research study in your institution. This study is in partial fulfillment for a Ph.D. in Dietetics and Nutrition at Florida International University for Miss Barrett.

The study involves screening children ages 14-19 years for risk factors of type 2 diabetes and cardiovascular diseases. Recent research has shown an increasing trend towards type 2 diabetes and cardiovascular diseases in young children and adolescents. I am seeking to conduct a pilot test in your institution prior to conducting the major study which will be conducted in other schools.

If school permission is granted, we will seek further consent from parents, and students to participate in this study. The pilot test involves having 30 randomly selected students from grades 9-11 to complete a three day food record, a 24 hour recall of all food and beverage consumed, and answering a physical activity and demographic questionnaire. This will take only two hours to complete and will be done during normal school hours.

I am therefore asking your permission to conduct this study in your school and to suggest the name of a teacher who is willing to help with the data collection. Please give your response by checking the attached form and return in the self-addressed, stamped envelope. Your prompt response will be appreciated. Thank you.

Yours truly,

.....
Sheila C. Barrett

(Graduate student and former
lecturer Mico College and U-Tech)

.....
Fatma G. Huffman Ph.D., RD
(major professor)

Robert R. Stempel School of Public Health
Department in Dietetics and Nutrition
11200 S.W. 8th Street, HES-1 450 • Miami, FL 33199 • Tel: (305) 348-2878 • Fax: (305) 348-1996

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RESPONSE TO REQUEST

I give permission to allow the researcher to conduct this pilot study in my school

☐ Yes

☐ No

.....
Signature

.....
Date

I recommend the following teacher to help with data collection

Name of teacher _____

Telephone _____

Address: _____

Email Address: _____

Name of School: _____

APPENDIX KII

IRB Approval- Pilot Study

FLORIDA INTERNATIONAL UNIVERSITY
Miami's public research university

IRB Approved

Date: 03/23/07

No.: 032207-00

CONSENT/ASSENT TO PARTICIPATE IN A RESEARCH STUDY

Title: Risk Factors of Type 2 Diabetes and Cardiovascular Diseases Among Jamaican Adolescents.

We are requesting your consent and your son/daughter's assent to be in a research study. The investigators of this study are Dr Fatma Huffman, Professor of Florida International University, and Sheila Barrett, doctoral student. The study is a pilot study to be undertaken by the researchers. This pilot study will evaluate three different methods of collecting dietary data to assess your child's eating patterns. Approximately 30 other adolescents aged 14-19 years will be selected from a high school in Kingston. The entire study may take up to half an hour of your child's time.

Procedure:

If you decide to have your child be a part of the study he/she will be asked to:

- ◆ Tell the researcher all the foods and drinks that he/she has consumed during the past 24 hours giving details of amounts eaten, and how these foods were prepared. This activity should not take more than 10 minutes of his/her time.
- ◆ Keep a record of how much food and drink he/she has eaten over a three-day period, one day should be a week-end day. For this, your child will be given a booklet to record the information and return it to the researcher on day four of the study.
- ◆ Complete a demographic questionnaire on his/her past health history, family history of obesity, diabetes and cardiovascular diseases.
- ◆ Complete a physical activity check-list. Completion of this checklist can be achieved in less than ten minutes.

Possible Risks

The risks associated with this study are minimal and require no more than answering some questions. Your child may feel some discomfort by revealing information on how much food he/she eats and his/her physical activity levels. Some of the questions may be embarrassing.

Benefits:

By participating in this study, you and your child will learn about his/her nutrient intake and activity levels. You and your child will receive the results of the nutrient analysis which can help in planning meals. The research will give us information about the eating patterns of Jamaican adolescents who may be at risk to type 2 diabetes and cardiovascular diseases and help us in planning preventive programs that can be made possible through the schools. There is no cost to you and your child in the study.

Robert R. Stempel School of Public Health
Program in Dietetics and Nutrition
11200 S.W. 8th Street, HLS-1 450 • Miami, FL 33199 • Tel: (305) 348-2878 • Fax: (305) 348-1996

Florida International University is an Equal Opportunity/Affirmative Action Institution • TDD: (305) 348-9511

Right to withdraw from the study:

Your child's participation in the study is voluntary and he/she has the right to withdraw from the study at any time.

