

Circulation

JOURNAL OF THE AMERICAN HEART ASSOCIATION



Nonfatal Acute Myocardial Infarction in Costa Rica: Modifiable Risk Factors, Population-Attributable Risks, and Adherence to Dietary Guidelines

Edmond K. Kabagambe, Ana Baylin and Hannia Campos

Circulation 2007;115:1075-1081

DOI: 10.1161/CIRCULATIONAHA.106.643544

Circulation is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 72514

Copyright © 2007 American Heart Association. All rights reserved. Print ISSN: 0009-7322. Online ISSN: 1524-4539

The online version of this article, along with updated information and services, is located on the World Wide Web at:

<http://circ.ahajournals.org/cgi/content/full/115/9/1075>

Subscriptions: Information about subscribing to *Circulation* is online at
<http://circ.ahajournals.org/subscriptions/>

Permissions: Permissions & Rights Desk, Lippincott Williams & Wilkins, a division of Wolters Kluwer Health, 351 West Camden Street, Baltimore, MD 21202-2436. Phone: 410-528-4050. Fax: 410-528-8550. E-mail:
journalpermissions@lww.com

Reprints: Information about reprints can be found online at
<http://www.lww.com/reprints>

Nonfatal Acute Myocardial Infarction in Costa Rica Modifiable Risk Factors, Population-Attributable Risks, and Adherence to Dietary Guidelines

Edmond K. Kabagambe, BVM, PhD; Ana Baylin, MD, DrPH; Hannia Campos, PhD

Background—Cardiovascular disease, including myocardial infarction (MI), is increasing in developing countries. Knowledge of risk factors and their impact on the population could offer insights into primary prevention.

Methods and Results—We estimated the population-attributable risk (PAR) for major MI risk factors among Costa Ricans without a history of diabetes, hypertension, or regular use of medication (889 MI cases, 1167 population-based controls). Lifestyle and dietary variables were measured with validated questionnaires. In multivariate analyses, abdominal obesity (PAR, 29.3%), smoking (PAR, 25.6%), nonuse of alcohol (PAR, 14.8%), caffeine intake (PAR, 12.8%), physical inactivity (PAR, 9.6%), and poor diet (PAR, 6.0%) were the most important MI risk factors. Subjects in the favorable categories of the above 6 risk factors showed a lower risk of MI (odds ratio, 0.09; 95% CI, 0.03 to 0.33) than those in the unfavorable categories. Compared with women, men were more likely to smoke (31% versus 10%) but less likely to have waist circumferences greater than Adult Treatment Panel III cutoffs (9% versus 35%). Many subjects did not meet the American Heart Association or World Health Organization/Food and Agriculture Organization dietary guidelines. For instance, 95% obtained $\geq 7\%$ of energy from saturated fat, 25% had $\leq 5\%$ of energy from polyunsaturated fat, 63% had $\geq 1\%$ energy from *trans* fat, and 53% had low fiber intake (< 25 g/d).

Conclusions—These findings confirm the benefit of a healthy diet, physical activity, moderate alcohol, and cessation of smoking as approaches for the primary prevention of MI. Obesity and smoking were the 2 most important risk factors for nonfatal MI in Costa Rica. (*Circulation*. 2007;115:1075-1081.)

Key Words: coronary disease ■ Costa Rica ■ diet ■ lifestyle ■ myocardial infarction ■ risk factors

Disability and mortality resulting from cardiovascular disease (CVD) are on the rise in many developing countries, partly because of the nutritional transition and westernization of lifestyles.¹⁻⁴ Developing countries account for 80% of the global CVD burden.^{1,2,5} In 2002, the number of health-years of life lost to heart disease including myocardial infarction (MI) per 1000 people in developing countries was between 6 and 20 for countries such as Costa Rica, Uganda, Croatia, Nigeria, Indonesia, and India, whereas for developed countries, they were 5 for Australia, 5 for Canada, 7 for the United Kingdom, and 8 for the United States.⁶⁻⁸ These numbers suggest poor quality of secondary prevention and lack of primary CVD prevention in developing countries. Recent data show that primary prevention could reduce CVD deaths by 4 times the reduction achieved through secondary prevention.⁹

Editorial p 1061

Despite the increase in the prevalence and impact of CVD, developing countries remain ill-prepared for the management of chronic diseases. Because of the variability in the prevalence of risk factors in different populations, a highly potent factor in one country could be less important in another where it is less common. Thus, identifying the prevalence of modifiable risk factors and their population-attributable risk (PAR)¹⁰ could offer insights into primary prevention of CVD. Although this approach has been used in developed countries to identify the impact of diet and other factors on CVD risk,^{5,11} similar work in developing countries is rare.^{3,5} We have, over the last 10 years, examined and reported on the relation between individual dietary factors and the risk of MI in Costa Rica, a developing country in a nutritional transition where CVD causes 1.3 deaths per 1000 people.⁶ In the

Received June 2, 2006; accepted December 5, 2006.

