ABSTRACT

Title of Document: Assessment of Metabolic Syndrome in a sample of Central and South Americans living in the Washington, D.C. area

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The Central/South American population is growing rapidly in the U.S., but little is known about the health status. The purpose of this study was *1)* to estimate the prevalence of MS and its individual components, *2)* compare risk factors among Hispanic sub-groups, and *3)* examine how metabolic syndrome (MS) prevalence estimates have changed from 1993-1994 to 2008-2009 in a sample of Central/South Americans living in the D.C. area. In this cross-sectional, medical record extraction survey, data from 1993-1994 were compared with data from 2008-2009 on 1,042 male and female adults collected by questionnaire. 28% of our subjects had MS. The most prevalent MS components were low HDL (43.2% men; 50.7% women), elevated triglycerides (37%), and high BMI $\geq$ 25 kg/m$^2$ (75.6%). Among Central/South Americans, Salvadorans had the highest prevalence of MS (30.7%).

MS prevalence was significantly greater for the 2008-2009 subjects (27.9%) compared with 1993-1994 subjects (19.7%) ($p \leq 0.05$).

# ASSESSMENT OF METABOLIC SYNDROME IN A SAMPLE OF CENTRAL AND SOUTH AMERICANS LIVING IN THE WASHINGTON, D.C. AREA

By

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# Dedication

I dedicate this thesis to my parents and my sister for their support and encouragement during my graduate education.

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# Chapter 1: Introduction

Cardiovascular diseases (CVD) are among the nation's leading causes of death. CVD is defined as diseases of the heart and blood vessels. CVD encompasses cerebrovascular disease (stroke), raised blood pressure, peripheral artery disease, heart failure, and the most common, coronary heart disease (CHD) (Rosamond et al., 2008). CHD is the leading cause of death in the United States (U.S.), causing approximately 53% of all deaths annually (Rosamond et al., 2008). The causes of CHD are multi-factorial and occur in a multi-step process. Underlying risk factors (obesity, physical inactivity, and atherogenic diet) give rise to major atherogenic risk factors (cigarette smoking, hypertension, elevated low-density lipoprotein (LDL) cholesterol, and aging), which then leads to the formation of coronary atherosclerosis. Coronary atherosclerosis is essentially the pathological process leading to CHD; it is caused by elevated levels ($\geq$ 100 mg/dL) of LDL cholesterol (Grundy et al., 2001). CHD is highly prevalent amongst Americans primarily due to the strong relationship that CHD has with dietary intake. Diet affects the risk factors for CHD and many other chronic diseases, including Diabetes Mellitus (DM), strokes, and certain cancers (Martínez-Ortiz, Fung, Baylin, Hu, & H Campos, 2006); all of which are among the top ten leading causes of death in the U.S.

Metabolic Syndrome (MS) is a cluster of metabolic abnormalities that occur together in an individual and are associated with an increased risk of developing cardiovascular disease (CVD) and type 2 DM (Meigs et al., 2003). The first acknowledgment of this syndrome that was documented was in 1988 by Gerald Reaven, when he coined the term "syndrome X." At that time, Reaven considered the following

abnormalities to be characteristic of syndrome X: resistance to insulin-stimulated glucose uptake, glucose intolerance, hyperinsulinemia, increased triglycerides, decreased high-density lipoprotein (HDL) cholesterol, and hypertension (Ford & Giles, 2003). Now known as the metabolic syndrome, other abnormalities have been associated with the syndrome, including central obesity, proinflammatory state, and prothrombotic state, all of which increase the risk of developing CVD and DM. MS is closely associated with a generalized metabolic disorder called insulin resistance, in which tissue responsiveness to the normal action of insulin is impaired (National Cholesterol Education Program Adult Treatment Panel III [NCEP ATP III], 2002). Overweight/obesity, physical inactivity, and genetic factors are the underlying causes of the MS.

Each of these MS components alone has detrimental health effects, but when combined, the components become more "powerful" (Reaven, 2006) by increasing the likelihood of developing CVD. Each definition of MS possesses, but is not limited to, the aforementioned components. The criteria and/or cutoff values of MS definitions may vary slightly. The definition of the MS has evolved over time. However, there are five commonly accepted components which are agreed upon by several organizations, such as the NCEP, International Diabetes Federation (IDF), European Group for the Study of Insulin Resistance (EGIR), and the World Health Organization (WHO).

Much of the known information about chronic diseases in the U.S. has been generated by large national studies such as the National Health and Nutrition Examination Survey (NHANES). NHANES is conducted to ascertain the current health and nutrition status of non-Hispanic whites, non-Hispanic blacks, and Hispanic Americans of Mexican, Puerto Rican, and Cuban descent living in the U.S. Despite the

wealth of information on these established Hispanic Americans, generalizations should not be made to other Hispanic subgroups. According to Nath (2005), “Findings from one Hispanic subgroup cannot be applicable or extrapolative to other Hispanic subgroups because each subgroup's social histories, cultural identities, health behaviors, and genetic compositions are unique.”

Despite the significant awareness of risk factors for CHD in these commonly studied groups of Americans, very little is known about the prevalence of MS among Central and South Americans. Central Americans, specifically, are the fastest growing group of Hispanics in the U.S., followed by South Americans. The most recent statistics from the U.S. Census estimate that there are 44.3 million Hispanic Americans, with 13.1% (5,793,387) originating from Central and South America (U.S. Census Bureau, 2006). Mexican-Americans make up 64% of the total Hispanic population. The total Hispanic population is 14.8% of the total U.S. population of 299 million (U.S. Census Bureau, 2006). These estimates are not inclusive of all Hispanics living in the U.S., they do not include all unauthorized immigrants. The population of all unauthorized immigrants is estimated to be approximately 11.9 million, 4% of the nation’s population, as of 2008 (Passel & Cohn, 2009). The Hispanic population is the fastest growing and largest minority group in the U.S. It is projected that this group will reach 59.7 million by the year 2020 (U.S. Census Bureau, 2006).

NCEP has established their third expert panel on detection, evaluation, and treatment of high blood cholesterol in adults (ATP III). This panel of medical and public health experts convened to make recommendations for updating the ATP II guidelines for cholesterol testing and management. Recommendations were made based on research

studies and the newest cholesterol-lowering medications, and considering the obesity epidemic and increasing rates of CHD mortality in the U.S. The increasing rates of CHD may be associated with the incidence of MS (NCEP ATP III, 2002).

In research studies conducted to determine the prevalence and/or risk for CHD prior to the development of the ATP III MS criteria, CHD risks were based on ATP II criteria. The recommendations of ATP II varied slightly from that of the current, updated recommendations of ATP III. The amendments to the recommendations were made by the expert panel based on controlled clinical trials that tested the newest cholesterol-lowering drugs (NCEP ATP III, 2002). ATP III offers an integrated set of new recommendations and guidelines, although many of its features remained the same. Some features of the report of the ATP have gone unchanged since the first panel, ATP I. Despite the similar features, each updated report has a new thrust. ATP I had major interests and strategies for primary prevention of CHD in those with elevated LDL cholesterol (≥160 mg/dL) or those with borderline levels of LDL cholesterol (130-159 mg/dL) plus multiple (2 or more) other risk factors. ATP II proclaimed the importance of the approach taken by ATP I, and then added a new feature. They added an intensive LDL management component for persons with diagnosed CHD. ATP II also set a new lower LDL cholesterol threshold of ≤100 mg/dL for CHD patients. ATP III, like ATP II, maintained the original approach of primary prevention of CHD and intensive management of LDL, while implementing a major new feature: primary prevention in persons with multiple risk factors. The significance of the new feature was that it proved more beneficial for those with multiple risk factors to receive even more intense LDL

management (more than what is recommended in ATP II) due to the high risk for CHD (NCEP ATP III, 2002).

There are several shared features of ATP III and ATP II. The ATP III report states that these features are: Continued identification of LDL cholesterol lowering as the primary goal of therapy; Consideration of high LDL cholesterol (≥160 mg/dL) as a potential target for LDL-lowering drug therapy, specifically for persons who continue to maintain high LDL levels (with or without multiple risk factors) even after dietary therapy; Emphasis on intensive LDL-lowering therapy in persons with established CHD; Identification of three categories of risk for different LDL goals and different intensities of LDL-lowering therapy, for those with CHD, multiple (2+) risk factors, and 0-1 risk factor; Identification of population groups, besides middle-aged men, for detection of high LDL cholesterol and for clinical intervention, specifically young adults, postmenopausal women, and older persons; and Emphasis on weight loss and physical activity to enhance risk reduction in persons with elevated LDL cholesterol (NCEP ATP III, 2002).

The new features of ATP III focus on multiple risk factors with modifications of lipid and lipoprotein classification, and show support for implementation. A person with diabetes, but not CHD is raised to the risk level of CHD risk equivalent, due to the likelihood of multiple risk factors. The low HDL cholesterol threshold was raised from <35 mg/dL to <40 mg/dL for better indication of depressed HDL; while the optimal LDL cholesterol level was identified as <100 mg/dL. A recommendation was made to analyze total cholesterol, LDL cholesterol, HDL cholesterol, and triglycerides as an initial screening, as opposed to total or HDL cholesterol alone. Strategies were presented for

promoting adherence to drug therapies, as well as therapeutic lifestyle changes (NCEP ATP III, 2002).

One major difference between ATP II and ATP III is the establishment of the definition of MS. The MS definition was developed and drew attention to its importance as a CHD risk factor and consequently included in ATP III, which provided a working definition of the syndrome for the first time (Ford & Giles, 2003). ATP II had set criteria for identifying CHD risk based on serum LDL cholesterol levels. The three risk categories were: borderline high LDL cholesterol (130-150 mg/dL) with fewer than two major risk factors, borderline high LDL cholesterol (130-150 mg/dL) with two or more major risk factors, and high LDL cholesterol (≥160 mg/dL). ATP III not only uses LDL cholesterol, but other risk factors to determine the presence of the MS, which ultimately leads to CHD.

In this study, modified NCEP ATP III criteria will be used to identify the MS among a Central and South American sample. In a similar study, (Miner & Jackson, 1995) used the ATP II criteria for identifying Central and South Americans who were at risk of developing CHD. MS criteria had not yet been established at the time of the study; however, more recent studies use MS definitions to identify those same risks. The most commonly used MS definition in the U.S. is that of NCEP ATP III. MS is diagnosed if an individual has any combination of three or more of the following risk factors: abdominal obesity, as measured by waist circumference, >102 cm and >88 cm for men and women, respectively; triglycerides ≥150 mg/dL; HDL cholesterol <40 mg/dL and <50 mg/dL for men and women, respectively; blood pressure ≥130/85 mmHg; and fasting blood glucose ≥110 mg/dL (NCEP ATP III, 2002). Subjects will be stratified among the Body Mass

Index (BMI) categories normal weight, overweight, and obesity to determine if the MS is more prevalent at a higher relative weight.

Central and South Americans are understudied in the U.S.; therefore, very little information is available on the health status of this population. This study provides data on the prevalence of MS in this population. It will elucidate differences in risk factors that may or may not exist between Hispanic subgroups. This research will be useful for public health planning, education, as well as program implementation that can offer preventative services to Hispanics to reduce risk factors for CHD.

Research Questions

1. What is the prevalence of abnormal MS indicators (FPG, TG, HDL, HBP, BMI) in a sample of Hispanics utilizing the Spanish Catholic Center?
2. Are there differences in the prevalence of MS among various Hispanic sub-groups, such as Salvadorans, Hondurans, and Guatemalans?
3. Is there a difference in the prevalence of abnormal MS indicators based on BMI categories?
4. How does the prevalence of MS and abnormal MS indicators in this population compare to data obtained by Miner and Jackson in 1995.

# Chapter 2: Literature Review

Central and South America consists of 21 countries with an estimated population of over 420 million people (Central Intelligence Agency [CIA], 2009). Despite being grouped as one type of people, Latin Americans are very diverse with various racial and cultural backgrounds. There are approximately 500-750 languages spoken in Central and South America today (Campbell, 1997). As of 2006, the number of people living in poverty in Latin America was approximately 205 million (38.5%). Poverty, as defined by the Pan American Health Organization (PAHO), is as follows: "A person is classified as "poor" when the per capita income of the household in which he or she lives falls below the "poverty line"—or the minimum income the members of a household must have in order to meet the basic needs (Pan American Health Organization [PAHO], 2007). "The poverty rates have been on the decline since 2002, when the rate was 221 million (44.0%) (PAHO, 2007). The poverty rate in some countries is very high, whereas in other countries the rate is very low. Poverty rates have been determined for the following countries based on the most recent available estimates (from highest to lowest): Honduras (74.8%), Nicaragua (69.3%), Bolivia (63.9%), Paraguay (60.5%), Peru (51.1%), Ecuador (48.3%), Dominican Republic (47.5%), Colombia (46.8%), Guatemala (45.3%), El Salvador (41.2%), Venezuela (37.1%), Brazil (36.3%), Panama (33.0%), Argentina (26.0%), Costa Rica (21.1%), Uruguay (18.8%), and Chile (18.7%). The poverty rate for Mexico is 35.5% (PAHO, 2007). The PAHO, (2007) states that "the poverty rate is almost twice as high in rural areas as in urban ones and the indigence rate is almost triple." The PAHO defines indigence as: "A person is classified as "indigent"

when the per capita income of the household in which he or she lives is below the "indigence line" or below the minimum income the members of a household must have in order to purchase the cost of a basic food basket, taking into consideration consumption habits, the effective availability of foodstuffs and their relative prices, as well as the differences between metropolitan areas, other urban areas, and rural areas" (PAHO, 2007).

The PAHO estimates that the leading causes of death in Latin America are from cardiovascular diseases and diabetes mellitus (PAHO, 2007). Mortality rates for cardiovascular diseases were highest in Nicaragua (219.4) and Dominican Republic (237.5), far exceeding 200 per 100,000 people. Countries such as Paraguay, Brazil, Colombia, Venezuela, Argentina, and Uruguay had mortality rates from that cause greater than 150, but below 200, per 100,000 people. The countries with the lowest mortality (less than 150 per 100,000) from cardiovascular diseases are Panama, El Salvador, Mexico, Costa Rica, Puerto Rico, Chile, Ecuador, and Peru (PAHO, 2007). Between the years of 1970 and 2000, mortality rates have varied among different countries. Mortality from ischemic heart disease increased in Costa Rica, Ecuador, Mexico, and Venezuela during that period due to unfavorable changes with respect to diet, obesity, smoking, and lack of physical activity, while a sharp decline was seen only in Argentina. Mortality from cerebrovascular diseases (stroke) dropped anywhere from 10% to 49% in the majority of Latin American countries, except for Venezuela, whose rate remained unchanged. It is worth noting that the mortality rate from strokes dropped 60% in the U.S. between the same years. The difference between rates is most likely due to, although the reasons are not well known, significant differences in education and

access to services, quality of medical care, the incidence of cerebrovascular events, and risk-factor control (PAHO, 2007).

Hypertension, a major risk factor for heart disease and stroke, was found to be highest in Chile (38.3%), followed by Costa Rica and Nicaragua with rates between 25% and 34%. El Salvador, Guatemala, and Honduras had prevalence rates lower than 25% (PAHO, 2007). Hypercholesterolemia, another major and independent risk factor for heart disease and stroke, affects millions of people around the world. Research conducted in 2003-2004 by the Central American Diabetes Initiative showed that the prevalence for hypercholesterolemia in Nicaragua was 19.7%, 45.7% in Costa Rica, and 35.5% in Guatemala (PAHO, 2007). According to the 2005 National Survey of Risk Factors in Argentina, 27.8% of participants self-reported having high levels of cholesterol (PAHO, 2007). The 2003 Health Survey in Chile found the prevalence of high total cholesterol to be 25% (PAHO, 2007).

