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Nutrition Research 23 (2003) 1515–1526

NUTRITION RESEARCH

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Black tea consumption and serum lipid profiles in Saudi women: a cross-sectional study in Saudi Arabia

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Received 14 March 2003; received in revised form 28 July 2003; accepted 1 August 2003

Abstract

The objective of this study was to examine the relation between black tea consumption and serum lipid concentrations using cross-sectional data on 1,764 Saudi women aged 30-70 years. Our data show that women who did drink more than 6 cups of tea per day (> 480 ml) had a significantly lower prevalence of high cholesterol (OR = 0.63), high triglycerides (OR = 0.56), high low-density lipoproteins (OR = 0.70), and high very low-density lipoproteins (OR = 0.61) than the non-tea drinkers. Moreover, increased consumption of black tea was significantly associated with decreased serum concentrations of total cholesterol ($P < 0.026$) and triglycerides ($P = 0.008$) and with a decreased proportion of low and very low-density lipoprotein cholesterols ($P = 0.015$ and 0.011 respectively) after adjusting for risk factors. The results of this cross-sectional study do support the potential beneficial effects of black tea on serum lipids among Saudi women.

Keywords: Black tea; Lipids; Women; Saudi Arabia; Prevention

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0271-5317/03/$ – see front matter
doi:10.1016/S0271-5317(03)00176-3

1. Introduction

Serum lipids and lipoproteins play important roles in the development of atherosclerosis, and thereby in the etiology of coronary heart disease (CHD). Not only hypercholesterolemia (HC) but also high levels of serum triglycerides (TG) are strong, independent predictors for CHD [1–3]. Furthermore, high levels of serum low-density lipoprotein cholesterol (LDL) are shown to represent increased risk of CHD [4,5]. Gender is an important determinant of serum lipid and lipoprotein values [6]. It is thus of particular interest to ascertain modifiable determinants of serum lipids and lipoproteins among women.

A previous population-based national epidemiological study conducted among adult Saudi (age $\geq$ 15 years) reported that the risk of developing HC increased by 2% for each year increase in age. Moreover, the risk of developing HC was significantly higher among women compared to men [7]. The 90th percentile of serum total cholesterol (TC) concentration was higher among female, compared with male subjects for all age groups after the age of 40 years. However, the 90th percentile of serum TC concentration for Saudi subjects was lower across all age groups than sex and age matched European subjects [8].

Tea is one of the most popular beverages consumed worldwide. Epidemiological studies have indicated a protective role of dietary flavonoids in cardiovascular disease, but evidence is still conflicting. Whereas earlier studies on tea consumption suggested no association. [9–11], recent evidence suggests a reduction in the risk of CHD due to its flavonoid content [12–15]. A number of epidemiological studies found that consumption of green or black tea was inversely correlated with plasma cholesterol concentrations [13,16]. Regular black tea, the major dietary source of flavonoids in Western populations, [17] is a popular beverage in Saudi Arabia and, hence, may be considered as an important source of dietary flavonoids among Saudis.

The present study examined the relation between black tea consumption and serum lipids and lipoproteins in Saudi women. Special care was taken to adjust for possible confounding factors including dietary factors.

2. Subjects and methods

2.1. Study population

Saudi Arabia comprises most of the Arab peninsula with a population of 18.8 millions [18]. A National Epidemiological Health Survey was carried out between 1993-1998. The study population was randomly derived from rural and urban male and female Saudi adults between 30 to 70 years of age living in Saudi Arabia (SA). 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 case of refusals or non-response, another subject was randomly selected from the same PHCC cluster. In each

participating PHCC, a physician was appointed as supervisor of the field research team. Trained staff was responsible for contacting eligible subjects, scheduling interviews, and conducting clinical examinations and laboratory tests. All personnel completed standardized training prior to 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, 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 included data from the largest administrative regions in SA (Riyadh, Makkah, Eastern) that represent about 60% of the total population according to the 1992 national population census. A total of 1764 Saudi women were included in this study

2.2. Data collection

All women were interviewed in-person using a structured questionnaire. The questionnaire was developed, pre-tested, 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. Medical records at the PHCC were used in completing and confirming 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 to record the blood analysis results.

