Lipids, Apoprotein B, and Associated Coronary Risk Factors in Urban and Rural Older Mexican Populations

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The objective of this comparative cross-sectional study was to determine the prevalence of dyslipidemias and examine its association with food intake and metabolic variables in urban and rural elder Mexican populations. Three different communities (urban areas of medium and low income and a rural area) were studied. A total of 344 subjects aged 60 years and older and 273 aged 35 to 59 years were included. The evaluated parameters were personal medical data, 24-hour diet recall, and fasting plasma lipids, insulin, and glucose levels. Older subjects, especially men, living in the rural area had lower cholesterol levels (5.02 ± 0.97 *v* 5.6 ± 1.07 mmol/L; *P* < .05) and insulin levels (12 ± 10 *v* 42 ± 68 mU/mL) and higher high-density lipoprotein cholesterol concentrations (1.31 ± 0.36 *v* 1.07 ±0.28 mmol/L) than the elders from the urban medium-income group. Possible explanations for these differences are found in the dietary habits of the groups. Rural elders had higher amounts of fiber (20 ± 11 *v* 10 ± 6 g/d) and carbohydrate (70% ± 0.08% *v* 52% ± 0.11% of calories) and lower fat (18% ± 0.07% *v* 33% ± 0.1% of calories) in their diets. In the urban groups, low-density lipoprotein hypercholesterolemia was present in 17.8% of adult and 39.1% of elderly women (*P* = .00001). In conclusion, environmental factors still play a prominent role in the pathophysiology of the dyslipidemias in the elderly.

DEVELOPING COUNTRIES have experienced major socioeconomic changes in the last decades that which have led to deep demographic and epidemiological changes. Mexico still has high mortality rates in the neonatal period and early childhood years, but life expectancy has increased 10 years during the last two decades. A study done in 1990 disclosed that in Mexico, 3.1 million people were more than 65 years old, representing 3.7% of the total Mexican population. By the year 2030, it is estimated that this group will number 15.2 million, or 11.7% of the population.[1]

In this setting of epidemiological transition, the prevalence of coronary risk factors has increased rapidly and continuously. In México, the prevalence of type 2 diabetes changed from 2.3% in the early 1960s to 8.1% in the early 1990s.[2] The nationwide prevalence of hypercholesterolemia (cholesterol ≥ 6.3 mmol/L) in the early 1990s reached rates similar to those observed in the United States.[3] Between ages 60 and 64 years, 17.4 % of the population had hypercholesterolemia. Although the incidence of atherosclerotic heart disease is already a heavy burden on the Mexican medical system and has become, in most states of the country, the leading cause of death,[4,5] it is evident from analyses of available data that the worst is yet to come. In a 2-year period (1995 to 1997), the number of cardiovascular-, stroke-, and diabetes-related deaths increased by 2% to 3%.[6,7] Similar trends had been reported in other Latin American countries.[8]

Prospective epidemiological studies have established the direct and strong relationship between elevated plasma cholesterol levels and increased prevalence of coronary artery disease (CAD).[9-17] Recent prospective and adequately designed studies have confirmed the role of plasma lipoproteins as determinants of progression of atherosclerosis in the elderly.[18-24] Indeed, high-density lipoprotein (HDL) cholesterol seems to be a better marker for increased cardiovascular morbidity than low-density lipoprotein (LDL) cholesterol in this age group.[21] Based on these results, in recent years, a growing consensus exists regarding the importance of dyslipidemias in the elderly. Unfortunately, the controversy has delayed the study of many other important aspects of the lipid disorders in the elderly. The interaction of environmental and genetic factors as determinants for the appearance of the different types of dyslipidemias in elders has not been described. Urban-rural differences in the prevalence of dyslipidemias have been recognized. Hypercholesterolemia and hypertriglyceridemia are usually more prevalent in urban than rural areas because of differences in diet and lifestyle.[25-29] The majority of epidemiological studies related to lipids and dyslipidemias have been performed in younger adult populations, and there are a few studies addressing the problem in the adult older group.[30-33]

Based on these data and because of the lack of information available in Mexico, we designed this study to (1) determine the prevalence of dyslipidemias and the mean serum lipids and apoprotein B values in rural and urban Mexican elder populations, (2) assess the effect of different lifestyles and dietary habits on the lipid profile in elders, and (3) compare the metabolic abnormalities associated with dyslipidemias in elder and adult subjects.