From the Department of Epidemiology, University of Alabama at Birmingham, School of Public Health, Birmingham (E.K.K.); Brown University, Department of Community Health, Providence, RI (A.B.); and Department of Nutrition, Harvard School of Public Health, Boston, Mass, and Centro Centroamericano de Población, Universidad de Costa Rica, Costa Rica (H.C.).

The online-only Data Supplement, consisting of a table, is available with this article at <http://circ.ahajournals.org/cgi/content/full/115/9/1075/DC1>.

Correspondence to Edmond K. Kabagambe, University of Alabama at Birmingham, School of Public Health, 1665 University Blvd, Ryals PH Bldg, Rm 230M, Birmingham, AL 35294-0022. E-mail edmondk@uab.edu

© 2007 American Heart Association, Inc.

Circulation is available at <http://www.circulationaha.org>

DOI: 10.1161/CIRCULATIONAHA.106.643544

present study, we report on the relation between the overall diet, lifestyle factors, and their impact on MI (as measured by PAR) in Costa Rica.

Methods

Study Population

All subjects were Hispanic Americans who lived in the central valley of Costa Rica between 1994 and 2004. The details of the study design have been published elsewhere.^{12–15} Briefly, eligible cases were men and women diagnosed as survivors of a first acute MI by 2 independent cardiologists at any of the 6 recruiting hospitals in the catchment area. To achieve 100% ascertainment, fieldworkers carried out daily visits to the 6 hospitals. All cases met the World Health Organization criteria for MI, which require typical symptoms plus either elevations in cardiac enzyme concentrations or diagnostic changes in the ECG.¹⁶ Cases were ineligible if they died during hospitalization, were ≥ 75 years of age on the day of their first MI, or were physically or mentally unable to answer the questionnaire. Enrollment was carried out while cases were in the step-down unit of the hospital. Cases were matched by age (± 5 years), sex, and area of residence to population controls who were randomly identified with the aid of data from the National Census and Statistics Bureau of Costa Rica. Because of the comprehensive social services provided in Costa Rica, all persons living in the catchment area had access to medical care without regard to income, education, or private insurance. Therefore, controls came from the source population that gave rise to the cases and are not likely to have had CVD that was not diagnosed because of poor access to medical care. Controls were ineligible if they had ever had an MI or if they were physically or mentally unable to answer the questionnaires. All cases and controls were visited at their homes for the collection of dietary and health information, anthropometric measurements, and biological specimens. Participation was 98% for cases and 88% for controls. All subjects gave informed consent on documents approved by the Human Subjects Committee of the Harvard School of Public Health and the University of Costa Rica.

Data Collection

Trained personnel visited all study participants at their homes. Sociodemographic characteristics, smoking, socioeconomic status, physical activity, and medical history data were collected during an interview using validated questionnaires.¹² Each subject provided a fasting blood sample for the assessment of plasma lipids.^{13,17} We collected dietary data using a semiquantitative food-frequency questionnaire developed and validated specifically to assess nutrient intake among the Costa Rican population.^{13,17–19} To avoid the potential for recall bias among cases, data were collected as close to the diagnosis of MI as possible. Another questionnaire assessed nondietary potential confounders and recorded anthropometric measurements. The latter were measured in duplicate, and an average was recorded.¹² Total physical activity was calculated by multiplying the frequency, duration, and intensity (in metabolic equivalents) of each physical activity and then summing up energy expenditure from all activities as described by Campos and Siles.¹²

We created a healthy dietary score (HDS) to summarize dietary intake using an approach similar to that of Stampfer and others.¹¹ The HDS included energy-adjusted^{13,20} intakes of saturated fat, *trans* fat, dietary cholesterol, polyunsaturated fat, and fiber. Because of known positive associations between saturated fat,^{14,21} *trans* fat,^{21,22} dietary cholesterol,²³ and MI, the quintiles for these variables were assigned in a descending order; quintiles were in ascending order for the known protective factors (fiber and polyunsaturated fat).^{21,24,25} Subjects were distributed into quintiles according to each of the 5 dietary variables. For each variable, the highest quintile represented a favorable effect on the risk of MI. The HDS is a sum of the ranks of the intake of saturated fat, *trans* fat, cholesterol, polyunsaturated fat, and fiber.

