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Lipoprotein metabolism and coffee intake – who is at risk?

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Lipoproteinmetabolismus und Kaffeekonsum – für wen besteht ein Risiko?*)

Summary: Data from a representative health and nutrition survey of German adults (sample of 1073 women and 806 men) were used to investigate the relationship between coffee consumption and the concentration of cholesterol in serum as well as other lipoprotein constituents. For these outcome variables multivariate analyses were conducted separately for men and women. Differences in age, body mass index, smoking habits, use of oral contraceptives, physical activity, alcohol, fish, fat, milk and tea consumption were controlled for in the models. Interactions between coffee drinking behavior and smoking habits as well as between coffee and the use of oral contraceptives in their relationship with serum cholesterol were of special interest in the analyses. Higher coffee intake (> 400 ml/d) showed higher total cholesterol, LDL cholesterol and lower triglyceride rich lipoprotein (TRL) and triglyceride concentrations in serum compared to lower intake (< 200 ml/d). Smoking appeared to be an aggravating factor in these relationships. Results of the linear regression analysis demonstrated an increase of 1.66 mg/dL LDL-C per cup of coffee daily consumed for men and of 1.58 mg/dL for women. The combination of high coffee intake, smoking and no oral contraceptive use ever was associated with the highest total and LDL-C and lowest TRL concentrations in this population. The observed differences may be explained by an increase of lipoprotein lipase activity due to coffee consumption.

Zusammenfassung: Unter Verwendung von Daten einer repräsentativen Gesundheits- und Ernährungsstudie über deutsche Erwachsene (1073 Frauen und 806 Männer) wurde der Zusammenhang von Kaffeekonsum und Serum-Cholesterinkonzentration und anderen Lipoproteinfraktionen geprüft. In multivariaten Modellanalysen, für Männer und Frauen getrennt durchgeführt, war für Alter, Body Mass Index, Rauchen, Gebrauch oraler Kontrazeptiva, sportliche Aktivität, Alkohol-, Fisch-, Fett-, Milch- und Teekonsum geprüft worden. Spezielles Interesse galt dem Einfluß von Rauchgewohnheiten sowie der Gebrauch oraler Kontrazeptiva auf die Beziehung zwischen Kaffeekonsum und den Serum-Lipidkonzentrationen. Im Vergleich zu geringer war höhere Kaffeezufuhr (> 400 ml/Tag) mit höheren

Abbreviation index:

C = cholesterol
LDL = low-density lipoprotein
HDL = high-density lipoprotein
TRL = triglyceride-rich lipoproteins
TG = triglycerides
OC = oral hormonal contraception
LPL = lipoprotein lipase

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Gesamt- und LDL-Cholesterin sowie niedrigeren triglyceridreichen Lipoprotein (TRL) und Triglycerid-Konzentrationen verbunden. Rauchen erwies sich in diesen Beziehungen als verstärkender Faktor. Die Ergebnisse der linearen Regression ergaben für Männer eine Erhöhung des LDL-Cholesterins um 1,66 mg/dL pro Tasse Kaffee, für Frauen eine Erhöhung um 1,58 mg/dL. In dieser Population war die Kombination von hohem Kaffeekonsum, Rauchen und bei Frauen der Nie-Gebrauch oraler Kontrazeptiva mit den höchsten Gesamt- und LDL-Cholesterin, sowie den niedrigsten TRL-Konzentrationen verbunden. Diese Befunde sind möglicherweise als Ergebnis erhöhter Aktivität der Lipoprotein-Lipase bei Kaffeekonsum interpretierbar.