SUBJECTS AND METHODS

Population Sample

This is a comparative, cross-sectional study that includes individuals from three different populations (urban areas of medium and low

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income and a rural area) derived from the CRONOS study (Cross-Cultural Research on Nutrition in the Older Adult Study Group), promoted by the European Economic Community, whose main objective was to describe the nutritional situation of older people in urban and rural communities in developing countries from a transcultural and multicentric perspective.[34] Three communities were selected according to a standardized rapid appraisal procedure. The first step in the design of the sample was to set up the primary sampling units. It was decided to use two basic geostatistical areas (geographical areas defined by the National Institute of Statistics, Geographics and Informatics) from two regions of Mexico City and one from a rural area in the state of Mexico. The selected communities were representative of a rural and of low- and medium-income urban populations close to the national average in health facilities and community services.

The Habitational Unit, Centro Urbano Presidente Aleman, located in Mexico City in the Colonia del Valle, was founded in the early 1950s. Its current population of 2,500 individuals is composed primarly of bureaucrats and pensionists from public service. The residents are representative of the middle class and have a regular income and access to education and the Social Security services.

The Colonia Isidro Fabela, an urban area located in the Mexico City, Tlalpan area, is populated mainly by migrants from the states of Mexico and Morelos who formed this community in the early 1960s. At present, 10,000 individuals live in this area. Common urban services operate at 80% level. The population is composed mainly of workers with low incomes and low levels of education, and less than 50% of this population is able to use the benefits of the Mexican Institute of Social Security.

The rural area was selected, located in the state of Mexico, 350 km from Mexico City and near Michoacán in Temascalcingo. This community has a high index of poverty and is composed by 15 agrarian communities with a population of 50,000 individuals, mainly Indians (Mazahuas).

We obtained maps of the three areas showing blocks, streets, and households. In the urban areas, the sample of individuals distributed by age and sex was taken at random from a census performed in previous years. Seventy eight percent of the selected subjects agreed to participate in the study. In the rural area, a similar approach was used with the younger adult population (85% of participation); all older individuals were included.

Population Studied

The study included 196 men and 316 women aged 60 years and older (elderly group) and 180 men and 290 women aged 30 to 59 years old (adult group) from the three selected communities. In this report, data from the adult group were not used to analyze the effect of the lifestyle on the evaluated parameters; this information is presented only as a reference for the mean values observed in these populations. Surveyed individuals were ascertained to have lived in their communities for at least 5 years before the interview and were able to understand and answer all survey questions independently. Institutionalized older people, those with an acute illness, and those with memory problems were excluded. This report includes the results from 121 men and 223 women from the older adult group and 93 men and 180 women from the younger adult group who agreed to give a blood sample for biochemical studies (60% of the original sample). In a separate analysis, no significant differences were observed in the sociodemographic characteristics of the group with and without biochemical analysis. The participants first received written information about the project, consent was obtained, and then they were examined at home and in a primary care center near their homes. They received medical assistance or advice when appropriate. The study was authorized by the local Research and Ethics Committee and was performed in accordance with the Helsinki Declaration of Human Studies.

Personal Interview

A general structured interview was conducted in each participant's home. The questionnaire assessed demographic and socioeconomic information, family health history, personal medical history, and lifestyle factors such as smoking and physical activity. Functional status in the older adults was assessed using the scale developed by Osler and De Groot,[35] including 16 questions regarding basic and instrumental activities of daily living.