The PAHO stated that "diabetes mellitus represents a major public health problem in the Americas, and there is evidence that its prevalence is increasing in some countries (Barceló & Rajpathak, 2001)." DM was the fourth leading cause of death in Latin America in 2001, with 5% of all deaths. However, it was the leading cause of death in Mexico in 2002 (12.8%), representing the first and second cause of death for women and men, respectively. There was an estimated 13.3 million people with DM in Latin America in 2000. By the year 2030, the population with DM is expected to reach 32.9 million (PAHO, 2007). The increasing obesity epidemic, however, may cause those numbers to be even higher. Previous research shows that the prevalence of DM in various Latin American countries is (listed from highest to lowest): Nicaragua (11.9%); Guatemala

(10.7%); Costa Rica (10.7%); El Salvador (9.8%); Honduras (8%); and Chile (7%) (PAHO, 2007). Despite the economic hardships faced by the countries in Latin America, there is a need for more efforts in diabetes prevention and control. In 2000, it was estimated that 339,035 deaths were caused by diabetes mellitus in Latin America (Barceló, Aedo, Rajpathak, & Robles, 2003). The total annual costs associated with diabetes, including medications, hospitalizations, consultations, and care for complications, were estimated as 65,216 million US dollars (Barceló et al., 2003).

The typical Latin American diet, regardless of Hispanic subgroup, tends to be high in fiber. The traditional diet consists largely of beans and rice, fresh fruits and vegetables, and meats such as beef, pork, and chicken. Fish is also eaten in moderation, where available. Corn tortillas are a staple food, especially in Central America. A normal Central American breakfast may include coffee sweetened with sugar, sweet bread of any kind, fried bacon, refried beans, fried plantains with cream, and corn tortillas, which are usually homemade and fried in a pan with or without oil. A lunch may include corn tortillas, carne asada or carne fritas, which is grilled or fried meat, respectively, or possibly fish, and refried beans. At about 3 p.m., a merienda (snack) is eaten that usually consists of sweetened coffee and sweet bread. Then for dinner, the typical meal is corn tortillas, refried beans, and meat (McDonald, 2009).

Typical meals in South America follow the same pattern as in Central America, that is, three meals are always eaten – breakfast, lunch, and dinner, and a snack for some, mostly children. However in the rural areas, only two meals are normal. Breakfast is typically bread-based, being made mostly from corn and cassava. Breads such as *arepas*, which are cooked on the griddle, *humitas*, which are steamed, and *casabe*, also cooked on

the griddle, are very popular. A very important part of breakfast is coffee, consumed alone or with milk. Lunch in South America would not be lunch if there is no soup. Soup is often eaten as the first course in a meal, or for some it is the only dish eaten. The soup is usually followed by fried meat or fish, vegetables, rice and beans, and fried plantains. Dinner is considered to be the most important meal of the day in the continent. Typical dishes often include stews, fried foods, roasts, and salads prepared by different methods. Beef, pork, and poultry are the most widely consumed meats. Dishes vary by country. Lastly, the most common dessert in all South American countries is *Dulce de leche* (Lovera, 2005).

Adults in Costa Rica with a dietary pattern such as that mentioned above were found to have an increased risk of myocardial infarction (MI) and low levels of plasma HDL (Martínez-Ortiz et al., 2006). Although traditional, (Bermudez & Tucker, 2003) found that food consumption patterns across Latin America are changing. There has been in increase in the intake of total fats, animal products, and sugar, while the consumption of cereals, fruits and some vegetables has rapidly declined. These dietary changes are increasing the prevalence of chronic diseases and burdening the health systems. For instance, “changes in Guatemalan food patterns and in nutrient intakes are marked by increased food variety, at the expense of reduction in the consumption of nutrient-dense foods and increase in the consumption of processed foods (Bermudez, Hernandez, Mazariegos, & Solomons, 2008).”

It is important to know that there is no one “Hispanic diet.” “The various Hispanic groups all have their own nutritional habits and key dishes, based on customs and the foods that are readily available in their geographic area (Rodriguez, 2004).”

Population characteristics

According to the U.S. Census, as of July 2006 the Hispanic population reached approximately 44.3 million (14.8% of the total population) (U.S. Census Bureau, 2006). The statistics proved there to be enormous growth in this group of people. From 2000 to 2006, the growth rate of Hispanics was 24.3%, which is almost four times that of the growth rate of the total population in the nation (U.S. Census Bureau, 2006).The trend of growth of Hispanics in the U.S. has been continuously increasing. It is projected that by the year 2050, the Hispanic population will reach 102.6 million, nearly one-quarter of the total population. Mexicans make up nearly 64% of the Hispanic population, followed by Puerto Ricans (9.0%), Central Americans (7.6%), South Americans (5.5%), Cubans (3.4%), and then Dominicans (2.8%) (U.S. Census Bureau, 2006). Of the 3.3 million Central Americans, 1,240,031 are Salvadoran, 780,191 are Guatemalan, 466,843 are Honduran, 275,126 are Nicaraguan, 141,286 are Panamanian, 111,978 are Costa Rican, and the remaining 99,422 are from other Central American countries. South Americans total 2.4 million, with the majority being from Colombia (723,596), followed by Ecuador (432,068), Peru (415,352), and then Argentina (189,303) (Passel, 2006). It is estimated that 796,000 Hispanics reside in Washington D.C., Maryland, and Virginia (Pew Hispanic Center, 2006).

It was reported in 2005 that the number of newly arrived “unauthorized” immigrants had increased the U.S. population by an average of 700,000 – 800,000 a year over the past decade. The U.S population was equally increased by legal immigrants over the same interval (Passel, 2005). This information indicates that two-thirds of all “unauthorized” immigrants have been in the country less than 10 years. National

estimates from 2006 show the current total of unauthorized immigrants to be about 8 to 9 million (Passel, 2006). The vast majority of immigrants have consistently been from Mexico; however, those arriving from Central America are increasing much more rapidly. The amount of unauthorized Central American immigrants increased by about 465,000 over a period of five years from 2000 to 2005 (Passel, 2006). The demographics of this group of immigrants are men and women between the ages of 18-39 years, and children. Nearly 49% or 5.4 million of this population is male, 29% or 3.9 million is female, and the remainder is children, which account for nearly 1.8 million or 16% of the new population. Not included in the total for "unauthorized" children are the 3.1 million children born in the U.S. to "illegal" immigrant parents. The data shows that a very small percentage of unauthorized immigrants are over the age of 40, while none are over the age of 65 (Passel, 2005).

With the number of unauthorized immigrants increasing, the amount of tax dollars spent to treat and care for this population is also increasing concurrently. It is suspected that there will be a tremendous financial impact that this growing population will have on education and health care costs, especially in treating CHD and MS. Many immigrants come to the U.S. in search of a better life and financial opportunities. However, much of the population either does not work or have jobs that offer low wages and require little education. The Pew Hispanic Center estimates that there were 7.2 million unauthorized workers in 2005. The majority of the workers are employed in the following occupations: Farming, cleaning, construction, food preparation, production, and transport (Passel, 2006). These unauthorized workers have a low income and many of the jobs do not provide health care benefits. Most immigrants that have no health insurance seek

assistance from organizations that offer free or low cost services, such as the Spanish Catholic Center located in Washington, DC.

Hispanic Health in the U.S.

National data on MS and CHD mortality in Central and South Americans is limited. According to the National Center for Health Statistics (NCHS), heart disease is the number one cause of death among Hispanics accounting for 23.2% of all deaths. This is lower compared to the percentage of deaths from heart disease in non-Hispanic whites and non-Hispanic blacks, which is 28.6% and 26.5%, respectively (National Centers for Health Statistics [NCHS] & Centers for Disease Control and Prevention [CDC], 2002).

The San Antonio Heart Study, a population-based study of cardiovascular disease and diabetes among Mexican Americans in San Antonio, Texas has provided much of the data and knowledge on health issues concerning Hispanic Americans. A study looking at the trend in the prevalence of MS and its impact on CVD incidence conducted by (Lorenzo, Williams, Hunt, & Haffner, 2006), showed that the prevalence of MS had increased over time. MS risk factors and socio-demographic data from two cohorts were recorded at baseline, 1979-1982 for cohort 1 and 1984-1988 for cohort 2, and then again at follow-up, approximately 8 years later. The authors observed that the prevalence of MS was higher at follow-up than at baseline in both cohorts, with noticeably higher rates in the second cohort. Participants in cohort 2 had decreased HDL cholesterol, high blood pressure, decreased total cholesterol, decreased smoking, less frequent elevated fasting blood glucose, equivalent prevalence of type 2 DM, and increased elevated waist circumference, as compared to those in cohort 1. When Framingham cardiovascular risk

scores were calculated, Mexican American men and women both had significantly higher scores than non-Hispanic whites (Lorenzo et al., 2006); (Stern & Wei, 1999). “Thus, the prediction is that Mexican Americans of both sexes would have higher cardiovascular mortality than non-Hispanic whites (Stern & Wei, 1999).”

A study, based on data from the Family Blood Pressure Program, comparing patterns of MS in four ethnic groups, African Americans, Caucasians, Hispanics, and Asians, conducted by (Kraja et al., 2005) showed that over 50% of the Hispanic sample surpassed the high density lipoprotein (HDL), blood pressure (BP), and glucose thresholds and over 70% surpassed the waist circumference (WC) and triglyceride (TG) thresholds for MS risk factors defined by the NCEP. Hispanics had the highest prevalence of MS (73%) among all other groups, as well as, the highest concentration of serum glucose. A high association of MS with type 2 DM was seen, thus the authors concluded that “Hispanics have a trend for being more susceptible to MS (Kraja et al., 2005).”

The Multi-Ethnic Study of Atherosclerosis (MESA), a medical research study involving more than 6,000 men and women from six communities in the United States, included Hispanic-American participants from Mexico, Dominican Republic, Puerto Rico, and Other Hispanic-American countries, with the most common being El Salvador , Ecuador, Colombia, and Guatemala (Allison et al., 2008). Based on data from MESA, (Allison et al., 2008) conducted a study to determine the prevalence and extent of CVD risk factors in four U.S. Hispanic subgroups. This study included 1,437 Hispanic men and women enrolled in the MESA study in 2000-2002. Results from this study documented that all non-Mexican-American Hispanic subgroups had significantly lower triglyceride

levels and lower prevalence of the MS, compared with Mexican Americans. However, these same subgroups did not show any significant differences from Mexican Americans with regard to fasting blood glucose, systolic blood pressure, nor LDL cholesterol (Allison et al., 2008).

Data from various research studies have reported that Hispanic Americans have higher rates of obesity, elevated blood pressure, dyslipidemia, elevated triglyceride levels, and diabetes (Mensah, Mokdad, Ford, Greenlund, & Croft, 2005); (Meigs et al., 2003). However, reports on this population demonstrated lower rates of both CHD and total CVD in men and women (Mensah et al., 2005). "Although they are usually classified as a single ethnic group, Hispanics are culturally, socioeconomically, and genetically heterogeneous and represent a wide variety of national origins and social classes. These differences are manifested in measures of CVD (Allison et al., 2008)."

Metabolic Syndrome Criteria

Currently, the MS can be diagnosed using several definitions that have been established by a variety of organizations. The most frequently used criteria have been defined by: NCEP ATP III, IDF, WHO, and the EGIR (Eckel, Grundy, & Zimmet, 2005). The criteria defined by most organizations consist of the following abnormalities in an individual: hypertension, insulin resistance, glucose intolerance, hypertriglyceridemia (high serum triglycerides), low levels of high density lipoprotein cholesterol (LDL-c), and abdominal obesity (Okosun, Liao, Rotimi, Prewitt, & Cooper, 2000). Each of the organizations listed has a unique criterion for abdominal obesity. The cutoff values are >102 cm (>40 in.) in men and >88 cm (>35 in.) in women for ATP III. The cutoff values

for IDF are ≥94 cm for Europid men and ≥80 cm for Europid women, with ethnicity specific values for others. WHO uses waist-to-hip ratio >0.9 in men and >0.85 in women and/or BMI >30 kg/$m^2$. The cutoff values for EGIR are ≥94 cm in men and ≥80 cm in women (Li & Ford, 2006). Medical professionals prefer to use simple tools with which to assess their patients, and therefore prefer to use the NCEP ATP III definition; most agree that it is simpler for clinical use (Eckel et al., 2005).

Waist Circumference

A commonality among those who have acquired risk factors for the MS is abdominal obesity. The ATP III report states, "Most persons with insulin resistance have abdominal obesity (ATP III)." Obesity, particularly in the abdominal region, affects many Americans, especially Hispanic Americans. Abdominal obesity (assessed by waist circumference (WC)) may be a better indicator of increased CHD risk than overall excess bodyweight (Sarti & Gallagher, 2006).

Ford, Mokdad, and Giles (2003) found that trends in WC in the U.S. had increased from 27.7% in NHANES III (1988-1994), a nationally representative sample of the U.S., to 36.0% in NHANES 1999-2000, a change of 8.3%. In a 2007 follow up study of the trends in WC, the authors found that over one-half of U.S. adults had abdominal obesity in the NHANES 2003-2004 (Li, Ford, McGuire, & Mokdad, 2007). In a 2003 study, Ardern, Katzmarzyk, Janssen, & Ross (2003) tested the use of the U.S. National Institutes of Health (NIH) guidelines for determining metabolic risk factors, which advocated risk stratification based on WC measurements within BMI categories as a means to capture those at increased cardiovascular risk. They found that the prevalence of

MS nearly doubled in overweight subjects with a high WC compared with subjects with a low WC.

This epidemic problem has created much controversy with respect to WC cutoffs that have been established by various organizations for metabolic syndrome criteria. The WC cutoffs were made based on evidence compiled from various research studies in Caucasian populations (Banerjee & Misra, 2007). WC cutoffs for Hispanics have not been determined and remain unknown (Zhu et al., 2005). Therefore, the established WC cutoffs may not be applicable to Central and South Americans when being evaluated for the MS. In April of 2005, IDF proposed a new definition of the MS in response to the proliferation of definitions (Ford, 2005). They hoped it would serve as a worldwide, unifying definition. In their criteria they proposed several ethnic specific WC cut offs. The values are as follows: ≥ 94 cm and ≥ 80 cm for Europids; ≥ 90 cm and ≥ 80 cm for South Asians (based on a Chinese, Malay, and Asian-Indian population); ≥ 90 cm and ≥ 80 cm for Chinese; and ≥ 85 cm and ≥ 90 cm for Japanese, all values are for males and females, respectively. Ethnic South and Central Americans are to use the recommendations for South Asians until more specific data are available. Sub-Saharan Africans and Eastern Mediterranean and Middle East (Arab) populations are to use European data until specific data becomes available (Alberti, Zimmet, & Shaw, 2005). The IDF recognizes that not all population groups are the same. By suggesting varying cutoffs, this allows for adjustment of WC to lower thresholds when ethnic groups are more prone to insulin resistance (Haffner, 2006).

Blood Glucose

Elevated fasting blood glucose (FBG) is commonly known for being used to diagnose DM; however, it is also an important criterion for diagnosing MS. Some organizations with working definitions, specifically WHO and EGIR, have made glucose intolerance, insulin resistance, or diagnosed DM an obligatory criterion. Whereas other organizations like ATP III, view all risk factors equally (Li & Ford, 2006). Standardized diagnostic criteria are used to categorize people without diagnosed diabetes as to whether they have diabetes, impaired fasting glucose or normal blood glucose levels. Persons with FBG levels >126 mg/dL on more than one occasion, are diagnosed with diabetes. FBG levels ≥100-125mg/dL indicate impaired fasting glucose. Impaired fasting glucose (IFG) is usually an indicator of insulin resistance, along with other metabolic risk factors. According to ATP III, (NCEP ATP III, 2002), "A portion of persons with impaired fasting glucose will eventually develop type 2 diabetes, which further enhances the risk for CHD." FBG levels 70-99 mg/dL are considered normal.

