Decreased Consumption of Dried Mature Beans Is Positively Associated with Urbanization and Nonfatal Acute Myocardial Infarction[1]

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ABSTRACT Legumes may protect against myocardial infarction (MI). The objective of this study was to determine whether consumption of dried mature beans (referred to as beans), the main legume in Latin America, is associated with MI. The cases (n = 2119) were survivors of a first acute MI and were matched by age, sex, and area of residence to randomly selected population controls (n = 2119) in Costa Rica. Dietary intake was assessed with a validated FFQ. Of the population, 69% consumed ≥1 serving of beans/d (1 serving = one-third cup of cooked beans, ~86 g). Consumption of ≥1 serving/d was significantly higher ($P < 0.001$) in rural (81%) than in urban (65%) areas. Individuals who never eat dried beans or whose consumption was <1 time/mo were classified as nonconsumers. Compared with nonconsumers, intake of 1 serving of beans/d was inversely associated with MI in analyses adjusted for smoking, history of diabetes, history of hypertension, abdominal obesity, physical activity, income, intake of alcohol, total energy, saturated fat, *trans* fat, polyunsaturated fat, and cholesterol [odds ratio (OR) = 0.62; 95% CI: 0.45–0.88]. No further protection was observed with increased number of servings/d (OR = 0.73; 95% CI: 0.52–1.03 for >1 serving/d). In summary, we found that consumption of 1 serving of beans/d is associated with a 38% lower risk of MI. No additional protection was observed at intakes > 1 serving/d. These findings are timely given the trend toward increased obesity, cardiovascular disease, and a reduction in the intake of beans in Latin American countries. J. Nutr. 135: 1770–1775, 2005.

KEY WORDS: • *myocardial infarction* • *beans* • *legumes* • *dietary fiber* • *Costa Rica*

Beans, *Phaseolus vulgaris*, are legumes that are thought to have originated from southern Mexico and Central America over 7000 y ago (1); they still form an important part of the staple diet in those regions. For many centuries, beans have remained part of the human diet in several countries on all continents. Black beans or black Spanish beans are the commonest variety in Latin America; they are usually consumed as dried mature beans together with rice. The combination of rice and dried mature black beans (later referred to as beans) supplies various nutrients including essential amino acids, folate, soluble fiber, copper, magnesium, iron, potassium, calcium, zinc, and α-linolenic acid (2–10). Although there are several varieties of beans that occur in different sizes, shapes, and colors, their nutrient composition is quite similar to that of black beans (**Table 1**).

Legumes including beans may protect against cardiovascular disease (CVD)[3] through various mechanisms (2,5,10,11). However, epidemiologic data on the association between individual legumes such as beans and peas and CVD are lacking. Beans form the core of the Latin American staple diet and contribute significantly to energy and micronutrient intakes (5–7,12). Despite the recommendation to increase the intake of beans by health organizations (8), their consumption, as well as that of other legumes, has decreased with urbanization (13). This is probably because of the increased availability and advertising of relatively cheap simple-carbohydrate diets such as pasta and white bread (7,13). As expected, these trends are likely to be responsible for the increased obesity and the slow emergence of cardiovascular and other chronic diseases in many Latin American countries, including Costa Rica, where myocardial infarction (MI) accounts for 47.2% of CVD (14,15).

Some of the few studies that have investigated the nutrients in beans [e.g., fiber (16–18), folate (19), magnesium (20,21), and copper (22)], suggest inverse associations with CVD. Unlike soybeans and peanuts, the role of other legumes (e.g., beans) in CVD has not been reported. We therefore investigated, in a large incident case-control study in Costa Rica, whether eating beans is associated with risk of MI and explored potential mechanisms for such an association.

SUBJECTS AND 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 were published elsewhere (23–25). Briefly, eligible cases were men and women who were diagnosed as survivors

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[3] Abbreviations used: CVD, cardiovascular disease; GDP, gross domestic product; MET, metabolic equivalent; MI, myocardial infarction; OR, odds ratio.