Key words: Serum lipids – coffee consumption – smoking – oral contraceptives

Schlüsselwörter: Serum Lipide – Kaffeekonsum – Rauchen – Orale Kontrazeptiva

Introduction

A positive association of total serum cholesterol and coffee consumption has been shown in several recent studies (13, 19, 22). Although a direct relationship to CHD mortality has been suspected, this has yet not been confirmed. In the early 1980s the relationship between coffee consumption and serum cholesterol concentration was observed in epidemiologic studies in Scandinavia (6, 24). In other industrialized countries this association was also observed, but was not as strong as in the Scandinavian studies (14). Various investigators suspected this association to be due to confounders like nutrition, smoking, health behavior or other lifestyle factors (7, 9, 10, 18). Other authors did not find a relation between coffee consumption and serum cholesterol (5, 16). Results from recent clinical experiments, however, suggest a causal association between coffee consumption and serum cholesterol concentration (25).

Interactions with health behavior as observed in epidemiological studies still are relevant for health intervention. The determination of these interactions and identification of population groups at higher risk will gain importance as evidence is accumulating that coffee is an important determinant of serum cholesterol concentrations. Recently, it has been suggested that it is the brewing method that is important and, particularly, boiled coffee has a hypercholesterolemic effect (3). There is uncertainty about the magnitude of the effect in countries where mainly filtered coffee is consumed (13, 15).

The effects of coffee on other serum lipoprotein fractions have been reported for small study groups (2, 4, 17). These lipoprotein fractions need to be taken into account before a reliable evaluation of atherogenic risk due to coffee consumption can be made.

The recently obtained data from the German Health and Nutrition survey provide the opportunity to study the relationship between coffee and serum lipid and lipoprotein concentrations and to examine interactions with age, smoking habits and oral contraceptive use in a representative sample of about 2000 adults (18 to 88 years of age) from the Federal Republic of Germany. The data provided the opportunity to control for the influence of age, body mass index, smoking, dietary habits, physical activity and oral contraceptive use. We wanted to follow up on previous findings with more detailed analyses of particular risk groups, investigate the influence on serum apolipoproteins and triglycerides and examine the influence of oral contraceptive use and smoking on the coffee-serum lipid relationship.

Material and methods

Population sample

In 1987/88 the first national representative Health and Nutrition Survey was conducted in the Federal Republic of Germany (old states). A representative sample of the German population was drawn by a multistage multistratified random sample survey procedure (1). A total of 11.141 households participated in the study (response rate of 73.8 %). From the persons in these households, a random subsample was drawn, comprising 2179 participants 18 years of age and older. From these 7.9 % were lost, therefore a total of 2006 adults (1144 women and 862 men), between 18 and 88 years of age were investigated. Dietary and other lifestyle habits were assessed using self-administered 7-day dietary and activity protocols and an extensive questionnaire (8). No information was available about type of coffee or specific methods of preparation.

Biochemical analysis

Blood was drawn from the participants before they had broken their overnight fast. All samples were processed for the preparation of serum within 2 h and stored chilled or frozen until analysis. Lipoprotein analyses using fresh serum were completed within 48 h after venipuncture. Cholesterol and triglyeride concentrations in serum and in lipoprotein fractions were analyzed using enzymic assays (CHOD-PAP method for cholesterol, GPO-PAP method for triglycerides). The triglyceride rich lipoproteins (TRL) were separated from lipoproteins with higher density by micro-ultracentrifugation (d = 1,006 kg/L, 3 h at 4 °C) (11). The TRL fraction comprises very low-density lipoproteins (VLDL), β-VLDL, chylomicrons and chylomicron remnants. Apolipoprotein B containing lipoproteins was precipitated with phosphotungstic acid/$MgCl_2$ from the bottom fraction and the supernatant was used for high-density lipoprotein (HDL) measurement. Lipid concentrations in low-density lipoproteins (LDL) were calculated by difference (12). Serum concentrations of apolipoproteins A-I, A-II and B were measured using and end-point immunoturbidimetric method (21). Serum lipoprotein and apolipoprotein concentrations were available from 1073 women and 806 men.

Statistical analysis

All statistical analyses were conducted separately for men and women. Pregnant (n=11) and breast-feeding (n=6) women were excluded from the analyses. The final data set comprised a population without major disturbances.