FBG tests are more commonly used than non-FBG tests for more precise results. In assessing the prevalence of DM in the U.S. population using NHANES 1999-2002, (Cowie et al., 2006) only included those who had fasted for 8 to < 24 hours in the analyses. The results of this study showed that Mexican-Americans, aged ≥ 20-59 years, have the highest rates of IFG compared to their non-Hispanic white and non-Hispanic black counterparts. In a sample of 1,304 Puerto Ricans living in New York City, the prevalence of DM was 28.2% for those aged 18-44 years, 38.9% for those aged 45-64 years, and 39.2% for ages 65 years and up (Melnik et al., 2004). These data reflect a growing concern for the elevated risk factors commonly seen in Hispanic groups.

High Density Lipoprotein Cholesterol

High levels of plasma HDL cholesterol tend to be a negative risk factor for developing CVD. For that reason, it is known as the "good" cholesterol. HDL participates in reverse cholesterol transport, which removes cholesterol, typically LDL, from the peripheral tissues and takes it to the liver for excretion, metabolism, and storage. Levels of HDL cholesterol can be affected by existing conditions, such as insulin resistance and type 2 DM. Research has shown that the greater the degree of hyperinsulinemia, the lower the HDL cholesterol concentrations (Reaven, 2006). Previous studies have found that low plasma levels of HDL cholesterol contribute to an increased cardiovascular risk and are a predictor of CHD, and suggest that HDL cholesterol may even be an independent risk factor (Ryder et al., 2007). Low HDL cholesterol increases CHD risk regardless of the LDL cholesterol level (Barter & Rye, 1996).

Low HDL cholesterol levels are very common among the Hispanic American population, especially in Central and South America. This has been demonstrated by study findings in Venezuela, where 50.3% of the black Hispanic men and 71.8% of women had low HDL cholesterol; while 50.8% of mixed Hispanic men and 56.2% of women had low HDL cholesterol levels, as defined by NCEP ATP III criteria (Ryder et al., 2007). Similar results were also seen in Chile (Espinosa-Larranaga, Vejar-Jalaf, & Medina-Santillan, 2005) and Guatemala (Gregory, Dai, Ramirez-Zea, & Stein, 2007), where the prevalence of low HDL-cholesterol was 39.0% of the total population and 75% of men and 87% of women, respectively. Despite the overwhelming evidence for HDL cholesterol as an independent risk factor for CHD, the importance of HDL cholesterol levels lower than 40 mg/dL for men and lower than 50 mg/dL for women seems to be

overlooked. LDL cholesterol takes precedence, largely when it comes to pharmacological management. Non-pharmacological therapies such as reducing smoking, healthy diets (consisting of 50 to 60% carbohydrates and 10 to 15% protein and fats), maintenance of BMI < 25 $kg/m^2$, and increasing exercise have a positive influence in elevating plasma HDL cholesterol levels (Espinosa-Larranaga et al., 2005).

Triglycerides

Elevated plasma triglycerides (TG), also known as hypertriglyceridemia, serve as a marker for atherogenic remnant lipoproteins and other lipid and nonlipid risk factors in the MS (NCEP ATP III, 2002). In the U.S., hypertriglyceridemia is most prevalent among Mexican-Americans (Ford, Giles, & Dietz, 2002); however it can also be observed in other Hispanic ethnic groups. Results from the Prevencion Study in Peru showed that an average of 52.0% of the male participants was suffering from high TG. This study demonstrated that increasing age is associated with a significant increase in high triglycerides (Medina-Lezama et al., 2007).

Blood Pressure

Hypertension (HTN) is defined by ATP III as systolic blood pressure ≥130 mmHg or diastolic blood pressure ≥85 mmHg. HTN is a significant public health burden in that it increases CVD morbidity, mortality, disability, and economic cost (Gu, Burt, Paulose-Ram, Yoon, & Gillum, 2008). There is an unequivocal association between blood pressure and the risk of CVD. HTN often occurs concomitantly with elevated total cholesterol (NCEP ATP III, 2002). According to data from the NHANES III, Gu et al.,

(2008) determined that participants who were pre-hypertensive and hypertensive were more likely to be male, obese, older, have diabetes, hypercholesterolemia, congestive heart failure, chronic kidney disease, and have had a prior stroke and previous heart attack. These data were taken from 16,917 participants aged 18 years and older who had mortality follow-up information. The mean blood pressure for hypertensives was 145/81 mmHg (23.7%), 125/77 mmHg for prehypertensives (30.8%), and 109/68 mmHg for normotensives (Gu et al., 2008). Research conducted in Venezuela revealed that HTN was one of the three most frequent components used to diagnose MS (Florez et al., 2005). Approximately 38.1% of the total population had HTN.

Metabolic Syndrome and Cardiovascular Diseases

CVD is a class of diseases that involves the heart and blood vessels and affects the cardiovascular system. CVDs include coronary heart disease (heart attacks), cerebrovascular disease (stroke), raised blood pressure (hypertension), peripheral artery disease, rheumatic heart disease, congenital heart disease and heart failure. The major causes of cardiovascular disease are tobacco use, physical inactivity, and an unhealthy diet. Among these causes is also the MS. Studies have confirmed that the metabolic syndrome may increase the risk of developing CVD by as much as 4-fold. Presence of the metabolic syndrome also increases morbidity and mortality in patients both with and without clinical evidence of CVD (Clark & El-Atat, 2007). Previous research suggests that CVD risk factors have an additive effect on risk for CVD; the same is generally true for MS components and for risk of CVD and type 2 diabetes (Wilson, D'Agostino, Parise, Sullivan, & Meigs, 2005). In a study by Isomaa et al. (2001), the presence of MS was

associated with an approximately threefold higher risk of coronary heart disease, myocardial infarction, and stroke in all subjects, and this risk was greater than the risk associated with any of the individual components.

CHD accounts for approximately 52% of all diagnosed cardiovascular diseases in the U.S., thus contributing to the high CHD mortality rate. There are several risk factors for CHD. Risk factors are diseases, physiologic states, biologic markers, or other identifiable factors that are associated with an increased incidence of CVD in populations that have these risk factors (Eaton, 2005). Among the risk factors is DM, which is an independent risk factor and has become increasingly important in the U.S. This is because of the increasing rates of obesity, aging of the population, and the growth of ethnic populations that are susceptible to developing type 2 DM (Grundy et al., 2001). Coronary atherosclerosis, caused by elevated blood cholesterol levels, hypercholesterolemia, is known to cause CHD. However, there are other traditional and emerging risk factors that are classified as modifiable or non-modifiable.

The traditional risk factors are age, gender, family history, cigarette smoking, hypertension, hyperlipidemia, diabetes mellitus, physical inactivity, diet, alcohol consumption, obesity, and left ventricular hypertrophy. Of those traditional risk factors, the non-modifiable risk factors are age, gender, and family history of the disease; all else can be modified through diet, exercise, and medication (Eaton, 2005). The emerging risk factors are highly sensitive C-reactive protein, homocysteine, lipoprotein (*a*), and fibrinogen (Eaton, 2005), as well as, proinflammatory cytokines, including interleukin-6 (IL-6) and tumor necrosis factor-$\alpha$ (Hanley et al., 2004; Langenberg, Bergstrom, Scheidt-

Nave, Pfeilschifter, & Barrett-Connor, 2006). Traditional and emerging risk factors play integral roles in the occurrence of coronary events.

With increases in prevalence around the world, it is likely that "the MS will be one of the most prevalent diseases of mankind, and one of the most costly in its contributions to morbidity and premature mortality, particularly from atherosclerosis and other cardiovascular diseases" (Hansen, Saye, & Wennogle, 1999).

Metabolic Syndrome and Type 2 Diabetes Mellitus

Diabetes mellitus and its precursors of insulin resistance and glucose intolerance are potent risk factors for CVD and mortality, as well as microvascular complications (DeFronzo, Ferrannini, Keen, & Zimmet, 2004; Haffner, 2006). People with diabetes are two to four times more likely to develop CVD due to a variety of risk factors, including: high blood pressure, lipid disorders, high LDL cholesterol, high triglycerides, low HDL cholesterol, smoking, obesity, and lack of physical activity (Rosamond et al., 2008). The majority of these risk factors are criteria included in all definitions of the MS. The increasing obesity rates in the US have tremendously increased the risk of developing insulin resistance. It has been proven that hyperinsulinemia, hypertension, and dyslipidemia are linked (DeFronzo et al., 2004); thus once you've developed one of them, the others will soon appear. This corresponds strongly with the notion that the MS enhances the risk for type 2 diabetes. According to the National Diabetes Education Program (NDEP), about 2.5 million or 10.4% of Hispanic and Latino Americans over the age of 20 years have been diagnosed with diabetes. (National Diabetes Education Program [NDEP], 2008).

A study that investigated the clustering of metabolic and inflammation variables using data from the Insulin Resistance Atherosclerosis Study (IRAS) on nondiabetic participants to determine the association of the clusters with risk of developing type 2 DM over time found that three factors, metabolic, inflammation, and blood pressure, emerged during the analysis as significant predictors for DM. Each factor was interpreted based on factor loadings of $\geq 0.40$ of certain inflammation and metabolic syndrome variables. Insulin sensitivity was present in both the metabolic and inflammation clusters. The results showed that "these factors were generally consistent across sex and ethnic subgroups, and each factor was found to be significantly associated with progression to diabetes over the follow-up period of 5.2 years (Hanley et al., 2004)." It is unequivocal that type 2 diabetes is associated with an increased cardiovascular risk.

Diabetes is the most potent CHD risk factor and is viewed as a CHD equivalent (Mann, Lee, Youlian Liao, & Natarajan, 2006).

## Summary

The Hispanic American population, specifically those from Central and South America, is dramatically increasing in the U.S. Central and South Americans are the fastest growing group of Hispanics in the U.S., with the second largest population. However, there is limited MS and CHD data on this rapidly growing group. National data, such as NHANES, has studied more established Hispanic Americans of Mexican, Puerto Rican, and Cuban descent. Data on Mexican Americans suggests that they have greater risk of cardiovascular mortality than non-Hispanic whites, contrary to what was previously thought (Stern & Wei, 1999). CHD morbidity and mortality has become

increasingly prevalent among the Hispanic population in the U.S. MS risk factors have contributed substantially to the increased incidence of heart disease. This study will ascertain whether Central and South Americans living in the Washington, D.C. area have similar MS and CHD risks as more established Hispanic groups.

# Chapter 3: Methods

A cross-sectional survey was conducted to assess the prevalence of MS and its individual components in a sample of participants attending the Spanish Catholic Center (SCC) Medical Clinic in Washington, D.C.

*Subjects*

Data were collected by medical record extraction from files at the SCC Washington, D.C. Medical Clinic. Permission was granted by the SCC and obtained from the Institutional Review Board at the University of Maryland, College Park.

The SCC is a private, non-profit agency serving Latino's and the immigrant community. They have locations in Washington, D.C. and Montgomery County, Maryland, with a total of four clinics (Catholic Charities, 2008). Data for this study were obtained from the Washington, D.C. clinic, which is in a heavily Hispanic neighborhood. Services offered at the medical clinics include primary care, gynecology, cardiovascular risk programs, including a diabetes clinic and heart program, cancer prevention program, and referrals (Catholic Charities, 2008). The majority of the patients that visit the clinic are adults of Hispanic origin, primarily from El Salvador. Services are provided based on income, and are usually free or low cost. In 2007, 6,232 patients were served at the SCC. In 2008, 1,713 new patients were served at the SCC's D.C. medical clinic alone, in addition to continuing patients (Catholic Charities, 2008). The SCC is funded by the United Way, the Archdiocese of Washington, D.C., and private and public donations (Miner & Jackson, 1995).

*Design*

A questionnaire was used to obtain background information about the patients (Appendix A). The data included demographic and socio-economic information reported by the patients, anthropometric and clinical data taken by the SCC staff, and biochemical data obtained from fasting blood and urine tests. Biochemical indices were analyzed by Quest Diagnostics Incorporated in Baltimore, Maryland. Quest Diagnostics uses standardized blood analysis techniques. Concentrations of fasting plasma lipids and glucose were measured using standardized blood analysis techniques. Blood glucose was analyzed using an automated enzymatic method (Caraway & Watts, 1986). Cholesterol and HDL cholesterol were both analyzed enzymatically. Triglyceride levels were analyzed by automated spectrophotometry (Stein, 1986). Low density lipoprotein cholesterol was mathematically derived using the Friedewald formula for subjects with triglyceride levels of 400 mg/dL or less (Friedewald, Levy, & Fredrickson, 1972).

The SCC maintained active records alphabetically for three years (2006-2009). On each occasion data were collected, medical records were extracted by systematic sampling. In systematic sampling, the researcher can have a single starting point, where the first record is chosen randomly and then all remaining records are chosen at evenly spaced increments (Quinn & Keough, 2002). After the initial record was chosen, every third record was subsequently selected to be included in the sample (n = 1,044). Of those active medical records, only records of participants from Central and South America with fasting blood analyses were extracted. Subjects were identified by an identification number to guarantee confidentiality.

*Statistical Analysis*

Descriptive and inferential statistics were used in the analysis. Data were presented as means ± standard deviations for continuous variables and as frequencies and percentages for categorical variables. Differences between mean values of MS components based on country of origin, BMI category, and year of attendance at the medical clinic were assessed by analysis of variance (ANOVA), with a Tukey-Kramer post-hoc test to accommodate groups with unequal sample sizes. Chi Square test was used to compare prevalence rates of MS and MS components in analyses stratified by gender and BMI. Student's t test compared independent means between men and women for selected variables. All tests were two-tailed. A significance level was set at $p \leq 0.05$, and analyses were performed using Statistical Analysis System (SAS) (Version 9.2; SAS Institute Inc., Cary, NC).

# Chapter 4: Results

## A) Prevalence of the metabolic syndrome in Central and South American residents in the Washington, D.C. area


### Abstract

*Background:* The Central and South American population is growing rapidly in the U.S., but little information is known about the health status of this population.

*Objectives:* The purpose of this study was to ascertain which metabolic abnormalities are most associated with the metabolic syndrome (MS) in this population, and to estimate the prevalence of MS and its individual risk factors and then compare differences in the risk factors among various Hispanic sub-groups of both genders.

*Design:* This cross-sectional, medical record extraction survey sampled 1,042 adult patients of the Spanish Catholic Center (SCC) Medical Clinic in Washington, DC. A questionnaire was used to collect sociodemographic, medical history, anthropometric, biochemical, and clinical data. In this study, the prevalence rates of MS and its components were estimated using modified NCEP-ATP III guidelines that included a BMI $\geq$ 25 kg/m$^2$ as a criterion.

*Results:* The overall prevalence of the metabolic syndrome in our study population was 28%. The most common abnormal metabolic indicator was an elevated BMI $\geq$ 25 kg/m$^2$ (75.6%). The results showed that 43.2% of men and 50.7% of women had HDL levels lower than normal, while the prevalence of hypertriglyceridemia was 37%. The risk of abnormal metabolic syndrome indicators increased steadily as BMI increased. The combination identifying the most subjects with the MS included the following: high

triglycerides, low HDL cholesterol, and overweight (BMI ≥ 25-29 kg/m$^2$) and obesity (BMI ≥ 30 kg/m$^2$) (n = 85 men; n = 136 women). Among the five most frequently reported Hispanic sub-groups, the prevalence of MS was 29.4%, which was a total of 255 subjects. Rates were highest among subjects from El Salvador, Honduras, Peru, and Guatemala, 30.7%, 29.0%, 29.6%, and 30.1%, respectively; and lowest among subjects from Bolivia (18.3%). Women had higher BMI, lower HDL cholesterol, but a lower prevalence of metabolic syndrome.

*Conclusion:* Our results indicate that the pattern of chronic disease risk, dyslipidemia and high BMI, increased the likelihood of having the metabolic syndrome, which is consistent with studies conducted on Mexican-Americans in the San Antonio Heart Study (Han et al., 2002) and other Central and South American populations.

