Prevalence of Cardiovascular Risk Factors in Rural and Urban Costa Rica

Hannia Campos, PhD; Leonardo Mata, DSc; Xinia Siles, RN; Marcela Vives, MS; Jose M. Or dovás, PhD; and Ernst J. Schaefer, MD

Background. Coronary artery disease (CAD) is becoming more prevalent in developing countries, particularly in the urban areas, in contrast to the CAD mortality trends observed in some industrialized nations.

Methods and Results. We determined the prevalence of cardiovascular risk factors (hypertension, diabetes, smoking, obesity, total cholesterol ≥240 mg/dl and ≥200–239 mg/dl, low density lipoprotein (LDL) cholesterol ≥160 mg/dl and >130–159 mg/dl, and high density lipoprotein (HDL) cholesterol <35 mg/dl) in 222 men and 243 women from rural and urban areas of Puriscal, Costa Rica, using the American Cholesterol Education Program guidelines. Urban Puriscal men had a significantly (p<0.05) higher prevalence of borderline high-risk total cholesterol (26% versus 14%), borderline high-risk LDL cholesterol (21% versus 11%), smoking (32% versus 13%), and higher prevalence of low HDL cholesterol (34% versus 24%), hypertension (16% versus 13%), diabetes (4.5% versus 2.7%), obesity (21% versus 14%), and saturated fat intake >15% of calories (14% versus 7%) than rural men from Puriscal. No significant differences between rural and urban women were found for any of the cardiovascular risk factors. Urban Puriscal residents were also more sedentary than rural Puriscal residents.

Conclusions. These data indicate that modifiable risk factors are more prevalent in urban than in rural Puriscal, Costa Rica, particularly in men. (Circulation 1992;85:648–658)

Recently, public health planning in most developing countries has focused mainly on problems related to communicable diseases that have in the past been responsible for most morbidity and mortality. This situation is different in more developed countries such as the United States, where coronary artery disease (CAD) is the leading cause of death. However, chronic and degenerative diseases such as CAD are making an increasingly important contribution to the mortality statistics of countries such as Brazil, Chile, Cuba, Argentina, and Costa Rica. Laurenti et al reported a substantial increase in death from heart and cerebrovascular disease between 1949 and 1969 in São Paulo, Brazil.

In Chile, industrialization and decreased rates of morbidity and mortality from infectious and nutritional diseases has changed the epidemiological profile from that of a developing country to the typical profile of a western industrialized nation. Although the prevalence of some risk factors (smoking, high total cholesterol, hypertension, and atherosclerosis) is lower than in industrialized countries, CAD incidence in Chile has increased considerably. Data from studies in Puerto Rico and Brazil also suggest that prevalences of hypertension and CAD are lower in the rural than in the urban areas. Our previous reports indicate that general and abdominal obesity, smoking, and diastolic blood pressure are higher in an urban than in a rural area of Costa Rica, and that these risk factors are associated with a more atherogenic plasma lipoprotein profile. In addition, higher dietary saturated fat and lower carbohydrate consumption are found in the urban than in the rural area; however, fat consumption in Costa Rica is significantly lower than in the Framingham population in the United States. It is estimated that 43% of the population in nonindustrialized countries and 77% of the Latin American population will be living in urban centers by the year 2000. Moreover, the population in these urban centers will have increased by 1.32 billion between the years 1975 and 2000 and will be affected by health problems that are now most commonly seen in industrialized societies.
It has been documented that elevated plasma cholesterol levels are significantly and independently associated with CAD.\textsuperscript{16,17} It has also been shown that CAD incidence can be reduced prospectively by lowering plasma total cholesterol, particularly low density lipoprotein (LDL) cholesterol.\textsuperscript{18} In the United States, population recommendations and guidelines for lowering blood cholesterol and for detecting and controlling other risk factors to prevent CAD have been established by the National Cholesterol Education Program (NCEP) adult treatment panel.\textsuperscript{19}

