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Dyslipidemia in seven Latin American cities: CARMELA study

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ABSTRACT

Objective. The objective of this study was to describe the prevalence of dyslipidemia in the CARMELA study population.

Methods. CARMELA was a cross-sectional study of cardiovascular risk conducted between September 2003 and August 2005 in adults (aged 25 to 64 years) living in Barquisimeto ($n=1,824$), Bogotá ($n=1,511$), Buenos Aires ($n=1,412$), Lima ($n=1,628$), Mexico City ($n=1,677$), Quito ($n=1,620$), and Santiago ($n=1,605$). Dyslipidemia was defined as the presence of one or more of the following conditions: triglycerides $\geq$200 mg/dL, or total cholesterol (TC) $\geq$240 mg/dL, or HDL cholesterol $<$40 mg/dL, or LDL cholesterol = not optimal, or currently taking antilipemic agents.

Results. Prevalence rates of dyslipidemia in men and women were: 75.5% (CI: 71.9–79.1) and 48.7% (CI: 45.4–51.9) in Barquisimeto; 70% (CI: 66.2–73.8) and 47.7% (CI: 43.9–51.5) in Bogotá; 50.4% (CI: 46.8–54.0) and 24.1% (CI: 21.0–27.2) in Buenos Aires; 73.1% (CI: 69.3–76.8) and 62.8% (CI: 59.2–66.5) in Lima; 62.5% (CI: 58.5–66.5) and 37.5% (CI: 33.5–41.6) in Mexico City; 52.2% (CI: 47.9–56.5) and 38.1% (CI: 34.5–41.7) in Quito; and, 50.8% (CI: 47.1–54.4) and 32.8% (CI: 29.3–36.3) in Santiago.

Conclusions. Dyslipidemia was disturbingly prevalent and varied across cities. The most frequent dyslipidemia was low HDL-C followed by high triglycerides. The high TC/HDL-C ratios and non-HDL-C levels suggest a high risk of cardiovascular disease.

Introduction

As the last century saw a decline in the burden of nutritional deficiency and infectious disease, the global burden of chronic disease, cardiovascular disease in particular, is increasing (Yusuf et al., 2001). In 2002, cardiovascular disease was responsible for 17 million deaths worldwide (Yach et al., 2004); nearly three-quarters of these deaths occurred in low and middle income countries. It has been estimated that by 2010, cardiovascular disease will be the leading cause of death in developing countries (WHO, 2007a, 2007b).

Dyslipidemias are well-established risk factors for cardiovascular disease; in particular, hypercholesterolemia has been of concern since recognition of the association between cardiovascular disease and serum cholesterol in the 1950s (Criqui and Golomb, 1998). Hypercholesterolemia currently causes 4.3 million deaths per year worldwide and 39 million disability-adjusted life years lost (Ezzati et al., 2005). As lipid science has evolved, it has become evident that there is a complex interaction between serum lipid fractions, prompting medical societies and governmental organizations to establish guidelines for assessment and treatment of dyslipidemia. The National Cholesterol Education Program Adult Treatment Panel III (NCEP-ATP III) guidelines (National Cholesterol Education Program, 2002), in particular, are spread worldwide.

Although assessments of cardiovascular risk factors have been primarily derived from wealthy, developed countries, variations among populations reveal the complexity of components that comprise the lipid profile (Menotti et al., 1993). Both small and large studies (Ciruzzi et al., 2003; Lanas et al., 2007; Ezzati, 2004; Yusuf et al., 2004) confirm that rates of myocardial infarction in Latin

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America reflect the contributions of multiple cardiovascular risk factors. Latin America encompasses a wide variety of geographic, ethnic, and socioeconomic differences; thus, prevalence of risk factors would be expected to reflect this diversity. The Cardiovascular Risk Factor Multiple Evaluation in Latin America (CARMELA) study was designed to evaluate and compare cardiovascular risk factor prevalence in seven Latin American cities. Overall prevalence of cardiovascular risk factors has been reported previously (Schargrodsky et al., 2008); comparative lipid profiles and prevalence of dyslipidemia by city are reported here.

Methods

CARMELA was a cross-sectional, population-based, observational study using stratified multistage sampling. The study was carried out between September 2003 and August 2005 in Barquisimeto (Venezuela), Bogotá (Colombia), Buenos Aires (Argentina), Lima (Peru), Mexico City (Mexico), Quito (Ecuador), and Santiago (Chile). The study was conducted according to the Declaration of Helsinki and the Good Clinical Practice Guidelines.

