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Tea Consumption and the Prevalence of Coronary Heart Disease in Saudi Adults: Results from A Saudi National Study[1]

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Background. **The aim of the study was to determine whether there was a relationship between tea consumption and the prevalence of coronary heart disease (CHD) in Saudi Arabia.**

Methods. **The relationship between tea consumption and the prevalence of CHD was investigated using multiple logistic regression analysis in the Saudi Coronary Artery Disease Study. A total of 3,430 men and women aged 30–70 years was studied.**

Results. **Of the 3,430 subjects who were assigned a category, 6.3% were classified as having indications of CHD. Those who did drink more than 6 cups of tea (>480 mL) per day had a significantly lower prevalence of CHD than the nontea drinkers ($P < 0.001$). Adjustments for risk factors including age, gender, occupation, education, smoking, family history, blood lipids, diabetes, blood pressure, BMI, physical activity, and coffee and fat intake did not remove the significance (OR = 0.49; 95% CI = 0.24–0.96). There was a positive dose-response effect between tea consumption and CHD ($P < 0.001$) that was persistent after adjustment for various risk factors ($P = 0.022$).**

Conclusions. **These findings support a potential protective effect of tea consumption in relation to CHD in this Saudi study in which all tea consumed was black tea.**

Key Words: **tea; coronary; heart; Saudi Arabia; prevalence.**

INTRODUCTION

According to the World Health Organization's *World Health Report 1997,* diseases of the heart and circulatory system account for more than 15 million deaths per year. Coronary heart disease (CHD) is a major health problem and a major cause of death in most industrialized and developing countries [*1*]. CHD is responsible for about 25% of all deaths worldwide [*2*] and is known to be multifactorial. The major risk factors include hypertension, hyperlipidemia, smoking, obesity, physical activity, and occupation [*3–6*]. In Saudi Arabia, data on mortality from CHD are not available. However, hospital-based data provide useful information on cases for which CHD represents the leading cause of admission [*7*]. The upsurge of CHD is correlated with changes in lifestyle, prevailing obesity, the state of being overweight, and smoking [*8*].

Epidemiological studies have indicated a protective role of dietary flavonoids in cardiovascular disease, but the evidence is still conflicting. Whereas some studies on tea consumption have suggested no association [*9–11*], other studies have suggested a reduction in the risk of CHD due to its flavonoid content [*12–15*]. Regular black tea, the major dietary source of flavonoids in Western populations [*16,17*], is a popular beverage in Saudi Arabia and, hence, may be considered an important source of dietary flavonoids among Saudis.

To examine the hypothesis that regular tea consumption is associated with a reduced risk of CHD, we analyzed cross-sectional data collected from 1993 to 1998 as part of the National Epidemiological Survey for Coronary Artery Disease in Saudi Arabia.

METHODS

Study Population

Saudi Arabia (SA) comprises most of the Arab peninsula with a population of 18.8 million [*18*]. A National Epidemiological Health Survey was carried out in this country between 1993 and 1998. The study population was randomly derived from rural and urban male and female Saudi adults between 30 to 70 years of

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age. A multistage stratified cluster sampling was utilized to randomly select the study population using probability proportional to size (PPS) across the 13 administrative regions of SA. The family health registries at primary health care centers (PHCC) in the selected localities were used to identify the study population. Efforts were made to encourage participation. In the case of refusals or nonresponses, another subject was randomly selected from the same PHCC cluster. In each participating PHCC, a physician was appointed as the supervisor of the field research team. Trained staff were responsible for contacting eligible subjects, scheduling interviews, and conducting clinical examinations and laboratory tests. All personnel completed standardized training prior to the study, and the supervisor or his/her assistant monitored the interview process, specimen collection, and handling and transport of blood samples. The protocol was approved by the medical members of the funding agency, the King Abdulaziz Center for Sciences and Technology, and participating primary health care centers. All study subjects gave their approval and consent to be included in the study.

The current analysis includes data from the largest administrative regions in SA (Riyadh, Makkah, Eastern), which represent about 60% of the total population according to the 1992 national population census. A total of 3,430 subjects was included in this study.