In our study, we evaluated the prevalence of CAD risk factors in rural and urban Puriscal, Costa Rica, and compared their prevalence with that previously reported in Framingham residents.\textsuperscript{20} We followed the risk factor criteria as established by the NCEP to examine the impact of these guidelines in a developing country. CAD risk factors were defined as diabetes (on hypoglycemic medication and/or fasting glucose levels $> 140 \text{ mg/dl}$), hypertension (on antihypertensive medication and/or diastolic blood pressure $> 95 \text{ mm Hg}$), smoking habits ($> 10$ cigarettes per day), high-risk total cholesterol ($\geq 240 \text{ mg/dl}$), borderline high-risk total cholesterol ($200-239 \text{ mg/dl}$), high-risk LDL cholesterol ($\geq 160 \text{ mg/dl}$), borderline high-risk LDL cholesterol ($130-159 \text{ mg/dl}$) and low high density lipoprotein (HDL) cholesterol ($< 35 \text{ mg/dl}$), and obesity (Metropolitan relative weight (MRW) $> 130\%$). In addition to the established NCEP risk factors, we included in our study an indicator of high saturated fat intake and decreased physical activity.

\textbf{Methods}

\textbf{Study Population}

The study sample was from the canton (county) of Puriscal in Costa Rica, which is located in Central America and has recently achieved a dramatic improvement in nutritional and health status.\textsuperscript{3} Communicable diseases, which were the leading cause of death in the 1960s, fell to the seventh rank, and cardiovascular disease has become the main cause of mortality.\textsuperscript{7} Within this latter group, 50\% of mortality was due to CAD.\textsuperscript{21} Age-standardized death rates due to CAD have increased in Costa Rica by 61\% in men and 22\% in women (from 145.4 and 107.2/100,000 in 1983 to 234.9 and 130.9 in 1986),\textsuperscript{22,23} whereas CAD mortality rates in the United States have decreased by 13\% from 229.8/100,000 in 1983 to 200.8/100,000 in 1986 in both men and women\textsuperscript{22,23} (see Figure 1). The current rate in Costa Rica for men and women (176.3/100,000) now approaches that reported for the United States.\textsuperscript{23}

Sample selection and methods have recently been described.\textsuperscript{12,13} Briefly, stratified random sampling was carried out in the rural and urban areas of Puriscal to obtain a similar number of participants in each group. Eligible households were defined as one man and one nonpregnant woman aged 20–65 years living in 130 households randomly selected from the 3,415 identified houses in the rural area and 130 households randomly selected from the 918 identified houses in the urban area. Participation rates were 85\% ($n=222$) for men and 93\% ($n=243$) for women in both rural and urban areas.

\textbf{Data Collection}

Data were collected in Puriscal, Costa Rica, from January through September 1988. The protocol for this study was approved by the Institute of Health Research at the University of Costa Rica, and their established guidelines for carrying out human studies were followed. Trained field workers visited participants in their households for recruitment, where subjects signed an informed consent form. Subsequent appointments were made for data collection, and a health history and general characteristics questionnaire was completed for each subject. Smoking status was evaluated by a self-report of the amount of cigarettes smoked per day. Smokers were considered those who smoked more than 10 cigarettes per day.

\textbf{Dietary Assessment}

A semiquantitative food frequency questionnaire (FFQ) with various modifications to account for population differences in the consumption of several foods was used for the Costa Rican subjects. The validity and reproducibility of this questionnaire have been previously reported by Willett et al.\textsuperscript{24–26} Nutrient intake calculations for each subject were determined at the Channing Laboratory, Harvard University, as previously described.\textsuperscript{25} For this study, we calculated the percent of subjects who consumed more than 15\% of calories as saturated fat and added this category as another modifiable risk factor. The 15\% cutpoint was selected as an indicator of high saturated fat intake because it represented the 75th
percentile for percent of calories from saturated fat in the Framingham population (personal communication), which was selected as a reference population in the United States for comparison purposes. We also obtained information on the amount of salt (grams) used to cook rice, a staple that is consumed at least twice daily by most Purascale residents. This measurement was used to obtain a reliable indicator of salt consumption trends.

**Anthropometric Measurements, Blood Pressure, and Physical Activity**

All anthropometric measurements were taken by three trained and standardized field workers, with subjects wearing light clothing and without shoes. Height was measured using a steel anthropometer. To ensure correct readings (to the nearest 0.1 cm) for height, subjects were always placed on a flat surface against a wall. Weight was determined on a Detecto bathroom scale or a Seca alpha No. 770 digital scale. Biweekly checkups were performed using calibrating weights. Body mass index (BMI) was calculated as weight (kilograms)/[height (meters)]^2. MRW was calculated as the ratio of observed weight to published values for desirable weight, with use of midpoint of the weight range for individuals of medium frame. Obesity was defined as having an MRW greater than 130%. Because it has been reported that BMI might be a more appropriate indicator of obesity for cross-cultural comparisons, we estimated the corresponding BMI cutpoint for MRW greater than 130%. MRW greater than 130% corresponded to BMI of at least 27.6 kg/m^2. Several studies have shown that those subjects with BMI greater than 28.0 kg/m^2 are at the highest risk for CAD; thus, the estimation of obesity in this population, using either MRW or BMI, was very similar. Furthermore, the correlation between MRW and BMI was r=0.996 (p<0.0001).