Approximately 1600 participants, between 25 and 64 years old, were to be included per city. Based on an initial evaluation of costs, general suggestions for surveillance of non-communicable diseases (Bonita et al., 2001) and acceptable levels of precision (95% CI: ±1 to ±6) it was decided to interview a sample of 200 subjects per sex and 10-year age group.

To assure that any subject had a non-null and known beforehand probability of being selected, the following steps were applied: 1) cities were divided into strata (geographic sectors) and then into blocks; 2) all blocks were identified by a sequential number in a map; 3) the total number of households in each city and the absolute distribution of subjects for each 10-year age group, to calculate a sampling fraction, were obtained from the last available census; 4) the final sample size to be selected was expanded based on the non-response rate found during a pilot study, which served to calculate the total number of households per age group needed to be visited; 7) the number of blocks to be selected in each stratum and then the number of households to be selected in each block were calculated using predefined formulas; 8) a set of blocks was selected by simple random sampling; 9) the selected blocks were visited and all households were identified and registered in a dataset; 10) the set of households at each block was randomly selected and placed in four categories based on the four age group sample fractions and the number of households needed to be visited in each block, such that in Category 1, all residents 25–64 years old were interviewed; in Category 2, only residents 35–64 years old were interviewed; in Category 3, only residents 45–64 years old were interviewed; and in Category 4, only residents 55–64 years old were interviewed; and 11) the probability of being selected for a subject of the population was the result of multiplying three figures: the probability that the block where the subject resides is chosen; the probability that the household in the selected block is chosen; and the probability that the subject is chosen, given that the subject's household has been selected.

The selected subjects completed a single clinical visit at designated institutions in each city. After a 12–14 hour overnight fast, venous blood was drawn during morning hours. Blood samples were processed immediately using commercially available kits. Procedures were standardized before study initiation and controlled for quality during the study's conduction by a central reference laboratory. Total cholesterol (TC) was determined by the spectrophotometry cholesterol oxidase/peroxidase enzymatic method. Serum triglycerides (TG) and high density lipoprotein cholesterol (HDL-C) were determined by the glycerol enzymatic method and the precipitating reactive method, respectively. Low density lipoprotein cholesterol (LDL-C) was calculated by the Friedewald formula (LDL-C = [TC − HDL-C] − [TG/5], valid if TG<400 mg/dL) (Friedewald et al., 1972); non-HDL-C (TC − HDL-C) and TC/HDL-C were calculated.

Definitions

Dyslipidemia was defined as the presence of one of more of the following conditions: TG ≥ 200 mg/dL, TC ≥ 240 mg/dL, HDL-C < 40 mg/dL, LDL-C = not optimal (LDL-C ≥ 100 mg/dL if Framingham 10-year risk score = high, or LDL-C ≥ 130 mg/dL if Framingham 10-year risk score = intermediate, or LDL-C ≥ 160 mg/dL if Framingham 10-year risk score = low) (Wilson et al., 1998), or currently taking antilipemic agents. Lipid values were classified according to NCEP-ATP III criteria (National Cholesterol Education Program, 2002).

Statistical analysis

Statistical processing addressed the non-equal probability character of the sample to generate data adjusted for the age and sex distribution of the population of each city. Therefore, weighted means and prevalence, along with their 95% confidence intervals, were estimated by survey analysis procedures (SAS Software, Release 9.1, Cary, North Carolina, USA), taking into account the multistage stratified sampling design via CLUSTER and STRATA statements. Overall prevalence was age-adjusted by the direct method, using the age distribution of the 2000 world population, to allow comparison between participant cities. A p-value<0.05 was considered significant.

Results

A total of 11,550 participants between the ages of 25 and 64 years were enrolled; lipid laboratory assessments were carried out in all enrolled subjects but LDL-C was not calculated in 273 subjects due to Friedewald's formula limitation (triglycerides>400 mg/dL). No imputations were applied for these missing values.