Anthropometric Measurements

In a second home visit, anthropometric measurements, blood pressure measurements, and dietary histories were obtained. The anthropometric measurements were performed by a trained nutritionist between 8 and 11 AM. Participants removed their shoes and upper garments and donned an examining gown. Height was measured to the nearest 0.5 cm (Dyna Top E-1 estadiomether). Waist circumference was measured on subjects in the standing position, at the end of gentle expiration, at a level midway between the lower rib margin and the iliac crest. Hip circumference was measured at the thickest part over the great trochanters. Both circumferences were measured in duplicate to the nearest 0.5 cm. Body weight was measured on a daily calibrated balance (Soehnle Actueil) and recorded to the nearest 0.1 kg. Body Mass Index (BMI) was calculated as weight (kg) divided by height (m^2) and was used as an index of overall adiposity. The waist-to-hip ratio (WHR) was used as measure of body fat distribution.

Measurements of skinfold thickness and arm-muscle circumference (AMC) provide an indirect measure of the quantity of body muscle mass and body fat. The skinfold thickness was measured with a Harpenden caliper. Percent of body fat was calculated from the formula[36] % Body Fat = (4.95- D - 4.142) x 100, where *D* is density, was obtained from the formula D = 1.1339 - (0.0717 x log skinfold thickness) for women and D = 1.1765 - (0.0744 x log skinfold thickness) in men.

The skinfold thickness is the sum of the tricipital, bicipital, subscapular, and suprailiac skinfolds. Systolic (1st-phase) and diastolic (5th-phase) blood pressures were measured to the nearest even digit by use of an electric sphygmomanometer with the subject in the supine position after a 5-minute rest.

Dietary Assessment

A trained dietitian interviewed all subjects about their food intake and dietary habits. Subjects were interviewed about their dietary intake one time only, using the dietary 24-hour recall.[36] Although there is great variation in day-to-day food intake, the individual intake results expressed by the group give a valid tool for these purposes.[37,38]

Blood Chemistry Studies

All individuals were invited to a primary care facility near their homes, where blood specimens were taken once after a 12- to 14-hour fast for determination of plasma lipids, apoprotein B, insulin, and glucose concentrations.

Plasma glucose was analyzed by the glucose-oxidase method (Boehringer Mannheim, Mannheim, Germany). Plasma total cholesterol and triglyceride concentrations were determined by enzymatic methods (Boehringer Mannheim). HDL cholesterol was measured after precipitation of very-low-density lipoprotein (VLDL) and LDL by the phosphotungstate method (Boehringer Mannheim), LDL cholesterol was estimated by the formula of Friedewald. Intraassay coefficient of variation values for total cholesterol, triglycerides, and HDL cholesterol were 3%, 5%, and 5%, respectively. The quantitative determination of apoprotein B was estimated by rate nephelometry. Our laboratory participates in the Lipid Standardization Program of the American College of Pathology; insulin was analyzed by ELISA in the ES-33 system (Boehringer Mannheim). Cross-reactivity with proinsulin for this assay was of 40%.

Definitions

Hypertriglyceridemia was considered at a triglyceride concentration of ≥2.26 mmol/L. An LDL cholesterol level of ≥4.13 mmol/L was considered to be hypercholesterolemia. HDL cholesterol concentration was considered abnormal if it was <0.90 mmol/L. The European Atherosclerosis Society (EAS) classification (1987) for clinical forms of dyslipidemias was used for categorization.[39] Hypertension and overweight were defined according to the recommendations of the Second Joint Task Force of European and other Societies on Coronary Prevention.[40] Overweight was defined as BMI ≥ 27 for men and women.[41] Based on the recommendation fron the World Health Organization (WHO) to use a BMI of 30 kg/m^2 to diagnose obesity, this definition was also included.[42] Individuals were considered diabetic if they had a previous diagnosis of diabetes by WHO criteria or had a fasting blood glucose values ≥ 7 mmol/L (126 mg/dL) and no previous history of diabetes. Hypertension was diagnosed when the systolic pressure was ≥140 mm Hg, diastolic pressure was ≥90 mm Hg, or subjects were currently using antihypertensive medications. Smoking was considered present if the subject smoked daily. Ischemic heart disease was considered if there was a history of myocardial infarction.

Statistical Analysis

The data were codified and captured under ASCII fixed format. The database was validated through recognition of missing values, outliers, and inconsistencies between variables. Descriptive analysis included estimation of mean values and SDs for continuous variables. These values were rounded at the nearest integrer or first decimal. Prevalences and frequencies are expressed as percentages.