Confidentiality:

To protect your child's privacy, all information gathered from him/her will be kept confidential. Your information will be identified by a personal identification number (PIN) which will be assigned to your child by the researcher. No one except Dr Huffman and Miss Barrett will know the name associated with your number. The data collected in this research will not be shared with anyone not directly related to the study unless required by law. The results will be presented as a group in all publications and at the general forum and conferences.

If you or your child would like to know more about the research, you can contact Dr Fatma Huffman at (305) 348-3788 or Miss Sheila Barrett at (305) 408-1890. If either of you feel you were mistreated or you have questions about being in the study you may contact Dr. Patricia Price, the Chairperson of the Florida International University Institutional Review Board, at (305) 348-2618 or (305) 348-2494.

If you have had all your questions answered to your liking and you would like _____ to be in the study, sign below.

(Print Teens Name)

Signature of Parent/Guardian

Date

If you have had all your questions answered to your liking and you would like to be in the study sign below.

Signature of Teen

Date

I have explained the research procedure, subject rights and answered questions asked by the participant. I have offered him/her a copy of this informed consent form.

Signature of Witness

Date

APPENDIX K III

IRB Consent Letter- Pilot Study

Office of Research Integrity
Research Compliance, MARC 430

MEMORANDUM

To: Sheila Barrett
CC: Dr. Fatma Huffman
File
From: Chris Grayson, CIM, Institutional Review Board Coordinator
Date: March 23, 2007
Proposal Title: Risk Factors of Type 2 Diabetes and Cardiovascular Diseases Among Jamaican Adolescents.
Approval # 032207-00

The Institutional Review Board of Florida International University has approved your study for the use of human subjects. Your IRB approval date is **March 22, 2007** and this approval will expire on **March 22, 2008**. As a requirement of IRB approval you are required to:

- 1) Provide immediate written notification to the IRB of:
 - Any additions to, or changes in the procedures involving human subjects.
 - Every serious or unusual or unanticipated adverse event as well as problems with the rights or welfare of the human subjects. Confirmation of receipt of serious AE reports must be made with the IRB office.
- 2) Utilize copies of the date stamped consent document(s) for the recruitment of subjects and receive annual renewal of consent documents.
- 3) **Receive annual review and re-approval prior to your expiration date.**

Special Conditions: N/A

Please note your approval number is indicated above. For further information, you may contact the IRB Coordinator by email at irbiacue@fiu.edu or visit the OSRA -- Human Subjects website at www.osra.fiu.edu.

APPENDIX L

ACANTHOSIS NIGRICANS SCALE- This Form To Be Completed By Researcher

Name of School: _____ Subject ID: _____

INSTRUCTIONS: Circle the number/phrase corresponding to each of the following responses.

ACANTHOSIS NIGRICANS		
Location	Score	Description
Neck	0	Absent: not detectable on close inspection
	1	Present: clearly present on close visual inspection, not visible to the casual observer, extent not measurable.
	2	Mild: limited to the base of skull, does not extend to the lateral margins of the neck (usually < 3 inches in breadth)
	3	Moderate: extending to the lateral margins of the neck (posterior border of the sternocleidomastoid) (usually 3-6 inches), should not be visible when the participant is viewed from the front.
	4	Severe: extending anteriorly (> 6 inches), visible when the participant is viewed from the front.
Axilla	0	Absent: not detectable on close inspection.
	1	Present: clearly present on close visual inspection, not visible to the casual observer, extent not measurable.
	2	Mild: localized to the central portion of the axilla, may have gone unnoticed by the participant.
	3	Moderate: involving entire fossa, but not visible when the arm is against the participant's side.
	4	Severe: visible from the front or back in the unclothed participant when the arm is against the participant's side.
Neck texture	0	Smooth to touch: no differentiation from normal skin to palpation.
	1	Rough to touch: clearly differentiated from normal skin.
	2	Coarseness can be observed visually, portions of the skin clearly raised above other areas.
	3	Extremely coarse: "hills and valleys" observable on visual examination.
Knuckles	Present	
	Absent	
Elbows	Present	
	Absent	
Knees	Present	
	Absent	

Neck

Grade 1

Neck

Grade 2

Grade 3

Neck

Grade 1

Neck

Grade 2

Grade 3

Grade 4

Knuckles

Elbow

Axilla

APPENDIX M

PHYSICAL ACTIVITY QUESTIONNAIRE (TO BE COMPLETED BY STUDENT)

NAME: _____ ID: _____ AGE: _____ GRADE: _____ DATE: _____

Remember

A. There are no wrong or right answers- this is not a test

B. Please answer all the questions as honestly and accurately as you can- this is very important

1. PHYSICAL ACTIVITY IN YOUR SPARE TIME

Have you done any of the following activities in the past 7 days (last week)?