Multiple regression models and univariate analysis of covariance were used to analyze the relationship between coffee consumption and serum concentrations of total cholesterol, LDL-C, HDL-C, TRL, apolipoprotein A-I, A-II and B and triglycerides, respectively. To compare to former models (13), we controlled for the following covariates: age (years), body mass index (kg/m^2), smoking status (currently, previously, never), alcohol (g/day), milk (ml/day), tea (ml/day), fish (g/day), decaffeinated coffee (ml/day) and fat consumption (g/day), total energy intake (kcal/day), physical activity (hours/day) and for women use of oral hormonal contraceptives (currently, previously, never). Persons with missing values for these data were excluded from the analyses. Starting with these basic models, we used stepwise regression analysis to exclude nonconfounding variables in the relationship between coffee consumption and the various blood lipid parameters. The final models were controlled for age, BMI, smoking and, in women, additionally for milk and decaffeinated coffee consumption.

Influence of smoking habits on the relationship between coffee and serum lipids were investigated by introducing interaction terms into the models and by running models for current smokers, former and nonsmokers separately. In a similar way the interaction with oral contraceptive use was analyzed in the female population. In addition, the relationship between coffee and serum lipids was investigated for different age groups, because we suspected interaction with hormonal changes due to menopause and increasing age. Women under the age of 45 were considered premenopausal (n=638).

For the presented figures, the adjusted mean levels of blood lipid parameters were calculated using analysis of variance (ANOVA) models (PROC GLM in SAS). For analysis of variance, coffee consumption was categorized into groups of low and high coffee consumption (less than 200 ml/d and more than 400 ml/d). Statistical analyses were performed using SAS (version 6.04) for PC (20).

Results

Descriptive statistics for men and women are presented in Table 1. Overall, most coffee drinkers consumed two to three cups of coffee per day. In women, mean serum concentrations of HDL-C and apolipoprotein A-I were higher than in men. Men, on the other hand, had higher mean concentrations of TRL, apolipoprotein B and triglycerides, drank more alcohol, consumed more fat and had a higher mean body mass index. A greater percentage of men was currently or formerly smoking as of women.

Tab. 1. Characteristics of the study population

Variables	Men Mean (n=806)	±Std Dev	Women Mean (n=1073)	±Std Dev
Total-C (mg/dL)	211.43	± 44.94	215.29	± 46.67
LDL-C (mg/dL)	145.10	± 39.03	148.38	± 41.48
HDL-C (mg/dL)*	40.45	± 9.97	47.33	± 10.96
TRL (mg/dL)*	25.88	± 21.42	19.60	± 15.75
Apolipoprotein B (mg/L)*	840.85	±195.19	811.13	±193.60
Apolipoprotein A-I (mg/L)*	1263.18	±165.01	1365.51	±163.64
Apolipoprotein A-II (mg/L)	385.73	± 61.83	384.80	± 61.03
Triglycerides (mg/dL)*	131.35	±123.13	102.70	± 72.41
Age (years)	43.77	± 16.14	42,93	± 15.30
Coffee consumption (ml/d)	387.48	±290.08	400.63	±255.97
Tea consumption (ml/d)	84.97	±186.00	82.98	±185.33
Alcohol consumption (g/d)*	23.00	± 22.42	9.44	± 12.51
Fat consumption (g/d)	104.71	± 36.02	81.81	± 28.54
Body Mass Index (kg/m)*	25.59	± 3.63	24.54	± 4.56
Physical activity (hrs/d)	0.18	± 0.40	0.19	± 0.47
Current smokers (%)	44.8		38.0	
Former smokers (%)	27.1		18.1	
Non smokers (%)	28.1		43.9	
Oral contraceptives				
Current users (%)	–		18.6	
Former users (%)	–		43.0	
Never users (%)	–		38.4	

* t-test $p < 0.05$

The frequency distributions of daily coffee consumption of smokers, former smokers and nonsmokers showed that both male and female smokers tended to drink more cups of coffee per day than nonsmokers. For the frequencies of men and women who had stopped smoking no trend with coffee intake was observed. The frequency distribution of coffee consumption by use of oral contraceptives showed that former and never-users tended to be more often in the groups with higher coffee consumption than current users.