## Introduction

Cardiovascular diseases (CVD) are among the nation's leading causes of death. Of note, "CVD is the leading cause of death among the largest and fastest growing ethnic minority in the United States, Latinos/Hispanics" (Davidson et al., 2007). Coronary heart disease (CHD) is the leading cause of death in the United States (U.S.), causing approximately 53% of all deaths annually (Rosamond et al., 2008). Dietary intake may, in part, be responsible for the increasing prevalence of CVD (Martínez-Ortiz et al., 2006). Diet affects the risk factors for CHD and many other chronic diseases, including Diabetes Mellitus (DM), strokes, and certain cancers (Martínez-Ortiz et al., 2006); all of which are among the top ten leading causes of death in the U.S.

Metabolic Syndrome (MS) is a cluster of metabolic abnormalities that occur together in an individual and are associated with an increased risk of developing

cardiovascular disease (CVD) and type 2 diabetes mellitus (DM) (Meigs et al., 2003). The following abnormalities are considered to be characteristic of the syndrome: glucose intolerance, hyperinsulinemia, high plasma triglycerides, decreased high-density lipoprotein (HDL) cholesterol, hypertension, central obesity, proinflammatory state, and prothrombotic state, all of which increase the risk of developing CVD and diabetes (Ford & Giles, 2003). MS is closely associated with a generalized metabolic disorder called insulin resistance, in which tissue responsiveness to the normal action of insulin is impaired (NCEP ATP III, 2002). Overweight/obesity, physical inactivity, and genetic factors are the underlying causes of the metabolic syndrome.

Each of the MS components alone has detrimental health effects, but when combined, the components become more "powerful" (Reaven, 2006) by increasing the likelihood of developing CVD. Each definition of MS possesses, but is not limited to, the aforementioned components. The definition of the MS has evolved over time. However, there are five commonly accepted components which are agreed upon by several organizations, such as the National Cholesterol Education Program, International Diabetes Federation, European Group for the Study of Insulin Resistance, and the World Health Organization.

Much of the known information about chronic diseases in the U.S. has been generated by large national studies such as the National Health and Nutrition Examination Survey (NHANES). NHANES is conducted to ascertain the current health and nutrition status of non-Hispanic whites, non-Hispanic blacks, and Hispanic Americans of Mexican, Puerto Rican, and Cuban descent living in the U.S. Despite the wealth of information on these established Hispanic Americans, generalizations should

not be made to other Hispanic subgroups. According to Nath (2005), “Findings from one Hispanic subgroup cannot be applicable or extrapolative to other Hispanic subgroups because each subgroup's social histories, cultural identities, health behaviors, and genetic compositions are unique.”

Despite the significant awareness of risk factors for CHD in these commonly studied groups of Americans, very little is known about the prevalence of metabolic syndrome among Central and South Americans. Central Americans, specifically, are the fastest growing group of Hispanics in the U.S., followed by South Americans. Furthermore, Central and South Americans made up 7.6% and 5.5% of the total Hispanic population in the U.S. in 2006, respectively. Combined, these two groups made up 13.1% of the Hispanic population, while Mexican-Americans made up 64% of the total Hispanic population of 44,252,278. The total Hispanic population was 14.8% of the total U.S. population of 299 million (U.S. Census Bureau, 2006).

This research will be useful for public health planning, education, as well as program implementation that can offer preventative services to Hispanics to reduce risk factors for CHD.

## Subjects and methods

*Study population*

A cross-sectional survey was conducted to assess the prevalence of metabolic syndrome and its individual components in a sample of participants attending the Spanish Catholic Center (SCC) Medical Clinic in Washington, DC. The SCC is a private, non-profit agency serving Latino’s and the immigrant community. SCC has locations in

Washington, D.C. and Montgomery County, Maryland, with a total of four clinics (Catholic Charities, 2008). Data for this study were obtained from the Washington, D.C. clinic, which is located in a heavily Hispanic neighborhood. Services are provided based on income, and are usually free or low cost. Our study sample consisted of 1,044 adults aged 18 years and older, who reported being from any Central or South American country, and who had fasting lipid profile measurements available. Data were collected by medical record extraction from files at the medical clinic using a questionnaire (Appendix A). On each occasion data were collected, medical records were extracted by systematic sampling. Subjects were identified by an identification number to guarantee confidentiality. Protocols were approved by the SCC and by the Institutional Review Board at the University of Maryland, College Park.

*Study variables*

A questionnaire was used to obtain sociodemographic information on the patients. Sociodemographic variables included date of birth, gender, self-reported country of origin, state of residence, education, employment status, and years living in the U.S. Lifestyle variables included current smoking status and alcohol consumption. Medical history information was used to assess subjects diagnosed by a physician with diabetes, hypertension, or heart problems.

*Biochemical measures*

Biochemical indices were analyzed by Quest Diagnostics Incorporated in Baltimore, Maryland. Concentrations of fasting plasma lipids and glucose were

measured using standardized blood analysis techniques. Blood glucose was analyzed using an automated enzymatic method (Caraway & Watts, 1986). Cholesterol and HDL cholesterol were both analyzed enzymatically. Triglyceride levels were analyzed by automated spectrophotometry (Stein, 1986). Low density lipoprotein cholesterol was mathematically derived using the Friedewald formula for subjects with triglyceride levels of 400 mg/dL or less (Friedewald et al., 1972).

*Metabolic syndrome assessment*

Each subject was assessed for the presence of metabolic syndrome using data collected on fasting plasma concentrations of glucose, HDL cholesterol, and triglycerides, blood pressure, height, and weight. The metabolic syndrome was defined by a modified NCEP-ATP III definition that identified subjects if three or more of the following were present: (1) BMI $\geq$ 25 kg/m$^2$, (2) fasting plasma glucose $\geq$ 110 mg/dl, (3) HDL cholesterol < 40 mg/dl for men and < 50 mg/dl for women, (4) triglycerides $\geq$ 150 mg/dl, (5) blood pressure $\geq$ 130/85 mm Hg (NCEP ATP III, 2002). The World Health Organization (WHO) and the American Association of Clinical Endocrinologist (AACE) have clinical criteria for MS and for the diagnosis of Insulin Resistance Syndrome (IRS), respectively, which use BMI instead of waist circumference. WHO uses a cutoff of > 30 kg/m$^2$ and AACE uses a cutoff of BMI $\geq$ 25 kg/m$^2$ as the body weight component of the syndrome (Grundy, Brewer, Cleeman, Smith, & Lenfant, 2004). In this study, the AACE BMI cutoff was used. BMI was calculated as weight divided by the square of height with available measurements and was categorized into four groups: underweight (< 18.5 kg/m$^2$), normal weight (18.5-24.9 kg/m$^2$), overweight (25.0-29.9 kg/m$^2$), and obese (>

30.0 kg/m$^2$), according to WHO criteria (World Health Organization, 1995). We excluded underweight subjects with a BMI < 18.5 kg/m$^2$ ($n$ = 1) and subjects receiving insulin therapy for treatment of diabetes ($n$ = 2).

*Statistical Analysis*

Descriptive and inferential statistics were used in the analysis. Data were presented as means ± standard deviations (SD) for continuous variables and as frequencies and percentages for categorical variables. Differences between mean values of MS components based on country of origin and BMI category were assessed by analysis of variance (ANOVA), with a Tukey-Kramer post-hoc test to accommodate groups with unequal sample sizes. Chi Square test was used to compare prevalence rates of MS and MS components in analyses stratified by gender and BMI. Student's t test compared independent means between men and women for selected variables. All tests were two-tailed. A significance level was set at $p \leq 0.05$, and analyses were performed using Statistical Analysis System (SAS) (Version 9.2; SAS Institute Inc., Cary, NC).

## Results

A total of 1,042 men and women were chosen for our study. A physical exam found that subjects were in good general health. The majority were women (n = 704; 67.6%). Ages ranged from 18 to 87 years, with a mean age and SD of 42 and 13 years, respectively. Anthropometric, biochemical, and clinical characteristics stratified by gender are shown in **Table 4.1**. Both men and women were similar in age; however, women were slightly older. A large number (33.7%) of subjects in the study were 34 years or younger (n = 351). Women had a significantly higher BMI than men ($p \leq 0.05$).

Table 4.1 shows that the mean TG value in men, as well as mean LDL cholesterol in men and women, exceeded the ATP III cutoff criteria for optimal levels.

Country of origin was subject reported (Appendix B). Nearly 50% of the study population reported being from El Salvador. Results indicate that the majority of subjects resided in Maryland (57%) at the time of the study and were employed with a median income of $13,000 per year. Most of the subjects were either married (45%) or single (42%). Of those who had dependents, the average number was 2.6 and 2.3 for men and women, respectively. A total of 69% of subjects had primary or secondary education, while only 23% spoke English fluently. Only about 100 (11%) subjects had medical insurance. The average number of years that subjects had been living in the U.S. was 8.8 years.

**Table 4.2** shows the prevalence of individual metabolic syndrome components among males and females in the study sample. These results indicate that the most common abnormal indicator of the metabolic syndrome was a high BMI $\geq$ 25 kg/m$^2$, as used in the AACE definition, for both men and women. High fasting plasma glucose concentrations were infrequently seen in both men and women, with a prevalence rate of only 9.7%, compared to the 75.6% for high BMI. HDL cholesterol was analyzed separately for men and women. The results showed that 43.2% of men had HDL cholesterol levels lower than recommended. The results for the women showed that just over half of them had lower than normal HDL cholesterol levels. The overall percentage of both men and women with hypertriglyceridemia was 37%. Over half (59%) of those subjects were women. Of the 338 men, 46.5% actually had hypertriglyceridemia, compared to 32.5% of all women. The overall prevalence of hypertension was 9.6%

among men and women. Of the 23.4% of subjects who had a systolic blood pressure at or above to 130 mmHg, 36.1% were men and 63.9% were women. As for an elevated diastolic blood pressure, only 11% of subjects met or exceeded this criterion.

Among men, 29.3% had one abnormal component, 26.0% had two abnormal components, 26.9%, 5.9%, and 1.2% had three, four, or all five abnormal components of the metabolic syndrome. When compared to men, these percentages were generally higher for women, with values of 29.7, 19.7, 19.9, 4.7, and 0.4%, respectively. The total prevalence of MS in our study population was 28% (n = 291). The prevalence for men was 11% (n= 115) and the prevalence for women was 17% (n = 176).

A chi-square test of independence was performed to examine the relation between elevated BMI and sex. The relation between these variables was significant, $X^2$ (1, N = 1042) = 6.03, $p < 0.05$. However, this association was significant only for a BMI of $\geq 30$ kg/m$^2$, not for a BMI $\geq 25$ kg/m$^2$.

*BMI category as a predictor of MS risk*

**Table 4.3** presents the prevalence of MS risk components by BMI category (normal, overweight, obese) in the overall study population. Across all MS components, TG, HDL, BP, and blood glucose, subjects with a BMI of $\geq 30$ kg/m$^2$ had significantly higher prevalence rates than subjects with BMI values $< 30$ kg/m$^2$. The number of obese subjects that met MS criteria for each component was nearly three times that of subjects with normal BMI. Comparisons between BMI categories were made with Chi-Square tests and were statistically significant based on a chosen $P$ value of $\leq 0.05$.

*Identifying MS by BMI category*

All possible combinations of three of the five NCEP-ATP III criteria used to diagnose MS are shown in **Table 4.4**. The presence of MS varied significantly by the specific criteria used. The results reveal that being overweight (BMI $\geq$ 25 kg/m$^2$) or obese (BMI $\geq$ 30 kg/m$^2$); in combination with hypertriglyceridemia and low HDL cholesterol was the most prevalent type of MS for both men and women. BMI, TG, and HDL identified 85 men and 136 women. There was a statistically significant difference between BMI category and the BMI, TG, and HDL combination of MS for both men and women ($p < 0.05$). The combinations identifying the most subjects with MS included having a BMI $\geq$ 25 kg/m$^2$, low HDL, high triglycerides, and high blood pressure. The combination that captured the least amount of subjects was HDL, blood pressure, and glucose (n = 8).

*Differences in MS risks among Hispanic sub-groups*

The prevalence of MS among the five most frequently reported countries of origin is shown in **Table 4.5**. The prevalences of having only one, two, three, four or all five MS components for subjects from El Salvador, Honduras, Peru, Guatemala, and Bolivia are also shown in the table. Among these five Hispanic sub-groups, the prevalence of MS was 29.4%, which was a total of 255 subjects. The overall prevalence of MS was very similar among subjects from El Salvador, Honduras, Peru, and Guatemala, with prevalence rates of 30.7%, 29.0%, 29.6%, and 30.1%, respectively. Subjects from Bolivia had a substantially lower MS prevalence of 18.3%. We also estimated the prevalence of the MS for males and females in the five most frequently reported countries

of origin, and the results are shown in **Table 4.6**. We found that a greater percentage of male subjects had the MS, with the exception of Bolivians, where only 7.1% (n = 1) of male subjects and 21.7% (n = 10) of female subjects had the MS.

## Discussion

The overall prevalence of metabolic syndrome in our study was 28%. Male subjects had a MS prevalence of 34.0%, while the prevalence for female subjects was 25.0%. In the NHANES 1999-2002, results from data collected on Mexican-American men and women showed that the prevalence of metabolic syndrome according to the NCEP-ATP III definition was 32.2 and 37.8% for men and women, respectively (Ford, 2005). Furthermore, in the San Antonio Heart Study (SAHS), Lorenzo et al. (2007) found the prevalence of NCEP-ATP III metabolic syndrome to be 29.6% for men and 30.9% for women among Mexican-Americans. Several studies conducted on Mexican-Americans have also found similar prevalence rates of the metabolic abnormalities of the metabolic syndrome (Ford, 2005; Ford & Giles, 2003; Lorenzo, Williams, Hunt, & Haffner, 2007; Lorenzo, Williams, Hunt, & Haffner, 2006). In a study of U.S. adults aged $\geq$ 20 years, the prevalence rates of hypertriglyceridemia, low HDL cholesterol, hypertension, and high glucose were 40.2%, 34.1%, 39.8%, and 21.1%, respectively among Mexican-American men. Among the Mexican-American women studied, the rates for the same abnormalities were 35.8, 46.6, 32.9, and 32.9%, respectively (Ford & Giles, 2003). Our study subjects had a lower prevalence of metabolic syndrome, but consistent with the NHANES and SAHS studies, the prevalence of MS was higher in women.

In this cohort of Central and South Americans, the most prevalent metabolic abnormalities were elevated BMI (78.4% men and 74.9% women), hypertriglyceridemia (46.5% men and 32.5% women), and low HDL cholesterol (43.2% men and 50.7% women). High fasting plasma glucose levels were not as frequent as one might expect in a population in which 78% of its subjects had a BMI at or above 25 $kg/m^2$. A correlation analysis examining whether BMI and blood glucose vary together was performed. Our results revealed that there was a weak, positive correlation between the two variables ($r = 0.11$). Previous studies have shown that "the heavier the person, the more likely he or she is to be insulin resistant" (Reaven, 2006), and that adiposity and insulin resistance are correlated ($r = 0.6$) (Reaven, 2006). (Vazquez, Duval, Jacobs, & Silventoinen, 2007) found that general obesity is a good predictor of diabetes among white U.S. and European populations. No differences were found in the prevalence of high BMI ($\geq 25$ $kg/m^2$) between men and women; however, hypertension and high glucose levels were both more frequently seen in men.

When compared to studies conducted on other Latin American populations, our results were very similar (Espinosa-Larranaga et al., 2005; Medina-Lezama et al., 2007). In a population-based study in Peru, PREVENCION, the most common metabolic abnormality in women was low HDL cholesterol (60.9%); whereas, in men it was hypertriglyceridemia (52.0%) followed by low HDL cholesterol (32.5%). Besides elevated BMI being very common among men and women in our study, the abnormalities found in the PREVENCION study subjects were very similar to those found in our study population. Just as in our study, they too found that abnormal fasting plasma glucose was the least common component for men (5.4%) and women (5.0%) (Medina-Lezama et al.,

2007). Additionally, in studies conducted in various Central and South American countries, Espinosa-Larranaga et al. (2005) concluded that approximately 50% of the populations in Argentina, Chile, Paraguay, Peru, and Colombia are overweight and more than 15% are obese. They also found that in Chile, 39.3% of the population had low HDL cholesterol; and in Venezuela, men had higher levels of triglycerides (47%) with low levels of HDL cholesterol (40%), which is consistent with our findings.

