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Prevalence of risk factors of coronary heart disease in Turks living in Germany: The Giessen Study

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Abstract

Turkish people represent the majority of immigrants in Germany. Even though a high proportion of Turks has been living in Germany since about 20 years, little is known about risk factors of coronary heart disease (CHD) in this population. In this study a sample of 325 male and 155 female Turks are investigated, who voluntarily underwent a health check-up in Germany. Data about the presence of CHD, risk factors and blood parameters were collected. Mean residence time was 21 and 17 years (males/females). A low percentage of female participants was observed compared to the general Turkish population in Germany. Age adjusted prevalence of CHD reached 9.5% in males and 6.7% in females, respectively. Dyslipoproteinemia (DLP) showed the highest prevalence of all risk factors investigated in both genders. Total cholesterol (TC) levels were comparable to those of other western countries and remarkably higher than reported for the population in Turkey. Besides this, low high density lipoprotein-cholesterol (HDL-C) and apolipoprotein A-I (ApoA-I) levels could be found in the majority of the sample. The highest odds ratios for CHD were estimated for stress and hypertension in males and obesity in females. It is concluded that Turkish immigrants in Germany showed an assimilation of lipid pattern to western populations. However, reasons for low HDL-C levels remain unclear. Changes in the lipid metabolism chiefly seem to contribute to the risk factor pattern of Turkish immigrants in Germany. © 1999 Elsevier Science Ireland Ltd. All rights reserved.

Keywords: Coronary heart disease; Cross-sectional study; Emigrants; Epidemiology; Health status; Lipids; Risk factors; Turks

Abbreviations: ApoA-I, apolipoprotein A-I; ApoA-II, apolipoprotein A-II; ApoB, apolipoprotein B; BMI, body mass index; CHD, coronary heart disease; DLP, dyslipoproteinemia; ECAT, European Concerted Action on Thrombosis and Disabilities; ECG, electrocardiography; Fbg, fibrinogen; HbA1c, hemoglobin A1c; HDL-C, high density lipoprotein cholesterol; LDL-C, low density lipoprotein cholesterol; Lp(a), lipoprotein (a); MONICA, Monitoring of Cardiovascular Disease Study; NCEP, National Cholesterol Education Program; NIH, National Institute of Health, Bethesda, DC, USA; OR, odds ratio; PROCAM, Prospective Cardiovascular Münster Study; PVD, peripheral vascular disease; TC, total cholesterol; TG, triglycerides; WHO, World Health Organization; ZI, Zentralinstitut für die kassenärztliche Versorgung in der BRD, Köln.

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1. Introduction

Coronary heart disease (CHD) is the most important cause of death in the industrialized countries. Epidemiological studies brought evidence for a tight linkage between the appearance of CHD and distinct concurrently occurring factors [1]. The major risk factors of CHD, i.e. diabetes mellitus, hypertension, smoking, and dyslipoproteinemia (DLP), are influenced both by environmental and genetic factors.

Evidence for genetically determined susceptibility for CHD is derived in particular from migration studies. Indians, for instance, are susceptible for the manifestation of glucose intolerance, DLP and, subsequently, for CHD. A marked increase in CHD was observed after migration of Indians to more industrialized regions such as Great Britain or Singapore [2–4].

Interest was focused on the Turkish population, which showed both a remarkable migration within Turkey from rural towards urban regions and a high migration rate to more industrialized countries like Germany during the past three decades.

Since the early 1960s a continuous migration of Turkish people to Germany occurred. These Turks, in the beginning predominantly males, underwent a physical examination by German physicians in Turkey before emigration. Thus, Turks migrating to Germany were a healthy, young population between the ages 20 and 30 at the time of immigration. In 1994 about 1 900 000 Turks [5] lived in Germany, including wives having followed their husbands, and their offspring.

In the 1980s there was increasing evidence that the prevalence and incidence of CHD increased dysproportionally in this population as compared to those Turks remaining in Turkey [6]. Angiographical findings also brought evidence for an earlier onset of CHD and a more severe disease in Turks living in Germany as compared to Germans (unpublished observations of the authors). A few years ago the first valid data concerning CHD morbidity rates of the Turkish population in Turkey were published [7]. Yet, there are no data available concerning the incidence of CHD and its risk factors in the general population of Turks living in Germany.