The results of the linear regression analysis demonstrated a significant relationship between coffee and serum LDL-C concentration for both men and women (Table 2). For men an increase in LDL-C of 1.66 mg/dL was found to be attributable to the daily consumption of one cup of coffee; for women this effect was calculated to be 1.58 mg/dL. Linear regression analysis for total serum cholesterol predicted an increase of 1.73 mg/dL for each cup of coffee consumed for men.

Tab. 2. Regression coefficients of LDL cholesterol [mg/dL] for men and women

	Men (n=794)	Women (n=1017)
	Regr.coeff.(B) ±SE of B	Regr.coeff.(B) ±SE of B
Independent variables:		
Age (years)	0.66 ± 0.09***	1.30 ± 0.10***
Alcohol (g/d)	0.01 ± 0.07	–0.27 ± 0.09**
BMI (kg/m²)	0.24 ± 0.39	0.34 ± 0.27
Coffee (cups/d)	1.66 ± 0.73*	1.58 ± 0.71*
Decaff.coffee (cups/d)	1.41 ± 2.30	–1.32 ± 2.68
Energy (kcal/d)	–0.01 ± 0.00**	–0.002 ± 0.004
Ex-smoker (dichotomous)	2.51 ± 3.66	–2.51 ± 3.22
Fat (g/d)	0.17 ± 0.07*	0.06 ± 0.08
Fish (categorial)	1.08 ± 1.98	2.21 ± 1.68
Milk (categorial)	–0.16 ± 0.33	–0.75 ± 0.28**
Sport (hrs/d)	–4.07 ± 3.32	–0.04 ± 2.40
Smoker (dichotomous)	6.06 ± 3.26	7.03 ± 2.79*
Tea (cups/d)	0.00 ± 0.01	0.00 ± 0.01
constant	109.10 ± 11.83***	81.36 ± 9.66***
	R^2=0.12	R^2=0.27

* $p < 0.05$
** $p < 0.01$
*** $p < 0.001$

Results of the covariance analyses (Table 3) showed significantly higher concentrations in mean total and LDL-C (Figs. 1 and 2) concentrations with higher coffee intake in both genders (adjusted for age, BMI, smoking and for women additionally for milk and decaffeinated coffee consumption). Furthermore, significantly lower serum TRL and triglyceride concentrations with higher intake levels were observed in women, but not in men. No relationships between coffee and HDL-C, apolipoprotein A-I, A-II and B concentrations in serum was found in either gender.

Tab. 3. Serumlipids [mg/dL] and lipoproteins [mg/L] by low (<200 ml/d) and high (>400 ml/d) coffee consumption