Data Collection

All subjects were interviewed in person using a structured questionnaire. The questionnaire was developed, pretested, and validated in a pilot study. The questionnaire included sections on sociodemographic data, medical history, family history, physical activity, dietary and social habits, anthropometric measurements, and laboratory data. The medical history section included detailed questions about (a) how the CHD was diagnosed, (b) how the CHD was managed, (c) the number of hospital admissions for CHD, and (d) the current use of medications. Medical records at the PHCC were used to complete and confirm the clinical data. Blood pressure and anthropometric data (weight, height, and waist and hip circumferences) were measured by a trained staff and recorded in the appropriate section of the questionnaire. The completed questionnaires were then sent to the laboratory supervisors for recording of the blood analysis results.

Extensive information was obtained on coronary risk factors as well as current medications for heart diseases, hyperlipidemia, hypertension, and diabetes mellitus. Physical activity questionnaires asked subjects to report (a) the frequency of leisure activity per week (five categories ranging from less than once per month to six or seven times per week), (b) the type and intensity of each activity (five categories ranging from light, such as normal walking or golfing, to heavy, such as running, distance cycling, or heavy-impact aerobics), and (c) the duration of each exercise session (four categories ranging from <10 to >30 min). The product of the three variables (frequency $\times$ intensity $\times$ time) was used as the physical activity value for each subject. The dietary questionnaires measured the habitual weekly consumption of red meat, chicken, fish, eggs, and fresh fruits and vegetables. Detailed information related to the amount and types of fat and oil used in food preparation was also collected. Amounts of daily consumption were ascertained for tea and coffee. Tea drinking is a common, popular social habit in Saudi Arabia. The tea consumed is always brewed in a teapot and consumed in small teacups (80 mL each). Because of the standard tea preparation and drinking among the population, the survey asked participants to report how many cups of tea usually drunk per day. The smoking questionnaire asked subjects to report their current and past smoking habits, duration of smoking, number of cigarettes per day, and years since quitting. Shesha (water pipe) smoking is common in Saudi Arabia. Data were available on both cigarette smoking (never, former, current, or passive) and shesha (never, former, current).

Blood pressure (mm Hg) was measured on the same arm with a standard cuff while the participant was sitting in a relaxed position. Two separate measurements were taken and the average was recorded. Hypertension was defined as any case with systolic blood pressure $\geq$160 mm Hg and or diastolic blood pressure $\geq$95 mm Hg or currently under anti-hypertensive medication regardless of blood pressure. Overnight fasting blood samples were collected and analyzed for glucose and lipid levels. A random sample (10%) was sent for analysis to two separate nationally certified laboratories in Riyadh City. The quality control data were 95–98% in agreement with the results obtained from the survey's laboratory. A subject was considered diabetic if a diagnosis of diabetes mellitus was known or if the fasting plasma glucose level was above 120 mg/dL using the glucose oxidase method [*19*].

Statistical Analysis

Case ascertainment. The prevalence of CHD, defined as nonfatal myocardial infarction or angina pectoris, was based on a self-reported medical history, medical records, and current medications. Risk factor comparisons between cases and controls were conducted using *t* tests for continuous variables and χ^2 tests for categorical variables. One Saudi teacup is equal to 80 mL. We defined four approximately equal categories of tea consumption based upon the distribution among the controls: none, 1–3 cups/day, 4–6 cups/day, and $>$6 cups/day. We then compared subjects according to levels of daily black tea consump-