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TABLE 1

Nutrient composition of boiled unsalted dried mature black beans[1,2]

Nutrient	Variety with lowest content		Black beans	Variety with highest content	
	unit/100 g of cooked dried mature beans				
Energy, *kJ*	Mung beans	441	552	Garbanzo beans	687
Carbohydrate, *g*	Mung beans	20	24	Garbanzo beans	27
Protein, *g*	Mung beans	7.0	8.7	White beans	9.7
Fiber, *g*	Yardlong beans	3.8	8.7	Navy beans	11
Polyunsaturated fat, *g*	Mung beans	0.13	0.23	Garbanzo beans	1.16
Potassium, *mg*	Mung beans	266	355	White beans	561
Phosphorus, *mg*	Mung beans	99	140	Yellow beans	183
Magnesium, *mg*	Kidney beans	42	70	Yardlong beans	98
Iron, *mg*	Mung beans	1.40	2.10	Hyacinth beans	4.58
Zinc, *mg*	Mung beans	0.84	1.12	Hyacinth beans	2.85
Copper, *mg*	Small white beans	0.15	0.21	Garbanzo beans	0.35
Folate, *μg*	Hyacinth beans	4	149	Pinto beans	172
Vitamin B6, *mg*	Hyacinth beans	0.04	0.07	Pinto beans	0.23

[1] Data from (41).
[2] Common varieties compared were black beans, yardlong beans, navy beans, pinto beans, small white beans, white beans, garbanzo beans, mung beans, yellow beans, fava beans, lima beans, hyacinth beans, and kidney beans.

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 WHO criteria for MI, which require typical symptoms plus either elevations in cardiac enzyme concentrations or diagnostic changes in the electrocardiogram (26). Cases were ineligible if they *1*) died during hospitalization, *2*) were ≥75 y old on the day of their first MI, and 3) were physically or mentally unable to answer the questionnaire. Enrollment was carried out while cases were in the hospital's step-down unit. Cases were matched by age (±5 y), 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 regardless of income. Therefore, control subjects came from the source population that gave rise to the cases and were not likely to have been having CVD that was not diagnosed because of poor access to medical care. Control subjects 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 in 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 a questionnaire with close-ended questions. Self-reported diabetes and hypertension were validated using the definitions recommended by the Expert Committee on the Diagnosis and Classification of Diabetes Mellitus (27) and the Third Joint National Committee on Detection, Evaluation, and Treatment of High Blood Pressure (JNCIII) (28) and were found to be reliable in this population (23).

Each subject provided a blood sample for assessment of plasma lipids. Blood samples were collected into tubes containing 0.1% EDTA. Samples were stored in a cooler with ice packs at 4°C and transported to the fieldwork station within 4 h. Blood was then centrifuged at 1430 × *g* for 20 min at 4°C to obtain plasma. Plasma samples were stored at −80°C; within 6 mo of collection, samples were transported over dry ice to the Harvard School of Public Health for analysis. Plasma triacylglycerol, total cholesterol, and HDL cholesterol concentrations were measured with enzymatic reagents (Boehringer-Mannheim) and a Roche Cobas Mira Plus autoanalyzer. We used the Friedewald equation to calculate LDL cholesterol concentrations (29). Cholesterol measurements were standardized to guidelines of the Centers for Disease Control and the National Heart, Lung and Blood Institute (30,31).

In addition to the blood sample, a subcutaneous adipose tissue biopsy was collected from the upper buttock, stored in a cooler with ice packs at 4°C, transported to the fieldwork station within 4 h, and stored at −80°C until analysis. Fatty acids from adipose tissue were quantified by GLC as described previously (32).

We collected dietary data using a semiquantitative FFQ that was developed and validated specifically to assess nutrient intake among the Costa Rican population (24,32–34). The FFQ assessed both the portion size and frequency of consumption of beans. Beans were listed as a food on the FFQ and study subjects were asked by an interviewer whether their intake of beans in the last year corresponded to 1 of the following 9 categories: <1 time/mo or never, 1–3 times/mo, 1 time/wk, 2–4 times/wk, 5–6 times/wk, 1 time/d, 2–3 times/d, 4–5 times/d, and 6+ times/d, where 1 time corresponds to 1 serving or one-third cup of cooked beans (~86 g). Beans are part of the staple diet of this population, and they are rarely prepared as a mixed dish. Another questionnaire assessed potential confounders and recorded anthropometric measurements.