	Low coffee consumption (observed)	(adjusted*)	High coffee consumption (observed)	(adjusted*)	p (F)
Men	n=222		n=356		
Total-C	204,8	206,0	216,7	215,5	p=0,008
LDL-C	139,1	140,0	150,4	149,6	p=0,002
HDL-C	40,1	40,1	40,2	40,2	p=0,848
TRL	25,6	26,0	26,1	25,7	p=0,838
Apo B	822,9	828,1	857,9	852,8	p=0,112
Apo A-I	1255,3	1255,8	1256,9	1256,4	p=0,965
Apo A-II	386,3	386,0	382,9	383,2	p=0,593
TG**	130,7	132,6	129,0	127,1	p=0,506
Smokers	n=82		n=179		
Total-C	202,1	203,4	219,5	218,2	p=0,009
LDL-C	138,3	139,2	154,5	153,6	p=0,004
HDL-C	38,1	37,9	38,8	38,9	p=0,389
TG	137,2	140,4	135,6	132,3	p=0,527
Former smokers	n=61		n=99		
Total-C	214,6	214,4	221,5	222,0	p=0,277
LDL-C	145,5	145,3	149,8	149,9	p=0,456
HDL-C	40,8	41,0	42,2	41,9	p=0,571
TG	144,7	141,9	137,9	140,6	p=0,948
Nonsmokers	n=79		n=78		
Total-C	199,9	204,0	203,9	199,8	p=0,512
LDL-C	134,9	138,2	142,1	138,8	p=0,907
HDL-C	41,8	41,4	40,8	41,1	p=0,837
TG	113,1	118,6	102,6	97,2	p=0,026
Women	n=240		n=522		
Total-C	207,4	210,1	218,0	215,3	p=0,011
LDL-C	139,9	141,9	151,7	149,7	p=0,008
HDL-C	46,6	46,8	47,5	47,3	p=0,518
TRL	20,8	21,4	18,9	18,3	p=0,007
Apo B	791,2	800,2	817,2	808,1	p=0,567
Apo A-I	1353,3	1355,9	1372,4	1369,8	p=0,301
Apo A-II	381,0	380,9	384,1	384,2	p=0,491
TG	111,2	114,1	98,6	95,8	p=0,001
Smokers	n=73		n=228		
Total-C	192,0	199,3	211,1	203,8	p=0,408
LDL-C	126,9	132,9	148,8	142,9	p=0,046
HDL-C	44,7	44,6	43,9	44,0	p=0,721
TRL	20,4	21,8	18,3	16,9	p=0,002
TG	113,6	120,2	98,5	91,9	p=0,001

	Low coffee consumption (observed)	(adjusted*)	High coffee consumption (observed)	(adjusted*)	p (F)
Former smokers	n=36		n=99		
Total-C	200,8	213,2	217,8	205,4	p=0,401
LDL-C	131,2	141,8	149,8	139,2	p=0,752
HDL-C	48,0	47,9	50,3	50,4	p=0,284
TRL	21,6	23,4	17,6	15,8	p=0,013
TG	114,5	122,7	93,2	85,0	p=0,005
Nonsmokers	n=131		n=195		
Total-C	217,8	218,8	226,3	225,2	p=0,171
LDL-C	149,6	149,9	155,9	155,5	p=0,194
HDL-C	47,3	47,3	50,2	50,2	p=0,014
TG	109,0	112,7	101,5	97,8	p=0,084
OC+	n=53		n=69		
Total-C	191,2	194,7	190,3	186,7	p=0,166
LDL-C	123,2	125,5	123,2	120,0	p=0,389
HDL-C	49,7	49,8	49,6	49,5	p=0,902
TG	108,5	112,5	101,2	97,2	p=0,180
Former OC+	n=60		n=171		
Total-C	188,7	191,3	198,3	195,7	p=0,481
LDL-C	126,8	128,8	136,6	134,6	p=0,301
HDL-C	46,1	46,6	46,2	45,7	p=0,578
TG	85,3	85,6	81,1	80,6	p=0,637
Never OC+	n=23		n=34		
Total-C	168,5	170,8	197,6	195,3	p=0,039
LDL-C	111,8	114,2	137,8	135,4	p=0,073
HDL-C	43,4	42,8	43,9	44,6	p=0,589
TG	70,5	73,5	83,6	80,6	p=0,513

* adjusted for age, BMI, smoking and, in women, additionally for milk- and decaffeinated coffee consumption
** triglycerides
\+ women <45 years

In a next step, the interaction of smoking behavior on the relationship of coffee and serum lipids was analyzed (Table 3). Figures 1 and 2 present the adjusted mean values of LDL-C by low and high coffee consumption and smoking habits. For male smokers there was a positive relationship between total serum and LDL-C and amounts of coffee consumed. The trend for former smokers was weaker, for the male nonsmoking group no relationship between coffee and total or LDL-C was observed. For female smokers LDL-C concentration was significantly higher in the higher coffee consumption group and triglyceride and TRL concentrations were significantly lower. For female non-smokers the relationships between coffee and serum total-, LDL-C and triglyceride concentrations were similar to the ones of the smokers. The concentration of HDL-C was significantly higher in the higher coffee consumption group. For former female smokers no significant relationship between total, LDL-C or HDL-C and coffee consumption