Blood pressure was always measured in the morning, in a sitting position. All measurements were taken in duplicate by the same registered nurse, using a sphygmomanometer. The average of the two measurements was used for this analysis. Hypertensives were identified as those individuals taking antihypertensive medications and/or having a diastolic blood pressure over 95 mm Hg at the time of the second house visit. Because women from the rural area visited the health care facility more often and a higher frequency of these women were taking antihypertensive medication, we suspected the use of this medication without actually having high blood pressure. Nevertheless, when users and nonusers of antihypertensive medication were compared, we found a significantly higher systolic and diastolic blood pressure in rural women taking this medication. Thus, we continued to use antihypertensive medication use as an indicator of hypertension.

Indicators of physical activity were obtained by adding up self-reported time spent on activities carried out on a typical day. We present the time spent sitting, walking on hills, and involved in agricultural activities because they indicate the major contrast between rural and urban subjects. In addition, to determine the level of fitness and confirm this previous information, each subject performed a modified version of the Harvard step test by using a portable wooden 40-cm step. Subjects were instructed to step up and down by following the beats of a metronome at a rhythm of 76 beats per minute for women and 96 beats per minute for men. Subjects were requested to perform the test for 3 minutes. When they were not able to do so, the time during which the exercise was performed was recorded. Pulse rates were taken immediately after the test and at 1 and 3 minutes after. A fitness score was calculated for each subject as seconds during exercise divided by (pulse 1 + pulse 2 + pulse 3) x 100. Subjects with a fitness score ≥55 were identified, and a percentage was used as an indicator of adequate fitness. This cutpoint was selected because it represented the 75th percentile of the urban population. The same cutpoint was used for men and women for comparison purposes.

**Blood Samples**

Blood samples were drawn after a 12–14-hour fast in 0.1% EDTA during the second house visit. A drop of blood was immediately obtained from the tube for glucose analysis, using an Accu-Check II Blood Glucose Monitor and Chemstrip 6G Test Strips (Boehringer Mannheim Diagnostics), standardized against an enzymatic (glucose oxidase/peroxidase) method (Weiner Laboratories). Blood tubes were immediately stored at 4°C. Within 36 hours, they were centrifuged at 2,500 rpm for 20 minutes at 4°C to isolate and aliquot plasma. HDL supernates were obtained after precipitation of apoB-containing particles with dextran-sulfate-Mg^2+, using the method of Warnick et al. All plasma aliquots were then stored at −70°C until they were transported to the Human Nutrition Research Center on Aging at Tufts University in Boston for lipoprotein determinations.

**Lipoprotein Analysis**

Plasma cholesterol, triglyceride, and HDL cholesterol levels were measured using an Abbott Diagnostics ABA-200 bichromatic analyzer and Abbott A-Gent enzymatic reagents as previously described. LDL cholesterol levels were estimated for all subjects with triglyceride levels <400 mg/dl using the Friedewald equation. Total cholesterol, triglyceride, and HDL cholesterol assays were standardized through the Centers for Disease Control (CDC) Lipid Standardization Program. The NCEP cutpoints were used to identify subjects with high and borderline high lipoprotein risk factors.

Statistical analysis data were analyzed using the t test and χ² procedures available in the Statistical Analysis System (SAS) software (Cary, N.C.).
Results

Table 1 shows a series of lifestyle indicators in rural and urban Puriscal men and women. The distribution of occupations was significantly different between rural and urban Puriscal residents. Both men and women from urban Puriscal were more likely to be professionals and administrators: 21% in urban residents compared with 4.5% in rural residents. White-collar jobs such as retail business and office employees, bus drivers, personal services, and nonspecialized labor were commonly observed in urban compared with rural Puriscal men (72% versus 22%, respectively) and in urban compared with rural Puriscal women (34% versus 9%, respectively). In contrast, only 5% of urban Puriscal men were involved in agricultural activities compared with 71% of men in rural Puriscal. Homemaking as the principal activity was also less prevalent among women in urban Puriscal compared with rural Puriscal (48% versus 89%, respectively). Significant rural–urban differences were also found in the educational level of Puriscal residents. In the urban area, 79% of the residents reported having at least completed elementary school education compared with 51% in the rural area.