Lipid profiles

Unique lipid profiles were found for each city (Table 1). Between-city heterogeneity p-value was <0.0001 for all lipid values. TC, LDL-C, and triglycerides increased with age in all cities ($p<0.0001$) while HDL-C was relatively flat across the age groups in all cities. Men had higher values of triglycerides in all cities ($p<0.0001$) while women had higher values of HDL-C in all cities ($p<0.0001$). TC and LDL-C showed diverse patterns by sex groups within cities, men had higher TC and LDL-C in Buenos Aires ($p=0.0007$ and $p<0.0001$) and higher TC in Quito ($p=0.0431$), meanwhile women had higher TC in Barquisimeto ($p=0.0295$) and higher LDL-C in Barquisimeto ($p=0.0075$) and Lima ($p=0.437$). There were no differences in TC or LDL-C in the other cities.

In contrast to the relatively high values of TC and LDL-C in Buenos Aires, Mexico City, Quito, and Santiago, HDL-C was higher in those same cities; lower HDL-C values were found in cities with relatively lower TC (Barquisimeto, Bogotá, and Lima). This variability was reflected in unique TC/HDL-C levels. For example, Lima, with both low TC level and low HDL-C, had the highest value for TC/HDL-C. Reciprocally, Buenos Aires, with high TC and high HDL-C, exhibited a relatively low TC/HDL-C ratio.

Subjects with hypertension (systolic ≥ 140mmHg or diastolic ≥ 90mmHG), diabetes (fasting glucose ≥ 126mg/dL or self-reported), obesity (BMI>30) and abdominal obesity (waist>102 cm in men, >88 cm in women), had consistently higher values of TC/HDL-C ($p<0.0001$) in all cities. Similarly, subjects with hypertension, diabetes, abdominal obesity, and carotid artery plaque had higher values of Non-HDL-C ($p<0.0001$) in all cities. Besides the mentioned conditions, when all cities were pooled together, TC/HDL-C showed higher values in subjects with sedentary physical activity ($p=0.003$), low years of education ($p=0.0014$), prior myocardial infarction ($p=0.0001$) or prior angina attack ($p=0.0356$). Non-HDL-C also showed higher values in subjects with sedentary physical activity ($p=0.0011$), low years of education ($p=0.036$) or prior myocardial infarction ($p=0.0017$).

Prevalence of dyslipidemia

The classification of lipids fractions according to the NCEP-ATP III is shown in Fig. 1 and weighted prevalence of dyslipidemia is presented in Table 2. The overall prevalence of dyslipidemia was different in all cities, between-city heterogeneity p-value was <0.0001. Substantially more men than women had dyslipidemia in each city ($p<0.0001$).

Table 1
Weighted mean lipid values (mg/dL[a]) (95% confidence interval). CARMELA study, September 2003–August 2005.