Statistical analysis. SAS software (SAS Institute) was used for all statistical analyses. Subjects who were missing values (n = 310) for major confounders were excluded, leaving 2119 cases and 2119 matched controls for the final analysis. Individual nutrient intakes were adjusted for total energy intake as described elsewhere (24,35). Because of the matched design, the significance of differences in the distribution of categorical variables by case-control status was tested using McNemar's test, whereas continuous variables were tested by the paired t test, if normally distributed, or by the Wilcoxon signed rank test, if not normally distributed.

Intake of beans as derived from 1 question in the semiquantitative FFQ was categorized as follows: <1 time/mo or never = 0 serving/d; 1–3 times/mo to 5–6 times/wk = "<1 serving/d"; 1 time/d = "1 serving/d"; and 2–3 times/d to 6+ times/d = ">1 serving/d." Intake of beans was modeled as a 4-level categorical variable (0 serving/d, <1 serving/d, 1 serving/d, and >1 serving/d), with people reporting no consumption of beans or consuming <1 serving/mo as a reference. Continuous nondietary and energy-adjusted dietary variables were distributed into quintiles and assessed for potential confounding by distributing them by categories of intake of beans and by testing their effect on the model parameter estimates and likelihood ratio test. The confounders included in the final conditional logistic regression analyses were smoking (never, past, <20, and ≥20 cigarettes/d), alcohol intake (never, past, current drinkers in tertiles), history of diabetes (yes/no), history of hypertension (yes/no), abdominal obesity based on waist-to-hip ratio (in quintiles), physical activity (in quintiles), income (in quintiles), and intake of total energy (in quintiles), saturated fat (in quintiles), *trans* fat (in quintiles), polyunsaturated fat (in quintiles), and dietary cholesterol (in quintiles).

We investigated the potential mechanisms for the inverse association between consumption of beans and MI by determining whether adjusting for major nutrients from beans (fiber, B-vitamins, iron, copper, zinc, potassium, magnesium, and α-linolenic acid) modified the association between beans and MI. The hypothesis was that if the nutrient was very important and beans were a major source, then it should attenuate the association, if that nutrient protects against MI.

We used stepwise multivariate linear regression to determine the variables that were associated with consumption of beans among controls. A semicontinuous variable from the FFQ (i.e., servings of beans/d) with values of 0, 0.08, 0.14, 0.43, 0.8, 1, 2.5, and 4.5 was used as the outcome variable for this analysis. An individual had 1 of the 8 values, i.e., 0 for <1 time/mo or never, 0.08 for 1–3 times/mo, 0.14 for 1 time/wk, 0.43 for 2–4 times/wk, 0.8 for 5–6 times/wk,1 for 1 time/d, 2.5 for 2–3 times/d, and 4.5 for 4–5 times/d. None of the subjects reported an intake of 6 times/d, the 9th category in the FFQ. The following variables were included in the model for stepwise selection with a probability to enter or stay in the model set at $P = 0.05$. The categorical variables were sex, area of residence, smoking, whether an alcohol drinker or not, history of diabetes, history of hypertension, and occupation. A number of variables including age, sedentary lifestyle (defined as inverse of physical activity), abdominal obesity, education (years of formal education), and income were modeled as continuous covariates in which a unit change represented 1 SD increase in the variable. Simple β-coefficients and standardized β-coefficients from a multiple linear regression model were obtained and used to identify the major variables associated with consumption of beans. The major sources of protein, fiber, magnesium, copper, and B-vitamins in the Costa Rican population were also assessed to determine the contribution of beans to these nutrients.