Statistical Analysis

SAS (SAS Institute, Inc., Cary, NC) and the Interactive Risk Attributable Program (National Cancer Institute, Bethesda, Md) software²⁶ were used for statistical analyses. Diabetes and hypertension could influence people's diets and other lifestyle attributes. From the initial study population ($n=4547$), we excluded all subjects with a history of diabetes ($n=861$), hypertension ($n=1508$), or regular use of medication for chronic conditions ($n=1788$). Subjects with missing data on potential confounders or major explanatory variables also were excluded, leaving 889 MI cases and 1167 controls for the final analysis. These exclusions caused case-control pairs to be broken. To minimize further loss of subjects, we used unconditional logistic regression that included matching variables in each model as proposed by Rosner and Hennekens²⁷ and implemented by Yusuf et al.⁵

The HDS and other continuous variables were distributed into quartiles and tested for their association with MI. Multivariate unconditional logistic regression with stepwise variable selection was used to identify variables for the final model. The probability for a variable to enter into or stay in the model was set at 0.05. The variables offered to the model were smoking, income, education, abdominal obesity, physical activity, HDS, and intake of alcohol, caffeine, folate, and total energy. Physical activity, a known risk factor for CVD,¹¹ and the matching variables were forced into the model.

The Interactive Risk Attributable Program software²⁶ was used to calculate PARs and corresponding 95% CIs for multicategory exposures after adjustment for other exposures and potential confounders. Briefly, PARs were estimated sequentially for each of the 6 multicategory exposures (HDS, smoking status, alcohol intake, abdominal obesity, physical activity, and caffeine intake). Each of the 6 exposures was entered into the PAR model as the main multicategory variable; then, matching variables (age, sex, and area of residence) and categories of the 5 remaining exposures for which PAR was not being estimated were included in the model as covariates. The process was repeated until PARs and 95% CIs were obtained for all 6 risk factors.

We estimated the proportion of subjects who met the American Heart Association²⁸ and World Health Organization/Food and Agriculture Organization²⁹ dietary guidelines and those who met the National Cholesterol Education Adult Treatment Panel (ATP) III guidelines^{30,31} for defining abdominal obesity. Because of reported differences in the diets of smokers and nonsmokers in other populations,³² we determined whether this difference is the same in Costa Rican men and women.

The authors had full access to and take full responsibility for the integrity of the data. All authors have read and agree to the manuscript as written.

Results

Lifestyle and Dietary Characteristics

Dietary and nondietary characteristics of MI cases and controls are shown in Table 1. Compared with controls, cases were more likely ($P<0.05$) to smoke, to have abdominal obesity, to earn less income, and to have a poor diet, especially with regard to the type of dietary fat, cholesterol, fiber, and caffeine. Cases and controls were similar ($P>0.05$) with regard to markers of socioeconomic status such as multivitamin use, education, and having private health insurance.

We examined among controls the relation between the HDS and various nutrients, lifestyle variables, and foods not used in the definition of the dietary score to determine how well the dietary score classified the subjects with regard to their diet and lifestyle (see online-only Data Supplement). Higher values of the dietary score were significantly associated with higher values for variables associated with good

TABLE 1. Characteristics of Nonfatal Acute MI Cases and Population-Based Controls in Costa Rica

Variable	Controls (n=1167)	Cases (n=889)	P*
Age, y†	55±11	55±11	...
Female sex, %†	17.3	11.6	...
Area of residence, % rural†	24.6	26.0	...
Current smoker (≥1 cigarette/d), %	27.6	53.3	<0.0001
Current drinker, %	59.8	54.4	0.02
Abdominal obesity‡	0.95±0.07	0.97±0.07	<0.0001
Physical activity, METs	1.64±0.77	1.63±0.80	0.22
Household income, US \$/mo	580±417	510±389	0.0001
Secondary education, %	45.7	42.2	0.11
Private health insurance, %	13.1	13.8	0.09
Multivitamin supplements, % users	6.6	5.0	0.12
HDS§	10.4±4.0	9.4±3.9	<0.0001
Saturated fat, % energy	11.7±3.0	12.6±3.2	<0.0001
Polyunsaturated fat, % energy	7.0±2.3	6.8±2.3	0.05
Trans fat, % energy	1.31±0.64	1.31±0.63	0.82
Cholesterol, mg/1000 kcal	118±52	132±65	<0.0001
Fiber, g	24.7±6.1	23.5±6.0	<0.0001
Caffeine, mg/d	335±197	408±217	<0.0001

Values are mean±SD unless otherwise indicated. METs indicates metabolic equivalents.

*Probability values are from the χ^2 , Wilcoxon rank-sum, or Student *t* test.

†Matching variable.

‡Same as waist-to-hip ratio.

§The HDS is a sum of the ranks of the variables for the intake of saturated fat, *trans* fat, and cholesterol ranked in a descending order and the ranks of polyunsaturated fat and fiber ranked in an ascending order.

||Adjusted for total energy intake using the regression method.

health. For instance, individuals with high values for the HDS were less likely to smoke, were more physically active, and had higher intakes of beans, fruits, and vegetables (data not shown).