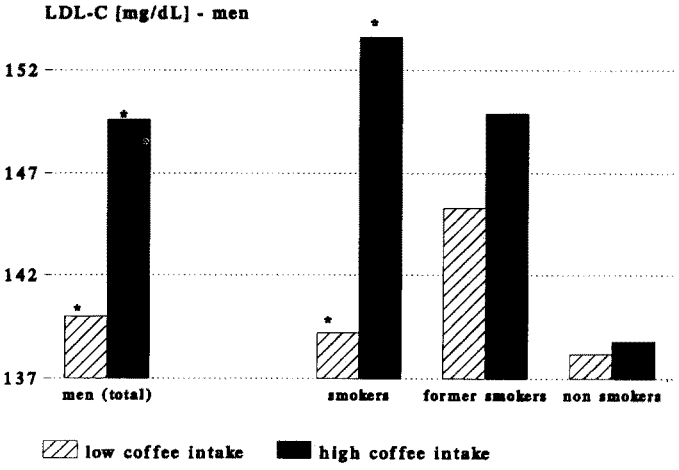

Fig. 1. LDL cholesterol concentration [mg/dL] in serum for men. Adjusted (for age, BMI and smoking) mean values by low (<200 ml/day) and high (>400 ml/day) coffee intake for all men (n=578) and for smokers (n=261), former smokers (n=160) and non smokers (n=157).
Asterisks mark significant differences between lipid parameter and coffee consumption at the $p<0.05$ level.

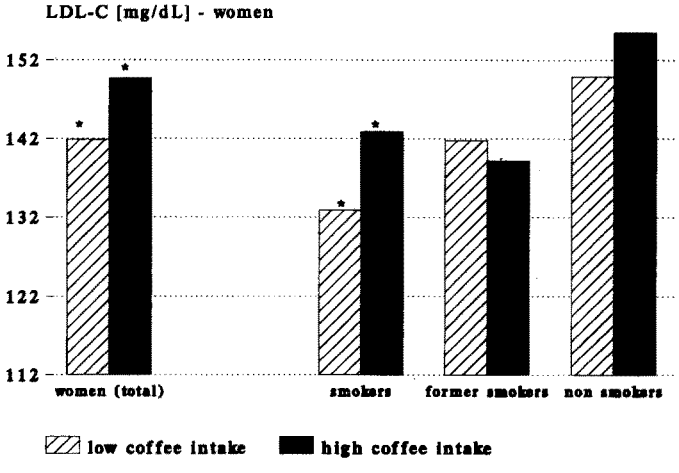

Fig. 2. LDL cholesterol concentration [mg/dL] in serum for women. Adjusted (for age, BMI, milk-, decaffeinated coffee consumption and smoking) mean values by low (<200 ml/day) and high (>400 ml/day) coffee intake for all women (n=762) and for smokers (n=301), former smokers (n=135) and non smokers (n=326).
Asterisks mark significant differences between lipid parameter and coffee consumption at the $p<0.05$ level.

was seen. Triglyceride and TRL concentration were significantly lower in the higher coffee consumption group.

High coffee consumption was associated with higher LDL-C concentration and this relationship was stronger for smokers.

For women additional analyses were carried out using analysis of covariance by oral hormonal contraception (never/formerly/currently using OC). Only women less than 45 years of age were included. The heavy coffee drinkers in the group of the ones who never had used OC showed higher total and LDL-C concentrations (Fig. 3) than women of the low coffee consumption group. For women currently or formerly using OC no significant relationship between coffee intake and serum lipids was observed.