In this study, dyslipidemia (elevated triglycerides and decreased HDL cholesterol levels) is very common. This pattern of dyslipidemia was also seen in Venezuelan subjects with the metabolic syndrome (Florez et al., 2005). It is possible that dietary patterns among Latin Americans contribute to the presence of dyslipidemia. Martínez-Ortiz, et al. (2006) positively associated a 'staple' dietary pattern, characterized by an increased intake of refined grains (white bread and rice), added sugar, coffee, legumes, red meat, and increased use of palm oil for cooking, with lower HDL cholesterol and increased risk of myocardial infarction in Costa Rican adults.

We noticed a pattern among the subjects that demonstrated that the higher the BMI, the higher the prevalence of each risk component of the MS as shown in table 4.3. Obese subjects had the highest prevalence rates, which were significantly higher than those of overweight subjects, and subjects of normal weight had significantly lower prevalence rates than the overweight subjects, with the exception of high glucose and hypertension. The prevalence rates of high glucose and hypertension in normal weight and overweight subjects did not vary greatly. When we compared the mean glucose values in subjects classified with normal and overweight BMI, there was no statistically significant difference between the groups ($p > 0.05$). In an analysis of Mexican-

American SAHS subjects, (Han et al., 2002) also found that the odds of developing metabolic disorders, such as hypertriglyceridemia, low HDL cholesterol, hypertension, and type 2 diabetes, increased with a BMI $\geq$ 30 kg/m$^2$ for men and women. However, they found that the odds of having low HDL cholesterol were greater for overweight as opposed to obese women, which is consistent with our findings.

In this population, overweight and obesity status, low HDL cholesterol, and high triglycerides were very powerful in identifying subjects with the MS. The combinations which included glucose were least likely to identify subjects with the metabolic syndrome; thus plasma glucose does not seem to aid in identifying high risk compared to other variables. By stratifying this analysis by gender and BMI category, this allowed us to distinguish which criteria of the MS is most likely to occur in Hispanics based on gender and relative weight. Hypertriglyceridemia, low HDL cholesterol and hypertension are commonly found in those who are insulin-resistant (Espinosa-Larranaga et al., 2005). However, we found that this combination of criteria did not capture as many subjects as the above mentioned criteria that included BMI, but it did identify subjects with normal BMI, which was rare in our population. The prevalence of hypertension in this study was fairly low (11.2% for men and 8.8% for women) which differs from studies that show that nearly 30% of the adult Latin American population has hypertension (Espinosa-Larranaga et al., 2005). These combinations which include dyslipidemia are especially detrimental because they are associated with type 2 diabetes and an increased risk of cardiovascular events (Espinosa-Larranaga et al., 2005). The results of a Pearson partial correlation, controlling for age, revealed that many of the metabolic indicators were correlated. The strongest correlations in our population existed

between total cholesterol and LDL cholesterol (r = 0.92), HDL cholesterol and triglycerides (r = - 0.49), total cholesterol and triglycerides (r = 0.33), BMI and HDL cholesterol (r = - 0.27), BMI and triglycerides (r = 0.26), and SBP and DBP (r = 0.62). The correlations found support our results, in that BMI influences other variables, such as HDL and triglycerides, and vice versa, as well as the fact that these variables are the most prevalent combination of abnormal metabolic components in study subjects.

We performed an analysis looking at the differences of metabolic syndrome risk factors between subjects that originated from five different Central and South American countries. These five sub-groups contained the largest numbers of subjects among all countries of origin represented in our study. The largest Hispanic sub-group in our study was from El Salvador (48.8%, n = 508) and the smallest sub-group was from Bolivia (5.8%, n = 60). Subjects from El Salvador had the highest prevalence of MS (30.7%), while those from Bolivia had the lowest prevalence (18.3%). The prevalence of MS was also determined for male and female subjects separately. That analysis showed that males from Guatemala had the highest prevalence of MS (46.9%), followed by Honduras and Peru, both with 38.5%, then El Salvador with 37%. There was only one male subject from Bolivia with MS (7.1%). The number of subjects with MS did not differ among Honduran, Peruvian, and Guatemalan men. The prevalence rates for the female subjects from El Salvador, Honduras, Peru, Guatemala, and Bolivia were 28.2%, 23.5%, 23.7%, 21.3%, and 21.7%, respectively, which were slightly lower than those of their male counterparts. Our findings show that subjects from Bolivia have lower risks associated with the MS. However, there is not enough evidence to prove any biological or ethnic

difference from the other Hispanic sub-groups. This difference may be due to the small sample size of subjects from Bolivia.

Because waist circumference measures were not available, we used BMI to classify subjects as having one of the criteria for the metabolic syndrome. Along with the NCEP ATP III criteria, we used the overweight/obesity risk factor component used by the AACE, which is a BMI of $\geq 25$ kg/m$^2$. The BMI criterion from the AACE clinical definition was used because a BMI >25.0 kg/m$^2$ identifies individuals at increased risk for insulin resistance and metabolic syndrome (Einhorn et al., 2003). We felt this BMI cutoff was appropriate because of the stature of our subjects. The average height was $65.1 \pm 2.9$ and $60.9 \pm 2.7$ inches for men and women, respectively. Had we chosen to use a higher BMI, then the MS prevalence may have been underestimated, and other metabolic abnormalities would go unnoticed and untreated. The MS consists of several indicators, and the obesity component varies according to the definition used. Some definitions use waist circumference (EGIR, NCEP ATP III, and IDF, while others use BMI (WHO and AACE). Studies have shown that BMI and waist circumference are highly correlated, with a correlation coefficient of about 0.91-0.94 in men and 0.88-0.94 in women (Cheal et al., 2004; Flegal et al., 2009; Ford, Mokdad, & Giles, 2003; Grundy et al., 2004).

Strengths of this study include its focus on and addition of data to an understudied segment of the Hispanic population that is rapidly growing in the U.S and the large sample size of study participants. The use of systematic sampling allows for data to be representative of all SCC patients. Limitations of this study are that waist circumference

was not collected at SCC and the patient population used for this study may not be representative of Hispanic Americans living in the Washington, D.C. metropolitan area.

## Conclusion

The prevalence of MS in the U.S. is on the rise. Our results indicate that the pattern of chronic disease risk, dyslipidemia and high BMI, increase the likelihood of having the MS, which is consistent with studies conducted on Mexican-Americans in the San Antonio Heart Study (Han et al., 2002) and other Central and South American populations. According to Nath (2005), “Findings from one Hispanic subgroup cannot be applicable or extrapolative to other Hispanic subgroups because each subgroup's social histories, cultural identities, health behaviors, and genetic compositions are unique.” This study elucidated whether a difference in MS risk does exist among Hispanic subgroups. Our findings showed that there were subtle differences, some statistically significant, among each subgroup identified in the study. Results are comparable to those more established Hispanic Americans of Mexican, Cuban, and Puerto Rican descent.

**Table 4.1. Characteristics of the Central and South American study population by gender[1]**

| | *n* | Men | *n* | Women |
|---|---|---|---|---|
| Age (years) | 338 | 41.5 ± 13.6 | 704 | 42.8 ± 13.2 |
| ≤ 34 (%) | 114 | 34 | 237 | 34 |
| 35-44 (%) | 96 | 28 | 166 | 24 |
| 45-54 (%) | 66 | 20 | 173 | 25 |
| 55-64 (%) | 46 | 14 | 90 | 13 |
| ≥ 65 (%) | 16 | 5 | 38 | 5 |
| Weight (kg.) | 331 | 77.3 ± 12.5 | 701 | 69.3 ± 14.2 |
| Height (cm.) | 323 | 165.4 ± 7.4 | 688 | 154.7 ± 6.9 |
| BMI ($kg/m^2$) | 323 | 28.3 ± 4.1 | 688 | 29.0 ± 5.6 |
| SBP (mmHg) | 336 | 119.7 ± 17.7 | 703 | 115.7 ± 18.5[3] |
| DBP (mmHg) | 336 | 72.9 ± 12.1 | 703 | 71.0 ± 10.9[3] |
| TC (mg/dL) | 332 | 191.5 ± 38.9 | 694 | 190.5 ± 36.7 |
| HDL-c (mg/dL) | 332 | 42.9 ± 10.4 | 694 | 50.5 ± 12.7[3] |
| LDL-c (mg/dL) | 320 | 116.7 ± 33.5 | 684 | 113.3 ± 31.3 |
| TG (mg/dL) | 331 | 163.8 ± 97.9 | 691 | 136.4 ± 78.6[3] |
| FPG (mg/dL) | 329 | 99.9 ± 31.3 | 686 | 93.3 ± 27.9[3] |

[1]Data are mean ± S.D, unless otherwise specified.
[2]Data are percentages (%).
[3]Significantly different from men.
BMI, Body Mass Index; SBP, Systolic Blood Pressure; DBP, Diastolic Blood Pressure; TC, Total Cholesterol; HDL, High Density Lipoprotein-cholesterol; LDL, Low Density Lipoprotein-cholesterol; TG, Triglycerides; FPG, Fasting Plasma Glucose

**Table 4.2. Prevalence of individual metabolic syndrome components among male and female Central and South Americans**

| | No. of subjects and % with abnormal MS components | | | | |
|---|---|---|---|---|---|
| MS component | **Men** | | **Women** | | *P* |
| | **No.** | **%** | **No.** | **%** | |
| High BMI ($\geq$ 25 kg/m$^2$) | 265 | 78.4 | 523 | 74.9 | 0.15 |
| High FPG (110 mg/dl) | 42 | 12.4 | 59 | 8.4 | 0.04 |
| Low HDL cholesterol† | 146 | 43.2 | 357 | 50.7 | < 0.01 |
| High TG (150 mg/dl) | 157 | 46.5 | 229 | 32.5 | < 0.01 |
| HBP (130/85 mmHg) | 38 | 11.2 | 62 | 8.8 | 0.21 |

†low HDL: male <40 mg/dl, female <50 mg/dl.
BMI, Body Mass Index; FPG, Fasting Plasma Glucose; HDL, High Density Lipoprotein-cholesterol; TG, Triglycerides; HTN, Hypertension.

**Table 4.3. Number of subjects and prevalence of metabolic syndrome components in Central and South Americans by BMI category**

| MS Component | Number and percent of subjects | | | |
|---|---|---|---|---|
| | **Normal** 18.5-24.9 $kg/m^2$ | **Overweight** 25.0-29.9 $kg/m^2$ | **Obese** ≥ 30.0 $kg/m^2$ | ***P* value** |
| High FPG (110 mg/dl) | 12 (5%) | 30 (7%) | 55 (16%) | < 0.0001 |
| Low HDL (< 40 mg/dl)† | 43 (19%) | 101 (23%) | 136 (39%) | < 0.0001 |
| Low HDL (< 50 mg/dl)₤ | 91 (41%) | 249 (57%) | 248 (71%) | < 0.0001 |
| High TG (150 mg/dl) | 37 (17%) | 158 (36%) | 173 (49%) | < 0.0001 |
| SBP (≥ 130 mmHg) | 34 (15%) | 94 (21%) | 105 (30%) | 0.0001 |
| DBP (≥ 85 mmHg) | 13 (6%) | 33 (8%) | 63 (18%) | < 0.0001 |
| HTN (130/85 mmHg) | 13 (6%) | 27 (6%) | 54 (15%) | < 0.0001 |

Data are *n* (%). †low HDL (< 40 mg/dl): males. ₤low HDL (< 50 mg/dl): females.
FPG, Fasting Plasma Glucose; HDL, High Density Lipoprotein-cholesterol; TG, Triglycerides; SBP, Systolic Blood Pressure; DBP, Diastolic Blood Pressure; HTN, Hypertension.

**Table 4.4. Identification of the metabolic syndrome using all combinations of any three criteria**

| Criteria used* | Number of subjects with metabolic syndrome | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Men** | | | | | **Women** | | | | |
| | **Normal** | **Overweight** | **Obese** | ***n*** | ***P*** | **Normal** | **Overweight** | **Obese** | ***n*** | ***P*** |
| BMI, TG, HDL | 0 | 43 | 42 | 85 | < 0.0001 | 0 | 48 | 88 | 136 | < 0.0001 |
| TG, HDL, BP | 1 | 6 | 6 | 13 | 0.35 | 1 | 4 | 14 | 19 | 0.003 |
| TG, HDL, FPG | 0 | 6 | 8 | 14 | 0.01 | 0 | 4 | 17 | 21 | < 0.0001 |
| HDL, BP, FPG | 1 | 1 | 3 | 5 | 0.27 | 0 | 0 | 3 | 3 | 0.07 |
| BMI, HDL, BP | 0 | 6 | 6 | 12 | 0.14 | 0 | 5 | 20 | 25 | < 0.0001 |
| BMI, TG, BP | 0 | 11 | 11 | 22 | 0.02 | 0 | 1 | 17 | 18 | < 0.0001 |
| BMI, TG, FPG | 0 | 11 | 12 | 23 | 0.01 | 0 | 8 | 21 | 29 | < 0.0001 |
| BMI, FPG, BP | 0 | 2 | 6 | 8 | 0.02 | 0 | 0 | 9 | 9 | 0.0004 |
| BMI, FPG, HDL | 0 | 4 | 11 | 15 | 0.0006 | 0 | 8 | 23 | 31 | < 0.0001 |
| TG, FPG, BP | 0 | 2 | 4 | 6 | 0.11 | 0 | 0 | 3 | 3 | 0.08 |

*BMI: men and women, ≥ 25.0 kg/m$^2$; glucose 110 mg/dl; HDL: men < 40 mg/dl, women < 50 mg/dl; triglyceride ≥150 mg/dl; blood pressure ≥130/85 mmHg. BMI, Body Mass Index; BP, Blood Pressure; HDL, High Density Lipoprotein-cholesterol; TG, Triglycerides; FPG, Fasting Plasma Glucose.

**Table 4.5. Percentage of Central and South Americans meeting metabolic syndrome criteria by country of origin***

| No. of components | **El Salvador** n = 508 | **Honduras** n = 107 | **Peru** n = 98 | **Guatemala** n = 93 | **Bolivia** n = 60 |
|---|---|---|---|---|---|
| 1 | 27.4 | 28.0 | 28.6 | 25.8 | 45.0 |
| 2 | 21.5 | 23.4 | 17.3 | 33.3 | 6.7 |
| 3 | 23.0 | 19.6 | 28.6 | 25.8 | 15.0 |
| 4 | 6.5 | 9.4 | 1.0 | 3.2 | 3.3 |
| 5 | 1.2 | 0 | 0 | 1.1 | 0 |
| Prevalence | 30.7 | 29.0 | 29.6 | 30.1 | 18.3 |
| Total No. of subjects w/ MS | 156 | 31 | 29 | 28 | 11 |
| Prevalence of MS among the five Hispanic subgroups | | | | | 29.4% |

*Values are percentages.

