

CLINICAL RESEARCH

## Cardiovascular risk factors in a Mexican middle-class urban population. The Lindavista Study. Baseline data

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### KEYWORDS

Risk factors;  
Lipids;  
Hypertension;  
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Obesity;  
Mexico

### Abstract

**Introduction and objective:** The aim of this communication is to describe the cardiovascular risk factors affecting a Mexican urban middle-class population.

**Methods:** A convenience sample of 2602 middle class urban subjects composed the cohort of the Lindavista Study, a prospective study aimed to determine if conventional cardiovascular risks factors have the same prognosis impact as in other populations. For the baseline data, several measurements were done: obesity indexes, smoking, blood pressure, fasting serum glucose, total cholesterol, HDL-c, LDL-c and triglycerides. This paper presents the basal values of this population, which represents a sample of the Mexican growing urban middle-class.

**Results:** The mean age in the sample was 50 years; 59% were females. Around 50% of the entire group were overweighted, while around 24% were obese. 32% smoked; 32% were hypertensive with a 20% rate of controlled pressure. 6% had diabetes, and 14% had impaired fasting glucose; 66% had total cholesterol  $\geq 200$  mg/dL; 62% showed HDL-c levels  $< 40$  mg/dL; 52% triglycerides  $> 150$  mg/dL, and 34% levels of LDL-c  $\geq 160$  mg/dL. Half of the population studied had the metabolic syndrome.

**Conclusion:** These data show a population with a high-risk profile, secondary to the agglomeration of several cardiovascular risk factors.

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**PALABRAS CLAVE**

Factores de riesgo;  
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Tabaquismo;  
Obesidad;  
México

**Factores de riesgo cardiovascular en mexicanos de clase media: el estudio Lindavista. Datos basales**
**Resumen**

*Introducción y objetivo:* el objetivo de este comunicado es describir los factores de riesgo cardiovascular en la población urbana mexicana de clase media.

*Métodos:* La cohorte del estudio Lindavista se compone de una muestra por conveniencia de 2,602 sujetos de clase media. El estudio es prospectivo y tiene como finalidad determinar si los factores de riesgo cardiovascular tienen el mismo factor pronóstico que en otras poblaciones. Para los datos basales, se hicieron varias determinaciones: índices de obesidad, consumo de tabaco, presión arterial, glucosa, colesterol total, c-HDL, c-LDL y triglicéridos en ayuno.

*Resultados:* La media de edad fue de 50 años; el 59% fueron mujeres. Aproximadamente el 50% de la muestra presentó sobrepeso, mientras que el 24% eran obesos. El 32% fumaban, el 32% eran hipertensos con una tasa de control del 20%. El 6% tenían diabetes y el 14% resistencia a la insulina. El 66% tuvieron colesterol total  $\geq 200$  mg/dl; el 62% mostraron bajos niveles de c-HDL, el 52% triglicéridos  $> 150$  mg/dl, y el 34% niveles de c-LDL  $\geq 160$  mg/dl. La mitad de la muestra tenía síndrome metabólico.

*Conclusión:* Los datos revelan una población de alto riesgo cardiovascular debido a la aglomeración de diversos factores de riesgo.

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**Introduction**

The metabolic syndrome (MS) includes various pathologic conditions such as dyslipidemia, systemic arterial hypertension (SAH), abdominal obesity, and type 2 diabetes mellitus (T2D), which, together with smoking, are risk factors of paramount importance in the development of cardiometabolic diseases.<sup>1</sup> Most of the epidemiologic knowledge regarding these risk factors has come from observational, large-scale longitudinal studies such as the Framingham Heart,<sup>2,3</sup> the Multiple Risk Factor Intervention Trial (MRFIT),<sup>4</sup> the Seven Countries,<sup>5</sup> the Prospective Cardiovascular Münster (PROCAM),<sup>6-8</sup> and the INTERHEART,<sup>9-11</sup> among others.