Self-reported physical activity indicators were also significantly different between urban and rural Puriscal. Residents from urban Puriscal spent more time sitting down ($p<0.05$) and less time walking on hills ($p<0.0001$) or involved in physically active agricultural activities ($p<0.0001$) than rural Puriscal residents. These self-reported physical activity differences were confirmed by a lower fitness score. Only 44% of urban men and 6% of urban women obtained a fitness score $\geq 55$ compared with 69% of rural men and 29% of rural women. These data also indicate that 14% of urban men consume more than 15% of calories as saturated fat compared with 7% of rural men. No difference in high saturated fat intake was found between rural and urban Puriscal women. The amount of salt used to cook rice was lower ($p<0.0001$) in the urban than in the rural area. This difference might indicate a trend toward a lower salt consumption in the urban area residents because rice is a staple and is consumed at least twice daily.

Mean values for nonbiochemical risk factors by age and sex are shown in Table 2. Diastolic blood pres-
sure increased with age in both men and women. Urban men in all age groups had higher diastolic blood pressure than rural men, but differences were not significant. BMI increased with age in both men and women, and significant rural–urban differences \((p<0.01)\) were found for men aged 36–50 years. In contrast, fitness score decreased with age only in men and women from the urban area. In addition, urban men aged 36–65 years had lower fitness scores than rural men from the same age group. Urban women were significantly \((p<0.01)\) less fit than rural women in all the age groups. Cigarettes smoked per day increased with age in men from the rural and urban area, with more \((p<0.05)\) cigarettes smoked per day in urban than in rural men in all age groups. Furthermore, saturated fat intake (percent calories) decreased with age in residents from both rural and urban Puriscal areas, with urban residents in the 36–50-year age group having higher saturated fat intake (percent calories) than their rural counterparts.

Table 3 shows mean levels for plasma parameters by age and sex in rural and urban Puriscal. Total cholesterol and LDL cholesterol increased with age in rural Puriscal, but for urban men, the highest total and LDL cholesterol values were found in the 36–50-year age group. Urban men aged 20–35 years had higher \((p<0.01)\) total and LDL cholesterol levels than rural men in the same group. Urban men aged 35–50 years also had higher \((p<0.05)\) total cholesterol levels. In men, no rural–urban differences in total cholesterol and LDL cholesterol levels were found in the 51–65-year age group. In women, total and LDL cholesterol levels increased with age in both rural and urban areas. Urban women had higher total cholesterol levels than rural women in the 20–35-year age group, but differences were not significant.

HDL cholesterol levels in men from urban Puriscal decreased with age. However, HDL cholesterol levels in rural men slightly increased in the 35–50-year age group with no differences observed after the fifth decade. Urban Puriscal men aged 36–50 years had lower \((p<0.01)\) HDL cholesterol levels than rural Puriscal men in the same age group. HDL cholesterol levels in rural Puriscal women remained very similar in all age groups but increased with age in urban Puriscal women. No significant differences in HDL cholesterol levels were found between rural and urban Puriscal women.

Triglycerides increased with age in both men and women in the rural and urban area, with particularly marked increases observed in urban Puriscal men and women, who also had the highest mean triglyceride levels. Triglyceride levels in urban men aged 36–50 years were higher \((p<0.005)\) than those in the rural men within the same age range.

Glucose levels also increased with age in men and women from both rural and urban areas. Urban men from Puriscal aged 36–50 years and urban Puriscal women aged 20–35 years had higher \((p<0.05)\) glucose levels than rural men and women in the same age group.