Based on the nonparametric distribution of the data, the Kruskal-Wallis one-way ANOVA test was conducted to estimate differences in mean values among the three communities. Categorical variables were compared by use of the x^2 statistic with Yates'correction or the exact Fisher test when appropriate. To quantify the probability to have dyslipidemias according to the different risk factors, we carried out an unconditional logistic regression analysis to determine the odds ratio (OR). Ninety-five percent confidence intervals (95%CI) and *P* values are reported for this latter association manner. To evaluate the association of hypercholesterolemia and hypertriglyceridemia as dependent binary variables with different independent variables, a multivariate stepwise logistic regression analysis was used. All the statistical analysis was conducted in SPSS/PC+ version 5.0 (Chicago, IL).

RESULTS

The prevalence of dyslipidemias was remarkably different between adults and elders. As shown in Table 1, a significantly smaller percent of the elders than of adults had normal lipid profiles. This difference was caused by increased frequencies of mild and moderate hypercholesterolemia. However, a smaller proportion of elders had the most severe form of dyslipidemia (cholesterol > 7.89 mmol/L and/or triglycerides > 5.6 mmol/L). A higher prevalence of moderate hypercholesterolemia was observed in elder women than in elder men (12.9% *v* 2.7%). These data show that the prevalence of an abnormal lipid profile is higher in the elderly, but a clear survival effect could be postulated based on the reduced prevalence of the most severe form of dyslipidemia.

As shown in Table 2, significant differences were found in the anthropometric, sociodemographic, dietary, and metabolic characteristics of the elder populations of the three communities. Individuals living in the rural area had significantly lower mean values for BMI, percentage of body fat, systolic blood pressure, and glycemia in both sexes, as well as lower mean diastolic blood pressure, total and LDL cholesterol and insulin levels, and higher HDL cholesterol levels in men only. Dietary habits were also different between the groups. Elder subjects living in the rural area have significantly higher consumption of dietary fiber than the older subjects living in urban conditions do. Their diet consisted mainly of simple and complex carbohydrates, and their fat intake was low (18% ± 0.07% of total calories). Elderly individuals living in the rural area had the lowest prevalence of dyslipidemias and other coronary risk factors.

Between the urban groups, differences were found in the evaluated parameters, although they were not as large as those reported for the rural elders. The elders from the urban medium-income group had the highest mean values of plasma cholesterol, triglycerides, and insulin. Older women from the urban low-income area had the highest mean values for BMI and fasting plasma glucose of the three groups of elder women. In comparison with the medium-income elders, the low-income urban elders consumed greater amounts of carbohydrates and had a lower fat content in their diets. These data show that environmental factors are still important determinants of the lipid profile in the elderly.

Dyslipidemias were highly prevalent in individuals from the urban communities. LDL hypercholesterolemia was present in 22.6% of adults compared with 28%, 32%, and 18% of the elderly men from the three communities (urban medium-income, urban low-income, and rural, respectively). The same

Table 1. Prevalence of Dyslipidemic Groups (EAS 1987) According to Age and Sex

	Normal	A	B	C	D	E
Cholesterol (mmol/L)	<5.2	5.2-6.5	6.5-7.8	<5.2	5.2-7.89	>7.89
Triglycerides (mmol/L)	<2.2	<2.2	<2.2	2.2-5.6	2.2-5.6	and/or >5.6
Adults (%) (n = 470)	39.2	27.5	2.6	7.7	17.9	5.1
Elders (%) (n = 512)	34.4*	30.9	9.4*	9.7	16.3	4.4
Adults						
Men (%) (n = 180)	32.3	32.3	2.2	6.5	23.7	3.2
Women (%) (n = 290)	42.8	25	2.8	8.3	15	6.1
Elders						
Men (%) (n = 196)	37.8	32.4	2.7	6.3	17.1	3.6
Women (%) (n = 316)	32.5	30.1	12.9*	3.8	15	4.8*

* $P < .05$, adults *v* elders.