Detailed 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 1) the frequency of leisure time activity per week (5 categories ranging from less than once per month to 6 or 7 times per week), 2) the type and intensity of each activity (5 categories ranging from light such as normal walking or golfing to heavy such as running, distance cycling or heavy impact aerobics), and 3) the duration of each exercise session (4 categories ranging from $<$10 minutes to $>$30 minutes). The product of the 3 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 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 tea-cups (80 ml each). Because of the standard way of tea preparation and drinking among the population, the survey, asked participants to report how many cups of tea they usually drink 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.

Blood pressure (mm Hg) was measured on the same arm with a standard cuff while the participant was sitting and 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 antihypertensive medication.

2.3. Serum lipid analysis

Overnight fasting blood samples were collected and analyzed for lipid levels. Analysis was done using Roche Diagnostics. The assay for TC was done using the enzymatic method, which is an enzymatic colorimetric test with cholesterol esterase and cholesterol oxidase. TG was also assayed using an enzymatic colorimetric test with glycerol phosphate oxidase. A high density lipoprotein (HDL) cholesterol precipitating reagent, magnesium sulphate at concentration of 0.26 mol./l, was used to remove low density lipoprotein (LDL) cholesterol, total cholesterol and very low density lipoprotein (VLDL). HDL cholesterol was, then, determined by an enzymatic colorimetric method. LDL cholesterol was estimated by using the formula: LDL cholesterol = total cholesterol-(HDL cholesterol $+0.46\times$triglyceride). The intra and inter-assay coefficients of variation were 2.2% and 2.6%, respectively, for TC and 2.2% and 2.2% respectively, for TG.

Quality control: Assay performance was monitored using the lipid control serum, control serum N (normal range) or control serum P (pathologic range) wherever applicable (Roche: Diagnostics, Basel, Switzerland). A random sample (10%) was sent for analysis in 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.

2.4. Statistical analysis

One Saudi cup of tea = 80 ml. We defined four approximately equal categories of tea consumption based upon the distribution among the population: none, 1-3 cups/day, 4-6 cups/day, and $>$ 6 cups/day. We then compared subjects according to levels of daily black tea consumption. Odds ratios and 95% confidence intervals (CI) were calculated using the non-tea drinkers as the reference category. Trend tests were calculated using categorical variables. Crude models were adjusted for age, and multivariate models were adjusted for cigarette smoking, education, family history of hyperlipidemia, physical activity, body mass index, oral contraceptive use, coffee, and fat intake. The effects of flavonoid rich foods, namely fruits and vegetables, and other food groups were also explored. Inclusion of fruits and vegetables, red meat, and fish did not affect the results and were excluded from the final models. Reported *p* values were two-sided, and all statistical analyses were done by using the statistical software Stata, version 6 [19].

3. Results

3.1. Characteristics of the study population

The majority of the subjects reported habitual daily tea consumption. Almost all women (87.2%) consumed black tea daily. Mean daily consumption of black tea was 3.4 cups in women. The prevalence and levels of major known risk factors and mean lipids levels among Saudi women are shown in Table 1. Mean concentrations $\pm$ SD of serum TC and TG were

Table 1
Characteristics of the Study Population (n = 1764)

	Mean ± SD* or %
Age (years)	42.4 ± 9.9
Medical history	
Hypertension (yes)	14.0%
Diabetes (Yes)	18.6%
Family history (yes)	32.5%
Oral contraceptives (yes)	46.9%
Hormone replacement therapy (yes)	1.7%
Smoking:	
Never	89.6%
Former	1.1%
Current	3.0%
Environmental tobacco smoke	6.3%
Dietary habits	
Tea (cups/day)[a]	3.4 ± 3.8
Coffee (cups/day)[a]	4.6 ± 5.6
Fruits & vegetables (weekly)	4.8 ± 2.3
Eggs (weekly)	2.8 ± 3.0
Red meat (weekly)	2.5 ± 1.4
Fish (weekly)	0.9 ± 1.1
Olive oil (yes)	5.3%
Butter (yes)	16.0%
Anthropometric measurements	
Physical activity[b]	6.7 ± 9.8
Body mass index (Kg/m^2)	30.4 ± 6.1
Waist (cm)	90.4 ± 12.2
Hip (cm)	104.8 ± 16.4
Waist to hip ratio	0.88 ± 0.2
Serum lipids[c]	
FTG (mg/dl)	139.4 ± 82.8
FTC (mg/dl)	208.2 ± 58.3
FHDL (mg/dl)	47.4 ± 16.2
FLDL (mg/dl)	173.0 ± 63.1
FVLDL (mg/dl)	12.2 ± 7.2
LDL / HDL	4.1 ± 2.2