We determined the proportion of subjects who did not meet the AHA²⁸ or World Health Organization/Food and Agriculture Organization²⁹ dietary guidelines or ATP III abdominal obesity guidelines³⁰ among the control subjects. A large proportion of subjects did not meet AHA or World Health Organization/Food and Agriculture Organization dietary guidelines. For instance, 95% of the subjects obtained ≥7% of energy from saturated fat, 25% obtained ≤5% of energy from polyunsaturated fat, 63% had ≥1% energy from *trans* fat, 39% consumed ≥300 mg/d cholesterol, and 53% had fiber intakes <25 g/d. Overall, 14% of the control population had waist circumferences that were greater than the ATP III cutoffs of 88 cm in women and 102 cm in men.³⁰ Compared with women, men were significantly ($P<0.0001$) less likely to have waist circumferences greater than ATP III cutoffs (9% versus 35%) but were more likely to smoke cigarettes (31% versus 10%).

Risk Factors for MI

The associations of dietary and nondietary risk factors for MI in the Costa Rican population are presented in Table 2. After stepwise variable selection with a probability to enter into or stay in the model set at 0.05, 6 variables were identified as the

major risk factors for MI in Costa Rica. All the risk factors were entered into the final multivariate unconditional logistic regression model simultaneously. The odds ratios (ORs) and 95% CIs reported in Table 2 are for the top compared with lowest category of each risk factor. In descending order, the strongest positive associations with MI were observed for smoking (OR, 5.79; 95% CI, 4.20 to 7.99), abdominal obesity (OR, 2.75; 95% CI, 1.95 to 3.88), and intake of caffeine (OR, 1.45; 95% CI, 1.05 to 1.99); the strongest inverse associations were observed for alcohol intake at 5.0 to 9.9 g/d (OR, 0.43; 95% CI, 0.27 to 0.69), higher values for the HDS (OR, 0.72; 95% CI, 0.55 to 0.95), and physical activity (OR, 0.75; 95% CI, 0.57 to 0.99).

To estimate the ORs for MI for a combination of the variables above, we compared subjects who are current drinkers, nonsmokers, and in the top 2 quartiles of the HDS and physical activity and the lower 2 categories of abdominal obesity and caffeine intake (low-risk category) with those who are nondrinkers, current smokers, and in the lower 2 quartiles of the health dietary score and physical activity and the top 2 categories of abdominal obesity and caffeine intake (high-risk category). The odds of MI among the low-risk group were indeed significantly lower (OR, 0.09; 95% CI, 0.03 to 0.33) than those of the subjects in the high-risk group.

PAR Estimates

The PAR, an estimate of how much disease could be eliminated if the risk factor were eliminated from the population, is shown

TABLE 2. Major Risk Factors and Their Associated PARs for MI in Costa Rica

Variable	Controls, n	Cases, n	OR (95% CI)*	PAR (95% CI)†
HDS quartile (median)‡				
1 (6)	393	376	1.00	...
2 (10)	208	170	0.95 (0.73 to 1.25)	...
3 (12)	302	201	0.81 (0.63 to 1.04)	...
4 (15)	264	142	0.72 (0.55 to 0.95)	6.0 (2.2 to 17.2)
Smoking status				
Never-smoker	407	181	1.00	...
Past smoker	438	234	1.11 (0.84 to 1.45)	...
Current smoker (<20 cigarettes/d)	215	168	1.84 (1.36 to 2.48)	...
Current smoker (≥20 cigarettes/d)	107	306	5.79 (4.20 to 7.99)	25.6 (17.9 to 35.2)
Alcohol intake				
Never-drinker	166	113	1.00	...
Past drinker	303	292	0.85 (0.60 to 1.22)	...
Current drinker (≤4.9 g/d)	314	197	0.74 (0.52 to 1.04)	...
Current drinker (5.0 to 9.9 g/d)	118	58	0.43 (0.27 to 0.69)	...
Current drinker (>9.9 g/d)	266	229	0.63 (0.43 to 0.92)	14.8 (6.3 to 39.1)
Abdominal obesity, quartile (median)§				
1 (0.87)	291	118	1.00	...
2 (0.93)	293	208	1.79 (1.29 to 2.48)	...
3 (0.97)	291	246	2.02 (1.44 to 2.84)	...
4 (1.02)	292	317	2.75 (1.95 to 3.88)	29.3 (19.9 to 40.7)
Physical activity, quartile (median), METs				
1 (0.97)	292	265	1.00	...
2 (1.32)	292	187	0.72 (0.55 to 0.95)	...
3 (1.63)	291	199	0.81 (0.62 to 1.07)	...
4 (2.35)	292	238	0.75 (0.57 to 0.99)	9.6 (4.3 to 22.7)
Caffeine intake (median), mg/d				
≤151 (119)	285	129	1.00	...
152 to 302 (186)	54	29	1.23 (0.72 to 2.09)	...
303 to 454 (347)	636	490	1.39 (1.07 to 1.80)	...
>454 (632)	192	241	1.45 (1.05 to 1.99)	12.8 (5.9 to 25.7)

Cigs indicates cigarettes; METs, metabolic equivalents.