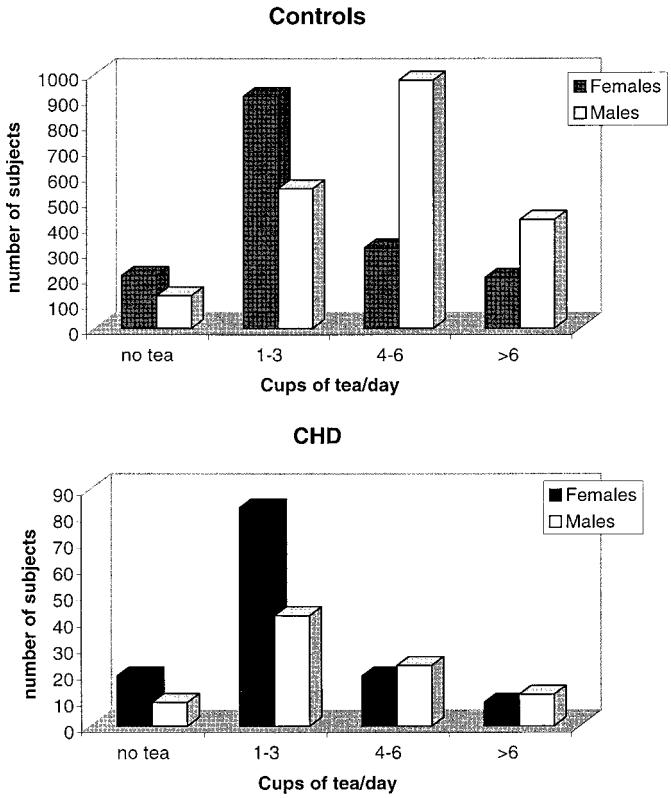

FIG. 1. Daily black tea intake among adult Saudis.

tion. Odds ratios and 95% confidence intervals were calculated using the nontea drinkers as the reference category. Trend tests were calculated using categorical variables. Crude models were adjusted for age and sex, and multivariate models were adjusted for all medical and behavioral risk factors for cardiovascular diseases such as cigarette smoking, education, occupation, family history of premature heart disease, systolic blood pressure, diabetes, physical activity, body mass index, and fat and coffee intake. A possible confounding effect was explored regarding the duration of cigarette smoking (pack-year) and smoking shesha. Inclusion of either pack-year or shesha smoking as separate variables or combined with cigarette smoking did not affect the results and thus they were excluded from the final models. Cigarette smoking was kept in the final model to allow comparability among other studies worldwide. The effects of flavonoid-rich foods, namely fruits and vegetables, and other food groups were also explored. Similarly, the inclusion of fruits and vegetables, red meats, and fish did not affect the results and thus these were excluded from the final models. Finally, lipids were entered into the multivariate model. Reported *P* values were two-sided, and all statistical analyses were done by using the statistical software Stata, version 6 [*20*].

RESULTS

The majority of the subjects reported habitual daily tea consumption. Almost all men (91.8%) and women (87.2%) consumed black tea daily. The mean daily consumption of black tea was 5.6 cups for men and 3.4 cups for women. The consumption of 6 or more cups of tea per day (>480 mL) was reported by 26.4% of men and 11.9% of women. (Fig. 1).

The overall prevalence of CHD, defined as nonfatal myocardial infarction or angina pectoris, was 6.3%. CHD was less prevalent in men (5.2%) than in women (7.4%). This might be related to the de-

TABLE 1

Characteristics of the Study Population

	Control $N = 3205$ means ± SD or %	CHD $N = 216$ means ± SD or %	*P*
Age (years)	44.0 ± 10.5	51.6 + 10.1	<0.001
Males (%)	49.1%	41.8%	0.035
Hypertension [a] (yes)	8.7%	63.6%	<0.001
Diabetes[b] (yes)	18.5%	35.7%	<0.001
Family history (yes)	18.4%	22.2%	0.159
Smoking: cigarettes			
Never	79.9%	82.2%	
Passive (environmental)	2.0%	3.4%	
Former	7.8%	10.0%	
Current	10.3%	4.4%	0.003
Smoking: shesha[c]			
Never	92.0%	93.1%	
Former	3.7%	5.0%	
Current	4.3%	1.9%	0.108
Anthropometry			
BMI (Kg/m^2)	29.1 ± 5.8	31.0 ± 5.9	<0.001
Waist (cm)	92.7 ± 13.0	96.2 ± 12.0	<0.001
Fitness[d]	9.1 ± 14.2	6.2 ± 8.5	0.003
Blood markers[e]			
FBG (mmol/L)	6.6 ± 3.3	7.7 ± 4.1	<0.001
FTG (mmol/L)	1.8 ± 1.2	2.0 ± 1.3	0.016
FTC (mmol/L)	5.5 ± 1.6	5.6 ± 1.5	0.263
FHDL (mmol/L)	1.1 ± 0.4	1.2 ± 0.4	0.204
FLDL (mmol/L)	4.7 ± 1.7	4.9 ± 1.7	0.286
LDL/HDL	4.7 ± 2.7	4.8 ± 2.5	0.985
Dietary habits			
Tea (cups/day)[f]	4.5 ± 4.9	3.5 ± 4.4	0.002
Coffee (cups/day)[f]	5.2 ± 6.5	5.7 ± 6.8	0.208
Red meat (F/week)[g]	2.7 ± 1.5	2.8 ± 1.7	0.148
Fruits and vegetables (F/week)[g]	5.0 ± 2.3	5.2 ± 2.1	0.101
Olive oil (yes)	6.1%	6.9%	0.638
Butter (yes)	14.3%	11.5%	0.307