Risk factors according to the NCEP guidelines, in men and women from rural and urban Puriscal and
those previously reported in the Framingham study,20 are shown in Table 4. In men, the prevalence of high-risk total cholesterol and high-risk LDL cholesterol in the rural and urban areas was very similar, but the prevalence of these risk factors was half of that reported for the Framingham population (total cholesterol ≥240 mg/dl: rural, 5.4%; urban, 7.2%; Framingham, 20.5%; LDL cholesterol ≥160 mg/dl: rural, 6.5%; urban, 6.6%; Framingham, 22.3%). However, the prevalence of borderline high-risk total cholesterol and borderline high-risk LDL cholesterol was twice as high in urban Puriscal men compared with rural (total cholesterol, 200–239 mg/dl: rural, 14.4%; urban, 26.1%; LDL cholesterol, 130–159 mg/dl: rural, 11.2%; urban, 20.8%). Low HDL cholesterol was the most prevalent risk factor among rural and urban Puriscal men, and it was more prevalent in Puriscal than in Framingham men (HDL cholesterol <35 mg/dl: rural, 25.2%; urban, 34.2%; Framingham, 18.6%). The prevalence of hypertension was higher in urban Puriscal men than in rural but lower in Puriscal than in Framingham men (rural, 12.6%; urban, 16.2%; Framingham, 19.1%); however, smoking and diabetes were more prevalent in urban Puriscal men than in rural or Framingham men (smoking: rural, 12.6%; urban, 32.4%; Framingham, 27.5%; diabetes: rural, 2.7%; urban, 4.5%; Framingham, 1.1%). Urban Puriscal men were more obese than rural men but less obese than Framingham men (rural, 14.4%; urban, 20.7%; Framingham, 30.5%). In sum, all of the CAD risk factors established by the NCEP were more prevalent in urban Puriscal men than in rural Puriscal men. In addition, the prevalence of smoking, diabetes, and low HDL cholesterol was higher in urban Puriscal men than in Framingham men.

The prevalence of risk factors among rural and urban Puriscal women is shown in Table 4. High-risk and borderline high-risk total cholesterol were very similar between rural and urban Puriscal women but lower in Puriscal than in Framingham women (total cholesterol ≥240 mg/dl: rural, 10.7%; urban, 9.2%; Framingham, 20.1%; total cholesterol 200–239 mg/dl: rural, 21.3%; urban, 20.8%). The prevalence of high-risk LDL cholesterol was higher among rural than among urban Puriscal women and in Framingham compared with Puriscal women (LDL cholesterol ≥160 mg/dl: rural, 13.1%; urban, 6.7%; Framingham, 19.6%). However, the prevalence of borderline high-risk LDL cholesterol was higher in urban than in rural Puriscal women (LDL cholesterol, 130–159 mg/dl: rural, 10.7%; urban, 18.5%). It should be noted that the prevalence of high-risk total and LDL cholesterol was higher in rural Puriscal women than in rural Puriscal men. Similar frequencies between rural and urban Puriscal women were found for low HDL cholesterol levels; however, as observed in men, prevalence of low HDL cholesterol levels was higher in Puriscal than in Framingham men (HDL cholesterol <35 mg/dl: rural, 14.1%; urban, 13.3%; Framingham, 4.5%). In addition, prevalence of hypertension and diabetes in women was higher in rural Puriscal than in urban Puriscal and Framingham women (hypertension: rural, 17.2%;

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**Table 3. Mean Plasma Parameters by Age Group and Sex in Rural and Urban Puriscal, Costa Rica**

<table>
<thead>
<tr>
<th>Sample size (n)</th>
<th>Rural</th>
<th>Urban</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yr)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>20–35</td>
<td>158</td>
<td>175</td>
<td>0.01</td>
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<tr>
<td>36–50</td>
<td>179</td>
<td>197</td>
<td>0.05</td>
</tr>
<tr>
<td>51–65</td>
<td>182</td>
<td>189</td>
<td>NS</td>
</tr>
<tr>
<td>Age (yr)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>LDL cholesterol</td>
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<td></td>
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</tr>
<tr>
<td>20–35</td>
<td>93</td>
<td>107</td>
<td>0.01</td>
</tr>
<tr>
<td>36–50</td>
<td>110</td>
<td>120</td>
<td>NS</td>
</tr>
<tr>
<td>51–65</td>
<td>111</td>
<td>110</td>
<td>NS</td>
</tr>
<tr>
<td>Age (yr)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>HDL cholesterol</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20–35</td>
<td>40</td>
<td>41</td>
<td>NS</td>
</tr>
<tr>
<td>36–50</td>
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</tr>
<tr>
<td>Age (yr)</td>
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<tr>
<td>Triglyceride</td>
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<tr>
<td>20–35</td>
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<td>150</td>
<td>NS</td>
</tr>
<tr>
<td>36–50</td>
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<td>NS</td>
</tr>
<tr>
<td>Age (yr)</td>
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<tr>
<td>Glucose</td>
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<td>36–50</td>
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<td>0.05</td>
</tr>
<tr>
<td>51–65</td>
<td>91</td>
<td>99</td>
<td>NS</td>
</tr>
</tbody>
</table>

Values are given in mg/dl.