*ORs are adjusted for age, sex, area of residence, and total energy intake in a model that included all the variables in Table 1.

†PAR compares the top categories with the reference.

‡The HDS is as defined in Table 1.

§Same as waist-to-hip ratio.

||Categories based on amount of caffeine (≈151 mg) per cup of coffee.³⁸

for each of the 6 identified risk factors (Table 2). Based on the magnitude of the PAR, the most important positive risk factors for MI in Costa Rica were abdominal obesity (PAR, 29.3%; 95% CI, 19.9 to 40.7), smoking (PAR, 25.6%; 95% CI, 17.9 to 35.2), caffeine intake (PAR, 12.8%; 95% CI, 5.9 to 25.7), nonuse of alcohol (PAR, 14.8%; 95% CI, 6.3 to 39.1), consumption of poor diets (PAR, 6.0%; 95% CI, 2.2 to 17.2), and physical inactivity (PAR, 9.6%; 95% CI, 4.3 to 22.7). Each PAR is adjusted for all the other risk factors shown in Table 2, age, sex, area of residence, and total energy intake.

Differences Between Smokers and Nonsmokers by Gender

Because smoking is a strong risk factor for MI in several populations,^{33,34} we examined whether there are differ-

ences in dietary and lifestyle characteristics of smokers and nonsmokers in analyses stratified by sex. The mean age at inception of smoking was 17 ± 5.1 years among men and 21 ± 8.9 years for women. The age at the start of smoking was very similar to the age at the start of drinking alcohol, which was 17.9 ± 5.2 years for men and 23.6 ± 7.0 years for women. The intensity of smoking was higher in men (13.6 ± 11.1) than in women (7.8 ± 6.2), and the lifetime number of cigarettes smoked was higher for men ($188\,695 \pm 145\,987$ cigarettes) than women ($91\,789 \pm 74\,339$ cigarettes). Although women in this population tended to be older than men, the duration of smoking was higher in men (35.8 ± 12.0 years) than women (31.6 ± 15.2 years) (data not shown).

TABLE 3. Comparison of Lifestyle and Dietary Characteristics of Smokers and Nonsmokers by Sex Among Controls

Variable	Men		Women	
	Never-Smoker (n=256)	Current Smoker (n=301)	Never-Smoker (n=151)	Current Smoker (n=21)
HDS*	10.4±4.1	9.9±4.0	10.9±3.9	9.8±3.8
Saturated fat ≥7% energy, %†	97	95	95	95
PUFA ≤5% energy, %	24	34‡	25	29
Trans fat ≥1% energy, %†	63	59	61	62
Cholesterol ≥300 mg, %†	40	45	23	24
Fiber <25 g/d, %	51	60‡	48	67
Caffeine, mg/d	288±175	425±211‡	283±168	261±244‡
Current alcohol drinker, %	58	74‡	39	52
Income, US \$	612±408	519±372‡	574±446	512±362
Physical activity, METs	1.74±0.86	1.75±0.90	1.40±0.33	1.35±0.39
Fruits, servings/d	2.08±2.11	1.68±2.00‡	2.56±2.11	2.44±3.19
Vegetable, servings/d	2.68±1.80	2.38±1.67	3.36±2.39	3.72±2.87
Beans, servings/d	1.45±0.96	1.58±0.97	1.07±0.90	1.04±0.90

Values are mean±SD unless otherwise indicated. PUFA indicates polyunsaturated fats; METs, metabolic equivalents.

*HDS is as defined in Table 1.

†Cutoff points based on AHA dietary guidelines.²⁸

‡Current smokers are significantly different from never-smokers in analyses stratified by sex.

There also were differences between smokers and non-smokers with regard to dietary intake and income (Table 3). Among men, current smokers were significantly ($P<0.05$) different from nonsmokers. The latter consumed less caffeine, earned more income, and consumed more fruits and dietary fiber. Among women (who were few in this sample), current smokers were significantly different ($P<0.05$) from nonsmokers only with regard to intake of caffeine, which was higher among never-smokers. Compared with men, women were significantly ($P<0.05$) more obese and more likely to have the metabolic syndrome (data not shown).