Emerging economy countries, such as Mexico, lack similar studies, so they extrapolate the results derived from investigations conducted within the industrialized world, in the hope that the human society is homogeneous and that environmental factors, more than genetics, are responsible for the development of a wide range of chronic degenerative diseases, including the MS.<sup>12</sup> However, each country has its specific ethnic characteristics and environmental conditions that require their own assessment, in order to elaborate pertinent governmental programs and policies that will actually be able to have impact on such particular population.

In recent decades, Mexico – as well as other Latin American countries – has undergone a profound and rapid nutritional and thus epidemiological transition,<sup>13</sup> leading to the fact that obesity, cardiovascular and other chronic degenerative conditions are nowadays the main causes of morbidity and mortality. Although several surveys have soundly established the epidemiological profile of cardiometabolic diseases in Mexico,<sup>14,15</sup> it remains to reveal whether different risk factors have equal weight in Mexicans as in the inhabitants of other countries. The purpose of this communication is to present the baseline characteristics

of those subjects enrolled in the Lindavista Study, a survey of long-term intervention conducted in persons without clinical evidence of cerebral vascular, cardiac or peripheral diseases, subjected to various interventions to reduce risk factors.

**Methods****Study design**

The project “Lindavista Study” is a multiple intervention trial on cardiovascular risk factors, encompassing a convenience sample of urban middle-class Mexico City inhabitants, with two parallel arms, one where therapeutic interventions were conducted by cardiologists and the second group where such interventions were made by general practitioners in primary care clinics or private offices. For the purpose of this paper we present the data from both groups.

The hypothesis of the study was that intensive care could abate in 20% the combined mortality of stroke and coronary events in ten years. When the study began in 1995, the rate of such combined mortality in Mexico was 372.7 per 100,000 persons, corrected for age.

Using the equation for sample size calculation for proportions, and assigning a value of  $\alpha$  of 0.01, and a power of 90%, it was estimated a total sample size of 1084 subjects per group, but anticipating a 20% of losses at follow-up, we recruited 2602 subjects. All subjects were recruited and signed informed consent at Hospital 1o. de Octubre ISSSTE and randomly assigned to study groups.

The protocol was approved by Ethics and Research Institutional Committees and the study was conducted according to standards derived from the Declaration of Helsinki,<sup>16</sup>

the Mexican Federal regulations<sup>17</sup> and the recommendation guidelines of Good Clinical Practice.<sup>18</sup>

Recruited subjects were aged 35 or older, of either gender, with no history or current clinical manifestations of vascular disease, who accepted to voluntarily participate in the study over a period of no less than 10 years. All participants underwent medical history and complete physical examination.

Using a validated questionnaire, demographic data were recorded (gender, age, marital status, education level, employment and income), as well as familial and personal history of dyslipidemias, hypertension, diabetes, obesity and/or cardiovascular events. Smoking status was also registered, including the magnitude of daily consumption; nicotine dependence was quantified with the Fagerström scale.<sup>19</sup> For the purpose of this survey, passive smoker was defined as a non-smoker person inhaling secondhand smoke produced by smokers within his/her vicinity (home or labor place) for at least eight hours.

Body weight was measured, in kilograms, with a calibrated clinical scale, and height was measured, in meters, with a wall-stadiometer; the body mass index (BMI) was calculated dividing the weight between the squared height. Waist (abdominal) circumference was measured with a fiber-glass tape, midway between the last rib and the iliac crest<sup>20</sup>; the result was registered in centimeters.

Blood pressure (BP) was determined, by qualified personnel, with a calibrated mercury sphygmomanometer, in accordance to the recommendations of the American Heart Association.<sup>21</sup> Systemic arterial hypertension (SAH) was diagnosed when BP was  $\geq 140/90$  in three visits. Blood chemistry determinations were made exclusively in venous blood. The techniques for collection and sample processing, and the measurements of lipids and lipoproteins, were made according to the Mexican Association for the Prevention of Atherosclerosis and Its Complications (AMPAC) guidelines.<sup>22</sup> Total cholesterol (TC), high density lipoprotein cholesterol (HDL-c), and triglycerides (TG) were determined using colorimetric assay kits, and according to the manufacturer's instructions. Low-density lipoprotein cholesterol (LDL-c) was calculated using the Friedewald formula<sup>23</sup>; in subjects with TG values higher than 400 mg/dL, the "non-HDL cholesterol" (CT-HDL-c)<sup>24</sup> was used instead.

