# Metabolic Syndrome in Andean Populations

Diana A. Chirinos*,†, Oscar L. Morey-Vargas†, Ronald B. Goldberg*, Julio A. Chirinos‡, Josefina Medina-Lezama†

*Coral Gables, FL, USA; Arequipa, Peru; and Philadelphia, PA, USA*

## ABSTRACT

The metabolic syndrome, a cluster of metabolic abnormalities, has been linked to both cardiovascular disease and type 2 diabetes mellitus risk. Several studies have shown that ethnicity is an important determinant for risk of developing the metabolic syndrome; therefore, further understanding of the prevalence and presentation of the metabolic syndrome in various ethnic groups is needed. Latin American communities, and particularly Andean countries, are largely understudied in relation to the metabolic syndrome and until recently, the prevalence of this metabolic disturbance in Andean Hispanics was unknown. Nonetheless, recent (and ongoing) population studies are providing important data regarding the prevalence and patterns of the metabolic syndrome in various Andean countries. This review aims to summarize and interpret the information provided by these studies in an effort to better characterize the metabolic syndrome in Andean Hispanics.

Cardiovascular disease is an emergent cause of death in many Latin American and Andean countries, and it is expected that its burden will increase in the near future unless appropriate control prevention strategies are implemented [1—6]. To design adequate prevention strategies, it is necessary to estimate the prevalence, characteristics, and distribution of various cardiovascular risk factors in these populations. Similarly, validated operational definitions will be needed to characterize conditions associated with increased cardiovascular risk, such as abdominal obesity and the metabolic syndrome (MetS). The MetS is a cluster of metabolic abnormalities associated with elevated risk of cardiovascular morbidity and mortality [7—11]. A recently published joint interim statement issued by several organizations has established an updated MetS definition, recognizing central adiposity, abnormal glucose regulation, elevated triglycerides, lowered high-density lipoprotein cholesterol (HDL-C), and elevated blood pressure as its central components [12]. Prospective data suggest that death from coronary heart disease is 3× higher among middle-age men with MetS after adjustment for conventional cardiovascular risk factors [13]. MetS is also an independent predictor for the development of type 2 diabetes mellitus [11,14]. In a large prospective study, the risk for diabetes after 7 years of follow-up was more than 3-fold higher in subjects with MetS, even after the adjustment for other risk factors for diabetes including impaired glucose tolerance and impaired fasting insulin [14].

Several studies have shown that ethnicity and sex are important determinants for the risk of having MetS [15—23]. In the United States, NHANES III (Third National Health and Nutrition Examination Survey) differences in the prevalence of MetS between ethnic groups were clearly observed. African American women and Mexican American women had higher prevalence rates of MetS than African American men and Mexican American men did, respectively, whereas the risk in Caucasians was similar between sexes [15]. Although several lines of evidence indicated that ethnicity is an important determinant of the MetS phenotype, until recently, the prevalence of MetS in Andean communities was largely unknown. Andean countries share indigenous population groups and historic patterns of colonization that have resulted in comparable genetic admixtures and cultural traditions that make them very similar. Recently published (and ongoing) population studies are providing important data regarding the prevalence and patterns of MetS in different Andean countries (Table 1). Among the largest of these are the study of coronary risk factors in the state of Zulia in Venezuela [15], the PREVENCION (Peruvian Study of Cardiovascular Disease Prevalence) study in the city of Arequipa in Peru [23—28], the National Survey of Health in Chile [29], and the CINDI/CARMEN (Countrywide Integrated Noncommunicable Disease Intervention Programme) study in the Colombian city of Bucaramanga [30]. Although the latter study did not specifically assess the prevalence of MetS [30], it provided important data regarding the prevalence of obesity and other cardiovascular risk factors in these populations. This paper aims to summarize and interpret the information provided by these studies to better characterize the MetS in Andean countries.

## PREVALENCE OF THE MetS AND ITS COMPONENTS IN ANDEAN POPULATIONS

One of the first large studies assessing the prevalence of the MetS and its individual components in an Andean population was the Zulia study of coronary risk factors [15]. It included >3,000 subjects from a representative sample

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From the *Behavioral Medicine Research Center, University of Miami, Coral Gables, FL, USA; †Santa Maria Catholic University School of Medicine and Santa Maria Research Institute, Arequipa, Peru; and the ‡Division of Cardiology, University of Pennsylvania and Philadelphia VA Medical Center, Philadelphia, PA, USA. Correspondence: D. A. Chirinos-Medina (dchirinos-medina@psy.miami.edu).