LDL, low density lipoprotein; HDL, high density lipoprotein.

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TABLE 4. Prevalence of Risk Factors in Framingham Study and in Rural and Urban Puriscal, Costa Rica

<table>
<thead>
<tr>
<th>CAD Risk Factor</th>
<th>Rural (%)</th>
<th>Urban (%)</th>
<th>Framingham (%)</th>
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</thead>
<tbody>
<tr>
<td>Total cholesterol ≥240 mg/dl</td>
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</tr>
<tr>
<td>Men</td>
<td>5.4</td>
<td>7.2</td>
<td>20.5</td>
</tr>
<tr>
<td>Women</td>
<td>10.7</td>
<td>9.2</td>
<td>20.1</td>
</tr>
<tr>
<td>Total cholesterol 200–239 mg/dl</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>14.4</td>
<td>26.1*</td>
<td>...</td>
</tr>
<tr>
<td>Women</td>
<td>21.3</td>
<td>20.8</td>
<td>...</td>
</tr>
<tr>
<td>LDL cholesterol ≥160 mg/dl</td>
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</tr>
<tr>
<td>Men</td>
<td>6.5</td>
<td>6.6</td>
<td>22.3</td>
</tr>
<tr>
<td>Women</td>
<td>13.1</td>
<td>6.7</td>
<td>19.6</td>
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<tr>
<td>LDL cholesterol 130–159 mg/dl</td>
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<tr>
<td>Men</td>
<td>11.2</td>
<td>20.8*</td>
<td>...</td>
</tr>
<tr>
<td>Women</td>
<td>10.7</td>
<td>18.5</td>
<td>...</td>
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<tr>
<td>HDL cholesterol &lt;35 mg/dl</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>25.2</td>
<td>34.2</td>
<td>18.6</td>
</tr>
<tr>
<td>Women</td>
<td>14.1</td>
<td>13.3</td>
<td>4.5</td>
</tr>
<tr>
<td>Hypertension</td>
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<tr>
<td>Men</td>
<td>12.6</td>
<td>16.2</td>
<td>19.1</td>
</tr>
<tr>
<td>Women</td>
<td>17.2</td>
<td>11.8</td>
<td>11.4</td>
</tr>
<tr>
<td>Diabetes</td>
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<tr>
<td>Men</td>
<td>2.7</td>
<td>4.5</td>
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<tr>
<td>Women</td>
<td>3.3</td>
<td>1.7</td>
<td>0.9</td>
</tr>
<tr>
<td>Smoking &gt;10 cigarettes/day</td>
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<tr>
<td>Men</td>
<td>12.6</td>
<td>32.4†</td>
<td>27.5</td>
</tr>
<tr>
<td>Women</td>
<td>0.0</td>
<td>1.7</td>
<td>27.0</td>
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<tr>
<td>Obesity (MRW &gt;130%)</td>
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</tr>
<tr>
<td>Men</td>
<td>14.4</td>
<td>20.7</td>
<td>30.5</td>
</tr>
<tr>
<td>Women</td>
<td>33.3</td>
<td>39.2</td>
<td>18.9</td>
</tr>
</tbody>
</table>

CAD, coronary artery disease; LDL, low density lipoprotein; HDL, high density lipoprotein; MRW, Metropolitan Relative Weight (Reference 27): In this population, the correlation between MRW and body mass index was r=0.996. MRW >130% corresponded to a body mass index ≥27.6 kg/m².

Significantly different from rural Puriscal; *p<0.05, †p<0.0001.
Sample sizes are rural Puriscal: men, 111; women, 123; urban Puriscal: men, 111; women, 120.
Framingham data from Wilson et al (Reference 20).

urban, 11.8%; Framingham, 11.4%; diabetes: rural, 3.3%; urban, 1.7%; Framingham, 0.9%). Obesity in women was also more commonly found in Puriscal than in Framingham women (rural, 33.3%; urban, 39.2%; Framingham, 18.9%). In contrast, there were no female smokers in Puriscal when compared with Framingham (rural, 0%; urban, 1.7%; Framingham, 27.0%). In sum, urban Puriscal women have a higher prevalence of borderline high-risk LDL cholesterol and obesity compared with rural Puriscal women and a lower prevalence of high-risk total cholesterol than Framingham women. The prevalence of low HDL cholesterol levels, hypertension, diabetes, and obesity is higher among Puriscal women compared with Framingham women.