Investigators in Turkey and Germany found low high density lipoprotein-cholesterol (HDL-C) levels in Turks independent of their geographic origin or socio-economic status as a possible predisposing factor for CHD [8,9]. In addition, a positive correlation between socio-economic status and total cholesterol (TC) levels was observed in Turkey [10]. In keeping with this observation, it was reported that meat consumption is significantly higher in urban regions in Turkey. A survey of alimentary habits of Turks living in Berlin, which is known for having a high percentage of Turkish people, found a 4-fold higher intake of meat compared to those living in Turkey [11].

A cross sectional study was conducted to obtain data about the risk factor status of Turks living in Germany. For this purpose a sample of 480 Turks older than 34 years were investigated, who voluntarily participated in a health check-up program provided by the German health authorities (so-called Check-up ’35) [12]. The survey was performed within a period of 2 years. All examinations were mainly considered as a primary prevention emphasizing the detection of CHD, diabetes mellitus, renal disease and DLP. The Check-up ’35 program was initiated in 1989 by German health authorities providing examinations in 2-year intervals. Within the first 2 years only 20% of all entitled Germans underwent this examination indicating the poor interest of the general population in primary prevention. All data concerning the Check-up ’35 are collected by the ‘Zentralinstitut für die kassenärztliche Versorgung in der BRD’ (ZI), Köln and published every 2 years [13].

2. Materials and methods

2.1. Survey design

A cross sectional study was designed in order to investigate the prevalence of CHD and concomitant risk factors. During a period of 2 years 25 Turkish and German general practitioners with a high percentage of Turkish patients from different parts of Germany participated in the survey. Within this time frame complete data of 480 Turkish people, undergoing the health check-up were collected. Examinations and questionnaires were identical with the Check-up ’35 protocol provided by German health authorities [14]. Interest was focused on those data providing information about the prevalence of risk factors. The check-up forms included clinical data concerning acknowledged risk factors such as hypertension (defined as systolic blood pressure >160 mmHg and/or diastolic blood pressure >95 mmHg), diabetes mellitus, smoking, hypercholesterolemia, family history of CHD, obesity (defined as body mass index (BMI) >30 kg/m^2), physical inactivity and stress.

The examining physicians were not obliged to follow a standardized diagnostic code concerning the diagnosis of CHD by the check-up protocol, but they had to decide on the basis of patient history, physical examination and electrocardiography (ECG), whether they diagnosed a patient as a possible CHD patient, and to make arrangements for further examinations or therapy, respectively. By following this procedure for diagnosing CHD our data became comparable to the results published by the ZI for the German population [13].

Besides the standardized examination forms provided by the ZI for all practitioners in Germany demographic information was documented on a separate form sheet including data about origin in Turkey and date of immigration. Completeness and correctness of all documents were checked by monitors.

2.2. Laboratory analysis

For laboratory analyses, blood was drawn in sitting position after a 12 h fasting period and immediately sent to a central laboratory. TC, triglycerides (TG), blood glucose, creatinine and uric acid were determined by a Technicon Dax auto-analyzer (Technicon Instruments, Tarrytown, USA) using Technicon Omnipak® reagents (TC by CHOD-PAP, TG by GPO-PAP method). For HDL-C and low density lipoprotein-cholesterol (LDL-C) measurement a TE-CAN™ (SLT Instruments Deutschland GmbH, Crailsheim, Germany) was used (HDL-C after precipitation with phosphotungstate and Mg^{2+} [15], LDL-C after precipitation with heparin [16]). For both methods precipitation kits were purchased from Merck, Darmstadt, Germany. Lipoprotein (a) Lp(a), apolipoprotein A-I (ApoA-I), apolipoprotein A-II (ApoA-II) and apolipoprotein B (ApoB) levels were determined by electroimmunodiffusion [17,18] (Sebia, Issy-les-Moulineaux, France), fibrinogen (Fbg) by a Behring 100 Nephelometer (Behringwerke, Marburg, Germany). Lp(a), ApoA-I, ApoA-II and ApoB values were examined in a subset of 400 randomly selected individuals, and Fbg levels in 277 participants, respectively.

Individuals were defined as dyslipoproteinemic when LDL-C was > 160 mg/dl and/or TG were > 250 mg/dl and/or HDL-C was < 35 mg/dl, according to the cut-off points of the National Cholesterol Education Program (NCEP) [19] and the National Institute of Health, Bethseda, DC (NIH) consensus conference [20]. Because there are no cut-off levels established for ApoA-I and ApoB indicating a higher risk for developing CHD, we arbitrarily defined cut-off points for ApoA-I < 100 mg/dl, and for ApoB as > 100 mg/dl, which corresponds to the recommendations of Cooper et al. [21].