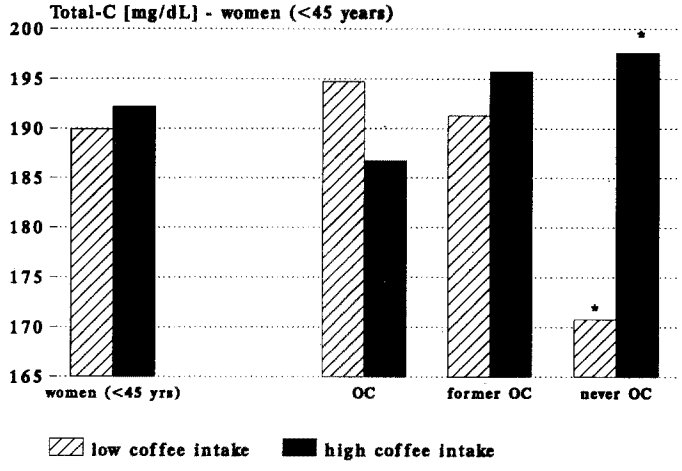

Fig. 3. Total cholesterol concentration [mg/dL] in serum for women less than 45 years of age. Adjusted (for age, BMI, milk-, decaffeinated coffee consumption and smoking) mean values by low (<200 ml/day) and high (>400 ml/day) coffee intake for all women less than 45 years (n=411) and for women currently (n=122), formerly (n=231) and never using oral hormonal contraception (OC, n=57).
Asterisks mark significant differences between lipid parameter and coffee consumption at the $p<0.05$ level.

Discussion

Many studies have investigated the effect of coffee on lipid metabolism in humans (4, 13, 19) and the greater part of them found higher serum cholesterol concentrations with higher coffee consumption. The difference was greatest in countries where mainly boiled coffee was consumed (2, 6, 10). In Germany, where the predominant brewing method is with the use of commercial paper filters higher serum cholesterol concentrations with higher coffee intakes have been observed as well (13, 15). This relationship seemed to be stronger and more consistent in men than in women. In Table 4 a synopsis with the results from two earlier German studies and from our current one is presented. Our results confirm the previous findings. Coffee consumption in our study was positively associated with higher concentrations of cholesterol and LDL-C and lower concentrations of TRL and triglycerides. Because the difference in total cholesterol was almost solely due to a corresponding difference in the atherogenic LDL-C (no significant differences in HDL-C), the HDL/LDL cholesterol quotient was more unfavorable in respect to car-

Tab. 4. German studies in which the relationship between coffee consumption and serum cholesterol has been investigated
(Regression coefficient of independent variable: coffee in cups/day and significance level)

Study	Population [mmol/L Serum]	Total cholesterol [mmol/L Serum]	LDL cholesterol
1) 1991 (data from 1983/84)	*men:*		
Berlin-Heidelberg-	18–24 yrs.(n=124)	0.109 $p<0.05$	0.104 $p<0.05$
Michelstadt study (12)	65–74 yrs.(n=126)	–0.088 NS	–0.094 NS
n=780, 3 German areas	*women:*		
	18–24 yrs.(n=152)	0.031 NS	0.010 NS
	65–74 yrs.(n=139)	–0.008 NS	0.025 NS
	controlled for: BMI, sports, fish-, milk-, fat-, alcohol-, tea intake, age, smoking, oral contraceptive use		
2) 1992 (data from 1987–89)	*men:*		
German Cardiovascular	25–69 yrs.(n=2550)	0.026 $p<0.001$	
Prevention study (15)	*women:*		
n=4595, nat. representative	25–69 yrs.(n=2245)	0.010 NS	
	controlled for: BMI, sports, milk-, tea-, fat-, alcohol intake, liquid intake, age, smoking, exsmoking, oral contraceptive use, diastolic bp		
3) 1992 (data from 1987–88)	*men:*		
VERA study (nutrition survey	18–88 yrs.(n=794)	0.045 $p<0.05$	0.043 $p<0.05$
& risk factor analysis)	*women:*		
n=2006, nat. representative	18–88 yrs.(n=1017)	0.026 NS	0.041 $p<0.05$
	controlled for: BMI, sports, fish-, milk-, tea-, fat-, alcohol intake, age, smoking, exsmoking, oral contraceptive use, energy		

diovascular risk in people with higher coffee consumption. The observed differences in TRL and triglycerides may be useful for the assessment of underlying biochemical changes. Strong associations between serum lipid fractions and coffee consumption were seen among smokers and among females who had never used oral contraceptives. Reasons for this could be an influence on the hypothetical mechanism, interaction with a cholesterol-raising factor in coffee, differences in coffee drinking style (stronger coffee, other trade or preparation methods) or differences in other lifestyle habits not controlled for.