Table 2. Anthropometric, Macronutrient Intake, and Metabolic Variables in Elderly and Adult Distributed in Three Communities

Variables	Elders: Urban Medium Income	Elders: Urban Low Income	Elders: Rural	Kruskal-Wallis *P*	Adults Total Group
Men					
n	45	36	40		93
Age (yr)	74 ± 8*	69 ± 7	73 ± 9	0.05	46 ± 7
BMI (kg/m^2)	26 ± 5†	26 ± 3‡	23 ± 4	0.002	26 ± 4
WHR	0.93 ± 0.05	0.94 ± 0.06	0.93 ± 0.06	0.65	0.94 ± 0.06
% Body fat	24 ± 4†	23 ± 5‡	17 ± 6	0.001	25.5 ± 3.9
BMI > 27 kg/m^2 (%)	45.2	37.1	18.8	0.001	39.6
BMI > 30 kg/m^2 (%)	14.5	25.1	6	0.001	21.8
SBP	136 ± 24†	137 ± 20‡	121 ± 22	0.005	124 ± 21
DBP	79 ± 22	88 ± 18‡	79 ± 16	0.04	84 ± 19
Glucose (mmol/L)	6.33 ± 2.7†	6.0 ± 2.8‡	4.6 ± 2.5	0.001	5.6 ± 3.05
Cholesterol (mmol/L)	5.6 ± 1.07†	5.47 ± 0.78‡	5.02 ± 0.97	0.05	5.31 ± 1.1
HDL cholesterol (mmol/L)	1.07 ± 0.28†	1.1 ± 0.23‡	1.31 ± 0.36	0.01	1.1 ± 0.28
LDL cholesterol (mmol/L)	3.97 ± 1.05†	3.73 ± 0.73‡	3.2 ± 0.92	0.002	3.5 ± 0.97
Triglycerides (mmol/L)	2.05 ± 1.76	1.85 ± 0.6	1.65 ± 1.4	0.04	185 ± 124
Insulin (μU/mL)	42 ± 68†	26 ± 47	12 ± 10	0.001	15 ± 11
Apoprotein B (mg/dL)	158 ± 47	164 ± 37	108 ± 43	0.001	—
Fiber (g/d)	10 ± 6†	9 ± 3	20 ± 11	0.001	17 ± 11
% Carbohydrate	52 ± 0.11†	60 ± 0.09‡	70 ± 0.08	0.001	58 ± 13
% Fat	33 ± 0.10†	27 ± 0.08‡	18 ± 0.07	0.001	27 ± 11
Women					
n	103	64	56		180
Age (yr)	73 ± 8	71 ± 8	72 ± 8	0.17	45 ± 7
BMI (kg/m^2)	26 ± 5†	27 ± 6‡	23 ± 4	0.001	28 ± 5
WHR	0.84 ± 0.06*†	0.88 ± 0.08	0.88 ± 0.06	0.001	0.85 ± 0.06
% Body fat	42 ± 3†	42 ± 7‡	35 ± 7	0.001	34.4 ± 3.5
BMI > 27 kg/m^2 (%)	39	54.7	22.7	0.001	55.4
BMI > 30 kg/m^2 (%)	17.5	32	4.6	0.001	28
SBP	137 ± 21†	137 ± 22‡	123 ± 21	0.003	118 ± 17
DBP	81 ± 20	91 ± 29	83 ± 18	0.05	80 ± 18
Glucose (mmol/L)	4.77 ± 1.5	6.83 ± 3.4‡	5.22 ± 2.8	0.001	5.27 ± 2.6
Cholesterol (mmol/L)	5.9 ± 1.1	5.5 ± 1.1	5.5 ± 1.1	0.06	5.3 ± 1.2
HDL cholesterol (mmol/L)	1.34 ± 0.31	1.13 ± 0.31	1.26 ± 0.28	0.001	1.15 ± 0.31
LDL cholesterol (mmol/L)	4.07 ± 1.1	3.71 ± 1	3.6 ± 1.1	0.01	3.5 ± 1.1
Triglycerides (mmol/L)	1.74 ± 0.4	1.58 ± 0.42	1.56 ± 0.49	0.21	1.85 ± 1.19
Insulin (μU/mL)	23 ± 36	18 ± 21	13 ± 11	0.001	19 ± 21
Apoprotein B (mg/dL)	164 ± 46*	165 ± 53	100 ± 34	0.001	—
Fiber (g/d)	9 ± 4	7 ± 3‡	18 ± 11	0.001	13 ± 9
% Carbohydrate	52 ± 0.03	57 ± 0.09‡	65 ± 0.10	0.001	58 ± 11
% Fat	33 ± 0.09	28 ± 0.08‡	20 ± 0.08	0.001	28 ± 10