If yes, how many times?

Check Only One Circle Per Box

	NO	If yes, how often?				
		1-2	3-4	5-6	>7	
Skipping/jump rope	☐	☐	☐	☐	☐	
Walking for exercise	☐	☐	☐	☐	☐	
Active Games (Tag)	☐	☐	☐	☐	☐	
Bicycling	☐	☐	☐	☐	☐	
Jogging/running	☐	☐	☐	☐	☐	
Swimming laps	☐	☐	☐	☐	☐	
Softball	☐	☐	☐	☐	☐	
Dance (social, recreational)	☐	☐	☐	☐	☐	
Football	☐	☐	☐	☐	☐	
Racket sports (tennis, badminton)	☐	☐	☐	☐	☐	
Netball	☐	☐	☐	☐	☐	
Volleyball	☐	☐	☐	☐	☐	
Basketball	☐	☐	☐	☐	☐	
Hockey (Street)	☐	☐	☐	☐	☐	
Martial Arts (karate, judo)	☐	☐	☐	☐	☐	
Cricket	☐	☐	☐	☐	☐	
OTHER	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	

2. Which ONE of the following describes you best for the last 7 days?

Read ALL FIVE statements before deciding on the one answer that describes you.

- ☐ All or most of my free time was spent doing things involving little physical effort.
- ☐ I sometimes (1-2 times last week) did physical things in my free time
- ☐ I often (3-4 times last week) did physical things in my free time

- ☐ I quite often (5-6 times last week) did physical things in my free time.
☐ I very often (> 7 times last week) did physical things in my free time.

3. How many days in the past week did you walk or bike to school?

None	1 time	2-3 times	4 times	Every day
☐	☐	☐	☐	☐

4. In the last 7 days, during your physical education (PE) classes, how often were you very active (playing hard, running, jumping, throwing)?

I don't do PE	Hardly ever	Sometimes	Quite Often	Always
☐	☐	☐	☐	☐

5. In the last 7 days, on how many days **RIGHT AFTER SCHOOL**, did you do sports, or play games in which you were very active?

None	1 time	2-3 times	4 times	5 times
☐	☐	☐	☐	☐

6. In the last 7 days, on how many **EVENINGS** did you play sports, dance, or play games in which you were very active?

None	1 time	2-3 times	4 times	5 times
☐	☐	☐	☐	☐

7. **THIS PAST WEEKEND**, how many times did you play sports, dance, or play games in which you were very active?

None	1 time	2-3 times	4-5 times	6 or more times
☐	☐	☐	☐	☐

8. In the last 7 days, what did you do most of the time at **RECESS**? (check only one)

- ☐ Sat down (talking, reading, doing school work).
☐ Stood around.
☐ Walked around a little.
☐ Ran around and played quite a bit.
☐ Ran and played hard most of the time.

9. In the last 7 days, what did you normally do **AT LUNCH** (besides eating lunch)? (check only one).

- ☐ Sat down (talking, reading, doing school work).
☐ Stood around.
☐ Walked around a little.
☐ Ran around and played quite a bit.
☐ Ran and played hard most of the time.

APPENDIX N

FOOD RECORD- 24-Hour Recall

TO BE COMPLETED BY RESEARCHER AND STUDENT

INSTRUCTIONS FOR FOOD RECORD (INSIDE COVER OF BOOKLET)

Student ID: _____

- 1) Please tell the researcher all the food and drink you consumed for the past 24 hours.
- 2) Give as much detailed descriptions as possible such as size of item, for example ripe banana (small, medium, large).
- 3) Tell the researcher the method of preparation such as grilled, fried, baked, boiled....
- 4) Say where you ate these foods; at home, school (canteen, cafeteria, school vendors), restaurant, fast food joint, road-side vendor).
- 5) Tell the researcher the exact amounts of each food or drink consumed, use units such as ounces, cups, each, small, medium, large. Refer to diagram for proportions of foods consumed.

Meal/Time	Food /Drink	Description of food eaten (fried, grilled, boiled)	Amounts Eaten (cups, ozs, each, small, medium, large)	Location
Breakfast	1.			
	2.			
	3.			
	4.			
Snack	1.			
	2.			
	3.			
Lunch	1.			
	2.			
	3.			
	4.			
	5.			
Dinner	1.			
	2.			
	3.			
	4.			
	5.			
Snack	1.			
	2.			