For every variable, except abdominal circumference, we used the cut-off points established in the latest recommendations of the Adult Treatment Panel III (ATP-III) of the National Cholesterol Education Program (NCEP),<sup>24</sup> the American Diabetes Association,<sup>25</sup> and the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC 7).<sup>26,27</sup> Overweight was diagnosed with a BMI greater than 25 and less than 30 kg/m<sup>2</sup>, and obesity when BMI was  $\geq 30$  kg/m<sup>2</sup>. LDL hypercholesterolemia was considered when LDL-c was above the established for each of the Framingham risk categories<sup>28</sup>; hypertriglyceridemia was diagnosed when TG  $\geq 150$  mg/dL, and hypoalphalipoproteinemia when HDL-c was  $<40$  mg/dL in both genders. According to the American Diabetes Association,<sup>25</sup> fasting blood glucose (FG) level was considered normal when it was less than 100 mg/dL; a diagnosis of impaired fasting glucose was established with glycemia between 100 and 125 mg/dL and, of diabetes mellitus, when glycemia was  $\geq 126$  mg/dL. Two

atherogenic indices were also calculated, as following: TC/HDL-c or LDL-C/HDL-c.<sup>29</sup> For abdominal circumference, the specific cut-off points established for Mexicans were taken into account:  $\geq 80$  cm in women, and  $\geq 90$  cm in men.<sup>30</sup>

Finally, based on the Framingham regression equations,<sup>31</sup> the absolute risk of nonfatal myocardial infarction and coronary death at 10 years was estimated, and subjects were further categorized in the three ATP-III original categories of risk ( $<10\%$ ,  $10\text{--}20\%$  and  $>20\%$ ).<sup>24</sup>

## Results

A total of 2602 subjects were included in the present study.

### Demographics

Table 1 shows the frequency in each variable. Age range was 35–76 years of age (mean  $50 \pm 10$  years). Approximately 70% of the subjects had high school or higher education, reflecting middle and upper middle-income social stratus. About 40% of the participants had income 10 times higher than Mexico's minimum wage at the time of recruitment.

### Somatometric data

Results (Table 2) show that approximately 75% of the subjects (both genders) were overweight or obese; 88% of the women had an abdominal circumference  $\geq 80$  cm, while 74% of the men had a circumference  $\geq 90$  cm.

### Smoking

The frequency of smoking in the studied sample was shown in Table 3. 47% of women and over two-thirds of the men

**Table 1** Demographic data.

Variables	n = 2602	
	Women (%)	Men (%)
Age group (years)		
<40	14	18
40–49	39	39
50–59	29	28
60–69	15	12
$\geq 70$	3	3
Education status		%
Illiterate		1
Elementary school		28
High school		35
College or more		36
Income level (times the minimum wage)		%
1–5		23
6–10		37
>10		40
Minimum wage in 2012: approx. 4.75 USD daily.		

**Table 2** Somatometric data.

BMI (kg/m <sup>2</sup> )		n = 2602	
		Women (%)	Men (%)
Low weight	<18	0	0
Normal weight	≥18 to <25	25	24
Overweight	≥25 to <30	47	52
Obesity	≥30	28	24

Abdominal circumference (cm)		n = 2602	
		Women (%)	Men (%)
Men ≥ 90 cm	Women ≥ 80 cm	88	74

**Table 3** Smoking data.

Smoking status		n = 2602	
		Women (%)	Men (%)
Never smoked		53	31
Active smokers		27	39
Former smokers		14	26
Passive smokers		6	4

Daily consumption of cigarettes		n = 2602	
		Women (%)	Men (%)
1–5		65	54
6–10		20	20
11–20		12	21
≥21		3	5