NOTE. Data are presented as means ± SD. Mean comparisons between the groups of elders were performed by ANOVA. No comparison were done against the adult group; these data are presented only as reference values of the population.

* $P < .05$, urban medium income *v* urban low income.

† $P < .05$, urban medium income *v* rural.

‡ $P < .05$, urban low income *v* rural.

phenomenon was observed in women (17.8% adult *v* 45%, 33%, and 31%, respectively). Hypertriglyceridemia was observed in 33.3% of adult and 32%, 25%, and 22% of the elder men from the three communities (urban medium-income, urban low-income, and rural, respectively). Hypoalphalipoproteinemia (HA) was present in 28.0% of adult and 32%, 28%, and 22% of the elder men from the three communities (urban medium-income, urban low-income, and rural, respectively). Similar changes were also observed in women, but a striking 63% were observed in cases from the urban low-income group.

As a complementary goal of the study, the association of several types of dyslipidemias with other variables in elders and adults was analyzed. In Table 3, the anthropometric and metabolic parameters of adult subjects with normal lipid levels, mild hypercholesterolemia (cholesterol 5.2 to 6.55 mmol/L and triglycerides < 2.2 mmol/L), or mixed hyperlipidemia (cholesterol 5.2 to 7.8 mmol/L and triglycerides 2.24 to 5.6 mmol/L) are shown. In Table 4, the same data are shown for the elder subjects. In adults, mixed lipemia was clearly associated with increased BMI, WHR, and systolic and diastolic blood pressure. Cases with mixed hyperlipidemia also had higher plasma concentrations of glucose and insulin and lower levels of HDL

Table 3. Metabolic and Anthropometric Variables in Normolipidemic, Mildly Hypercholesterolemic, and Mixed Hyperlipidemic Adults

Variables	Normolipidemic	Mild Hypercholesterolemia	Mixed Hyperlipidemia	*P*
Cholesterol	<5.5	5.2-6.5	5.2-7.8 mmol/L	
Triglycerides	<2.2	<2.2	2.2-5.6 mmol/L	
Men/women (%)	30/77	30/45	22/24	.07
Urban medium (%)	26	49	36	.07
Urban low (%)	44	29	38	.09
Rural (%)	30	22	26	NS
BMI (kg/m^2)	26.8 ± 4.6	26.2 ± 4.6	29 ± 4.1	.002
WHR	0.88 ± 0.08	0.86 ± 0.07	0.9 ± 0.06	.01
Fat content of diet (%)	26.5 ± 9.7	29.9 ± 11.9	27.5 ± 8.8	.175
Carbohydrate content of diet (%)	59.7 ± 10.7	54.9 ± 14.1	57.7 ± 9.5	.07
Fiber content of diet (g/d)	14.2 ± 10.2	14 ± 9.3	14 ± 9.4	.87
SBP	119 ± 19	117 ± 17	127 ± 23	.12
DBP	81 ± 18	77 ± 11	88 ± 24	.04
Glucose (mmol/L)	4.8 ± 1.6	5.3 ± 2.8	6.27 ± 3.6	.01
Insulin (μU/L)	15.7 ± 13.2	15.5 ± 16	23.4 ± 30	.01
HDL cholesterol (mmol/L)	1.1 ± 0.2	1.3 ± 0.7	1.02 ± 0.18	.001

NOTE. Data are presented as means ± SD. *P* values were obtained by one-way ANOVA.
Abbreviations: SBP, systolic blood pressure; DBP, diastolic blood pressure.