[a] Blood pressure above 160/95 or anti-hypertensive medication.
[b] History of diagnosed diabetes.
[c] Water pipe, a common practice in Saudi Arabia.
[d] Score is calculated as the product of frequency × intensity × duration.
[e] FBG, fasting blood glucose; FTG, fasting triglycerides; FTC, fasting total cholesterol; FHDL, fasting high-density lipoprotein; FLDL, fasting low-density lipoprotein.
[f] One cup = 80 mL.
[g] F, frequency of intake per week.

TABLE 2

Risk Factor Distribution for CHD by Level of Daily Tea Intake

		Daily tea consumption		
	No $N = 363$ mean ± SD or %	1–3 cups[a] $N = 1585$ mean ± SD or %	4–6 cups[a] $N = 833$ mean ± SD or %	>6 cups[a] $N = 649$ mean ± SD or %
Age (years)	46.7 ± 11.7	44.8 + 10.9	43.9 + 10.0	43.3 + 9.6*
Males (%)	37.7%	37.3%	59.8%	67.8%*
Hypertension[b] (yes)	15.2%	15.4%	9.9%	6.6%*
Diabetes[c] (yes)	24.0%	22.3%	18.6%	11.1%*
Family history (yes)	16.8%	20.2%	17.5%	17.6%
Smoking cigarettes				
Never	88.7%	84.5%	76.7%	69.3%
Former	5.2%	6.5%	10.0%	11.1%
Current	5.5%	5.4%	12.0%	18.5%*
Smoking: shesha[d]				
Never	94.5%	93.7.3%	90.2%	90.2%
Former	2.2%	2.4%	5.0%	5.2%
Current	3.3%	3.9%	4.8%	4.6%
Anthropometry				
BMI (Kg/m^2)	29.2 ± 6.4	29.8 ± 5.8	29.0 ± 5.5	28.1 ± 5.7*
Waist (cm)	92.3 ± 12.5	92.7 ± 12.7	93.7 ± 12.9	93.2 ± 13.7
Fitness[e]	8.8 ± 15.2	8.7 ± 13.2	8.4 ± 12.6	10.2 ± 16.2
Blood markers[f]				
FBG (mmol/L)	7.0 ± 3.9	6.8 ± 3.4	6.6 ± 3.3	6.4 ± 2.9*
FTG (mmol/L)	1.7 ± 1.1	1.8 ± 1.2	1.9 ± 1.2	1.9 ± 1.2
FTC (mmol/L)	5.5 ± 1.5	5.5 ± 1.6	5.5 ± 1.7	5.4 ± 1.4
FHDL (mmol/L)	1.2 ± 0.4	1.2 ± 0.4	1.1 ± 0.4	1.1 ± 0.4*
FLDL (mmol/L)	4.7 ± 1.7	4.7 ± 1.7	4.8 ± 1.8	4.7 ± 1.5
LDL/HDL	4.4 ± 2.4	4.6 ± 2.5	5.0 ± 3.1	4.8 ± 2.4
Dietary habits				
Coffee (yes)	61.4%	82.7%	86.7%	92.7%*
Olive oil (yes)	7.8%	6.0%	6.6%	5.2%
Butter (yes)	21.3%	12.3%	11.4%	17.9%*