	TC	LDL-C	HDL-C	TG	Non-HDL-C	TC/HDL-C
Barquisimeto	$n=1848$	$n=1784$	$n=1848$	$n=1848$	$n=1848$	$n=1848$
All	174.2 (171.8–176.5)	104.6 (102.4–106.3)	40.1 (39.4–40.9)	150.7 (144.8–156.6)	134.1 (131.9–136.2)	4.6 (4.5–4.7)
Men	171.7 (168.6–174.8)	101.9 (99.2–104.6)	35.8 (35.0–36.7)	177.1 (166.2–187.9)	135.9 (132.9–138.9)	5.1 (4.9–5.2)
Women	175.8 (172.9–178.7)	106.3 (104.2–108.4)	42.9 (42.1–43.8)	133.4 (128.4–138.5)	132.9 (130.2–135.5)	4.3 (4.2–4.4)
Bogotá	$n=1553$	$n=1472$	$n=1553$	$n=1553$	$n=1553$	$n=1553$
All	193.7 (191.4–196.1)	120.4 (118.2–122.7)	42.2 (41.6–42.9)	164.7 (157.9–171.5)	151.5 (149.0–154.0)	4.9 (4.8–5.0)
Men	195.2 (192.0–198.5)	119.8 (116.7–122.9)	39.2 (38.4–39.9)	200.0 (190.2–209.9)	156.1 (152.6–159.5)	5.2 (5.1–5.4)
Women	192.5 (189.5–195.6)	120.9 (118.1–123.7)	44.6 (43.8–45.5)	136.8 (129.4–144.3)	147.9 (144.9–150.9)	4.6 (4.5–4.7)
Buenos Aires	$n=1482$	$n=1461$	$n=1482$	$n=1482$	$n=1482$	$n=1482$
All	201.0 (198.5–203.5)	126.1 (123.8–128.4)	52.5 (51.7–53.3)	114.3 (110.4–118.2)	148.6 (146.0–151.1)	4.1 (4.0–4.1)
Men	205.0 (201.4–208.6)	132.2 (128.9–135.4)	46.6 (45.7–47.5)	134.9 (128.2–141.6)	158.4 (155.0–161.8)	4.6 (4.5–4.7)
Women	197.7 (194.3–201.1)	121.1 (118.4–123.8)	57.5 (56.4–58.5)	96.9 (91.7–102.1)	140.2 (137.0–143.4)	3.6 (3.5–3.7)
Lima	$n=1652$	$n=1619$	$n=1652$	$n=1652$	$n=1652$	$n=1652$
All	188.4 (186.2–190.7)	121.5 (119.8–123.3)	39.4 (38.8–40.0)	140.3 (135.2–145.4)	148.6 (146.0–151.1)	5.0 (4.9–5.1)
Men	187.3 (184.4–190.1)	119.7 (117.3–122.0)	37.4 (36.6–38.1)	155.3 (147.6–163.0)	149.9 (147.0–152.8)	5.2 (5.1–5.3)
Women	189.5 (186.3–192.8)	123.3 (120.8–125.8)	41.3 (40.5–42.2)	125.5 (119.8–131.2)	148.2 (145.4–151.1)	4.7 (4.7–4.8)
Mexico City	$n=1722$	$n=1631$	$n=1722$	$n=1722$	$n=1722$	$n=1722$
All	202.9 (200.2–205.5)	118.7 (116.9–120.6)	49.2 (48.3–50.1)	183.9 (175.2–192.6)	153.7 (150.9–156.4)	4.3 (4.3–4.4)
Men	204.3 (200.9–207.6)	120.6 (118.1–123.1)	44.1 (43.2–45.0)	214.3 (204.2–224.4)	160.2 (156.9–163.5)	4.8 (4.7–4.9)
Women	201.6 (198.2–205.0)	117.2 (114.5–119.8)	53.7 (52.6–54.7)	157.2 (148.8–165.6)	147.9 (144.4–151.5)	3.9 (3.8–4.0)
Quito	$n=1638$	$n=1582$	$n=1638$	$n=1638$	$n=1638$	1638
All	207.3 (204.6–210.0)	126.6 (124.3–128.9)	49.0 (48.3–49.7)	162.5 (156.1–168.9)	158.3 (155.5–161.1)	4.4 (4.3–4.5)
Men	209.6 (206.0–213.2)	127.8 (124.6–130.9)	46.6 (45.7–47.5)	181.9 (172.8–191.1)	163.0 (159.3–166.8)	4.7 (4.6–4.8)
Women	205.0 (201.5–208.4)	125.5 (122.6–130.9)	51.4 (50.5–52.2)	143.2 (136.4–150.0)	153.6 (150.1–157.1)	4.2 (4.1–4.3)
Santiago	$n=1655$	$n=1595$	$n=1655$	$n=1655$	$n=1655$	$n=1655$
All	199.1 (196.7–201.5)	119.6 (117.7–121.4)	49.4 (48.7–50.0)	159.6 (149.2–170.0)	149.8 (147.4–152.2)	4.3 (4.2–4.3)
Men	199.0 (196.0–201.9)	119.9 (117.4–122.5)	45.5 (44.7–46.3)	177.1 (167.0–187.2)	153.5 (150.4–156.5)	4.6 (4.5–4.7)
Women	199.3 (196.2–202.4)	119.2 (116.8–121.6)	52.9 (51.9–53.9)	143.6 (126.7–160.6)	146.4 (143.3–149.4)	4.0 (3.9–4.0)

TC = total cholesterol; LDL-C = low density lipoprotein cholesterol, calculated; HDL-C = high density lipoprotein cholesterol; TG = triglycerides; non-HDL-C = non-high density lipoprotein cholesterol, calculated; TC/HDL-C = total cholesterol/HDL-C ratio, calculated.
[a] Except TC/HDL-C, ratio reported without units.

Due to the wide variation in lipid profiles among cities, the relative importance of specific lipid factors fluctuated. In Lima, Barquisimeto, and Bogotá, low HDL-C characterized dyslipidemia, while in Mexico City, high triglycerides were the most frequent. In contrast, prevalence of abnormally high TC, LDL-C or triglycerides or low HDL-C was relatively similar in Quito, Santiago, and Buenos Aires.