cholesterol. These findings are frequently observed in the insulin resistance syndrome. Mean values of these parameters were similar between normolipidemic cases and subjects with mild hypercholesterolemia or isolated hypertriglyceridemia. The number of cases of severe hypercholesterolemia and/or hypertriglyceridemia was too small for comparison. As shown in Table 4, in the elder subjects with mixed hyperlipidemia, different findings were observed. Indeed, the elders with mixed hyperlipidemia had lower HDL cholesterol levels but no other features associated with the insulin resistance syndrome. No other difference in association between metabolic abnormalities and different types of dyslipidemias was observed in elders and adults.

DISCUSSION

Two main objectives were pursued in this study. Based on the lack of information in the Mexican population, the first goal was to determine the prevalence of dyslipidemias and mean serum lipid and apoprotein B values in elder populations. Mean values of the lipid parameters are shown in Table 2. To describe the prevalence of the different types of dyslipidemias, the classification proposed by the European Atherosclerosis Society in 1987[39] was used. Using this approach, cases were classified in six categories: normolipidemia, mild or moderate hypercholesterolemia, isolated hypertriglyceridemia, mixed hyperlipidemia, and severe hyperlipidemia. This classification was selected because it allows identification of the type of

Table 4. Metabolic and Anthropometric Variables in Normolipidemic, Mildly Hypercholesterolemic, and Mixed Hyperlipidemic Elders

Variables	Normolipidemic	Mild Hypercholesterolemia	Mixed Hyperlipidemia	*P*
Cholesterol	<5.2	5.2-6.5	5.2-7.8 mmol/L	
Triglycerides	<2.2	<2.2	2.2-5.6 mmol/L	
Men/women	42/68	36/63	19/33	.95
Urban medium (%)	35	49	40	.02
Urban low (%)	25	30	39	.01
Rural (%)	40	21	21	.02
BMI (kg/m^2)	25.8 ± 5.7	25.7 ± 4.6	26.1 ± 3.2	.48
WHR	0.89 ± 0.08	0.89 ± 0.07	0.9 ± 0.09	.29
Fat content of diet (%)	25.7 ± 11	29.3 ± 11.2	28.7 ± 9.5	.04
Carbohydrate content of diet (%)	60.5 ± 12.3	56.9 ± 12.3	58.3 ± 9.7	.09
Fiber content of diet (g/d)	12.9 ± 8.9	11.6 ± 7	10.6 ± 7.6	.06
SBP	130 ± 22	134 ± 23	134 ± 22	.64
DBP	84 ± 21	84 ± 25	73 ± 15	.31
Glucose (mmol/dL)	5.1 ± 1.9	5.3 ± 2.1	6.3 ± 3.5	.01
Apoprotein B (mg/dL)	79.4 ± 12	123 ± 15	146 ± 14	.001
Insulin (μU/L)	18.6 ± 27	27.5 ± 50	15.3 ± 9.1	.94
HDL cholesterol (mmol/L)	1.23 ± 0.31	1.28 ± 0.31	1.07 ± 0.26	.001

NOTE. Data are presented as means ± SD. *P* values were obtained by one-way ANOVA.

lipoprotein responsible for the abnormal lipid levels, and other groups had used it to describe similar data in other populations.[43] Normal lipid levels were observed more frequently in the adults than in the elders (39.2 *v* 34.4%; $P = .01$). The most frequent abnormalities in lipid profile observed in the elders were mild and moderate hypercholesterolemia, usually explained by plasma accumulation of LDL particles. Indeed, the largest difference between adults and elders was the threefold increase in the frequency of moderate hypercholesterolemia in the elder group (2.6% *v* 9.4%). The change was even greater in elder women. These data are in accordance with the decreased fractional catabolic rate of the LDL particles observed in the elderly because of a smaller number of hepatic LDL receptors[44] and the impact of estrogen deficiency on the LDL metabolism. A decreased prevalence of the lipid profiles known to be more atherogenic, ie, mixed hyperlipidemia and severe hyperlipidemia, were observed in the elders comparison with the adults. These data are in accordance with a survival bias observed in cross-sectional studies in elders.