* Mean and standard deviation.

[a] One cup = 80 ml.

[b] Physical activity score is calculated as the product of "frequency * intensity * duration".

[c] FTG = Fasting triglycerides; FTC = fasting total cholesterol; FHDL = fasting high density lipoprotein; FLDL = fasting low density lipoprotein; FVLDL = fasting very low density lipoprotein.

208.2 ± 58.3 and 139.4 ± 82.8, respectively. The corresponding figures for HDL and LDL cholesterol were 47.4 ± 16.2 and 173.0 ± 63.1, respectively.

3.2. Black tea consumption and lifestyle characteristics

We then compared women in the highest versus lowest levels of tea intake. The characteristics of women according to tea consumption are shown in Table 2. Consumption of more

Table 2
Risk factors distribution for CHD by level of daily tea intake among Saudi women

	N0 N = 226 X ± SD* or %	Daily Tea Consumption		>6 cups[a] N = 209 X ± SD* or %
		1–3 cups[a] N = 994 X ± SD* or %	4–6 cups[a] N = 335 X ± SD* or %	
Mean age (years)	44.3 ± 11.1	42.6 ± 10.1	41.6 ± 9.4	40.7 ± 8.5
Age group (%)				
30–40 y	47.4%	52.7%	55.8%	60.8%
41–50 y	27.0%	27.6%	26.6%	25.3%
51–60 y	14.6%	13.4%	13.7%	12.0%
61–70 y	11.0%	6.3%	3.9%	1.9%
Smoking:				
Never	90.7%	88.5%	92.5%	88.5%
Former	0.5%	0.9%	1.2%	2.9%
Current	3.5%	2.7%	3.0%	3.8%
Passive	5.3%	7.9%	3.3%	4.8%
Oral contraceptives (yes)	43.0%	47.2%	52.1%	39.4%
Hypertension (yes)	14.6%	16.7%	11.1%	4.8%
Diabetes (Yes)	24.0%	20.1%	16.7%	8.7%
Family history (yes)	35.4%	28.1%	33.0%	49.5%
Anthropometric measurements				
Physical activity[b]	8.8 ± 15.2	8.7 ± 13.2	8.4 ± 12.6	10.2 ± 16.2
Body mass index (Kg/m^2)	30.2 ± 6.5	30.8 ± 6.0	30.4 ± 5.6	28.8 ± 6.9
Waist (cm)	90.9 ± 12.5	90.7 ± 12.0	90.5 ± 12.1	88.2 ± 12.7
Hip (cm)	105.6 ± 16.1	105.4 ± 16.7	103.7 ± 16.3	102.4 ± 15.2
Waist to hip ratio	0.88 ± 0.16	0.88 ± 0.18	0.89 ± 0.16	0.87 ± 0.15
Serum lipids[c]				
FTG (mg/dl)	144.9 ± 87.8	141.3 ± 81.0	138.3 ± 86.7	126.9 ± 78.1
FTC (mg/dl)	211.4 ± 53.1	209.6 ± 57.9	206.6 ± 63.8	201.0 ± 56.5
FHDL (mg/dl)	47.7 ± 16.1	47.5 ± 16.1	47.2 ± 15.6	47.1 ± 17.4
FLDL (mg/dl)	176.3 ± 58.7	174.4 ± 62.6	171.5 ± 69.5	165.0 ± 59.1
FVLDL (mg/dl)	12.7 ± 7.7	12.3 ± 7.1	12.1 ± 7.6	11.1 ± 6.8
LDL/HDL	4.2 ± 2.3	4.2 ± 2.3	4.1 ± 2.2	4.0 ± 2.1
Dietary habits				
Fruits & vegetables (F/wk)[d]	5.0 ± 2.3	5.1 ± 2.2	4.9 ± 2.3	3.5 ± 2.4
Eggs (F/wk)[d]	2.2 ± 2.7	2.5 ± 2.6	3.3 ± 3.6	3.5 ± 3.7
Red meat (F/wk)[d]	2.3 ± 1.4	2.5 ± 1.4	2.9 ± 1.6	2.2 ± 1.4
Fish (F/wk)[d]	1.2 ± 1.2	1.0 ± 1.1	0.8 ± 1.0	0.6 ± 1.1
Coffee (cups/day)[a]	4.4 ± 7.3	3.9 ± 4.9	4.8 ± 4.7	7.3 ± 7.1
Coffee (yes)	64.2%	83.6%	90.5%	93.3%
Olive oil (yes)	5.0%	6.4%	4.8%	1.5%
Butter (yes)	23.0%	13.4%	15.6%	21.1%