Despite high prevalence of hypercholesterolemia, pharmacologic treatment among the patients who were prescribed antilipemic agents was not common and varied across cities; Buenos Aires reported 45% and Chile 42% at the top tier, followed by Mexico City 22%, Lima 20%, and Bogotá 18%, at the middle tier, and Barquisimeto 8% and Quito 8% at the lowest tier.

Discussion

Dyslipidemia was highly prevalent in the seven assessed cities. The main dyslipidemia factors were low HDL-C and high triglycerides, event though high TC and LDL-C were vastly prevalent. The lipid profiles were heterogeneous across cities, sex and age groups ($p>0.0001$) but shared some remarkable patterns. The low rate of antilipemic therapy is also of note, given the substantial evidence that cholesterol reduction is valuable in reducing cardiovascular disease (Grundy et al., 2004).

Abnormally high TC and LDL-C levels correlate with increasing cardiovascular risk. However, the predictive power of a given TC value may be influenced by genetic, cultural, and environmental factors (Criqui and Golomb, 1998; Grover et al 1994; and Law et al., 1994). Conversely, high HDL-C is considered a protective factor (Assmann and Gotto, 2004; Gordon et al., 1989). Paradoxically, in the CARMELA study, the highest HDL-C levels were found in cities with the highest TC levels, confirming that specific lipid factors taken alone do not uniformly reflect risk in a population.

The non-HDL-C has been suggested as better predictor of cardiovascular disease than LDL-C and easier to calculate (Cui et al., 2001; Bittner et al., 2002; Pischon et al., 2005; Ridker et al., 2005). NCEP-ATP III guidelines suggest that as a secondary target of therapy, a reasonable goal for non-HDL would be 30 mg/dL higher than the LDL-C goal (i.e. 130, 160 or 190 mg/dL, depending of the CHD risk). In the CARMELA study the mean values of non-HDL-C ranged from 133.8 mg/dL in Barquisimeto to 183.1 mg/dL in Mexico City, suggesting that an important number of subjects would be above their target levels across cities.

The TC/HDL-C ratio has been correlated with the development of acute coronary events and it is considered to give the most predictive lipid value (Assmann et al., 1998; Castelli 1996; Kinosian et al., 1994). It is of note that the mean TC/HDL-C in all CARMELA cities was above the suggested goal for this ratio, <4 (Criqui and Golomb, 1998), which implies that an important segment of the CARMELA population would be at higher risk of cardiovascular disease. Furthermore, in the CARMELA study, subjects with previous myocardial infarction and angina episodes showed significantly higher values of TC/HDL-C than patients without them.

Comparisons of CARMELA with other Latin American studies are difficult due to methods and time differences. The World Health Organization cites TC values for the 7 countries in the CARMELA study ranging from 174 mg/dL (Venezuela) to 240 mg/dL (Colombia) (WHO, 2007a, 2007b). In the CARMELA study, which used a sampling approach intended to represent city-wide values, TC was also lowest in Barquisimeto, Venezuela (174 mg/dL). However, highest mean values for TC were found in Quito, Ecuador (207 mg/dL). Another recent study, based on a non-representative sample, reported higher TC, LDL-C, and HDL-C values than the ones reported in the CARMELA study (Touboul et al, 2006).

Turning to hypercholesterolemia (TC ≥ 240 mg/dL), WHO reported prevalence of 20% and 10% in Argentina and Venezuela, respectively (WHO, 2007a, 2007b). The disparity between countries is similar to that found in corresponding cities in the CARMELA study. Other studies in Latin America reported different trends, one conducted in Bucaramanga, Colombia (Bautista et al., 2006) reported prevalence of hypercholesterolemia of 15.7% in men and 19.7% in