RESULTS

Characteristics of the study population. The characteristics of nonfatal MI cases and population-based matched controls in Costa Rica were compared (**Table 2**). Controls were ($P < 0.05$) less likely to be current smokers and to have a history of diabetes or hypertension but were more likely ($P < 0.05$) to be current drinkers, physically active, thinner, more educated, and have a higher income. Controls consumed less total energy, saturated fat, and cholesterol but more polyunsaturated fat than cases ($P < 0.05$). Age-standardized characteristics of the controls were examined by categories of intake of dried mature beans (**Table 3**). Consumption of beans was negatively associated with sex, urbanization, history of hypertension, income, and total and LDL cholesterol but was positively associated with smoking, physical activity, and somewhat with abdominal obesity. Of the population, 69% consumed at least 1 serving of beans/d. Consumption of 1 serving/d was higher ($P < 0.001$) in men (73%) than women (59%) and in rural (81%) compared with urban (65%) areas (data not shown).

We examined the distribution of age-standardized potential dietary confounders by frequency of consumption of beans among controls (**Table 4**). Intake of total fat, monounsaturated fat, cholesterol, fruits, vegetables, and soybean oil decreased with an increase in intake of beans, whereas total energy, folate, magnesium, copper, iron, white rice, and palm oil increased with an increase in intake of beans. In the multivariable linear models including age, gender, and physical activity as predictors, the higher abdominal obesity and increase in total energy intake in the top compared with the lowest category of intake of beans was due in part to the high proportion of men in the top group for both variables and also to physical activity for the case of energy intake.

Factors determining consumption of beans. Using β-coefficients from a multiple linear regression model, we identified the variables that were associated with consumption of beans in Costa Rica (**Fig. 1**). Decreased consumption of beans was associated with female gender ($P < 0.0001$), higher education ($P < 0.0001$), living in urban areas ($P < 0.0001$), higher income ($P < 0.0001$), being a nonsmoker ($P < 0.02$), seden-

TABLE 2

Characteristics of the Costa Rican cases of nonfatal acute MI and population-based matched controls[1]

Variable	Controls (n = 2119)	Cases (n = 2119)
Age,[2] *y*	58 ± 11	59 ± 11
Women in the sample,[2] %	27	27
People living in urban areas,[2] %	74	74
Current smokers, %	21	40*
Current alcohol drinkers, %	52	49*
Physical activity,[2] *MET*	1.56 ± 0.70	1.51 ± 0.69
Abdominal obesity[3]	0.95 ± 0.08	0.97 ± 0.07*
History of diabetes, %	14	25*
History of hypertension, %	30	39*
Secondary education or higher, %	40	37*
Household income, *US$*	571 ± 427	496 ± 390*
Total energy, *kJ*	10,250 ± 3211	11,318 ± 3938*
Saturated fat, *% energy*	10 ± 3	11 ± 3*
Monounsaturated fat, *% energy*	12 ± 4	12 ± 4
Polyunsaturated fat, *% energy*	6.2 ± 2.0	6.0 ± 2.0*
Trans fat, *% energy*	1.31 ± 0.64	1.33 ± 0.64
Cholesterol, *mg/4187 kJ*	118 ± 52	126 ± 59*

[1] Values are percentages or means ± SD. * Different from controls, $P < 0.05$.
[2] Matching variable.
[3] Based on waist-to-hip ratio.

TABLE 3

Characteristics of the Costa Rican adult subjects who served as population-based matched controls by categories of intake of dried mature beans[1,2]

	Servings of dried beans/d			
Variable[3]	0	<1	1	>1
n	106	547	635	831
Age, *y*	60	57	60	57
Women in the sample, %	71	50	47	29
People living in urban areas, %	85	83	73	66
Current smokers, %	15	18	19	25
Current alcohol drinkers, %	41	57	52	52
Physical activity, *MET*	1.42	1.43	1.51	1.70
Abdominal obesity[4]	0.91	0.95	0.95	0.96
History of diabetes, %	15	14	13	15
History of hypertension, %	40	32	29	27
Secondary education or higher, %	44	56	43	26
Household income, *US$*	614	723	587	443
Total plasma cholesterol, *mmol/L*	5.07	4.86	4.86	4.84
LDL cholesterol, *mmol/L*	2.97	2.79	2.79	2.85
HDL cholesterol, *mmol/L*	1.35	1.29	1.32	1.29
Triacylglycerol, *mmol/L*	1.67	1.75	1.69	1.67

[1] Values are percentages or means.
[2] One serving is ~86 g or one-third cup of cooked beans.
[3] All variables except age are standardized for the age of the control population.
[4] Based on waist-to-hip ratio.

tary lifestyle ($P < 0.0001$), and increasing age ($P < 0.001$). Compared with men, especially in urban areas, women were less likely to have multiple servings of beans on a given day.