[a] One cup = 80 mL.
[b] Blood pressure above 160/95 or use of anti-hypertensive medication.
[c] History of diagnosed diabetes.
[d] Water pipe, a common practice in Saudi Arabia.
[e] Score is calculated as the product of frequency × intensity × duration.
[f] FBG, fasting blood glucose; FTG, fasting triglycerides; FTC, fasting total cholesterol; FHDL, fasting high-density lipoprotein; FLDL, fasting low-density lipoprotein.
* $P < 0.01$.

creased physical activity ($P < 0.001$) and higher prevalence of obesity ($P < 0.001$) and hypertension ($P < 0.001$) among Saudi women (data not shown). The characteristics of the study population are shown in Table 1. The prevalence and levels of major known risk factors and lipids among subjects with CHD (cases) differed from those among subjects without CHD (controls). Surprisingly, cases were less likely to smoke cigarettes (4.4%) and shesha (1.9%) than controls (10.3% and 4.3%, respectively). Cases were also less likely to drink tea (3.5 cups/day) than controls (4.5 cups/day).

We then compared subjects in the highest versus lowest levels of tea intake. The characteristics of subjects according to tea consumption are shown in Table 2. The heaviest tea drinkers were younger, males, smokers, more likely to drink coffee and consume less fat, and had lower rates of treatment for blood pressure and diabetes mellitus (all $P < 0.01$). Tea drinkers of >6 cups/day (Table 3) had a significantly lower risk of hypertension than nondrinkers (OR = 0.55; 95% CI = 0.34–0.91) independent of risk factors and serum lipids.

A total of 87% of CHD cases and 89.6% of controls drank at least 1 cup of tea per day, while 9.7% of CHD cases and 19.5% of controls drank more than 6 cups (>480 mL) of tea per day.

Similarly, tea drinkers of >6 cups/day (Table 4) had a significantly lower risk of CHD than nondrinkers (OR = 0.49; 95% CI = 0.24–0.96) independent of coronary risk factors and serum lipids. Subjects drinking tea in the two middle levels of consumption had nonsignificant reductions in the risk of hypertension ($P = 0.001$) and CHD ($P = 0.022$), of lower magnitude but consistent with a significant linear trend across levels of tea intake.

TABLE 3

Odds Ratios (OR) and 95% Confidence Intervals (95% CI) for Hypertension by Level of Daily Tea Intake

Full models	No $N = 363$ (reference)	Level of daily tea consumption: 1–3 cups[a] $N = 1585$ OR (95% CI)	4–6 cups[a] $N = 833$ OR (95% CI)	>6 cups[a] $N = 649$ OR (95% CI)	P for trend
Crude	1	1.00 (0.72, 1.38)	0.52 (0.35, 0.76)	0.36 (0.23, 0.56)	<0.001
Age, sex	1	1.17 (0.83, 1.64)	0.73 (0.49, 1.10)	0.57 (0.36, 0.90)	<0.001
Age, sex + risk factors[b]	1	1.13 (0.79, 1.63)	0.79 (0.52, 1.21)	0.62 (0.38, 1.00)	0.003
Age, sex + risk factors[b] + coffee	1	1.08 (0.75, 1.56)	0.74 (0.48, 1.14)	0.57 (0.35, 0.93)	0.001
Age, sex + risk factors[b] + coffee + FTC, FTG, LDL/HDL[c]	1	1.02 (0.71, 1.48)	0.73 (0.47, 1.12)	0.55 (0.34, 0.91)	0.001

[a] One cup = 80 mL.
[b] Adjusted for age, sex, education, occupation, cigarette smoking (never, former, current), diabetes, body mass index, and physical activity index.
[c] Adjusted for the above plus fasting blood cholesterol, fasting blood triglycerides, and the ratio of fasting low-density lipoproteins to high-density lipoproteins.

DISCUSSION

The antioxidant properties of dietary flavonoids have recently drawn considerable attention in the prevention of CHD [*21–23*]. Tea, the most widely consumed beverage in the world, is a rich source of antioxidants. In fact, tea may very well be one of the major sources of antioxidants worldwide due to the high concentration of polyphenols in tea combined with the frequent consumption of this beverage.