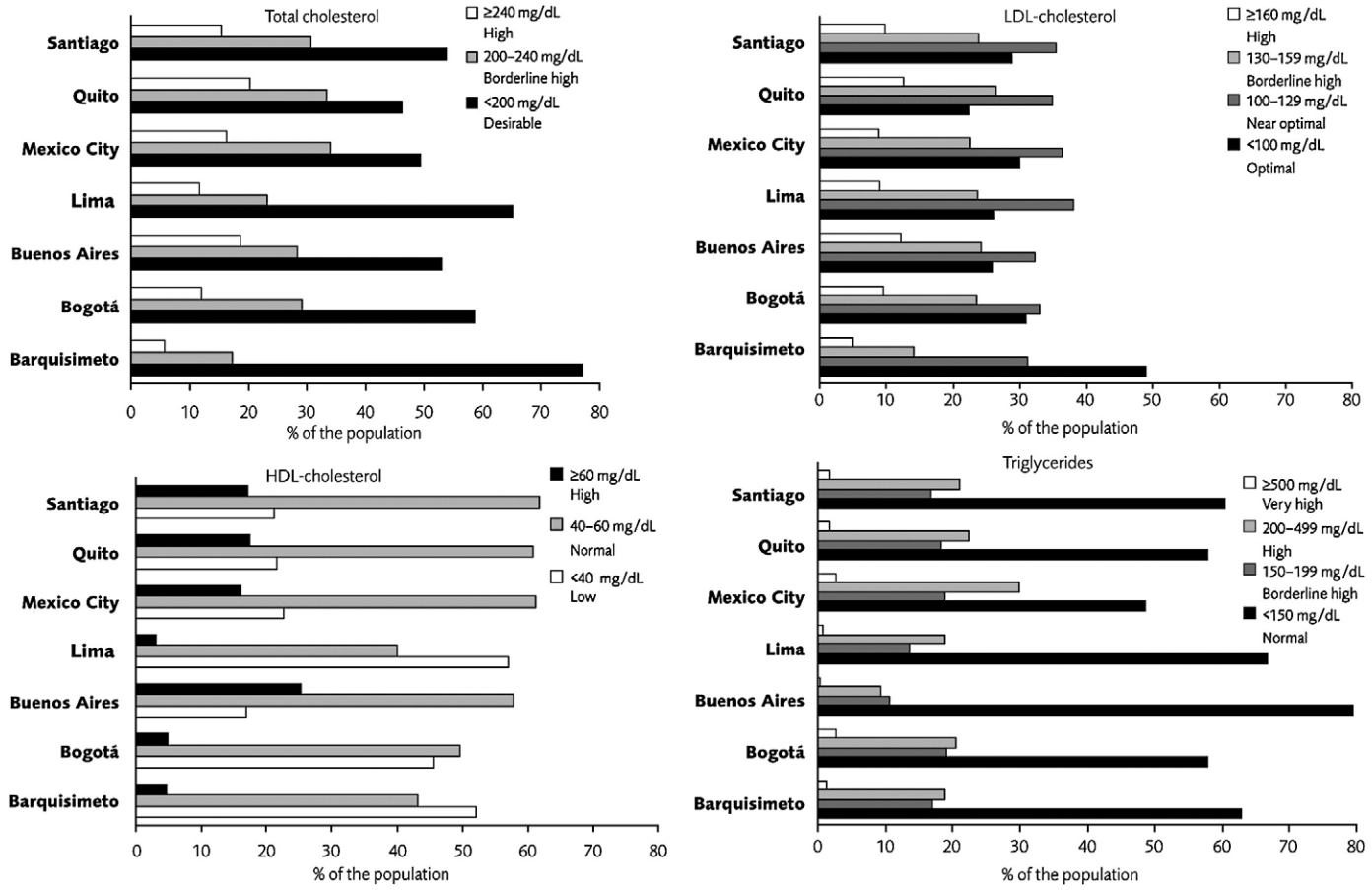

Fig. 1. Weighted prevalence of normal and abnormal lipid values based on NCEP-ATP III classifications by city. CARMELA study, September 2003–August 2005.

women; another study in Puriscal, Costa Rica (Campos et al 1992) reported 7.2% in men and 9.2% in women; meanwhile the pooled CARMELA population found 14.2% in men and 13.6% in women; and in a Brazilian city, hypercholesterolemia was lower than the one in the CARMELA study (4% vs 14%) (de Souza et al., 2003). In the latter study, overall dyslipidemia (24%), defined similarly to those in CARMELA,

Table 2
Weighted prevalence (%) (95% confidence interval) of dyslipidemia. CARMELA study, September 2003–August 2005.