The frequency distribution of the abnormal lipid profiles observed in the population reported here reported was compared against the reported in the PROCAM study.[43] The prevalence of a normal lipid profile was significantly smaller in the PROCAM population (22.1% for adult men and 21% for men aged 55 to 64 years). As in our study, in the German population, the most frequent lipid abnormality observed was mild and moderate hypercholesterolemia (38.7% and 18.3% for men and 41.5% and 33%, for women respectively). The largest difference observed between adults and elders was an increased prevalence of moderate hypercholesterolemia, especially in women. Our data are in agreement with those reported in other populations, although the prevalences differ, probably because of different lifestyles and genetic backgrounds.

Our second goal was to assess the effect of different lifestyles and dietary habits on the lipid profile in elders and adults. The mean concentration of plasma lipids was strongly influenced by the place of residency. Elders and adults living in urban areas have higher cholesterol, triglyceride, LDL cholesterol, and apoprotein B concentrations than their peers living the rural area. The elders living in a rural area eat low-fat diets, were thinner, and had much better risk factor profiles then those living in urban environment. Remarkably, the prevalence of hypoalphalipoproteinemia was significantly higher in elder women from the urban low-income area. This subgroup also had other metabolic abnormalities, such as higher mean BMI and fasting plasma glucose. A possible explanation for this observation could be found in dietary habits. Their diet had significantly higher amounts of fat than the rural group but still contained a high proportion of carbohydrates. These data provide evidence that environmental factors play a key role in the age-associated changes of lipoprotein levels. Consequently, in older age, it is important to recognize that several behavioral factors can acutely affect plasma lipid concentrations. Even more, it could be possible that the modification of these environmental factors contribute to reduction of cardiovascular risk. Support for this affirmation is found in the similar clinical benefit observed in all age groups (40 to 75 years) obtained from the reduction of the concentration of plasma lipids induced in the WOSCOPS study.

Our third objective was to compare the metabolic abnormalities associated with dyslipidemias in elder and adult subjects. This approach gave us an interesting observation. In adults, subjects with mixed hyperlipidemia have most of the clinical characteristics of the insulin resistance syndrome. As shown in Table 4, this association was no longer observed in the elders. These data suggest that the majority of subjects with mixed hyperlipidemia in adult life in whom insulin resistance is associated do not have prolonged life spans.[45] The results reflect the interaction of different risk factors in the development of CAD and provide additional evidence that a survival effect is present in the elder population.

Using the current recommendations, the observed mean apoprotein B levels were abnormally high, even in elders living in the rural area. Although significant variability exists in the apoprotein B levels because of methodological issues, most authors agree that a concentration higher than 100 mg/dL must be considered a coronary risk factor.[45] It is obvious that this recommendation could not be applied to a population composed of elders because most of the cases, even those considered to have low risk when other clinical parameters are used, would be considered at risk. The low specificity of apoprotein B levels as a risk factor in the elders was also observed in the PROCAM study. In this study, the median concentration of apoprotein B in men and women aged 55 to 64 years was 116 and 106 mg/dL, respectively. Unfortunately, no other study has included apoprotein B levels for the study of the lipid abnormalities in the elderly.[30-32] These data suggest that the currently used cutpoints, derived from studies in younger subjects, may not be useful in elder populations for the interpretation of plasma apoprotein B concentrations.

Some limitations of the study must be recognized. A single lipid measurement does not take into account within-individual short-term variation.[47] The possibility of describing the dynamics of the lipid changes over time is limited because of the cross-sectional nature of the study.

In conclusion, the present survey confirms the high prevalence of dyslipidemias in the Mexican elder urban population. Older adults living in the rural area had the lowest prevalence of dyslipidemias and other coronary risk factors. The data presented here confirm that environmental factors are important determinants of the lipid profile in older adults and suggest that behavioral programs could modify plasma lipid levels and possibly be useful in the prevention of CAD. There is an urgent need to improve attitudes toward screening, prevention, and treatment of coronary risk factors in older people, especially in developing countries, which have limited economic resources and are facing rapid growth in their elder populations.

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