Among adult Saudis, we found an inverse association between black tea consumption and CHD. Moreover, our data revealed a significant 50% reduction in risk among those drinking >6 cups of tea per day (>480 mL/day), independent of lipid and nonlipid coronary risk factors. The inverse association of black tea intake with CHD risk is generally consistent with findings from other studies [*12–15,24*]. Epidemiological studies carried out in The Netherlands [*15–16,25*] correlated a higher flavonoid intake with a lower incidence of CHD. On the other hand, case-control [*9–11*] studies found no association between tea consumption and CHD. Similarly, data from prospective studies reported either reduced risk [*26*] or no association between tea intake and the risk of CHD mortality [*27–29*]. However, a true inverse association may have been masked because of the low prevalence of heavy tea consumption or because of potential recall, information, or selection biases. Moreover, these conflicting findings may be due to variable contents of flavonoids in different brands of black tea [*30*] and different ways of brewing [*31,32*] and drinking black tea in different populations.

A possible explanation for the potentially protective mechanisms of tea in this population is the significantly lower rates of hypertension among tea drinkers. Peters and colleagues [*33*] conducted a meta-analysis (six studies) of tea consumption in relation to stroke. They found that the only case-control study conducted in Australia indicated a nonsignificant increased risk

TABLE 4

Odds Ratios (OR) and 95% Confidence Intervals (95% CI) for CHD by Level of Daily Tea Intake

Full models	No $N = 363$ (reference)	Level of daily tea consumption: 1–3 cups[a] $N = 1585$ OR (95% CI)	4–6 cups[a] $N = 833$ OR (95% CI)	>6 cups[a] $N = 649$ OR (95% CI)	P for trend
Crude	1	1.02 (0.66, 1.57)	0.64 (0.38, 1.04)	0.40 (0.22, 0.72)	<0.001
Age, sex	1	1.18 (0.76, 1.83)	0.88 (0.53, 1.47)	0.61 (0.33, 1.11)	0.023
Age, sex + coronary risk factors ϕ	1	0.97 (0.59, 1.56)	0.83 (0.47, 1.43)	0.50 (0.25, 0.98)	0.025
Age, sex + coronary risk factors ϕ + coffee	1	0.95 (0.58, 1.53)	0.81 (0.46, 1.41)	0.49 (0.24, 0.95)	0.021
Age, sex + coronary risk factors ϕ + coffee + FTC, FTG, LDL/HDL ‡	1	0.94 (0.58, 1.53)	0.81 (0.46, 1.41)	0.49 (0.24, 0.96)	0.022

[a] One cup = 80 mL.
[b] Adjusted for age, sex, education, occupation, cigarette smoking (never, former, current), systolic blood pressure, family history of premature heart disease, diabetes, body mass index, physical activity index, and fat intake.
[c] Adjusted for the above plus fasting blood cholesterol, fasting blood triglycerides, and the ratio of fasting low-density lipoproteins to high-density lipoproteins.

of 51 percent with each 3 cups/day. However, cohort studies conducted in the United States, continental Europe, and Asia reported a significant reduction in the incidence of stroke of 12 percent per 3 cups of tea/day. The protective effect of tea on stroke increased in the cohort studies by 5 percent with each year of follow-up (4–15 years). Other possible explanations for the inverse association between tea and CHD are that flavonoids in black tea may reduce myocardial infarction by reducing platelet aggregation [*34*,*35*], by reducing aortic atherosclerosis [*25*] and ischemic damage [*36*], or by inhibiting low-density lipoprotein oxidation [*11*,*37*]. Moreover, some European prospective studies, where black tea has a greater contribution to total flavonoid intake, have suggested an inverse association between flavonoids and CHD mortality [*14–16*]. This protective effect might be related to the role of black tea in reversing endothelial vasomotor dysfunction in patients with CHD [*38*]. Alternatively, higher tea consumption may be a surrogate for a healthier lifestyle. Our data suggest that heavy tea drinkers differ from nondrinkers in terms of health behaviors (more smoking, more coffee intake, and less fat intake) and medical conditions (less hypertension and diabetes). Nevertheless, adjustment for neither coronary risk factors nor individual lipids changed the risk estimates.