In contrast to these earlier results, however, the currently observed relationship between coffee and LDL-C was also significant for women. Other studies did not take into account menopausal status. We controlled for hormonal status by stratifying women by age. Women under the age of 45 were considered premenopausal. Young women appeared to be more sensitive to the lipid-raising effect of coffee than older women or men of any age. Oral hormonal contraceptive use (OC) was considered also. Women who had never used OC showed higher total and LDL-C concentrations and were more sensitive to coffee consumption in its effect on serum lipids that women using OC.

There were consistent differences between participants with low and high coffee intakes in respect to total, LDL-C, TRL and triglycerides. Smoking appeared to be an aggravating factor. The combination of smoking, high coffee consumption and the never used OC status (in women) was associated with the highest total, LDL-C and lowest TRL and triglyceride concentrations in this population.

With increasing coffee intake the ratio of triglyceride rich lipoproteins to cholesterol rich lipoproteins was shifted to a catabolically more processed, high cholesterol pattern, i.e., with higher coffee consumption higher LDL-C and lower TRL and triglyceride concentrations were found. This could indicate an accelerated breakdown of triglyceride-rich particles related to high coffee intakes. Other investigators (23) actually observed an increase of lipoprotein lipase (LPL) activity induced by a short-term increase of coffee consumption. Higher LPL activity is known to accelerate hepatic uptake of TRL remnants. This, in turn, stimulates the down regulation of hepatic LDL receptors. The ensuing reduction of LDL clearance is the underlying reason for higher LDL cholesterol concentrations (Fig. 4). This hypothesis should be investigated in detail, because understanding of the underlying mechanism may be an important step in the prevention of cardiovascular diseases.

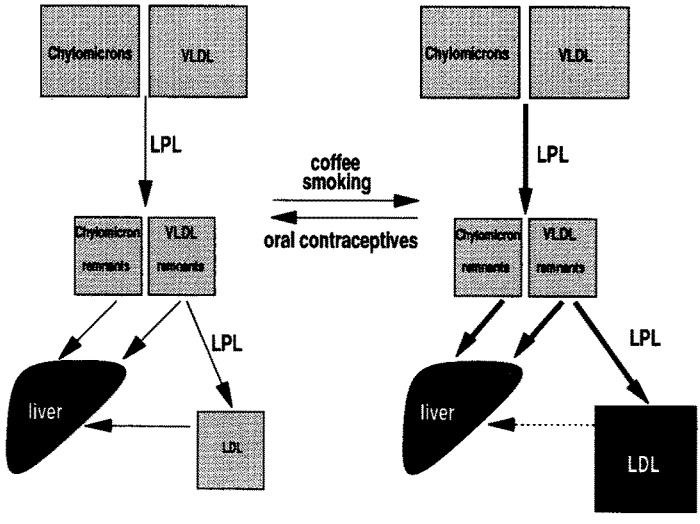

Fig. 4. This figure shows the schematic representation of the hypothetical breakdown of chylomicrons and the very low-density lipoproteins (VLDL). The width of the arrows is proportional to the rate of conversion of the respective lipoprotein fraction. The figure on the left represents the situation with normal lipoprotein lipase (LPL) activity. The figure on the right shows the situation with elevated LPL activity: here, the accelerated hepatic uptake of VLDL remnants brings about the down regulation of hepatic LDL receptors. The ensuing reduction of LDL clearance results in higher LDL cholesterol concentrations. Higher amounts of coffee consumption and smoking was related to the situation of elevated LPL activity (picture right) while the use of oral hormonal contraceptives was related to normal LPL activity (left).

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