**Table 4.6. Percentage of male and female Central and South Americans having MS criteria clustering by country of origin***

| | Men | | | | | Women | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| No. of components | **El Salvador** (n = 160) | **Honduras** (n = 39) | **Peru** (n =39) | **Guatemala** (n = 32) | **Bolivia** (n = 14) | **El Salvador** (n =348) | **Honduras** (n = 68) | **Peru** (n = 59) | **Guatemala** (n = 61) | **Bolivia** (n = 46) |
| 1 | 25.0 | 30.7 | 23.1 | 28.1 | 57.1 | 28.4 | 26.5 | 32.2 | 24.6 | 38.8 |
| 2 | 29.4 | 17.9 | 17.9 | 15.6 | 21.4 | 17.8 | 26.5 | 16.9 | 42.6 | 2.2 |
| 3 | 26.9 | 28.2 | 35.9 | 43.8 | 7.1 | 21.3 | 14.7 | 23.7 | 16.4 | 17.4 |
| 4 | 8.0 | 10.3 | 2.6 | 0 | 0 | 6.0 | 8.8 | 0 | 4.9 | 4.3 |
| 5 | 1.9 | 0 | 0 | 3.1 | 0 | 0.9 | 0 | 0 | 0 | 0 |
| No. of subjects w/ MS | 58 | 15 | 15 | 15 | 1 | 98 | 16 | 14 | 13 | 10 |
| **Prev. of MS** | **37.0** | **38.5** | **38.5** | **46.9** | **7.1** | **28.2** | **23.5** | **23.7** | **21.3** | **21.7** |

*Values are percentages, unless otherwise specified.

## B) Comparison of metabolic syndrome indicators in two samples of Central and South Americans living in the Washington, D.C. area in 1993-1994 and 2008-2009


### Abstract

*Background*: The Central and South American population is growing rapidly in the U.S., but little information is known about the health status of this population.

*Objectives***:** The purpose of this study was to estimate the prevalence of individual components of the metabolic syndrome (MS) as well as the prevalence of MS using data from two samples of Central and South Americans utilizing the Spanish Catholic Center from 1993 – 1994 and from 2008 – 2009, and to examine how prevalence estimates might have changed over time between these groups.

*Design***:** This cross-sectional, medical record extraction survey sampled 1,641 adult patients of the Spanish Catholic Center (SCC) Medical Clinic in Washington, DC. A questionnaire was used to collect sociodemographic, medical history, anthropometric, biochemical, and clinical data. In this study, the prevalence rates of MS and its components were estimated using modified NCEP-ATP III guidelines that included a BMI $\geq$ 25 kg/m$^2$ as a criterion.

*Results*: Among the subjects surveyed in 1993-1994, the MS prevalence was 19.7%. The most prevalent MS components were low HDL (40.4% men and 51.3% women), elevated triglycerides (40.9% men and 33.1% women), and high BMI $\geq$ 25 kg/m$^2$ (27.6% men and 36.6% women). The overall prevalence of the MS in the subjects surveyed in 2008-2009 was 28%. The most common abnormal metabolic indicator was an elevated BMI $\geq$ 25 kg/m$^2$ (75.6%). The results showed that 43.2% of men and 50.7% of women had HDL levels lower than normal, while the prevalence of hypertriglyceridemia was 46.5% and

32.5% for men and women, respectively. The prevalence of MS is significantly greater for subjects in 2008-2009 compared with subjects in 1993-1994 ($p \leq 0.05$).

*Conclusion***:** Our results indicate that the pattern of chronic disease risk, dyslipidemia and high BMI, increased the likelihood of having the metabolic syndrome. Although this distinct pattern was identified in both the 1993-1994 and 2008-2009 study populations, risks for the MS have increased over time.

## Introduction

Metabolic Syndrome (MS) is a cluster of metabolic abnormalities that occur together in an individual and are associated with an increased risk of developing cardiovascular disease (CVD) and type 2 diabetes mellitus (DM) (Meigs et al., 2003). The following abnormalities are considered to be characteristic of the syndrome: glucose intolerance, hyperinsulinemia, high plasma triglycerides, decreased high-density lipoprotein (HDL) cholesterol, hypertension, central obesity, proinflammatory state, and prothrombotic state, all of which increase the risk of developing CVD and diabetes (Ford & Giles, 2003). MS is closely associated with a generalized metabolic disorder called insulin resistance, in which tissue responsiveness to the normal action of insulin is impaired (NCEP ATP III, 2002). Overweight/obesity, physical inactivity, genetic factors, and poor diet are the underlying causes of the metabolic syndrome (Levesque & Lamarche, 2008).

According to data from the Third National Health and Nutrition Examination Survey, 1988 – 1994 (NHANES III), the estimated prevalence of MS among U.S. adults was 21.8%, with rates that increased with age (Ford et al., 2002). In a similar study, Ford, Giles, & Mokdad (2004), estimated the MS prevalence to be 23.1% among subjects from NHANES III; whereas, Ford & Giles (2003) estimated that 23.9% of NHANES III participants have the MS. The prevalence of MS among participants from the San Antonio Heart and Framingham Offspring Studies in the early to mid 1990's ranged from 21.3% and 32.8% using the NCEP-ATP III criteria (Meigs et al., 2003). In later studies, the prevalence of MS was estimated to be 26.7% (Ford et al., 2004) and 34.5% (Ford, 2005) among subjects aged 20 years and older from NHANES 1999 – 2000. These

studies suggest that the prevalence of MS increases over time, especially as rates of obesity increase worldwide.

Much of the known information about chronic diseases in the U.S. has been generated by large national studies such as the NHANES. NHANES is conducted to ascertain the current health and nutrition status of non-Hispanic whites, non-Hispanic blacks, and Hispanic Americans of primarily Mexican, Puerto Rican, and Cuban descent living in the U.S. Despite the wealth of information on these established Hispanic Americans, generalizations should not be made to other Hispanic subgroups. According to Nath (2005), "Findings from one Hispanic subgroup cannot be applicable or extrapolative to other Hispanic subgroups because each subgroup's social histories, cultural identities, health behaviors, and genetic compositions are unique." Despite the significant awareness of risk factors for CHD in these commonly studied groups of Americans, very little is known about the prevalence of metabolic syndrome among Central and South Americans.

The objectives of this study are to estimate the prevalence of individual risk factors for metabolic syndrome as well as the prevalence of metabolic syndrome using data from a sample of Central and South Americans utilizing the Spanish Catholic Center from 1993 – 1994, to estimate the metabolic syndrome prevalence rates of Central and South Americans utilizing the SCC in 2008 – 2009, and examine how prevalence estimates might have changed over time.

## Subjects and methods

*Study populations*

A cross-sectional survey was conducted to assess the prevalence of metabolic syndrome and its individual components in a sample of participants attending the Spanish Catholic Center (SCC) Medical Clinic in Washington, D.C. The SCC is a private, non-profit agency serving Latino's and the immigrant community. SCC has locations in Washington, D.C. and Montgomery County, Maryland, with a total of four clinics (Catholic Charities, 2008). Data for this study were obtained from the Washington, D.C. clinic, which is in a heavily Hispanic neighborhood. Services are provided based on income, and are usually free or low cost. Our study sample consisted of 1,042 adults aged 18 years and older, who reported being from any Central or South American country, and who had fasting lipid profile measurements available. Data were collected by medical record extraction from files at the medical clinic using a questionnaire (Appendix A). On each occasion data were collected, medical records were extracted by systematic sampling. Subjects were identified by an identification number to guarantee confidentiality. Protocols were approved by the SCC and by the Institutional Review Board at the University of Maryland, College Park.

*Study variables*

A questionnaire was used to obtain sociodemographic information reported by the patients. Sociodemographic variables included date of birth, gender, self-reported country of origin, state of residence, education, employment status, and years living in the U.S. Lifestyle variables included current smoking status and alcohol consumption.

Medical history information was also collected and used to assess how many subjects had been told they had diabetes, hypertension, or heart problems.

*Biochemical measures*

Biochemical indices were analyzed by Quest Diagnostics Incorporated in Baltimore, Maryland. Concentrations of fasting plasma lipids and glucose were measured using standardized blood analysis techniques. Blood glucose was analyzed using an automated enzymatic method (Caraway & Watts, 1986). Cholesterol and HDL cholesterol were both analyzed enzymatically. Triglyceride levels were analyzed by automated spectrophotometry (Stein, 1986). LDL cholesterol was mathematically derived using the Friedewald formula for subjects with triglyceride levels of 400 mg/dL or less (Friedewald et al., 1972).

SCC Coronary Heart Disease Risk Assessment 1993 – 1994

Data from a cross-sectional study conducted in 1993 – 1994 at the SCC, examining coronary heart disease risks in Central and South Americans attending the clinical in Washington, D.C. for medical care were also used in this study (Miner & Jackson, 1995). The present study parallels this previous study using a similar questionnaire and variables and having biochemical indices analyzed by the same laboratories.

*Metabolic syndrome assessment*

Each subject was assessed for the presence of MS using data collected on fasting plasma concentrations of glucose, HDL cholesterol, and triglycerides, blood pressure, height, and weight. The MS was defined by a modified NCEP ATP III definition that identified subjects if three or more of the following were present: (1) BMI $\geq$ 25 kg/ $m^2$, (2) fasting plasma glucose $\geq$ 110 mg/dl, (3) HDL cholesterol < 40 mg/dl for men and < 50 mg/dl for women, (4) triglycerides $\geq$ 150 mg/dl, (5) blood pressure $\geq$ 130/85 mm Hg (NCEP ATP III, 2002). Data for waist circumference measurements were not available; as a result, we substituted a BMI $\geq$ 25 kg/ $m^2$ for both men and women as an index for body weight. The WHO and AACE have clinical criteria for MS and for the diagnosis of Insulin Resistance Syndrome (IRS), respectively, which use BMI instead of waist circumference. WHO uses a cutoff of > 30 kg/ $m^2$ and AACE uses a cutoff of BMI $\geq$ 25 kg/ $m^2$ as the body weight component of the syndrome (Scott M Grundy et al., 2004). In this study, the AACE BMI cutoff was used. BMI was calculated as weight divided by the square of height with available measurements and was categorized into four groups: underweight (< 18.5 kg/$m^2$), normal weight (18.5-24.9 kg/$m^2$), overweight (25.0-29.9 kg/$m^2$), and obese (> 30.0 kg/$m^2$), according to WHO criteria (World Health Organization, 1995).

*Statistical Analysis*

Descriptive and inferential statistics were used in the analysis. Data were presented as means ± standard deviations for continuous variables and as frequencies and percentages for categorical variables. We excluded underweight subjects with a BMI <

18.5 kg/m$^2$ ($n$ = 5) and subjects receiving insulin therapy for treatment of diabetes ($n$ = 2). From the 607 SCC 1993-1994 study subjects examined, we excluded eight subjects aged <18 years. Differences between mean values of MS components based on year of attendance at the medical clinic and country of origin were assessed by analysis of variance (ANOVA), with a Tukey-Kramer post-hoc test to accommodate groups with unequal sample sizes. Chi Square test was used to compare prevalence rates of MS and MS components in the two populations and analyses stratified by gender. Student's t test compared independent means between study populations as well as for men and women for selected variables. All tests were two-tailed. A significance level was set at $p \leq 0.05$, and analyses were performed using Statistical Analysis System (SAS) (Version 9.2; SAS Institute Inc., Cary, NC).

**Results**

A total of 1,641 men and women were chosen for our study. A physical exam found that subjects were in good general health. Ages ranged from 18 to 87 years. The 1993-1994 and 2008-2009 study sample sizes were 599 and 1,042, respectively. Anthropometric, biochemical, and clinical characteristics of the two study populations stratified by gender are shown in **Table 4.7**. Among the 1993-1994 subjects, the mean age and SD was 37 and 14 years, respectively and 66.1% were women (n = 396). Women were significantly older ($p \leq 0.05$) and had significantly higher BMI than men ($p \leq 0.05$). Among the 2008-2009 subjects, the mean age and SD was 42 and 13 years, respectively and 67.6% were women (n = 704). Both men and women were similar in age; however, women were slightly older. The majority of subjects in the study were 34 years or younger (33.7%; n = 351). Women had a significantly higher BMI than men ($p \leq 0.05$).

There was heterogeneity by sex among anthropometric measurements and metabolic risks within and between the study populations. Metabolic risks were more common among men compared with women. Table 4.7 shows that the mean TG value in men, as well as mean LDL cholesterol in men and women, exceeded the ATP III cutoff criteria for optimal levels. The mean HDL cholesterol value for women in 1993-1994 was also lower than the ATP III cutoff criterion and lower than the mean for women from 2008-2009. Overall, when the two populations were compared as a whole, the 2008-2009 subjects had significantly higher BMI, lower fasting glucose, and lower systolic and diastolic blood pressures ($p \leq 0.05$).

When comparing men from the previous and present studies, many of the characteristics were similar. Men from the 1993-1994 study had significantly higher systolic and diastolic blood pressures ($p \leq 0.05$); whereas men from the present study were significantly heavier, had a higher BMI, and were older ($p \leq 0.05$). When the women from each study were compared, a number of differences were identified between them. Besides being significantly heavier, taller, and older ($p \leq 0.05$), the women from the 2008-2009 study had lower mean metabolic risk values, some being significantly lower, such as fasting glucose, total cholesterol, and blood pressure.

Country of origin was subject reported. Nearly 50% of each study population reported being from El Salvador. Results indicate that the majority of subjects (63%) from 1993-1994 resided in Washington, D.C., whereas the majority of subjects (57%) from 2008-2009 resided in Maryland at the time of the study, and were employed with a median income of approximately $7,800 to $13,000 per year. Most of the subjects were either married (40% vs. 45%) or single (46% vs. 42%) in the 1993-1994 and 2008-2009

studies, respectively. In the 2008-2009 study, of those who had dependents, the average number was 2.6 and 2.3 for men and women, respectively. A total of 69% of subjects had primary or secondary education, while only 23% spoke English fluently. Only about 100 (11%) subjects had medical insurance. The average number of years that subjects had been living in the U.S. was 8.8 years. In the 1993-1994 study, nearly all (96%) subjects obtained primary or secondary education, only 2% of subjects had medical insurance, and only 8% spoke fluent English.

**Table 4.8** shows the prevalence of individual MS components and the MS among male and female Central and South American subjects from the 1993-1994 and 2008-2009 study samples. The prevalence of having low HDL was very high among all subjects. The most prevalent MS indicators among men in 1993-1994 were low HDL (40.4%) and high TG (40.9%), while low HDL (51.3%) and high BMI (36.6%) were most prevalent for women. Women had a significantly higher prevalence of low HDL compared to men in both study samples (51.3% vs. 40.4% in 1993-1994 and 50.7% vs. 43.2% in 2008-2009) ($p \leq 0.05$). For those men and women in the 2008-2009 study, the most common abnormal indicators of the MS was a high BMI (78.4% of men and 74.3% of women), as used in the AACE definition (Scott M Grundy et al., 2004), low HDL, and high TG. The overall prevalence of hypertension was 9.6% among men and women in 2008-2009. Of the 23.4% of subjects who had a SBP at or above 130 mmHg, 36.1% were men and 63.9% were women. As for an elevated DBP, only 11% of subjects met or exceeded this criterion. On the contrary, subjects in 1993-1994 had higher prevalence rates of elevated SBP and DBP. The difference in prevalence rates of hypertension was statistically significant for both men (20.2% vs. 11.2%) and women (18.7% vs. 8.8%) (*p*

$\leq 0.05$). The prevalence of MS is significantly greater for subjects in 2008-2009 compared with subjects in 1993-1994 ($p \leq 0.05$).

The prevalence of MS component clustering among men and women from the 1993-1994 study is presented in **Table 4.9**. Clustering of abnormal MS components was more prevalent among men at each level of clustering (two through five components) when compared to women, except for the clustering of four components. Overall, 152 men had one or more MS components, with the majority of those men having only one component (31.5%). Women were more likely than men to have only one component (32.3%). However, men had a higher prevalence of clustering of 3 components, indicating having the MS, compared to women (14.8% vs. 13.4%). Based on the number of subjects with three, four, or five MS components, the prevalence of MS for men was 19.7% (n = 40) and the prevalence for women was also 19.7% (n = 78).

In the population studied in 2008-2009, 29.3% of men had one abnormal component, 26.0% of men had two abnormal components, 26.9%, 5.9%, and 1.2% of men had three, four, or all five abnormal components of the MS. When compared to men, these percentages were generally lower for women, with values of 29.7, 19.7, 19.9, 4.7, and 0.4%, respectively. The total prevalence of MS in this study population was 27.9%. The prevalence for men was 34.0% (n = 115) and the prevalence for women was 25% (n = 176).