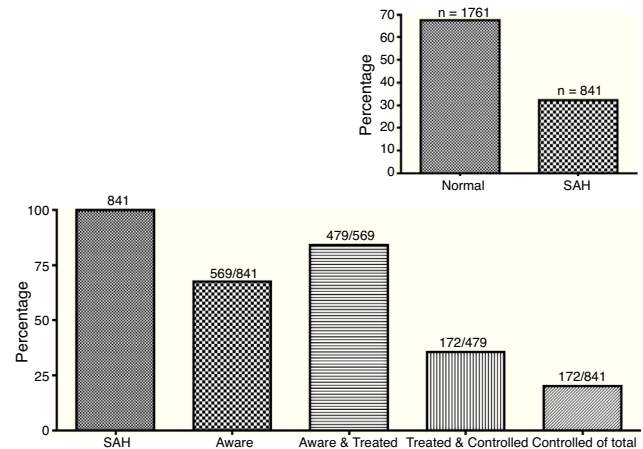
  

Dependence: Fagerström score		n = 2602	
		Women (%)	Men (%)
Low (0–3)		32	24
Medium/high (4–7)		62	65
Very high (≥8)		6	11

had, or had had contact with cigarette smoke. The prevalence was higher in men than in women. About 5% of the subjects were considered passive smokers. The majority of the active smokers reported a reduced number, i.e., less than 5, of cigarettes daily. Dependence was higher in men.

### Systemic arterial hypertension

Hypertension was present in 841 participants (32%) had hypertension. Of the total diagnosed as hypertensive, 272 subjects (32%) were unaware of their condition; within the 569 (68%) that were aware, 479 (56%) claimed to regularly consume an antihypertensive drug, but only 175 patients (36% of those treated and 20% of the entire hypertensive population) had good control of their systemic arterial blood pressure, i.e., below 140/90 mmHg for systolic and diastolic pressures, respectively (Fig. 1).



**Figure 1** Percentage of hypertensive subjects in the sample (insert). Relative awareness, treatment and control rates in hypertensive subjects.

### Type 2 diabetes mellitus

Hundred-sixty patients (6%) were diagnosed with diabetes mellitus. In addition, 385 subjects (14.7%) showed abnormal fasting blood glucose.

### Dyslipidemias

Table 4 shows the distribution of the study sample according to their serum lipids and lipoproteins levels. About 36% of participants had borderline total hypercholesterolemia, while 30% had elevated levels of serum total cholesterol. Although TC gender differences were not significant, there was a higher proportion of women with hypercholesterolemia ≥240 mg/dL. Of all participants, 62% had HDL-c values <40 mg/dL. Women had a lower proportion of hypoalphalipoproteinemia than men (52 vs. 78%). Only a small percentage of subjects, mainly women, had HDL-c ≥60 mg/dL. Ten percent of subjects had optimal values of LDL-c (≤100 mg/dL); 25% had near to optimal (110–129 mg/dL), 31% borderline (130–159 mg/dL), 20% high (160–189 mg/dL), and only 14% had very high (≥190 mg/dL) levels. Only in a small percentage of the subjects it was necessary to calculate the value of ‘non-HDL cholesterol’; in 55% of these people, the results were very high, ≥190 mg/dL. Slightly less than half the women and nearly two-thirds of the men had values of TG ≥150 mg/dL. The mean levels of lipids and lipoproteins also are shown in the same table. TC was above the acceptable level of 200 mg/dL; HDL-c level in women was significantly higher than in men. LDL-c was about 150 mg/dL, without statistical differences between genders. TG was above the normal limit of 150 mg/dL, and more elevated in men. Coronary risk, as assessed by atherogenic ratios, was high in both groups, but significantly higher in men than in women. Nevertheless, few patients were stratified in the elevated risk category according to the Framingham score. Fig. 2 shows the collection of cardiovascular risks factors in the study sample: as can be seen, most participants presented from one to three risk factors.