* Mean and standard deviation.

[a] One cup = 80 ml.

[b] Physical activity Score is calculated as the product of "frequency * intensity * duration."

[c] FTG = Fasting triglycerides; FTC = fasting total cholesterol; FHDL = fasting high density lipoprotein; FLDL = fasting low density lipoprotein; FVLDL = fasting very low density lipoprotein.

[d] Frequency of intake per week.

than six cups of black tea per day (>480 ml) was reported by 11.9% (209) of women. The heaviest tea drinkers were more likely to have a family history of hyperlipidemia, drink coffee and consume less fruits and vegetables. However, the heaviest tea drinkers were less likely to report treatment for blood pressure and diabetes mellitus (all $P < 0.05$).

Serum levels of TG ($P=0.02$), TC ($P=0.048$), LDL ($P=0.046$), and VLDL ($P=0.02$) were significantly lower in women drinking > 6 cups of tea per day compared to non tea drinkers.

3.3. Black tea consumption and serum lipids and lipoproteins

Tea drinkers of > 6 cups/day had an overall significant lower risk for hyperlipidemia (Table 3). Those who did drink more than 6 cups of tea (>480 ml) tea per day had a significantly lower prevalence of high TC (adjusted OR = 0.63; 95% CI = 0.41 –0.97), high TG (adjusted OR = 0.56; 95% CI = 0.35 –0.86), high LDL (adjusted OR = 0.70; 95% CI = 0.45 –1.07) and high VLDL (adjusted OR = 0.61; 95% CI = 0.39 –0.93) than the non-tea drinkers. Moreover, increased consumption of black tea was associated with decreased serum concentrations of TC (P for trend < 0.026) and TG (P for trend = 0.008) and with a decreased proportion of LDL and VLDL (P for trend = 0.015 and 0.011 respectively) after adjusting for age, education, family history, body mass index, smoking, physical activity, use of oral contraceptives, and coffee and fat intake. On the contrary, our data showed no significant association between black tea intake, HDL and LDL/HDL ratio.

4. Discussion

Antioxidant properties of dietary flavonoids have recently drawn considerable attention in the prevention of CHD [20–22]. 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 quercetin, kaepferol, myrecitin, and catechins in tea combined with the frequent consumption of this beverage.

Much of the treatment of hyperlipidemia for primary and secondary prevention of CHD centers on reduction of elevated serum TC and LDL levels because of the established association between CHD and this lipoprotein [23–25]. The relation between elevated TG and CHD has been less clear, and thus, the role of elevated TG as an independent CHD risk factor continues to be debated. However, emerging evidence points to an association between elevated plasma TG and CHD. This suggests that to achieve the greatest possible reduction in CHD risk, antihyperlipidemic prevention and treatment strategies should also be aimed at reducing elevated levels of plasma TG.