Several important limitations of this study should be considered. A misclassification of beverage intake may have occurred. Neither subjects nor interviewers were aware of any specific study hypotheses, so we expect the reported habitual intakes to be without recall bias or seasonality. The inability to distinguish tea brewing time or tea content may also introduce misclassification. However, in this population of adult Saudi men and women, we expect consumption to be limited to hot, caffeinated black tea.

In summary, the present cross-sectional study showed a protective association between black tea consumption and CHD among Saudi adults. More data from prospective cohort studies will help to distinguish whether tea drinking has a true biological effect or whether it serves as a surrogate for a risk profile promoting lower CHD risk.

REFERENCES

1. Rao GH, White JC. Coronary artery disease: an overview of risk factors. Indian Heart J 1993;45:145–53.
2. WHO Expert Committee. Prevention in childhood and youth of adult cardiovascular disease: time for action. Geneva: WHO 1990 [Technical Report Series No. 792].
3. The Lipid Research Clinics coronary primary prevention trials results. I. Reduction in incidence of coronary heart disease. JAMA 1984;251:351–64.
4. The Lipid Research Clinics coronary primary prevention trials results. II. The relation of reduction in incidence of coronary heart disease to cholesterol lowering. JAMA 1984;251:365–74.
5. Tuchsen F, Endahl LA. Increasing inequality in ischaemic heart disease morbidity among employed men in Denmark 1981–1993: the need for a new preventive policy. Int J Epidemiol 1999;28: 640–4.
6. Leino M, Raitakari OT, Porkka KVK, Taimela S, Viikari JSA. Association of education with cardiovascular risk factors in young adults: the Cardiovascular Risk in Young Finns Study. Int J Epidemiol 1999;28:667–75.
7. Alwan A. Prevention and control of cardiovascular disease. Geneva: WHO, EMRO Technical Publications, 1995:22 [Eastern Mediterranean Series].
8. El-Hazmi MAF, Warsy AS. Prevalence of obesity in Saudi population. Ann Saudi Med 1997;17:302–6.
9. Rosenberg L, Palmer JR, Kelly JP, *et al.* Coffee drinking and non-fatal myocardial infarction in men under 55 years of age. Am J Epidemiol 1988;128:570–8.
10. Brown CA, Bolton-Smith C, Woodward M, Tunstall-Pedoe H. Coffee and tea consumption and the prevalence of coronary heart disease in men and women: results from the Scottish Heart Health Study. J Epidemiol Community Health 1993;47:171–5.
11. Rimm ER, Katan MB, Ascherio A, Stampfer M, Willet W. Relation between intake of flavonoids and risk for coronary heart disease in male health professionals. Ann Intern Med 1996;125: 384–9.
12. Sesso HD, Gaziano JM, Buring JE, Hennekens CH. Coffee and tea intake and the risk of myocardial infarction. Am J Epidemiol 1999;149:162–7.
13. Stensvold I, Tverdal A, Solvoll K, Per Foss O. Tea consumption relationship to cholesterol, blood pressure, and coronary and total mortality. Prev Med 1992;21:546–53.
14. Knekt P, Jarvinen R, Reunanen A, *et al.* Flavonoid intake and coronary mortality in Finland: a cohort study. BMJ 1996;312: 478–81.
15. Hertog MG, Kromhout D, Aravanis C, *et al.* Flavonoid intake and long-term risk of coronary heart disease and cancer in the Seven Countries Study. Arch Intern Med 1995;155:381–6.
16. Hertog MG, Feskens EJ, Hollman PC, Katan MB, Kromhout D. Dietary antioxidant flavonoids and risk of coronary heart disease: the Zutphen Elderly Study. Lancet 1993;342:1007–11.
17. Hertog MGL. Flavanols and flavones in foods and their relation with cancer and coronary heart disease risk. The Hague: DIP-Data Koninklijke Bibliotheek, 1994.
18. Milaat W. Public health around the world: Saudi Arabia. Public Health Med 1999;1:34–8.
19. Trinder P. Determination of glucose in blood using glucose oxidase with an alternative oxygen acceptor. Ann Clin Biochem 1964;6:24
20. Stata Corp. Stata statistical software, intercooled stata, release 6.0. College Station, TX: Stata Corp., 1999.
21. Hollman PCH, Hertog MCL, Katan MB. Role of dietary flavonoids in protection against cancer and coronary heart disease. Biochem Soc Trans 1996;24:785–9.
22. Katan MB. Flavonoids and heart disease. Am J Clin Nutr 1997; 65:1542–3.
23. Muldoon MF, Kritchevsky SB. Flavonoids and heart disease. BMJ 1996;312:458–9.
24. Green MS, Harari G. Association of serum lipoproteins and health-related habits with coffee and tea consumption in free-living subjects examined in the Israeli CORDIS Study. Prev Med 1992;21:532–45.
25. Geleijnse JM, Lauber LJ, Hofman A, Pols HAP, Witteman JCM. Tea flavonoids may protect against atherosclerosis: the Rotterdam study. Arch Intern Med 1999;159:2170–4.
26. Arts IC, Hollman PC, Feskens EJ, Bueno de Mesquita HB, Kromhout D. Catechin intake might explain the inverse relation