Relation between beans and MI. We examined the relation between the frequency of consumption of beans and the risk of nonfatal MI (**Table 5**). In both the basic [odds ratio (OR) = 0.69; 95% CI: 0.51–0.91] and multivariate adjusted (OR = 0.62; 95% CI: 0.45–0.88) analyses, moderate consumption (1 serving/d) of beans was associated with a reduced risk of MI. Consumption of beans at >1 serving/d was also inversely associated with the risk of MI but the association was not significant (multivariate adjusted OR = 0.73; 95% CI: 0.52–1.03) (Table 5).

Because in Costa Rica beans are either fried in vegetable oil or cooked with oil added afterwards, we fitted a model that included type of oil used for cooking or frying and the confounders in multivariate model 2 shown in Table 5 (except dietary fats). In this analysis, the main results were not modified appreciably. The OR was 0.69 (0.50–0.96) for those having 1 serving of beans/d and 0.81 (0.58–1.12) for those consuming >1 serving/d. Consumption of beans tended to vary with gender, and the highest consumption was among men.

Sources of micronutrients and contribution of beans. The importance of beans is shown by the contribution of this food to protein, fiber, and micronutrients in the Costa Rican diet. For instance, beans contributed 11% of protein, 25% of fiber, 17% of folate, 5% of vitamin B-6, 5% of magnesium, 14% of copper, and 13% of iron. We tested whether major nutrients in beans could explain individually the observed association between beans and MI by adding each nutrient to the multivariable model for beans and MI. However, none of the nutrients affected the association between beans and MI (data not shown).

Because people in the top categories of intake of beans had higher intakes of α-linolenic acid (Table 4), we examined in a stratified analysis whether this was due to α-linolenic acid content in beans or due to the added cooking oils. In this analysis, α-linolenic acid (assessed in adipose tissue) increased with the number of servings of beans irrespective of the type of oil used for cooking. For instance, for people whose intake was 0, <1, 1, or >1 serving of beans/d, adipose tissue α-linolenic acid concentrations were 0.65, 0.65, 0.69, and 0.78%, respectively, among soybean oil users; 0.46, 0.46, 0.48, and 0.50%, respectively, among palm oil users; and 060, 0.58, 0.60, and 0.65%, respectively, among users of other oils (mainly sunflower oil).