APPENDIX O

ANTHROPOMETRIC AND MEDICAL DATA SHEET

Name of School: _____ Subject ID: _____

Weight in Kg:			
Height cm			
BMI			
Percentile BMI			
Waist Circumference cm			
Hip circumference cm			
Waist to Hip Ratio			
Blood Pressure mm/Hg	Diastolic	Systolic	Average
	1)	1)	
	2)	2)	
Fasting Blood Glucose mg/dL	Finger prick: FBG		
	Venipuncture: FPG		
HbA1c (%)	Finger prick:		
	Venipuncture:		
Lipid Profile- TC mg/dL	Finger prick:	TC	
	Venipuncture	TC	

APPENDIX P

Silhouettes For Measuring Family History of Overweight and Obesity

Men:	1	2	3	4	5	6	7	8	9
BMI:	19.8	21.1	22.2	23.6	25.8	28.1	31.5	35.2	41.5

Women:	1	2	3	4	5	6	7	8	9
BMI:	18.3	19.3	20.9	23.1	26.2	29.9	34.3	38.6	45.4

Bulik CM, Wade TD, Heath AC, Martin NG, Stunkard AJ, Eaves LJ. Relating body mass index to figural stimuli: population-based normative data for Caucasians. *Int J Obes Relat Metab Disord*, Oct 2001;25(10):1517-24

APPENDIX Q

Blood Pressure Levels for the 90th and 95th percentile for Boys 1-17 Years

of Age by Percentile of Height

Systolic BP (mmHg) by Percentile of Height									Diastolic BP (mmHg) by Percentile of Height						
Age(Yr)	%ile	5%	10%	25%	50%	75%	90%	95%	5%	10%	25%	50%	75%	90%	95%
1	90 th	94	95	97	99	101	102	103	49	49	50	51	52	53	54
	95 th	98	99	101	103	105	106	107	54	54	55	56	57	58	58
2	90 th	98	99	101	103	104	106	107	54	54	55	56	57	58	58
	95 th	101	103	105	107	108	110	110	58	59	60	61	62	63	63
3	90 th	101	102	103	105	107	109	109	59	59	60	61	62	63	63
	95 th	105	106	107	109	111	112	113	63	63	64	65	66	67	68
4	90 th	103	104	105	107	109	110	111	63	63	64	65	66	67	67
	95 th	107	108	109	111	113	114	115	67	68	68	69	70	71	72
5	90 th	104	105	107	109	111	112	113	66	67	68	69	69	70	71
	95 th	108	109	111	113	114	116	117	71	71	72	73	74	75	76
6	90 th	105	106	108	110	112	113	114	70	70	71	72	73	74	74
	95 th	109	110	112	114	116	117	118	74	75	75	76	77	78	79
7	90 th	106	107	109	111	113	114	115	72	73	73	74	75	76	77
	95 th	110	111	113	115	117	118	119	77	77	78	79	80	81	81
8	90 th	108	109	110	112	114	116	116	74	75	75	76	77	78	79
	95 th	112	113	114	116	118	119	120	79	79	80	81	82	83	83
9	90 th	109	110	112	114	116	117	118	76	76	77	78	79	80	80
	95 th	113	114	116	118	119	121	122	80	81	81	82	83	84	85
10	90 th	111	112	113	115	117	119	119	77	77	78	79	80	81	81
	95 th	115	116	117	119	121	123	123	81	82	83	83	84	85	86
11	90 th	113	114	115	117	119	121	121	77	78	79	80	81	81	82
	95 th	117	118	119	121	123	125	125	82	82	83	84	85	86	87
12	90 th	115	116	118	120	121	123	124	78	78	79	80	81	82	83
	95 th	119	120	122	124	125	127	128	83	83	84	85	86	87	87
13	90 th	118	119	120	122	124	125	126	78	79	80	81	81	82	83
	95 th	121	122	124	126	128	129	130	83	83	84	85	86	87	88
14	90 th	120	121	123	125	127	128	129	79	79	80	81	82	83	83
	95 th	124	125	127	129	131	132	133	83	84	85	86	87	87	88
15	90 th	123	124	126	128	130	131	132	80	80	81	82	83	84	84
	95 th	127	128	130	132	133	135	136	84	85	86	86	87	88	89
16	90 th	126	127	129	131	132	134	134	81	82	82	83	84	85	86
	95 th	130	131	133	134	136	138	138	86	86	87	88	89	90	90
17	90 th	128	129	131	133	135	136	137	83	84	85	86	87	87	88
	95 th	132	133	135	137	139	140	141	88	88	89	90	91	92	93

Source: Rosner B, Prineas RJ, Loggie JM, Daniels SR: Blood pressure nomograms for children and adolescents, by height, sex, and age, in the United States. *J Pediatr* 123:871-86, 1993.