**Table 4** Lipids and lipoproteins (see text for details).

Lipids or lipoproteins (mg/dL)	<i>n</i> = 2602		
	Women (%)	Men (%)	Total (%)
<i>TC</i>			
<200	33	37	34
200–239	35	37	36
≥240	32	26	30
<i>HDL-c</i>			
<40	52	78	62
40–59	40	20	32
≥60	8	2	6
<i>LDL-c</i>			
<100	9	11	10
100–129	24	25	25
130–159	30	33	31
160–189	21	19	20
≥190	16	12	14
<i>non-HDL-c</i>			
<130	43	21	30
130–159	0	5	3
160–189	19	15	12
≥190	38	59	55
<i>TG</i>			
<150	56	35	55
150–199	20	21	19
200–499	23	40	25
≥500	1	4	1
Mean values of lipids and lipoproteins			
	<i>n</i> = 2602		
	Women (mg/dL ± SD)	Men (mg/dL ± SD)	Total (mg/dL ± SD)
<i>TC</i>	222 ± 48	216 ± 45	220 ± 47
<i>HDL-c</i>	40 ± 12	33 ± 10	38 ± 12
<i>LDL-c</i>	151 ± 40	147 ± 42	149 ± 41
<i>TG</i>	160 ± 90	205 ± 110	178 ± 103
Atherogenic indices			
	<i>n</i> = 2602		
	Women (mean ± SD)	Men (mean ± SD)	Total (mean ± SD)
<i>TC/HDL-c</i>	5.5 ± 2	6.5 ± 2	6 ± 2
<i>LDL-C/HDL-c</i>	3.8 ± 1.6	5 ± 2	4.4 ± 1.5
Framingham categories of absolute risk at 10 years			
	<i>n</i> = 2602		
	Women (%)	Men (%)	Total (%)
<10%	92	45	67
10–20%	6	33	21
>20%	2	22	12

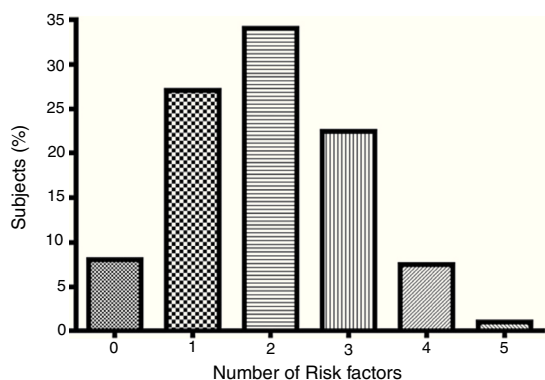
## Metabolic syndrome

More than half the individuals were diagnosed with MS. Among the cohort, the most common concurrent components of the syndrome were abdominal adiposity and low HDL-c (Fig. 3).

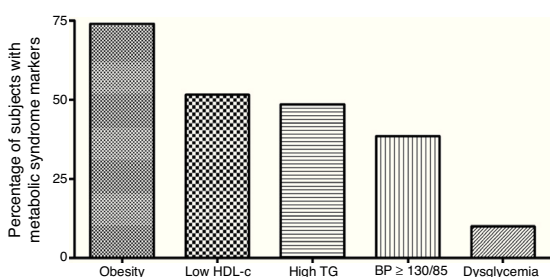
## Discussion

The study sample surely reflects the cardiometabolic profile of an important segment of the Mexican contemporary urban middle class. Along with other evidence from larger studies on the prevalence of chronic diseases (e.g., Posadas,<sup>32</sup>





**Figure 2** Relative presence of cardiovascular risk factors (age, systemic arterial hypertension, dyslipidemia, smoking, obesity, and diabetes) in the sample.