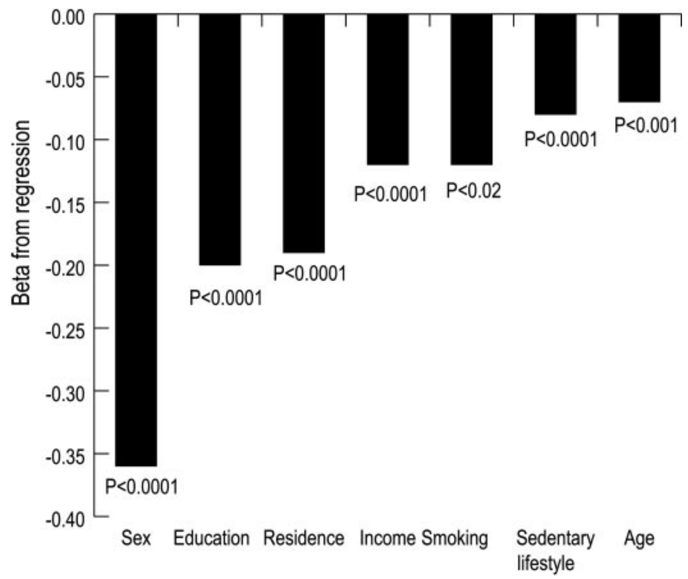

FIGURE 1 Variables associated with reduced consumption of dried mature beans among control subjects in Costa Rica. The dependent variable in the linear regression was servings of beans/d. The dichotomous independent variables were sex (0 for men and 1 for women), residence (0 for rural and 1 for urban), and smoking (0 for current and 1 for never and past smokers). The continuous independent variables represent 1 SD increase in income (in US$ per month, 1 SD = $427), education (in y, 1 SD = 5.4 y), age (in y, 1 SD = 11 y) and sedentary lifestyle [in metabolic equivalents (MET^{-1}), 1 SD = 0.31 MET^{-1}]. The standardized β-coefficients were −0.21 for 1 SD increase in education, −0.16 for women, −0.13 for 1 SD increase in income, −0.09 for urban residence, −0.09 for 1 SD increase in sedentary lifestyle, −0.08 for 1 SD increase in age, and −0.05 for nonsmokers.

TABLE 4

Distribution of potential dietary confounders by intake of dried mature beans among Costa Rican population-based matched controls[1,2]

	Servings of dried beans/d			
Variable[3]	0	<1	1	>1
n	106	547	635	831
Total energy, *kJ*	7658	8700	8930	10,877
Carbohydrate, *% energy*	56	55	55	56
Protein, *% energy*	13	13	13	13
Total fat, *% energy*	33	33	32	31
Saturated fat, *% energy*	10	11	11	10
Monounsaturated fat, *% energy*	13	13	12	11
Polyunsaturated fat, *% energy*	6	6	6	6
Trans fat, *% energy*	1.28	1.30	1.33	1.31
Dietary α-linolenic acid,[4] *g*	1.48	1.46	1.59	1.79
Cholesterol, *mg/4187 kJ*	124	125	120	111
Fiber,[4] *g*	20	22	24	28
Folic acid,[4] *μg*	368	401	424	466
Magnesium,[4] *μg*	323	342	359	395
Copper,[4] *mg*	1.63	1.70	1.77	1.95
Iron,[4] *mg*	14	15	16	17
Fruit servings, *n*	2.15	2.20	2.07	1.97
Vegetable servings, *n*	2.99	2.91	3.00	2.57
White rice servings, *n*	1.76	1.54	1.57	2.36
Palm oil users, *%*	13	16	21	30
Soybean oil users, *%*	59	52	51	52

[1] Values are percentages or means.
[2] One serving is ~86 g or one-third cup of cooked beans.
[3] All variables are standardized for the age of the control population.
[4] Nutrient does not include supplements and is adjusted for total energy intake using regression methods.

DISCUSSION

Our results showed that having 1 serving (OR = 0.62; 95% CI: 0.45–0.88) or >1 serving (OR = 0.73; 95% CI: 0.52–1.03) of beans per day was associated with a lower risk of nonfatal acute MI independently of other dietary and nondietary risk factors for MI. The frequency of intake was determined mainly by sex, income, level of education, physical activity, area of residence, age, and smoking status. The observed association between beans and MI was not likely to have been confounded by age, sex, area of residence, income, or dietary intake because of the study's matched design, the

TABLE 5

Intake of dried mature beans and risk of nonfatal acute MI among Costa Rican adults[1,2]

	Servings of dried beans/d			
	0	<1	1	>1
n	232	1062	1151	1793
Basic model[3]	1.00	0.78 (0.59–1.05)	0.69 (0.51–0.91)	0.98 (0.74–1.30)
Multivariate 1[4]	1.00	0.78 (0.56–1.10)	0.63 (0.45–0.87)	0.74 (0.53–1.03)
Multivariate 2[5]	1.00	0.76 (0.54–1.08)	0.62 (0.45–0.88)	0.73 (0.52–1.03)

[1] Values are OR (95% CI).
[2] One serving is ~86 g or one-third cup of cooked beans.
[3] OR conditioned on matching factors (age, sex, and area of residence).
[4] Adjusted for smoking, history of diabetes, history of hypertension, abdominal obesity, physical activity, household income, and intake of total energy and alcohol.
[5] In addition, adjusted for intake of saturated fat, *trans* fat, polyunsaturated fat, and dietary cholesterol.

restriction of recruitment to survivors of a first nonfatal acute MI, use of randomly selected population controls, use of an FFQ designed and validated for use in Costa Rica, and the various statistical adjustments for both lifestyle and dietary variables.