In this study, black tea consumption (> 480 ml/day) was associated with significant lower levels of serum TC, TG, LDL and VLDL in Saudi women. Geleijnse and co-workers [26] reported a significant, inverse association of black tea intake with severe aortic atherosclerosis. Odds ratios decreased from 0.54 (95% CI = 0.32-0.92) for drinking 125 to 250 ml (1-2 cups) of tea to 0.31 (95% CI = 0.16-0.59) for drinking more than 500 ml/d (4 cups per day). The associations were stronger in women than in men. The inverse associations remained statistically significant even after adjustment for dietary and other risk factors. Epidemiologic

Table 3
Odds ratios (OR) and 95% confidence intervals (95% CI) for serum lipids and lipoproteins by level of daily tea intake

Serum lipids	Saudi Females (n = 1764)		
	OR[1] (95% CI)	OR[2] (95% CI)	OR[3] (95% CI)
Cholesterol >200mg			
T1*	1	1	1
T2	0.91 (0.67–1.22)	0.96 (0.71–1.29)	0.87 (0.62–1.22)
T3	0.76 (0.53–1.06)	0.82 (0.58–1.16)	0.79 (0.53–1.16)
T4	0.64 (0.43–0.93)	0.72 (0.48–1.05)	0.63 (0.41–0.97)
P for trend	0.005	0.033	0.026
Triglycerides > 135mg			
T1*	1	1	1
T2	0.83 (0.62–1.11)	0.87 (0.64–1.16)	0.83 (0.60–1.16)
T3	0.78 (0.55–1.09)	0.83 (0.59–1.17)	0.77 (0.52–1.34)
T4	0.48 (0.32–0.71)	0.52 (0.35–0.78)	0.56 (0.35–0.86)
P for trend	0.000	0.002	0.008
Low density lipoproteins >160mg			
T1*	1	1	1
T2	1.03 (0.76–1.37)	1.10 (0.81–1.48)	1.08 (0.77–1.51)
T3	0.77 (0.54–1.08)	0.85 (0.59–1.20)	0.85 (0.57–1.25)
T4	0.68 (0.46–0.99)	0.77 (0.52–1.13)	0.70 (0.45–1.07)
P for trend	0.003	0.025	0.015
Very low density lipoproteins >10mg			
T1*	1	1	1
T2	1.05 (0.78–1.41)	1.12 (0.82–1.50)	1.07 (0.76–1.49)
T3	0.97 (0.68–1.36)	1.05 (0.74–1.49)	0.99 (0.67–1.46)
T4	0.62 (0.41–0.91)	0.62 (0.42–0.91)	0.61 (0.39–0.93)
P for trend	0.001	0.007	0.011
High density lipoproteins <40mg			
T1*	1	1	1
T2	1.00 (0.73–1.36)	1.00 (0.73–1.36)	1.01 (0.71–1.42)
T3	0.94 (0.65–1.34)	0.95 (0.65–1.35)	1.01 (0.67–1.52)
T4	1.20 (0.80–1.78)	1.21 (0.81–1.80)	1.20 (0.77–1.86)
P for trend	0.485	0.459	0.412
LDL/HDL ratio >5			
T1*	1	1	1
T2	1.05 (0.76–1.43)	1.11 (0.80–1.53)	1.25 (0.86–1.80)
T3	0.91 (0.63–1.32)	1.01 (0.69–1.46)	1.18 (0.77–1.81)
T4	0.85 (0.56–1.09)	0.97 (0.63–1.48)	1.04 (0.64–1.68)
P for trend	0.245	0.613	0.882

OR1: crude odds ratio;
OR2: adjusted for age,
OR3: adjusted for age, education, smoking, family history, fitness index, BMI, oral contraceptives, eggs intake, fat intake * Tea categories: T1 = no tea; T2 = 1–3 cups/day; T3 = 4–6 cups/day; T4 = > 6 cups/day

studies in Western countries have generally failed to show any association between black tea and serum TC. Only one study in Norway observed a significant negative association between the two in both men and women [13]. A non-significant negative association was reported in Israel [27] and the United States [28]. There was virtually no association between tea and serum total cholesterol in other studies in the United States [29–31], Israel [32], and

the United Kingdom [10]. 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 [33] and different ways of brewing [34,35] and drinking black tea in different populations.