APPENDIX R

Blood Pressure Levels for the 90th and 95th percentile for Girls 1-17 Yearsof Age by Percentile of Height

Systolic BP (mmHg) by Percentile of Height									Diastolic BP (mmHg) by Percentile of Height						
Age(Yr)	%ile	5%	10%	25%	50%	75%	90%	95%	5%	10%	25%	50%	75%	90%	95%
1	90 th	98	98	99	101	102	103	104	52	52	53	53	54	55	55
	95 th	101	102	103	104	106	107	108	56	56	57	58	58	59	60
2	90 th	99	99	101	102	103	104	105	57	57	58	58	59	60	60
	95 th	103	103	104	106	107	108	109	61	61	62	62	63	64	64
3	90 th	100	101	102	103	104	105	106	61	61	61	62	63	64	64
	95 th	104	104	106	107	108	109	110	65	65	66	66	67	68	68
4	90 th	101	102	103	104	106	107	108	64	64	65	65	66	67	67
	95 th	105	106	107	108	109	111	111	68	68	69	69	70	71	71
5	90 th	103	103	105	106	107	108	109	66	67	67	68	69	69	70
	95 th	107	107	108	110	111	112	113	71	71	71	72	73	74	74
6	90 th	104	105	106	107	109	110	111	69	69	69	70	71	72	72
	95 th	108	109	110	111	113	114	114	73	73	74	74	75	76	76
7	90 th	106	107	108	109	110	112	112	71	71	71	72	73	74	74
	95 th	110	111	112	113	114	115	116	75	75	75	76	77	78	78
8	90 th	108	109	110	111	112	114	114	72	72	73	74	74	75	76
	95 th	112	113	114	115	116	117	118	76	77	77	78	79	79	80
9	90 th	110	111	112	113	114	116	116	74	74	74	75	76	77	77
	95 th	114	115	116	117	118	119	120	78	78	79	79	80	81	81
10	90 th	112	113	114	115	116	118	118	75	75	76	77	77	78	78
	95 th	116	117	118	119	120	122	122	79	79	80	81	81	82	83
11	90 th	114	115	116	117	119	120	120	76	77	77	78	79	79	80
	95 th	118	119	120	121	122	124	124	81	81	81	82	83	83	84
12	90 th	116	117	118	119	121	122	123	78	78	78	79	80	81	81
	95 th	120	121	122	123	125	126	126	82	82	82	83	84	85	85
13	90 th	118	119	120	121	123	124	124	79	79	79	80	81	82	82
	95 th	122	123	124	125	126	128	128	83	83	84	84	85	86	86
14	90 th	120	121	122	123	124	125	126	80	80	80	81	82	83	83
	95 th	124	125	126	127	128	129	130	84	84	85	85	86	87	87
15	90 th	121	122	123	124	126	127	128	80	81	81	82	83	83	84
	95 th	125	126	127	128	130	131	131	85	85	85	86	87	88	88
16	90 th	122	123	124	125	127	128	129	81	81	82	82	83	84	84
	95 th	123	127	128	129	130	132	132	85	85	85	87	87	88	88
17	90 th	123	123	124	126	127	128	129	81	81	82	83	83	84	85
	95 th	127	127	128	130	131	132	133	85	86	86	87	88	88	89

Source: Rosner B, Prineas RJ, Loggie JM, Daniels SR: Blood pressure nomograms for children and adolescents, by height, sex, and age, in the United States. *J Pediatr* 123:871-86, 1993.