The cumulative frequency of modifiable NCEP risk factors (hypertension, diabetes, obesity, smoking, LDL cholesterol ≥160 mg/dl, HDL cholesterol <35 mg/dl) in men from rural and urban Puriscal is shown in Figure 2. Cumulative frequency of modifiable risk factors was lower in the rural than in the urban area of Puriscal. There were no men with 0 risk factors because male sex is considered a risk factor by the NCEP guidelines. Fifty-eight percent of rural men had one risk factor (male sex) compared with 32.4% in the urban area. Two risk factors were found in 23.6% of rural men and 31.4% of urban men, and

![Figure 2. Bar graph shows cumulative frequency of modifiable National Cholesterol Education Program (NCEP) risk factors in rural and urban Puriscal, Costa Rica, men (hypertension, diabetes, obesity, smoking, low density lipoprotein cholesterol ≥160 mg/dl, and high density lipoprotein cholesterol <35 mg/dl). Because male sex is an NCEP risk factor, there are no male subjects in this category; data are presented this way for comparison of risk factors with women.](http://circ.ahajournals.org/cover)
three risk factors were found in 17.0% of rural men compared with 32.4% of urban men. Three or more NCEP risk factors were found in 1.9% of rural men and in 3.8% of urban men. The cumulative frequency of NCEP risk factors was also higher in urban Puriscal women than in rural Puriscal women, but differences were not as striking as those in men. The cumulative frequency of modifiable risk factors in rural and urban women are shown in Figure 3. The population was distributed in the following way: 0 risk factors (rural, 55.7%; urban, 44.9%), one risk factor (rural, 24.4%; urban, 43.2%), two risk factors (rural, 16.5%; urban, 9.3%), and three risk factors (rural, 3.5%; urban, 2.5%).

Discussion

The prevalence of most CAD risk factors, according to the NCEP guidelines, was higher in urban Puriscal than in rural Puriscal, particularly in men. Significant rural–urban differences were found in borderline high-risk total and LDL cholesterol, with urban men having almost twice as many subjects in this category compared with rural men. The prevalence of diabetes, hypertension, and obesity was also higher in urban than in rural men. These differences in risk factors may be explained in part by differences in lifestyle. Urban men, particularly those aged 36–50 years, consumed more saturated fat and smoked more cigarettes per day than rural men in the same age group. Our data also indicate that urban men were more sedentary than rural men. Urban men spent more time sitting down and less time in high-energy-demanding activities such as agricultural work or walking on hills. This observation was confirmed by results from the step test, where significantly lower fitness scores were found among urban than among rural men.

The differences in risk factors between rural and urban women were less pronounced. Higher prevalence of obesity was found in urban women, but prevalence of diabetes was very similar in both areas. Furthermore, higher prevalence of hypertension was found among rural women than among urban women. This unexpected female difference in hypertension could be due to differences in salt-related habits. Our data indicate that rural women cook with significantly higher amounts of salt than urban women. In addition, 23% of rural women compared with 11% of urban women were reported to add extra salt to their meals once food was at the table (data not shown). Lifestyle characteristics were significantly different between rural and urban women. Only 48% of urban women worked at home compared with 89% in the rural area. As observed among men, women from the urban area were more sedentary and had significantly lower fitness scores, but these differences were not as striking as those observed in men. In addition, there were no female smokers in either the rural or the urban area, and the saturated fat intakes were very similar in both groups.