In the past, the relation between hypertriglyceridemia and CHD has been uncertain. However, a large meta-analysis of 17 prospective trials [1] reported hypertriglyceridemia to be an independent risk factor for cardiovascular disease. In this study the univariate relative risks for triglycerides were 1.32 (95% CI 1.26-1.39) and 1.76 (95% CI 1.50-2.07), for men and women respectively, indicating an approximately 30% increased risk in men and a 75% increase in women. The corresponding rates were somewhat lower (14% and 37%) but still statistically significant after adjustment for HDL cholesterol level. The PROCAM [4] study showed that elevated TG was an independent risk factor for cardiovascular events with HDL values $<$50 mg/dl (1.29 mmol/l) and LDL$>$133 mg/dl (3.44 mmol/l). New data have recently emerged on gender specific differences in optimal serum lipoprotein levels. LDL serum levels increase progressively as women age and go through menopause, so that by the time women reach their 50s, their average LDL concentrations are higher than those of men of the same age [36]. There is ample evidence based on epidemiological studies and intervention trials demonstrating the importance of LDL [37–41]. Therefore, it is not surprising that the LDL level is the main lipid target for all therapeutic guidelines [5,42].

The association of black tea consumption with increased levels of serum HDL cholesterol or lower LDL/HDL ratio was not observed in this study. Although we cannot provide a clear explanation for this discrepancy, the overall level of serum HDL was high (47.4 $\pm$ 16.2) and LDL/HDL ratio (4.1 $\pm$ 2.2) was low among Saudi women, regardless of tea intake. The Framingham Heart Study showed that although HDL levels in men stay relatively static as they age, in women HDL decreases with aging [43]. Despite this, HDL levels in women averages around 10 mg/dl higher than in men throughout their lives, even after menopause [43].

Several important limitations of this study should be considered. Misclassification of beverage intake may have occurred. Neither subjects nor interviewers were aware of any specific study hypotheses, so we expect 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 women, we expect consumption to be limited to hot, caffeinated black tea. Because of the lack of detailed dietary information, we adjusted for a limited number of food items, but not for nutrients. High intake of saturated fat was reported to increase serum total cholesterol [44], and dietary fiber is known to reduce serum total cholesterol [45]. Our data showed that neither intake of red meat nor intake of fruits and vegetables was associated with serum lipid profiles. Moreover, the adjusted models included fat intake. The present study was based on a fairly large number of women who participated in the National Survey, thus, it is unlikely that the inverse associations between black tea and serum TC, TG, LDL and VLDL were due to selection bias. Alternatively, higher tea consumption may be a surrogate for a healthier lifestyle. Our data suggest that heavy tea drinkers differ from non-drinkers in term of health behaviors (more smoking, more coffee and less fat intake) and medical conditions (less hypertension and diabetes). Never-

theless, adjustment for neither coronary risk factors nor dietary factors changed the risk estimates.

In summary, the present cross-sectional study supports the hypothesis that black tea consumption reduces serum lipid concentration. Supplementing tea as beverage might react beneficially with other antiatherosclerotic strategies. Investigations on the hypolipidemic and antiatherosclerotic action of tea are still in their infancy and further fundamental data from controlled trials are needed to confirm a beneficial effect of black tea on serum lipid profile.

Acknowledgments

The National Coronary Artery Survey was funded by the Saudi Government. This publication was partially supported by a small grant from Unilever Health Institute, Vlaardingen, UNC, PO Box 114, 3130 AC Vlaardingen, The Netherlands.

I.A. Hakim designed the present study, performed statistical analyses and wrote the manuscript. M.A. Alsaif and A. Aloud participated in the quality control of the data entry and the preparation of the database. M. Alduwaihy, K.A. Al-Nuaim, and O.S. Al-Attas initiated and participated in the organization of the National study and were responsible for overseeing data collection and laboratory analyses.

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