between tea consumption and ischemic heart disease: the Zutphen Elderly Study. Am J Clin Nutr 2001;74:227–32.

27. Klatsky AL, Armstrong MA, Friedman GD. Coffee, tea, and mortality. Ann Epidemiol 1993;3:375–81.

28. Woodward M, Tunstall-Pedoe H. Coffee and tea consumption in the Scottish Heart Health Study follow up: conflicting relations with coronary risk factors, coronary disease, and all cause mortality. J Epidemiol Community Health 1999;53:481–7.

29. Arts IC, Jacobs DR Jr, Harnack LJ, Gross M, Folsom AR. Dietary catechins in relation to coronary heart disease death among postmenopausal women. Epidemiology 2001;12:668–75.

30. Hertog MGL, Hollman PCH, Putte B. Content of potentially anticarcinogenic flavonoids of tea infusions, wines, and fruit juices. J Agric Food Chem 1993;41:1242–6.

31. Hakim IA, Harris RB, Weisgerber U. Tea intake and skin squamous cell carcinoma: influence of type of tea beverages. Cancer Epidemiol Biomarkers Prev 2000;9:727–31.

32. Hakim IA, Weisgerber UM, Harris RB, Balentine D, van-Mierlo CAJ, Paetau-Robinson I. Preparation, composition and consumption patterns of tea-based beverages in Arizona. Nutr Res 2000;20:1715–24.

33. Peters U, Poole C, Arab L. Does tea affect cardiovascular disease? A meta-analysis. Am J Epidemiol 2001;154:495–503.

34. Yang JA, Choi JH, Rhee SJ. Effects of green tea catechin on phospholipase A2 activity and antithrombus in streptozotocin diabetic rats. J Nutr Sci Vitaminol 1999;45:337–46.

35. Chen Q, Shi H, Zhang KQ, Rosen RT. Antioxidative effect of polyphenol extract prepared from various Chinese teas. Prev Med 1992;21:520–5.

36. Laughton MJ, Evans PJ, Moroney MA, Hoult JR, Halliwell B. Inhibition of mammalian 5-lipoxygenase and cyclo-oxygenase by flavonoids and phenolic dietary additives: relationship to antioxidant activity and to iron ion-reducing ability. Biochem Pharmacol 1991;42:1673–81.

37. Ishikawa T, Suzukawa M, Ito T, Yoshida H, Ayaori M, Nishiwaki M, Yonemura A, Hara Y, Nakamura H. Effect of tea flavonoid supplementation on the susceptibility of low-density lipoprotein to oxidative modification. Am J Clin Nutr 1997;66:261–6.

38. Duffy SJ, Keaney JF Jr, Holbrook M, Gokce N, Swerdloff PL, Frei B, Vita JA. Short- and long-term black tea consumption reverses endothelial dysfunction in patients with coronary artery disease. Circulation 2001;104:151–6.