Discussion

We sought to identify the factors that could largely explain the nonfatal MI cases in Costa Rica. In analyses adjusted for various CVD risk factors, we found that abdominal obesity, smoking, and caffeine intake were the most important factors associated with increased risk of MI, whereas intake of alcohol, consumption of a healthy diet, and increased physical activity were inversely associated with the risk of MI in Costa Rica. This study also revealed that a large proportion of Costa Ricans do not meet the AHA²⁸ or World Health Organization/Food and Agriculture Organization²⁹ dietary guidelines or ATP III^{30,31} guidelines for abdominal obesity and that there is large disparity in the distribution of the 2 most important risk factors of MI among men and women in Costa Rica: Smoking was much more common in men than women, whereas abdominal obesity was more prevalent among women.

These findings are similar to those from the United States and Europe in which a healthy diet, regular physical activity, cessation of smoking, and consumption of moderate alcohol were associated with a reduction in the risk of CVD.^{5,11} Our results are also consistent with those of others³² in that the diet of current smokers is poorer than that of never-smokers,

especially with regard to intake of fruits, polyunsaturated fat, and fiber. This is important because to date programs that promote cessation of smoking do not address the poor diets of smokers, yet the poor diets of smokers could exacerbate their risk for chronic diseases, including MI. Given that 11% of the total global CVD mortality is attributable to smoking³³ and that smokers have a poor diet,³² public health programs that aim at controlling smoking in populations should include messages for improving diets of smokers, especially among men who generally have poor diets that are low in fruits, vegetables, and other nutrients.

The HDS used in the present study, although based on 5 dietary variables (intake of saturated fat, *trans* fat, cholesterol, polyunsaturated fat, and fiber), correlated well with intake of foods such as fruits and vegetables that were not used in the construction of the HDS. Furthermore, the HDS correlated with markers of a healthy lifestyle such as nonsmoking and physical activity, suggesting that the HDS is a good index for capturing the quality of the diet at the population level. The HDS was strongly and inversely associated with MI (eg, for a 1-SD increase in the HDS, the OR for MI was 0.84 [95% CI, 0.76 to 0.93]), showing that the quality of diet is indeed an important factor in the occurrence of MI and that fiber and the type of dietary fat are the key variables in defining a healthy diet.

We used stepwise regression to identify the variables that may explain the observed MI cases and their impact at the population level. Diet, alcohol, caffeine, smoking, physical activity, and abdominal obesity were the most important factors identified. Smoking and abdominal obesity were the most important factors (with highest PARs) associated with MI, first because of their potency as shown by the ORs and second because they are prevalent in the Costa Rican population. For instance, 27.6% of controls and 53.3% of MI cases smoked cigarettes, and among controls, 14% had a waist

circumference that would put subjects at risk of the metabolic syndrome³⁰ and 55% had a body mass index >25 kg/m². The 6% potential reduction in the number of MI cases expected if people switched to a healthy diet is not surprising, given that a substantial number of people in Costa Rica have a less-than-optimal diet. For instance, among controls, 95% consumed $\geq 7\%$ of daily energy intake as saturated fat, 25% had $\leq 5\%$ of energy as polyunsaturated fat, 63% consumed $\geq 1\%$ of energy as *trans* fat, and 39% had dietary cholesterol intake ≥ 300 mg/d cholesterol. Several people (53%) did not meet the recommended 25 g/d of fiber intake. These numbers indicate that there are still plenty of opportunities for dietary intervention in Costa Rica. One approach could be education on the impact of diet on health and on the reduction of body weight with particular emphasis on women, who were more likely to be obese compared with men in the present study. Surprisingly, consumption of a healthy diet (as estimated with the HDS) did not depend on a person's level of education or income.

Because of the case-control nature of the data, we could not determine temporal relationships between the identified risk factors and observed MI. In addition, compared with the general Costa Rican population, the present study population had few women, had somewhat older people, and did not include people with diabetes or hypertension. Thus, the population described in the present study may not be ideal to represent the general Costa Rican population with regard to age and prevalence of diabetes and hypertension. Furthermore, it is not possible to determine whether the PAR estimates from the present study of subjects without a history of diabetes, hypertension, or current use of medication for chronic conditions are similar to those in the general Costa Rican population. Despite these differences, the characteristics (eg, diet, physical activity, and socioeconomic status) of our study population are similar to those described from other population studies in Costa Rica^{35–37}; thus, the present study could provide good insight into the CVD situation in Costa Rica. Although the exclusion of several subjects because of missing data and history of diabetes, hypertension, or use of medication for chronic conditions could potentially introduce selection bias, we opted to exclude such subjects. Their inclusion, especially if they changed their diets or lifestyle, would introduce other biases. Nonetheless, the characteristics of subjects in the present study are similar to those from other studies.^{35–37}

Conclusions

Consumption of a healthy diet, moderate alcohol, and low caffeine; cessation of smoking; increased physical activity; and reduction in abdominal obesity are likely to have a large impact in reducing the risk of MI in Costa Rica. Smoking and abdominal obesity showed the strongest PARs for MI. Thus, it is prudent to emphasize cessation of smoking and reduction of body weight in Costa Rica and probably most other developing countries where obesity and smoking are prevalent. Because most people in the present study started smoking at 17 years of age, antismoking programs should target teenagers before this age. As in other studies, the diet of smokers compared with nonsmokers was poor, suggesting

that programs that target smoking cessation should also aim at improving diets of smokers. It is notable that compared with men, women in the present study were fatter, consumed a diet significantly higher in saturated fat, and were more likely to have the metabolic syndrome, but fewer smoked cigarettes.