	Barquisimeto	Bogotá	Buenos Aires	Lima	Mexico City	Quito	Santiago
Dyslipidemia[a]	$n=1848$	$n=1553$	$n=1482$	$n=1652$	$n=1722$	$n=1638$	$n=1655$
Overall	59.6 (56.7–62.6)	58.2 (55.2–61.3)	38.7 (36.2–41.2)	68.1 (65.5–70.8)	50.1 (46.9–53.3)	45.7 (42.7–48.6)	42.7 (40.0–45.3)
Men	75.7 (72.1–79.3)	70.5 (66.8–74.2)	52.4 (48.8–56.0)	73.4 (69.7–77.0)	63.3 (59.4–67.2)	52.6 (48.3–56.8)	51.5 (47.9–55.1)
Women	49.1 (45.9–52.4)	48.6 (44.8–52.4)	27.1 (23.9–30.3)	63.0 (59.4–66.6)	34.6 (33.5–42.5)	38.1 (34.5–41.7)	34.6 (31.2–38.0)
TC ≥240 mg/dL	$n=1848$	$n=1553$	$n=1482$	$n=1652$	$n=1722$	$n=1638$	$n=1655$
Overall	5.7 (4.7–6.7)	11.7 (10.2–13.2)	18.7 (16.7–20.7)	11.6 (10.1–13.1)	16.4 (14.2–18.7)	20.2 (18.0–22.3)	15.3 (13.4–17.2)
Men	4.5 (2.9–6.0)	11.8 (9.3–14.3)	19.3 (16.5–22.1)	9.8 (7.9–11.7)	16.9 (14.0–19.9)	21.7 (18.3–25.1)	15.8 (13.2–18.4)
Women	6.4 (5.0–7.9)	11.1 (9.0–13.2)	16.9 (14.3–19.6)	12.4 (10.3–14.6)	15.2 (12.2–18.1)	18.6 (15.9–21.4)	14.3 (11.8–16.9)
LDL-C = not optimal	$n=1784$	$n=1472$	$n=1461$	$n=1619$	$n=1631$	$n=1582$	$n=1595$
Overall	9.8 (8.4–11.2)	19.1 (16.7–21.5)	24.7 (22.2–27.1)	17.7 (15.9–19.4)	25.6 (23.3–27.9)	23.9 (21.2–26.6)	19.9 (17.9–21.9)
Men	10.1 (8.0–12.3)	21.7 (19.0–24.5)	34.0 (30.5–37.6)	17.4 (14.9–19.9)	30.8 (26.0–35.6)	26.6 (22.9–30.4)	23.7 (20.5–26.8)
Women	9.7 (7.7–11.6)	17.1 (14.1–20.2)	17.0 (14.3–19.7)	17.9 (15.2–20.6)	21.5 (18.8–24.2)	21.4 (17.8–25.0)	16.6 (14.2–19.0)
HDL-C <40 mg/dL	$n=1848$	$n=1553$	$n=1482$	$n=1652$	$n=1722$	$n=1638$	$n=1655$
Overall	52.2 (49.1–55.4)	45.6 (42.1–49.1)	16.9 (15.1–18.8)	56.9 (53.7–60.0)	22.6 (20.1–25.1)	21.6 (19.0–24.2)	21.2 (18.8–23.5)
Men	70.7 (66.8–74.5)	59.0 (54.8–63.2)	29.4 (26.2–32.5)	64.5 (60.4–68.5)	35.2 (31.7–38.8)	27.7 (24.3–31.2)	31.1 (27.9–34.4)
Women	40.2 (36.7–43.7)	35.1 (31.0–39.1)	6.4 (4.4–8.4)	49.3 (45.0–53.6)	11.5 (8.7–14.4)	15.5 (12.6–18.3)	12.1 (9.2–14.9)
TG ≥200 mg/dL	$n=1848$	$n=1553$	$n=1482$	$n=1652$	$n=1722$	$n=1638$	$n=1655$
Overall	20.2 (17.9–22.4)	23.2 (20.8–25.5)	9.8 (8.6–11.1)	19.5 (17.6–21.5)	32.5 (29.4–37.5)	23.8 (21.4–26.3)	22.7 (20.5–24.9)
Men	27.9 (24.2–31.7)	33.8 (30.8–36.9)	16.0 (13.5–18.5)	25.1 (22.1–28.1)	43.3 (39.1–47.5)	29.7 (26.2–33.3)	30.0 (26.9–33.1)
Women	15.1 (12.9–17.4)	14.8 (12.1–17.4)	4.6 (3.0–6.2)	14.0 (11.6–16.4)	23.1 (20.1–26.0)	18.0 (15.1–20.8)	16.0 (13.5–18.6)
Current therapy	$n=241$	$n=196$	$n=153$	$n=114$	$n=186$	$n=219$	$n=112$
All[b]	8.2 (4.6–11.7)	18.1 (11.9–24.4)	44.5 (35.7–53.3)	19.9 (11.5–28.2)	21.7 (14.7–28.8)	8.3 (4.1–12.4)	41.9 (32.1–51.7)
Men[b]	9.0 (1.8–16.2)	20.2 (9.8–30.7)	42.9 (29.1–56.7)	23.5 (5.7–41.3)	23.6 (13.2–34.0)	23.6 (13.2–34.0)	32.8 (18.8–46.7)
Women[b]	7.8.(4.3–11.2)	16.7 (10.0–23.5)	46.0 (34.0–57.9)	17.4 (10.9–23.9)	19.9 (8.6–31.2)	19.9 (8.6–31.2)	48.9 (36.8–60.9)