In both the 1993-1994 and 2008-2009 study populations, the most frequently reported country of origin was El Salvador. There were a total of 804 Salvadorian subjects in the study, 296 were from the 1993-1994 study and 508 were from the 2008-2009 study. The difference in MS risks over time was determined in this subset of the

study subjects. **Table 4.10** shows the anthropometric and metabolic characteristics of subjects from El Salvador from the 1993-1994 and 2008-2009 studies. Subjects from 2008-2009 were significantly heavier than their counterparts from 1993-1994 ($P \leq 0.05$). Mean BMI for subjects from 1993-1994 was 28.1 ± 12.5, while subjects from 2008-2009 had a mean BMI of 29.3 ± 5.2, this difference is statistically significant ($P \leq 0.05$). Many of the values of biochemical variables measured in the study were similar among both populations. The mean DBP of subjects from 2008-2009 was significantly lower (72.0 ±12.1 vs. 80.2 ± 11.1) when compared to the other Salvadoran subjects ($P \leq 0.05$). This was the only statistically significant difference between biochemical variables among the two study populations. Most of the values were greater in the 1993-1994 study population, although not significant.

An elevated BMI of $\geq 25$ kg/m$^2$ was more prevalent among the more recent study subjects. There was a statistically significant difference between the prevalence of elevated BMI of the two study populations ($\chi^2$, $P \leq 0.05$). This statistical difference was seen at a BMI of $\geq 25$ kg/m$^2$ and $\geq 30$ kg/m$^2$. Prevalence rates for hypertriglyceridemia, elevated SBP, and high TC were higher among subjects from 2008-2009, however these differences were not statistically significant.

## Discussion

The overall prevalence of MS in the present study was 29.7%. Male subjects had a MS prevalence of 34.0%, while the prevalence for female subjects was 25%. In the previous study in 1993-1994, the overall MS prevalence was 19.7%, and the prevalence of MS in both men and women was also 19.7%. These estimates indicate an increase in

the prevalence of MS over time, which was also demonstrated in a study by Ford et al. (2004) when determining whether the prevalence of MS had changed from NHANES III (23.1%) to NHANES 1999 – 2000 (26.7%). It was noted that the increase in the prevalence of MS was mainly due to increases in waist circumference and hypertriglyceridemia. An examination of the prevalence of MS and individual risk factors for MS in participants from NHANES 2003 – 2006 found that the overall prevalence was 34% (Ervin, 2009), much higher than that found in the NHANES 1999 – 2000 and in our estimate from 1993 – 1994.

There are several statistical differences in mean biochemical measures between men and women from the two studies. The majority of those differences are seen among women. We expected the mean biochemical values to increase over time, especially with worsening obesity; however, that did not occur for all variables. Values for women in the 2008 – 2009 population that were significantly different from the women in the 1993 – 1994 population were lower (SBP, DBP, TC, and FPG), thus indicating that certain risks have decreased. The differences between mean values of men in the two studies were not as great. SBP and DBP were the only variables that were significantly greater in the 1993 – 1994 population, all else were similar. Weight, BMI and age were greater in the 2008 – 2009 study participants when compared to participants from the previous study. The prevalence of MS was also greater in this present study sample, which is consistent with studies that demonstrated that the MS prevalence increased with BMI (Lorenzo et al., 2006) and age (Ervin, 2009; Medina-Lezama et al., 2007).

In the 1993 – 1994 cohort of Central and South Americans, the most prevalent metabolic abnormalities were low HDL cholesterol (40.4% men and 51.3% women),

hypertriglyceridemia (40.9% men and 33.1% women), and elevated BMI (27.6% men and 36.6% women). The prevalence of having a BMI $\geq$ 25 kg/m$^2$ and low HDL < 50 mg/dL and < 40 mg/dL for women and men, respectively, was significantly greater in women compared to men. The 2008 – 2009 cohort of Central and South Americans experienced a very similar pattern of prevalent metabolic abnormalities. The most prevalent abnormalities were elevated BMI (78.4% men and 74.9% women), hypertriglyceridemia (46.5% men and 32.5% women), and low HDL cholesterol (43.2% men and 50.7% women). High FPG levels were not as frequent as one might expect in a population in which 78% of its subjects had a BMI at or above 25 kg/m$^2$. The MS prevalence was significantly greater in the present population than in the previous population ($p \leq 0.05$), mainly due to the significant increases in the number of subjects meeting and exceeding the BMI criterion of $\geq$ 25 kg/m$^2$. The MS has increased by a substantial amount between 1994 and 2009, especially in men (19.7% vs. 34.0%).

When compared to studies conducted on other Hispanic American populations, our results were very similar (Espinosa-Larranaga et al., 2005; Medina-Lezama et al., 2007). In a population-based study in Peru, PREVENCION, the most common metabolic abnormality in women was low HDL cholesterol (60.9%); whereas, in men it was hypertriglyceridemia (52.0%) followed by low HDL cholesterol (32.5%). Besides elevated BMI being very common among men and women in our study, the abnormalities found in the PREVENCION study subjects were very similar to those found in the 1993 – 1994 and 2008 – 2009 study populations. Just as in our study, they too found that abnormal fasting plasma glucose was the least common component for men (5.4%) and women (5.0%) (Medina-Lezama et al., 2007). Additionally, in studies conducted in

various Central and South American countries, Espinosa-Larranaga et al., (2005) concluded that approximately 50% of the populations in Argentina, Chile, Paraguay, Peru, and Colombia are overweight and more than 15% are obese. They also found that in Chile, 39.3% of the population had low HDL cholesterol; and in Venezuela, men had higher levels of triglycerides (47%) with low levels of HDL cholesterol (40%), which is consistent with our findings.

Mexican-Americans from San Antonio, TX have also been identified as having prevalent dyslipidemia, with hypertriglyceridemia (48.9% men and 36.8% women), low HDL cholesterol (53.6% men and 60.4% women), and large waist circumference (31.2% men and 56.4% women), but this sample also had a much higher prevalence of hypertension (44.1% men and 36.9% women) than our Central and South American subjects (Meigs et al., 2003). Cheal et al., (2004) determined that "being overweight, in combination with high plasma triglycerides and/or low HDL cholesterol, was a powerful predictor of having the metabolic syndrome."

In this study, dyslipidemia (elevated triglycerides and decreased HDL cholesterol levels) is very common. This pattern of dyslipidemia was also seen in Venezuelan subjects with the metabolic syndrome (Florez et al., 2005). It is possible that dietary patterns among Latin Americans contribute to the presence of dyslipidemia. Martínez-Ortiz, et al. (2006) positively associated a 'staple' dietary pattern, characterized by an increased intake of refined grains (white bread and rice), added sugar, coffee, legumes, red meat, and increased use of palm oil for cooking, with lower HDL cholesterol and increased risk of myocardial infarction in Costa Rican adults.

As can be seen from Table 4.9, the percentages of subjects with 1 or more MS components are not consistently greater in one sex or the other. Women have higher prevalence estimates of one (32.3% vs. 31.5%) and four (5.8% vs. 3.4%) abnormal components compared to men, respectively, which have higher prevalence estimates of two, three, and five components. The prevalence estimates for clustering of MS components found in the 2008 – 2009 study population were similar, in that women had a higher prevalence of one abnormal component compared to men, but men had higher prevalence estimates for two through five components. Much like the women in the 2008-2009 study, the number of women with the MS is greater than that of men (78 vs. 40). However, the prevalence of MS is the same for both men and women, which indicates very similar risks.

A similar study by Medina-Lezama et al. (2007) found that Peruvian women had higher prevalence estimates for one through five components of the MS. In that study, 31.8% of women had the MS with 3, 4, or all 5 components as opposed to 17.8% of men. In a another study, Cheal et al. (2004) determined that the men had higher prevalence estimates of one, two, four, and all five components of the MS. Along with the previous study, this 2004 study also identified women as having a higher prevalence of the MS.

We performed an analysis looking at the differences of metabolic syndrome risk factors between subjects that originated from the largest Hispanic sub-group in our study. In both the 1993 – 1994 and 2008 – 2009 studies, El Salvador was the most frequently reported county of origin, 49.4% and 48.8%, respectively, of all countries reported. As shown in Table 4.10, no real difference in MS characteristics exists between the 1993-1994 and 2008-2009 sample of Salvadorans. Differences that do exist follow the same

pattern as what was seen when the entire study populations were compared, which are an increase in the prevalence of high BMI and a decrease in the prevalence of hypertension among subjects from 2008 – 2009. The results from the anthropometric characteristics, biochemical variables, and MS characteristics of Salvadorian subjects are consistent with the other Central and South American subjects used in our study as a whole, thus indicating similar metabolic risks. However, in an examination comparing El Salvador to other countries individually, differences in metabolic risks may exist.

Strengths of this study include its focus on and addition of data to an understudied segment of the Hispanic population that is rapidly growing in the U.S and the large sample size of study participants. The use of systematic sampling allows for data to be representative of all SCC patients. Comparing data from two different time periods allowed for comparison of trends in MS prevalence over time. Limitations of this study are that waist circumference was not collected at SCC and the patient population used for this study may not be representative of Hispanic Americans living in the Washington, D.C. metropolitan area.

## Conclusion

The prevalence of MS has increased over time. When the two study populations were compared, it was determined that the prevalence of MS was higher in the present study, with a more noticeable increase among men. Subjects from 1993 – 1994 and 2008 – 2009 had the same prevalent metabolic abnormalities. Our study, as well as other studies of Central and/or South Americans, suggests that “being overweight, in combination with high plasma triglycerides and/or low HDL cholesterol, was a powerful

predictor of having the metabolic syndrome" (Cheal et al., (2004). It is possible that dietary patterns among Hispanic Americans contribute to the presence of dyslipidemia. For these subjects with dyslipidemia and elevated BMI, medical treatment, drug therapy, and dietary changes could help lower the risk of MS and subsequent CVD and DM.

**Table 4.7. Characteristics of the Central and South American study population by gender in 1993 – 1994 and 2008 – 2009[1]**

| | 1993 - 1994 | | | | 2008 - 2009 | | | |
|---|---|---|---|---|---|---|---|---|
| | ***n*** | **Men** | ***n*** | **Women** | ***n*** | **Men** | ***n*** | **Women** |
| Age (years) | 203 | 35.1 ± 19.4 | 396 | 38.9 ± 14.2 | 338 | 41.5 ± 13.6[3] | 704 | 42.8 ± 13.2[2] |
| ≤ 34 (%) | 119 | 58.6 | 180 | 45.5 | 114 | 33.7 | 237 | 33.6 |
| 35-44 (%) | 40 | 19.7 | 95 | 24.0 | 96 | 28.4 | 166 | 23.6 |
| 45-54 (%) | 23 | 11.3 | 59 | 14.9 | 66 | 19.5 | 173 | 24.6 |
| 55-64 (%) | 14 | 6.9 | 40 | 10.1 | 46 | 13.6 | 90 | 12.8 |
| ≥ 65 (%) | 7 | 3.5 | 22 | 5.6 | 16 | 4.7 | 38 | 5.4 |
| Weight (kg.) | 163 | 71.2 ± 11.4 | 350 | 64.6 ± 12.8 | 331 | 77.3 ± 12.5[3] | 701 | 69.3 ± 14.2[2] |
| Height (cm.) | 91 | 164.8 ± 8.2 | 198 | 153.0 ± 7.3 | 323 | 165.4 ± 7.4 | 688 | 154.7 ± 6.9[2] |
| BMI ($kg/m^2$) | 91 | 26.1 ± 3.8 | 198 | 28.4 ± 5.2 | 323 | 28.3 ± 4.1[3] | 688 | 29.0 ± 5.6 |
| SBP (mmHg) | 185 | 123.3 ± 19.4 | 369 | 119.8 ± 21.2 | 336 | 119.7 ± 17.7[3] | 703 | 115.7 ± 18.5[2] |
| DBP (mmHg) | 185 | 82.2 ± 11.1 | 369 | 79.2 ± 11.2 | 336 | 72.9 ± 12.1[3] | 703 | 71.0 ± 10.9[2] |
| TC (mg/dL) | 203 | 192.7 ± 44.7 | 389 | 195.7 ± 48.5 | 332 | 191.5 ± 38.9 | 694 | 190.5 ± 36.7[2] |
| HDL-c (mg/dL) | 201 | 43.8 ± 11.6 | 387 | 49.9 ± 12.4 | 332 | 42.9 ± 10.4 | 694 | 50.5 ± 12.7 |
| LDL-c (mg/dL) | 192 | 116.5 ± 34.6 | 379 | 116.9 ± 31.8 | 320 | 116.7 ± 33.5 | 684 | 113.3 ± 31.3 |
| FPG (mg/dL) | 202 | 102.0 ± 41.9 | 389 | 99.2 ± 46.2 | 329 | 99.9 ± 31.3 | 686 | 93.3 ± 27.9[2] |
| TG (mg/dL) | 203 | 167.6 ± 132.3 | 389 | 136.5 ± 83.2 | 331 | 163.8 ± 97.9 | 691 | 136.4 ± 78.6 |

[1] Data are mean ± S.D, unless otherwise specified. [2] Significantly different from women in the 1993-1994 population. [3] Significantly different from men in the 1993-1994 population.

BMI, Body Mass Index; SBP, Systolic Blood Pressure; DBP, Diastolic Blood Pressure; TC, Total Cholesterol; HDL, High Density Lipoprotein-cholesterol; LDL, Low Density Lipoprotein-cholesterol; FPG, Fasting Plasma Glucose; TG, Triglycerides

**Table 4.8. Prevalence of individual metabolic syndrome components and the metabolic syndrome among Central and South American men and women from 1993 – 1994 and 2008 – 2009**

| | No. and % with abnormal MS components | | | |
|---|---|---|---|---|
| **1993-1994 (n=599)** | | | | |
| **Component** | **Men (n = 203)** | | **Women (n = 396)** | |
| | ***n*** | **%** | ***n*** | **%** |
| High BMI* | 56 | 27.6 | 145 | 36.6[2] |
| Low HDL† | 82 | 40.4 | 203 | 51.3[2] |
| Hypertension | 41 | 20.2 | 74 | 18.7 |
| High FPG | 31 | 15.3 | 44 | 11.1 |
| High TG | 83 | 40.9 | 131 | 33.1[2] |
| MS prevalence | 40 | 19.7 | 78 | 19.7 |
| **2008-2009 (n=1042)** | | | | |
| **Component** | **Men (n = 338)** | | **Women (n = 704)** | |
| | ***n*** | **%** | ***n*** | **%** |
| High BMI | 265 | 78.4[1] | 523 | 74.3[1] |
| Low HDL† | 146 | 43.2 | 357 | 50.7[2] |
| Hypertension | 38 | 11.2[1] | 62 | 8.8[1] |
| High FPG | 42 | 12.4 | 59 | 8.4[2] |
| High TG | 157 | 46.5 | 229 | 32.5[2] |
| MS prevalence | 115 | 34.0[1] | 176 | 25.0[12] |

Data are %. * BMI ≥ 25 kg/m2; HDL, High Density Lipoprotein-cholesterol; FPG, Fasting Plasma Glucose; †low HDL: male <40 mg/dl, female <50 mg/dl; TG, Triglycerides; [1] Significantly different from 1993-1994 population; [2] Significantly different from men

**Table 4.9. Prevalence of MS clustering among Central and South American men and women from 1993-1994 and 2008-2009**

| **1993-1994** | **Men** | **Women** |
|---|---|---|
| No. of components | *n* = 203 | *n* = 396 |
| 1 | 31.5 | 32.3 |
| 2 | 23.6 | 19.9 |
| 3 | 14.8 | 13.4 |
| 4 | 3.4 | 5.8 |
| 5 | 1.5 | 0.5 |
| Total No. of subjects w/ MS | 40 | 78 |
| Prevalence of MS | 19.7 | 19.7 |

| **2008-2009** | **Men** | **Women** |
|---|---|---|
| No. of components | *n* = 338 | *n* = 704 |
| 1 | 29.3 | 29.7 |
| 2 | 26.0 | 19.7 |
| 3 | 26.9 | 19.9 |
| 4 | 5.9 | 4.7 |
| 5 | 1.2 | 0.4 |
| Total No. of subjects w/ MS | 115 | 176 |
| Prevalence of MS | 34.0 | 25.0 |

*Values are percentages, unless otherwise specified.