Acknowledgments

We are grateful to the staff of Proyecto Salud Coronaria, San José, Costa Rica; the staff at the Centro Nacional de Estadística y Censos de Costa Rica; the staff at the 6 main hospitals in San Jose, Heredia, Alajuela, and Cartago for their help in recruiting the cases and controls; and the staff at Harvard School of Public Health for their help with laboratory analyses.

Sources of Funding

This study was supported by grants HL071888 and HL60692 from the National Institutes of Health.

Disclosures

None.

References

1. Reddy KS. Cardiovascular disease in non-Western countries. *N Engl J Med*. 2004;350:2438–2440.
2. Reddy KS, Yusuf S. Emerging epidemic of cardiovascular disease in developing countries. *Circulation*. 1998;97:596–601.
3. He J, Gu D, Wu X, Reynolds K, Duan X, Yao C, Wang J, Chen C-S, Chen J, Wildman RP, Klag MJ, Whelton PK. Major causes of death among men and women in China. *N Engl J Med*. 2005;353:1124–1134.
4. Araya MR, Padilla SG. [Trends in mortality from ischemic heart disease and acute myocardial infarction in Costa Rica, 1970–2001]. *Rev Panam Salud Publica*. 2004;16:295–301.
5. Yusuf S, Hawken S, Ounpuu S, Dans T, Avezum A, Lanas F, McQueen M, Budaj A, Pais P, Varigos J, Lisheng L. Effect of potentially modifiable risk factors associated with myocardial infarction in 52 countries (the INTERHEART study): case-control study. *Lancet*. 2004;364:937–952.
6. PAHO. *Health in the Americas, Volume II*. Washington, DC: Pan American Health Organization; 2002. Scientific and technical publication No. 587.
7. WHO. World Data Table on disability adjusted life years. 2004. Available at: http://www.who.int/cardiovascular_diseases/en/cvd_atlas_29_world_data_table.pdf. Accessed September 8, 2006.
8. Kelly CN, Stanner SA. Diet and cardiovascular disease in the UK: are the messages getting across? *Proc Nutr Soc*. 2003;62:583–589.
9. Unal B, Critchley JA, Capewell S. Modelling the decline in coronary heart disease deaths in England and Wales, 1981–2000: comparing contributions from primary prevention and secondary prevention. *BMJ*. 2005; 331:614.
10. Rothman KJ, Greenland S. *Modern Epidemiology*. 2nd ed. Philadelphia, Pa: Lippincott-Raven Publishers; 1998.
11. Stampfer MJ, Hu FB, Manson JE, Rimm EB, Willett WC. Primary prevention of coronary heart disease in women through diet and lifestyle. *N Engl J Med*. 2000;343:16–22.
12. Campos H, Siles X. Siesta and the risk of coronary heart disease: results from a population-based, case-control study in Costa Rica. *Int J Epidemiol*. 2000;29:429–437.
13. Kabagambe EK, Baylin A, Allan DA, Siles X, Spiegelman D, Campos H. Application of the method of triads to evaluate the performance of food frequency questionnaires and biomarkers as indicators of long-term dietary intake. *Am J Epidemiol*. 2001;154:1126–1135.
14. Kabagambe EK, Baylin A, Siles X, Campos H. Individual saturated fatty acids and nonfatal acute myocardial infarction in Costa Rica. *Eur J Clin Nutr*. 2003;57:1447–1457.
15. Kabagambe EK, Baylin A, Ruiz-Narvarez E, Rimm EB, Campos H. Alcohol intake, drinking patterns and risk of nonfatal acute myocardial infarction in Costa Rica. *Am J Clin Nutr*. 2005;82:1336–1345.
16. Tunstall-Pedoe H, Kuulasmaa K, Amouyel P, Arveiler D, Rajakangas AM, Pajak A. Myocardial infarction and coronary deaths in the World Health Organization MONICA project: registration procedures, event