Low HDL cholesterol is a risk factor for CAD within populations of industrialized countries and is usually associated with increased triglyceride levels. Elevated plasma triglyceride levels also seem to be independently associated with CAD. A higher prevalence of low HDL cholesterol (<35 mg/dl) was found in the urban area than in the rural area. However, the prevalence of low HDL cholesterol levels was higher in rural and urban Puriscal residents when compared with Framingham residents. Puriscal men and women from both areas also had higher plasma triglyceride levels than those previously reported in men and women from Framingham. This pattern of low HDL cholesterol and high triglyceride levels in Puriscal could be due in part to the mestizo background of the Costa Ricans, because a similar pattern has been observed in the Pima Indians, the Tarahumara Indians, and in Mexican-Americans. However, populations who habitually consume low-fat and high-carbohydrate diets usually have low HDL cholesterol and high triglyceride levels. These observations have led to the hypothesis that low HDL cholesterol levels per se do not enhance CAD risk, but rather low HDL cholesterol levels represent a marker for increased levels of other atherogenic lipoproteins such as small very low density lipoprotein, intermediate density lipoprotein, and small, dense LDL. Alternatively, it has been proposed that the critical determinant of atherosclerosis is the ratio of LDL cholesterol to HDL cholesterol. This concept supports the view that low HDL cholesterol levels are not a risk for CAD in the presence of low LDL cholesterol levels. Thus, the higher prevalence of low HDL cholesterol levels observed in Puriscal compared with Framingham should be interpreted with caution, because CAD
rates in Costa Rica are lower than in the United States. These data indicate that LDL cholesterol levels are probably a better indicator of CAD risk in cross-cultural studies or in populations who habitually consume high-carbohydrate and low-fat diets. Prevalence of high-risk LDL cholesterol (≥160 mg/dl) in Puriscal (6%) was less than one third of what has been reported for the Framingham residents (21%). However, with the possible genetic predisposition to low HDL cholesterol and high triglyceride levels among Puriscal residents, it could be predicted that these individuals might be at greatly increased CAD risk if they increase the prevalence of other risk factors such as high LDL cholesterol, obesity, high saturated fat intake, and smoking. Our data suggest that these risk factors were increased in the urban area, particularly in men.

CAD has decreased in most industrialized countries during the past 20 years; however, mortality statistics from less developed countries indicate that CAD is increasing in eastern and southern Europe, and it is now the main cause of death in 31 countries of the Americas. Initial observation studies in “non-Westernized” societies such as the Tarahumara Indians in Mexico, the rural Guatemalan Indians, the Kalahari Bushmen, and the highland residents of Tukisenta, New Guinea, have suggested that high levels of physical activity, low-fat diets, low prevalence of obesity, and low plasma cholesterol levels are found in areas with very low prevalence of cardiovascular complications. However, it has recently been suggested that CAD risk factors such as general and abdominal obesity, high blood pressure, higher saturated fat diets, and higher LDL cholesterol levels are more prevalent in urban than in rural areas. These trends are worrisome because it is estimated that between the years 1975 and 2000, 77% of the population in Latin America and 43% overall in less developed countries (approximately 1.3 billion people) will be living in urban areas with health problems similar to those most commonly faced by more industrialized countries. Currently, we do not have mortality data available to confirm that in Costa Rica, higher CAD mortality rates are observed selectively among urban compared with rural dwellers. However, we hypothesize that the increased CAD mortality rates observed in Costa Rica, particularly in men, may be occurring mostly in the urban areas due to an increased prevalence of risk factors. In contrast, the reduction in mortality caused by CAD recently observed in industrialized countries can be explained by modification of various risk factors such as cigarette smoking, hypertension, and dietary intake. Costa Rica, and particularly the rural Costa Rican areas, have only recently been exposed to changes in lifestyle that are associated with CAD risk; thus, the lower prevalence of CAD observed in Costa Rica compared with the United States may be due to the length of time the risk factors have been present in Costa Rica, and higher mortality caused by CAD may be expected in Costa Rica in the near future.

The presence of these NCEP risk factors is associated with an increased risk of CAD mortality. The increase in CAD mortality in Costa Rica seems to be occurring mostly in men (61%) compared with women (22%). It should be noted that the risk factor profile observed in Puriscal seems minor when compared with the reported increase in mortality rates. This discrepancy may reflect the fact that the majority of men at risk are probably residents of the metropolitan area of Costa Rica; the urban risk factor profile in Puriscal is an indicator of atherogenicity, but its occurrence is more dramatic in more urbanized, densely populated areas. One should also be aware that this study represents one area in transition, and we made the assumption that this area reflects the contrast between urban and rural lifestyles elsewhere; however, these observations may not necessarily be true in other areas or countries.

The prevalence of high-risk total cholesterol and LDL cholesterol levels, hypertension, and obesity was lower, whereas the prevalence of smoking, diabetes, and low HDL cholesterol levels was higher in urban Puriscal residents than in Framingham residents. A higher prevalence of most risk factors was found among urban than among rural Puriscal men. The increase in CAD mortality observed in Costa Rica may be due to a higher prevalence of risk factors, particularly in men from the urban areas. However, CAD rates are still lower in Costa Rica than in the United States, probably because of lower LDL cholesterol levels.

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References


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