**Table 4.10. Anthropometric and metabolic characteristics of subjects from El Salvador from 1993 – 1994 and 2008 – 2009[1]**

| | 1993 – 1994 | 2008 – 2009 |
|---|---|---|
| n | 296 | 508 |
| **Anthropometric characteristics** | | |
| Weight (kg.) | 68.3 ± 12.5 | 73.2 ± 14.2[2] |
| Height (cm.) | 157.6 ± 9.6 | 157.7 ± 78.0 |
| BMI (kg/m$^2$) | 28.1 ± 4.8 | 29.3 ± 5.2[2] |
| **Biochemical variables** | | |
| Fasting Plasma Glucose (mg/dL) | 99.0 ± 35.6 | 96.6 ± 32.0 |
| Triglyceride (mg/dL) | 153.5 ± 115.1 | 150.9 ± 87.4 |
| Systolic Blood Pressure (mmHg) | 120.0 ± 19.0 | 118.2 ± 19.1 |
| Diastolic Blood Pressure (mmHg) | 80.2 ± 11.1 | 72.0 ±12.1[2] |
| High Density Lipoprotein (mg/dL) | 45.7 ± 11.6 | 46.2 ± 11.4 |
| Low Density Lipoprotein (mg/dL) | 112.6 ± 30.8 | 114.4 ± 30.5 |
| Total Cholesterol (mg/dL) | 188.5 ± 38.8 | 190.3 ± 37.0 |
| **Metabolic syndrome characteristics** | | |
| High BMI (% population) | 34.5 | 79.5[2] |
| High FPG (% population) | 12.8 | 9.8 |
| High TG (% population) | 34.8 | 38.0 |
| Hypertension (% population) | 18.2 | 11.2[2] |
| Low HDL (% population)[3] | 65.9 | 65.6 |

[1] Means ± SD, unless otherwise specified.
[2] Significantly different from the 1993 – 1994 population, $P \leq 0.05$ (Student's *t* test for continuous variables and chi-square test for categorical variables).
[3] HDL < 50 mg/dL for the entire population.

# Chapter 5: Summary and Implications

## Summary

The purpose of this study was to provide information on MS risk among a sample of Central and South Americans attending a large Catholic medical clinic and to determine if this population is at equal or greater risk for metabolic abnormalities than more established Hispanic Americans (Mexican Americans) living in the U.S. This thesis examined: (1) the prevalence of abnormal MS indicators (FPG, TG, HDL, HBP, BMI), (2) the differences in the prevalence of MS among various Hispanic sub-groups, (3) the difference in the prevalence of abnormal MS indicators based on BMI categories, and (4) how the prevalence of MS and abnormal MS indicators in a 2008-2009 study population compare to previous subject data obtained in 1993-1994 from the same medical clinic.

The major findings suggest that among the 2008-2009 sample of Central and South Americans, the prevalence of MS components increases steadily as relative weight increases; thus increasing the likelihood of developing other abnormal risk factors. High triglyceride and low HDL cholesterol levels, in addition to elevated BMI $\geq 25$ kg/m$^2$, were the most common metabolic abnormalities in this population for both men and women. This combination of dyslipidemia and elevated BMI puts subjects at an increased risk for insulin resistance. High blood pressure was not prevalent, but when in combination with dyslipidemia and high BMI, it may further increase the risk for inflammation, insulin resistance and type 2 DM. The overall prevalence of MS was very similar among subjects from El Salvador, Honduras, Peru, and Guatemala, with

prevalence rates of 30.7%, 29.0%, 29.6%, and 30.1%, respectively. Subjects from Bolivia had a substantially lower MS prevalence of 18.3%.

When the two study populations were compared, it was determined that the prevalence of MS was indeed higher in the 2008-2009 study, with a more noticeable increase among men (19.7% in 1993-1994 vs. 34.0% in 2008-2009) ($P \leq 0.05$). Subjects from 1993-1994 and 2008-2009 had the same prevalent metabolic abnormalities, and in some instances, the prevalence estimates of individual MS components were greater in the 1993-1994 population. Overall, the 2008-2009 subjects had significantly higher BMI, lower fasting glucose, and lower systolic and diastolic blood pressure ($p \leq 0.05$).

**Implications**

With this information, drug therapy, public policy, and dietary changes could help lower the risk of MS and subsequent CVD and type 2 DM in these Central and South American groups. Although a reduction in blood pressure and glucose levels are recommended goals for managing MS (Grundy et al., 2004), this population has a lower prevalence of these risk factors; therefore, an emphasis should be placed on reducing the prevalence of dyslipidemia and relative weight reduction.

A target of therapy would be to reduce atherogenic dyslipidemia, which causes CVD. Statins, which are commonly recognized for their cholesterol-lowering properties, can "reduce risk for CVD events in patients with metabolic syndrome" (Grundy et al., 2004). Fibrates also play a role in reducing atherogenic dyslipidemia by reducing plasma TG levels and moderately increasing HDL cholesterol concentrations (Levesque & Lamarche, 2008). Clinical studies have shown that combined statin-fibrate therapy

demonstrates improvements in abnormal lipoprotein patterning and CVD risk status (Grundy et al., 2004; Levesque & Lamarche, 2008). The Central and South American subjects studied would greatly benefit from such therapies.

This thesis was intended to raise awareness of the prevalence of MS in an understudied group of Hispanics, Central and South Americans. The subjects utilizing the medical clinic used in the study are, for the most part, immigrants, yet the suggested therapies to improve CVD risks might be unattainable for most of these immigrants. With this new information, policy-makers and health care professionals can find a way to provide free or low-cost prescription drugs that would improve the CVD and type 2 DM risk status.

Finally, dietary changes are very important in lowering obesity and preventing cardiovascular events. Reducing caloric intake and increasing physical activity will be helpful in reducing CVD risks. Providing nutrition education is crucial to understanding the relationship of diet and disease. Individuals with MS should adhere to basic dietary principles, such as 'low intakes of saturated fats, trans fats, and cholesterol, reduced consumption of simple sugars, and increased intakes of fruits, vegetables, and whole grains" (Levesque & Lamarche, 2008). Such nutrition information should be provided in medical clinics.

# Appendices

## Appendix A: Metabolic Syndrome Risk Questionnaire Spanish Catholic Center

| Variable | Input Variable | | Columns |
|---|---|---|---|
| CARD 1 | | | |
| 1. Identification number | _____ | IDNO | 1-4 |
| 2. Appointment date at SCC | _____ | DATE | 5-10 |
| 3. Patient's state of residence WDC=1; MD=2; VA=3 | _____ | ADDRESS | 11-12 |
| 4. Patient's country of origin (El Salvador=1; Honduras=2; Peru=3; Argentina=4; Guatemala=5; Colombia=6; Nicaragua=7; Bolivia=8; Puerto Rico=10; Brazil=11; Cuba=12; Dom. Republic =13; Other=14; Ecuador=15; Paraguay=16; Mexico=17; Panama=18; Chile=19; Venezuela=20 | _____ | ORIGIN | 13-14 |
| 5. Date of birth (mm/dd/yy) | _____ | AGE | 15-20 |
| 6. Gender of patient (M=1, F=2) | _____ | SEX | 21 |
| 7. Marital status (M=1; S=2; D=3; W=4) | _____ | MARITAL | 22 |
| 8. Level of education completed (pri=1; high=2; coll=3; tech=4; None=5; missing=9) | _____ | EDUC | 23 |
| 9. Do you work? (Yes=1; No=2) | _____ | WORK | 24 |
| 10. Hours per week (miss=999) | _____ | HOURS | 25-27 |
| 11. Household salary (miss=999999) | _____ | SALARY | 28-33 |
| 12. Do you speak English? (Y=1; N=2; Miss=9) | _____ | ENGLISH | 34 |
| 13. Do you have health insurance? (Y=1; N=2; miss=9) | _____ | INSURED | 35 |

| | | | |
|---|---|---|---|
| 14. Number of dependents | _____ | NODEPEND | 36-38 |

Medical History (Patient Reported)

| | | | |
|---|---|---|---|
| 15. Years living in the U.S. | _____ | YEARSUS | 39-40 |
| 16. Do you have Hypertension? (Y=1; N=2; miss=9) | _____ | HBP | 41 |
| 17. Do you have Diabetes? | _____ | DIABETES | 42 |
| 18. Do you have Tuberculosis? | _____ | TB | 43 |
| 19. Do you have Epilepsy? | _____ | EPIL | 44 |
| 20. Do you have Arthritis? | _____ | ARTH | 45 |
| 21. Do you have Heart trouble? | _____ | HEART | 46 |
| 22. Do you have Allergies? | _____ | ALLGY | 47 |
| 23. Do you smoke? | _____ | SMOKE | 48 |
| 24. Do you drink alcohol? | _____ | DRINK | 49 |
| 25. Do you drink coffee? | _____ | COFF | 50 |

Hematology and Biochemistry Results

| | | | |
|---|---|---|---|
| 26. Hematocrit (%) | _____ | HCT .1 | 51-53 |
| 27. Hemoglobin (g/dl) | _____ | HGB .1 | 54-56 |
| 28. Red Blood Cell (mil/$mm^3$) | _____ | RBC .2 | 57-59 |
| 29. MCV (cu microns) | _____ | MCV | 60-62 |
| 30. MCH (pg/cell) | _____ | MCH .1 | 63-65 |
| 31. MCHC (%) | _____ | MCHC .1 | 66-68 |
| 32. WBC (thou/$mm^3$) | _____ | WBC .1 | 69-71 |
| 33. Lymphocyte (%) | _____ | LYMPH .1 | 72-74 |

| | | | |
|---|---|---|---|
| 34. Neutrophil (%) | _____ | NEUTRO .1 | 75-77 |

CARD 2

| | | | |
|---|---|---|---|
| 35. Monocyte (%) | _____ | MONO .1 | 1-2 |
| 36. Eosinophil (%) | _____ | EOSIN .1 | 3-5 |
| 37. Basophil (%) | _____ | BASO .1 | 6-7 |
| 38. Platelet (thou/$mm^3$) | _____ | PLATE | 8-10 |
| 39. What is the Urine color? (yell=1; straw=2; amber=3) | _____ | COLOR | 11 |
| 40. What is the Urine appearance? (clear=1; hazy=2) | _____ | APPEAR | 12 |
| 41. What is the Urine pH? | _____ | PH .1 | 13-15 |
| 42. Specific gravity | _____ | SG .3 | 16-19 |
| 43. Is there glucose in the urine? (pos=1; neg=2) | _____ | UGLC | 20 |
| 44. Is there protein in the urine? | _____ | UPROT | 21 |
| 45. Are there ketones in the urine? | _____ | UKETONE | 22 |
| 46. Is there blood in the urine? | _____ | UBLOOD | 23 |
| 47. Bilirubin | _____ | BILIRUBN | 24 |
| 48. Urobilinogen | _____ | UROBIL | 25 |
| 49. Leukocyte esterase | _____ | LEUKEST | 26 |
| 50. Nitrite | _____ | NITRITE | 27 |
| 51. WBC in urine | _____ | UWBC | 28 |
| 52. RBC in urine | _____ | URBC | 29 |
| 53. Urinary Epithelial cells | _____ | UEPITH | 30 |

| | | | |
|---|---|---|---|
| 54. Mucus in urine | _____ | UMUCUS | 31 |
| 55. Urinary bacteria | _____ | UBACT | 32 |
| 56. Urinary crystals | _____ | UCRYST | 33 |
| 57. Urinary casts | _____ | UCASTS | 34 |
| 58. Virology (RPR-qual) | _____ | VIRQUAL | 35 |
| 59. Virology (RPR-quan) | _____ | VIRQUAN | 36 |
| 60. Blood glucose (mg/dl) | _____ | GLUC | 37-39 |
| 61. Blood urea nitrogen (mg/dl) | _____ | BUN | 40-41 |
| 62. Creatinine (mg/dl) | _____ | CREAT .2 | 42-44 |
| 63. Sodium (meq/l) | _____ | NA | 45-47 |
| 64. Potassium (meq/l) | _____ | K .1 | 48-49 |
| 65. Chloride (meq/l) | _____ | CL | 50-52 |
| 66. Carbon Dioxide (meq/l) | _____ | CO2 | 53-54 |
| 67. Uric acid (mg/dl) | _____ | URIC | 55-56 |
| 68. Total Protein (g/dl) | _____ | TOTPROT .1 | 57-58 |
| 69. Albumin (g/dl) | _____ | ALBMN .1 | 59-60 |
| 70. Globulin (g/dl) | _____ | GLBLN .1 | 61-62 |
| 71. Albumin/globulin ration | _____ | AGRATIO .1 | 63-64 |
| 72. Calcium (mg/dl) | _____ | BCALC .1 | 65-67 |
| 73. Phosphorus (mg/dl) | _____ | BPHOS | 68-69 |
| 74. Cholesterol (mg/dl) | _____ | BCHOL | 70-72 |
| 75. HDL cholesterol (mg/dl) | _____ | HDL | 73-75 |

CARD 3

| | | | |
|---|---|---|---|
| 76. LDL cholesterol (mg/dl) | _____ | LDL | 1-3 |
| 77. Chol/HDL ratio | _____ | CHORATIO .1 | 4-5 |
| 78. Triglycerides (mg/dl) | _____ | TG | 6-8 |
| 79. Alkaline Phosphatase (U/l) | _____ | ALKPHOS | 9-11 |
| 80. SGOT (U/l) | _____ | SGOT | 12-13 |
| 81. SGPT (U/l) | _____ | SGPT | 14-15 |
| 82. Lactic Dehydrogenase (U/l) | _____ | LD | 16-18 |
| 83. Total bilirubin | _____ | TOTBILI .1 | 19-20 |
| 84. Ferritin (ng/ml) | _____ | FERR | 21-23 |
| 85. Gamma Glutamyl Tranferase (U/l) | _____ | GGT | 24-26 |
| 86. Weight (lbs.) | _____ | WT | 27-29 |
| 87. Height (in.) | _____ | HT | 30-31 |
| 88. Systolic BP (mm Hg) | _____ | SBP | 32-34 |
| 89. Diastolic BP (mm Hg) | _____ | DBP | 35-37 |
| 90. Waist circumference (in.) | _____ | WC | 38-40 |
| 91. What was the reason for the visit?<br>Physical exam/checkup/F/U=1; acute illness=2;<br>Chronic pain = 3 | _____ | VISIT | 41 |
| 92. CHL # | _____ | CHL | 42-48 |

## Appendix B: Subject reported country of origin

| *Country* | *Number of subjects* | *% of subjects* |
|---|---|---|
| El Salvador | 508 | 48.8 |
| Honduras | 107 | 10.3 |
| Peru | 98 | 9.4 |
| Argentina | 11 | 1.0 |
| Guatemala | 93 | 8.9 |
| Colombia | 45 | 4.3 |
| Nicaragua | 29 | 2.8 |
| Bolivia | 60 | 5.8 |
| Brazil | 15 | 1.4 |
| Dominican Republic | 25 | 2.4 |
| Ecuador | 18 | 1.7 |
| Chile | 4 | 0.4 |
| Venezuela | 3 | 0.3 |
| Other* | 26 | 2.5 |
| **Total** | 1042 | 100 % |

*Subjects that reported being from countries such as Costa Rica, Paraguay, Uruguay, Puerto Rico, Cuba, and Panama**.**

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