- rates, and case-fatality rates in 38 populations from 21 countries in four continents. *Circulation*. 1994;90:583–612.
17. Baylin A, Kabagambe EK, Siles X, Campos H. Adipose tissue biomarkers of fatty acid intake. *Am J Clin Nutr*. 2002;76:750–757.
 18. El-Sohemy A, Baylin A, Ascherio A, Kabagambe E, Spiegelman D, Campos H. Population-based study of alpha- and gamma-tocopherol in plasma and adipose tissue as biomarkers of intake in Costa Rican adults. *Am J Clin Nutr*. 2001;74:356–363.
 19. El-Sohemy A, Baylin A, Kabagambe E, Ascherio A, Spiegelman D, Campos H. Individual carotenoid concentrations in adipose tissue and plasma as biomarkers of dietary intake. *Am J Clin Nutr*. 2002;76:172–179.
 20. Willett WC. *Nutritional Epidemiology*. 2nd ed. New York, NY: Oxford University Press; 1998.
 21. Hu FB, Manson JE, Willett WC. Types of dietary fat and risk of coronary heart disease: a critical review. *J Am Coll Nutr*. 2001;20:5–19.
 22. Baylin A, Kabagambe EK, Ascherio A, Spiegelman D, Campos H. High 18:2 trans-fatty acids in adipose tissue are associated with increased risk of nonfatal acute myocardial infarction in Costa Rican adults. *J Nutr*. 2003;133:1186–1191.
 23. Tanasescu M, Cho E, Manson JE, Hu FB. Dietary fat and cholesterol and the risk of cardiovascular disease among women with type 2 diabetes. *Am J Clin Nutr*. 2004;79:999–1005.
 24. Baylin A, Kabagambe EK, Ascherio A, Spiegelman D, Campos H. Adipose tissue alpha-linolenic acid and nonfatal acute myocardial infarction in Costa Rica. *Circulation*. 2003;107:1586–1591.
 25. Pietinen P, Rimm EB, Korhonen P, Hartman AM, Willett WC, Albanes D, Virtamo J. Intake of dietary fiber and risk of coronary heart disease in a cohort of Finnish men: the Alpha-Tocopherol, Beta-Carotene Cancer Prevention Study. *Circulation*. 1996;94:2720–2727.
 26. National Cancer Institute. Interactive Risk Attributable Program (IRAP) software version 2.2, July 2002. Available at: <http://dceg.cancer.gov/IRAP>. Accessed September 8, 2006.
 27. Rosner B, Hennekens CH. Analytic methods in matched pair epidemiological studies. *Int J Epidemiol*. 1978;7:367–372.
 28. Lichtenstein AH, Appel LJ, Brands M, Carnethon M, Daniels S, Franch HA, Franklin B, Kris-Etherton P, Harris WS, Howard B, Karanja N, Lefevre M, Rudel L, Sacks F, Van Horn L, Winston M, Wylie-Rosett J. Diet and lifestyle recommendations revision 2006: a scientific statement from the American Heart Association Nutrition Committee. *Circulation*. 2006;114:82–96.
 29. Nishida C, Uauy R, Kumanyika S, Shetty P. The joint WHO/FAO expert consultation on diet, nutrition and the prevention of chronic diseases: process, product and policy implications. *Public Health Nutr*. 2004;7:245–250.
 30. Grundy SM, Brewer HB Jr, Cleeman JI, Smith SC Jr, Lenfant C. Definition of metabolic syndrome: report of the National Heart, Lung, and Blood Institute/American Heart Association conference on scientific issues related to definition. *Circulation*. 2004;109:433–438.
 31. Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III): final report. *Circulation*. 2002;106:3143–3421.
 32. Koh W-P, Yuan J-M, Sun C-L, Lee H-P, Yu MC. Middle-aged and older Chinese men and women in Singapore who smoke have less healthy diets and lifestyles than nonsmokers. *J Nutr*. 2005;135:2473–2477.
 33. Ezzati M, Henley SJ, Thun MJ, Lopez AD. Role of smoking in global and regional cardiovascular mortality. *Circulation*. 2005;112:489–497.
 34. Barnoya J, Bialous SA, Glantz SA. Effective interventions to reduce smoking-induced heart disease around the world: time to act. *Circulation*. 2005;112:456–458.
 35. Arauz AG, Monge RA, Munoz L, Rojas MT. [Diet as a risk factor for cardiovascular disease in residents of the metropolitan area, San Jose, Costa Rica]. *Arch Latinoam Nutr*. 1991;41:350–362.
 36. Monge-Rojas R. Dietary intake as a cardiovascular risk factor in Costa Rican adolescents. *J Adolesc Health*. 2001;28:328–337.
 37. Rodriguez Herrera N, Gladys Arauz A, Meza Rojas N, Rosello Araya M. [Atherogenic factors in the diet of the Costa Rican population, 1991]. *Arch Latinoam Nutr*. 1996;46:27–32.
 38. Bunker ML, McWilliams M. Caffeine content of common beverages. *J Am Diet Assoc*. 1979;74:28–32.