**Figure 3** Relative presence of metabolic syndrome markers in the sample.

Cueto,<sup>33</sup> ENEC,<sup>34</sup> ENSA 2000,<sup>35</sup> ENSANUT,<sup>36</sup> and FRIMEX<sup>14</sup>) data herein are helpful for the diagnosis of the most important cardiometabolic risk factors in Mexican urban populations. Deep changes (economic, social, political and cultural) that occurred in Mexico during the last 50 years, have modified the nutritional and epidemiological trends. The adoption of a *western* lifestyle, including drastic changes in diet composition and in the performance of physical activity,<sup>37,38</sup> has led to an increased prevalence of cardiometabolic risk factors (dyslipidemia, hypertension, smoking, diabetes, obesity and sedentary lifestyle) thus has favored a rapid increase in chronic diseases.

With this in mind, the present study found that three-quarters of participants were overweight or obese, and exceeded the cuff-off points for waist circumference, thus were diagnosed with central obesity. The latter has been associated with insulin resistance, hyperinsulinemia, and increased risk of T2D and vascular outcomes.<sup>39,40</sup> Evidencing such relationship, more than half of the cohort, independently of gender, presented metabolic syndrome.

Hypertension was found in 32% of the population, figures similar to those found in the ENSA 2000 and ENSANUT.<sup>35,36</sup> The rates of awareness, treatment and control of hypertension were higher than those found in the aforementioned surveys, the Mexican Registry of Cerebro-Vascular Disease (RENAMEVAC)<sup>41</sup> and the FRIMEX study.<sup>14</sup> As other studies also infer, higher socio-economic levels are frequently associated with lower rates of mortality and morbidity.<sup>42</sup> The study sample herein assessed was composed essentially with middle class urban subjects, with higher levels of education, the

latter might influence the degree of awareness, compliance to treatment and self-control of hypertension.

For its side and opposed to the results of other surveys, T2D was observed in only 6% of the study cohort. The relative youth of most of the participants can explain this low incidence.

The fact that two-thirds of the subjects had high levels of TC and LDL-c indicates a high coronary risk in such population. However, a more important aspect within the lipid profile was the high incidence of hypoalphalipoproteinemia (low HDL-c), a feature consistently observed in previous studies in both Mexicans and US inhabitants of Mexican ancestry.<sup>43</sup> Such aberrancy is more conspicuous in men than in women; therefore, the atherogenic ratios are higher in men than in women. We found that more than half of the subjects had elevated TG levels, a fact that might be associated with HDL-c as their inverse relationship has been described extensively.<sup>44</sup> Such prevalence is higher than that reported in ENSANUT, which found that hypertriglyceridemia affected just 31.5% of the surveyed population, although the same degree of hypoalphalipoproteinemia was observed.<sup>36</sup>

Finally, cigarette consumption is one of the most important independent risk factor for vascular damage; moreover, it also acts synergistically with other risk factors.<sup>45</sup> A large proportion of study subjects were exposed to, actively or passively and chronically, tobacco smoke. The relatively low consumption of cigarettes, which correlates well with Fag nstrom scores, suggests that this population of smokers may quit the habit more easily. The frequency of active smoking is similar to that reported in various Mexican national surveys<sup>46</sup> and to international studies, e.g., the CARMELA study.<sup>47</sup>

In summary, data herein found demonstrate that Mexican urban population accumulates several important risk factors, making it especially prone to suffer the catastrophic consequences of atherosclerosis and other cardiometabolic disturbances, as evidenced with the mortality rates. This is supported by the fact that the first three causes of death among Mexican adults correspond to diabetes mellitus, ischemic heart disease, and cerebrovascular disease.<sup>48</sup>

The hypothesis of the study and nutrition campaigns should be aimed to specifically bear the most frequent metabolic abnormalities, i.e., central obesity, low HDL-c levels, and hypertension. Similarly, at the individual level of attention, therapeutics ought to benefit each and every major cardiometabolic risk factor. The objective of the Lindavista Study is to show such improvements in a period of 10 years, and to quantify the pathogenicity of each of these factors in an urban population segment of middle class, in order to establish whether these factors have a similar behavior in our populations. This report is only the description of the demographic, anthropometric and cardiometabolic of this cohort, before therapeutic interventions. The results of the interventional section of the study will be the subject of future publications.

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## Conflicts of interest

Authors declare no conflicts of interest.

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