[a] Presence of dyslipidemia was defined by the following criteria: triglycerides ≥200 mg/dL, or TC ≥240 mg/dL, HDL-C <40 mg/dL or LDL-C = not optimal (LDL-C ≥100 mg/dL if Framingham 10-year risk score = high, or LDL-C ≥130 mg/dL if Framingham 10-year risk score = intermediate, or LDL-C ≥160 mg/dL if Framingham 10-year risk score = low)[13] or currently taking antilipemic agents.

[b] Subjects currently taking antilipemic agents among all subjects who were prescribed antilipemic therapy.

was also lower than all seven CARMELA cities, illustrating the general dissimilarity in lipid profiles across Latin American cities.

Evaluating other regions, a Saudi Arabian study observed variations in patterns of lipid profiles across 5 geographic regions; the authors noted that these variations were not entirely consistent with the concept that more developed areas had a higher prevalence of dyslipidemia, and that other factors might contribute to this variation (al-Nuaim, 1997). Indeed, despite the common attribution of hypercholesterolemia as a "disease of affluence," it has been recently suggested that body mass index and cholesterol increase rapidly with national income, and after leveling off, eventually decline, reflecting change in energy consumption at much earlier stages of economic development than previously recognized (Ezzati et al., 2005). Variations along the spectrum of economic development (International Money Found, 2007) might well be reflected in the distinct variations in lipid profiles among the 7 CARMELA cities. Relatively high rates of high TC were found in both Quito, a country with low gross domestic product, and at the other end of the spectrum, the more affluent cities like Buenos Aires, Santiago, and Mexico City.

In addition to variation in economic development, environmental and cultural differences in food sources, genetics, and intrauterine and early childhood differences in nutrition, might well contribute to variation in lipid profiles between CARMELA populations (Yusuf et al 2001). The recognition of unique lipid patterns that CARMELA reports can support local targeted public health, clinical, and pharmacologic efforts to mitigate long-term morbidity and mortality (Gaziano et al., 2007; Beaglehole et al., 2007).

Study limitations and strengths

The limitation of this study is the lack of an alternative method to determine LDL when the Friedewald's formula was not applicable. The strengths are the application of same methodology in 7 different cities during similar period, the use of the whole city population as sample frame and that the subjects were selected by probabilistic sampling. These features allow establishing baseline data to replicate the study in the near future for measuring lipid profile changes over time.

Conclusion

The CARMELA study reveals wide variations in lipid profiles across seven Latin American cities. Dyslipidemia is disturbingly prevalent, ranging from 36% to 68%, where the low HDL-C and high triglycerides were the more frequent abnormalities. The high TC/HDL-C ratios and non-HDL-C levels suggest a high risk of cardiovascular disease in all studied cities. The low rate of antilipemic treatment, the prevalence of non-optimal HDL and the high TC/HDL-C ratio are also of note. Immediate clinical and public health measures addressing detection, lifestyle, and therapeutic options are necessary to manage dyslipidemia and decrease cardiovascular disease in Latin America.

Conflicts of interest statement

Raul Vinueza, MD was an employee of Pfizer Inc during the conduction and analysis of the study and has shares in the company. Honorio Silva, MD was an employee of Pfizer, Inc. during the conduct of the study (now retired). All other authors declare no conflict of interest.

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