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**TABLE 1.** Epidemiological studies examining the MetS among Andean Hispanics

| Ref. # | Study | Geographic area | Years of observation | Sample, n (% females) | Age range, yrs | Diagnosis criteria |
|---|---|---|---|---|---|---|
| 15 | Zulia Coronary Heart Disease Risk Factor Study | Zulia, Venezuela | 1999–2001 | 3,108 (69.6) | ≥20 | NCEP ATP III |
| 24 | PREVENCION study | Arequipa, Peru | 2003–2007 | 1,878 (53.8) | 20–80 | NCEP ATP III; AHA/NHLBI |
| 29 | National Health Survey in Chile | Chile | 2003 | 1,818 (54.2) | ≥17 | NCEP ATP III; IDF |
| 30 | CINDI/CARMEN study | Bucaramanga, Colombia | 2001 | 2,989 (NA) | 15–64 | NA |

AHA/NHLBI, American Heart Association/National Heart, Lung, and Blood Institute; CINDI/CARMEN, Countrywide Integrated Noncommunicable Disease Intervention Programme; IDF, International Diabetes Federation; MetS, metabolic syndrome; NA, not available; NCEP ATP III, Third Report of the National Cholesterol Education Program Expert Panel on Detection, Evaluation and Treatment Panel; PREVENCION, Prevalence and Patterns of Hypertension in Peruvian Andean Hispanics.

from each health district in the Venezuelan state of Zulia. This study showed that more than 60% of adults had low levels of HDL-C (defined as a serum level <50 mg/dl in women and <40 mg/dl in men), and that there were high age-adjusted prevalences of abdominal obesity (42.9%), hypertriglyceridemia (32.3%), and high blood pressure (38.1%) in this population. In contrast, the investigators reported a relatively low prevalence of abnormal fasting glucose (10.9%) [15]. Overall, the age-adjusted prevalence of MetS was 35% among men and 29.8% in women. Measurement procedures across studies are described in Appendix 1 (available online).

Another important study that provided national estimates of the prevalence of MetS among Andean Hispanics was the National Survey in Chile [29]. A total of 1,833 randomly selected adults aged 17 years were included in the study. Overall, the age-adjusted prevalence of the MetS, according to the NCEP ATP III (Third Report of the National Cholesterol Education Program Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults) definition, was 31.6%, with similar prevalence estimates across sex (32.7% and 30.8% for men and women, respectively). In concordance to findings from Zulia, this study showed that low HDL-C (defined as a serum level <50 mg/dl in women and <40 mg/dl in men) was the most prevalent component of the MetS among Chilean adults with a prevalence of 52.3%, followed by hypertension, hypertriglyceridemia, and abdominal obesity with prevalence rates of 46.0%, 30.3%, and 29.7%, respectively (95% confidence intervals are shown in Table 2). In this population, however, the investigators reported a low prevalence of abnormal fasting glucose (22%).

The PREVENCION study subsequently reported data from a population-based sample of 1,878 adults in Arequipa, Peru [24–26]. Comparable to the findings from Venezuela and Chile, this study reported very high age-standardized prevalences of low HDL-cholesterol (32.3% of men and 60% of women) and significant prevalences of abdominal obesity (15.2% of men and 39.7% of women) as defined by the NCEP ATP III. The age-standardized prevalences of hypertriglyceridemia, high blood pressure, and high fasting glucose were 54.2%, 28.2%, and 6.3% in men, and 38.2%, 25.2%, and 5.9% in women, respectively [26]. In this population, the prevalence of MetS was 23.2% in women and 14.3% in men [24]. These data clearly showed that in Arequipa abdominal obesity and low HDL-C were significantly more frequent among women, whereas hypertriglyceridemia was more frequent in men. Similar sex differences in the prevalences of low HDL-C and hypertriglyceridemia were also reported in the Zulia study. It is worth noting that sex-specific HDL-C cutoffs are used to determine the presence of this MetS component (<50 mg/dl in women and <40 mg/dl in men). Therefore, although mean levels of HDL-C were comparable between sexes in Andean Hispanics (i.e., 48.4 and 46.0 mg/dl in Peruvian men and women, respectively), prevalence of low HDL-C was strikingly higher in Andean women when compared with women of other ethnicities. For example, prevalence estimates of low HDL-C were 68% and 60% for women in the Zulia [15] and PREVENCION study [24], respectively; whereas the latest estimates in the United States indicate only 32% of women present this component [31]. Similar comparisons have been presented in a recently published paper by the Latin American Consortium of Studies in Obesity [32].

As shown in Table 2, another similarity between the Zulia and the PREVENCION study populations was the higher prevalence of abdominal obesity among women versus men. In contrast, a significantly greater prevalence of elevated blood pressure was noted in Zulia's men and accounted for the high overall prevalence of the MetS among men in this population. In Arequipa, the prevalence of high blood pressure was similar across sexes (see Table 2). It appears that the risk of MetS and abdominal obesity in Andean populations increases steeply with age, particularly in women. Before age 50 years, no significant sex differences in the prevalence of the MetS were found in the PREVENCION study (13.5% vs. 10% in women and men, respectively; $p = NS$); whereas at or after age 50 years, the prevalence was nearly twice as high among women than men (52.8% vs. 27.8%; $p < 0.0001$). The prevalence of abdominal obesity in Arequipa was