APPENDIX S

Comparison of Subject's BMI with Parents' BMI

BMI Categories	Subjects BMI		Mothers BMI		Fathers BMI	
	N (%)	Mean $\pm$ SD	N (%)	Mean $\pm$ SD	N (%)	Mean $\pm$ SD
Overall BMI	276	23.76 $\pm$ 7.72	267	24.72 $\pm$ 6.55	255	23.14 $\pm$ 7.40
Underweight (BMI < 18.5)	68(24.6%)	16.72 $\pm$ 1.26	11 (4.0%)	18.3 $\pm$.0	0	0
Normal (BMI 18.0-24.9)	118 (42.4%)	20.91 $\pm$ 1.75	116 (42.0%)	22.06 $\pm$ 1.37	134(48.6%)	22.47 $\pm$ 1.22
Overweight (BMI 25.0-29.9)	41 (14.9%)	27.32 $\pm$ 1.38	109 (39.5%)	27.54 $\pm$ 1.80	91 (33.0%)	26.56 $\pm$ 1.08
Obesity Class I (BMI 30.0-34.9)	21(7.2 %)	32.33 $\pm$ 1.68	24(8.7%)	34.3 $\pm$.0	27 (9.8%)	31.63 $\pm$ 0.71
Obesity Class II (BMI 35.0-39.9)	18 (6.9 %)	36.83 $\pm$ 0.98	6 (2.2%)	37.3 $\pm$ 2.0	3 (1.1%)	35.4 $\pm$ 0.34
Obesity Class III (BMI > 40)	11 (4.0%)	46.21 $\pm$ 8.43	1 (0.4%)	45.4 $\pm$.0	0	0
Missing	0		9 (3.3%)		21 (7.6%)	

APPENDIX T

Relationships Between Select Macronutrient Intakes and Risk Factors of T2DM and CVDs

Risk Factors	Total Carbohydrate g) (n=273)		Total fats (g) (n= 272)		Total kcals (n=273)	
	r	P value	r	P value	r	P value
High BMI	-.17	.004	-.16	.006	-.17	.004
High WC	-.14	.020	-.18	.003	-.15	.011
Acanthosis Nigricans	-.15	.013	-.13	.036	-.13	.029
Family history of T2DM	-.06	.330	-.06	.333	-.16	.008
Total # of risk factors	-.12	.039	-.08	.169	-.11	.073

* Significant using the Holm's Sequential Bonferroni Method overall $\alpha = .05$ for each macronutrient variable.

APPENDIX U

Table 19

Relationships between Complex and Refined Carbohydrate Intakes and Risk Factors of T2DM and CVDS

Risk factors	Starch (g) (n=273)		Sugar (g) (n=268)		Fiber (g) (n=270)	
	r	P value	r	P value	r	P value
BMI	-.14	.017	-.14	.020	-.15	.015
Waist Circumference	-.12	.045	-.11	.080	-.15	.012
Physical Activity	.13	.026	-.13	.029	.08	.161
Family History of Obesity	-.12	.056	-.03	.631	-.17	.005
Acanthosis Nigricans	-.15	.011	0.05	.388	-.18	.003*
Total # of risk factors	-.13	.030	-.06	.339	-.14	.017

* Significant using the Holm's Sequential Bonferroni Method overall $\alpha = .05$ for each macronutrient variable.

APPENDIX V

Table 20

Relationships Between Types of Fats and Risk Factors of T2DM and CVDS

Risk Factors	Saturated Fats		Monounsaturated Fats		Polyunsaturated	
	(g)		(g)		Fats (g)	
	(n=273)		(n=273)		(n=273)	
	r	P value	r	P value	r	P value
HbA1c	.04	.517	.13	.032	.13	.031
BMI	-.10	.094	-.12	.051	-.12	.043
WC	-.16	.007	-.15	.013	-.13	.028
AN	-.17	.006	-.17	.005	-.15	.011

No significance found using the Holm's Sequential Bonferroni Method overall $\alpha = .05$ for each macronutrient variable and the 13 risk factors.

APPENDIX W

Boxplots Comparing Finger prick and Venous Measurements of FBG

APPENDIX X

Boxplots Comparing Finger prick and Venous Measurements of TC

APPENDIX Y

Boxplots Comparing Finger prick and Venous Measurements of HbA1c

VITA

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To: Dean Vish Prasad
College of Engineering

This dissertation, written by Andres Barrios, and entitled Nonlinear Quantum Transport in Low-Dimensional Electronic Devices, having been approved in respect to style and content, is referred to you for judgment.

We have read this dissertation and recommend that it be approved.

Pierre E. Schmidt

Padeusz M. Babij

Stephan L. Mintz

Carolyn M. Van Vliet, Major Professor

Date of Defense: April 4, 2002

The dissertation of Andres Barrios is approved.

Dean Vish Prasad
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Dean Douglas Wartzok
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Florida International University, 2002