Because of the absence of published data on the association between intake of beans and MI, we are unable to make direct comparisons with other studies. The few studies on legumes did not report associations for beans as an individual food but rather combined pulses and peanuts in the analyses. However, our results are in line with those of Bazzano et al. (2), who reported a 22% reduction in risk of coronary heart disease for people consuming legumes (including beans and peanuts) at least 4 times/wk compared with those whose intake was <1 time/wk. It is notable that the intake of beans in our study was much higher than the consumption of legumes (i.e., combined beans, peanuts, etc.) reported by Bazzano et al. (2). For instance, 69% of our study population reported consuming at least 1 serving/d and 39% reported intakes ≥2–3 servings/d compared with the top category of 4 times/wk in the First National Health and Nutrition Examination Survey Epidemiologic Follow-up Study (2).

The finding of an inverse association between consumption of beans and MI is not surprising given that beans contain complex carbohydrates, which lower the glycemic load, and are rich in magnesium, copper, fiber, and α-linolenic acid, components that improve insulin sensitivity and lipid profiles, reduce thrombosis and oxidation, and lower the risk of MI (9–11,17,36–38). Beans contribute a large amount of fiber and α-linolenic acid in the Costa Rican diet, and α-linolenic acid was previously associated with a protective effect on CVD in the Costa Rican and other populations (18,38,39). In an attempt to explore potential mechanisms for the observed inverse association, we adjusted the association for nutrients found in beans. Fiber, folate, iron, magnesium, potassium, and adipose tissue α-linolenic acid caused small decreases in the magnitude of the association, suggesting that either their individual effects are small but are captured when aggregated (as when beans are analyzed as a food) or other unknown nutrients in beans may also be important. The other possible explanation is that beans are a good source of protein, which may play a role in weight management, if combined with other health lifestyle factors.

We observed a modest difference in OR between those consuming 1 serving/d and those consuming >1 serving/d, suggesting that increased servings of beans per day may not confer additional protection. The reason for this is unclear but may be related to the high incidence of current smokers, increased abdominal obesity, and higher intakes of white rice and palm oil but less of soybean oil, fruits, and vegetables in the top category of intake of beans. Although we adjusted the association between beans and MI for the above variables, complete control of confounding may not have been achieved, thus leaving some residual confounding. This could explain the observed modest difference in the OR. Also, consumption of beans at >1 serving/d may be a marker of a poor diet because beans may be replacing other good foods in the diet. For instance, individuals in the top category of intake of beans consumed fewer traditional fruits and vegetables but ate more white rice, a food that has a high glycemic index.

We found that higher income, higher education, sedentary lifestyle, living in urban areas, older age, not being a smoker, and gender were the main variables associated with intake of beans in Costa Rica. This finding is in agreement with those of Leterme and Muñoz (7) who reported that income, age, and area of residence, among others, were important determinants of consumption of beans in Latin America. Income, even at the population level, is indeed an important determinant of consumption of beans, e.g., in Costa Rica where the per capita gross domestic product (GDP) was US$4204 in 2000, the intake of beans was estimated to be between 5 and 11 kg/(person • y) whereas in Nicaragua, a country with a per capita GDP of US$514, the intake of beans was estimated at 25 kg/(person • y) (7,40).

Moderate consumption of dried mature beans (1 serving/d) is associated with a 38% reduction in the risk of MI in Costa Rica. Decreased consumption of dried mature beans was predicted by residence in urban areas, higher income, having higher education, sedentary lifestyle, increasing age, and being a nonsmoker. Compared with men, especially in urban areas, women were less likely to have multiple servings of beans on a given day. These findings are timely given the trend toward increased obesity, CVD, and a reduction in the intake of beans in Latin American countries.

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