2.3. Statistical analysis

Statistical analyses were carried out using the software packages SPSS and SAS. Means were compared by ANOVA after introducing age as covariate and log transformation of the variable, if the test for Gaussian distribution failed. Variables with a skewed distribution are shown as median and 5th–95th percentile, respectively. Age adjusted odds ratios (OR) were calculated by logistic regression analysis to evaluate validity of risk factors. A P-value < 0.05 was considered as significant. In order to generate comparable, standardized results CHD prevalence was adjusted to the World Health Organization (WHO) criteria by using the world standard population weights [22] of 12/31, 11/31 and 8/31 for the age groups 35–44, 45–54 and 55–64 years.

Table 1
Relative distribution (%) in geographical origin from Turkey in male and female Turkish health check-up participants in Germany

Part of Anatolia	Males ($n = 325$)	Females ($n = 155$)
Middle	36.3	38.7
West	23.4	27.1
East	14.8	15.5
North	10.2	10.3
South	5.8	1.3

3. Results

3.1. Demographic data

More than 50% of the Turkish population studied originated from the western (Marmara and Egean region) and the middle parts of Anatolia with a high portion of people coming from urban regions. Turks from other parts of Anatolia, which are known to be more conservative, represented a minority (Table 1).

A total of 97.5% of the male and 85.8% of the female Turks had lived in Germany for more than 10 years. The average residence time since immigration was 21 years in males and 17 years in females, respectively. As shown in Table 2, all demographic parameters except weight significantly differed between males and females. Because Turkish women were on the average 12 cm shorter than Turkish males, the resulting BMI differed significantly between genders, too.

A comparison of the age distribution between the Turkish population in Turkey and in Germany is presented in Table 3. As expected, according to the historical background, the 45–54 age group prevailed in Turks in Germany, who also contributed to about 50% of all participants. In comparison, the 45–54 years of

Table 2
Demographic parameters (median, 5th–95th percentile) in male and female Turkish health check-up participants in Germany

	Males	Females
n (%)	325 (67.7)	155 (32.3)
Age in years*	50.5 (37.0–61.0)	48.0 (37.0–61.0)
Age in years at immigration*	29 (16–39)	31 (15–46)
Time in years since immigration*	21 (12–28)	17 (5–27)
Weight (kg)	78 (62–97)	76 (59–96)
Height (cm)*	170 (159–178)	158 (149–172)
BMI (kg/m²)*	27.1 (22.3–33.6)	29.7 (22.0–38.9)

* $P < 0.001$.

Table 3
Comparison of the relative distribution (%) of age and gender between the general population of Turks in Turkey, in Germany and the surveyed Turkish health check-up participants

	Turks in Turkey [47] age ≥ 35 years ($n = 554.7 \times 10^3$)		Turks in Germany [47] age ≥ 35 years ($n = 13951.1 \times 10^3$)		Health check-up participants ($n = 480$)	
	Males	Females	Males	Females	Males	Females
Distribution of genders (%)	49.3	50.7	55.9	44.1	67.7	32.3
Age group						
35–44	36.5	35.1	29.9	44.8	17.2	36.1
45–54	29.5	28.6	47.7	39.9	57.2	40.6
55–64	20.1	19.8	20.2	12.9	22.8	21.9
>64	13.9	16.6	2.2	2.4	2.8	1.3

age group in Turkey represent only about 29% of the population. The opposite situation was observed in the >64 years group. While about 15% of the population in Turkey are older than 64 years, the low percentage of approximately 2% in this age group in Germany reflects the proportion of Turks in Germany in the general population. A tendency towards increasing demand for preventive care was observed with increasing age in both genders.

The distribution of gender showed that male check-up participants prevailed as compared to both males in the general population of Turks in Germany and in Turkey. Consequently, the percentage of Turkish females in Germany was less compared to Turkey and only reached a proportion of 32% in the check-up group.

3.2. Prevalence of CHD

History, physical examination and ECG yielded 10.4% ($n = 33$) male and 6.5% ($n = 10$) female Turks (age 35–64 years) with clinically suspected CHD (Table 4). After adjusting for age according to WHO criteria [22] CHD prevalence reached 9.5 and 6.7% in males and females, respectively. Prevalence of CHD was 3-fold higher in men and 2-fold higher in women in the 55–64 age group when compared to the 45–54 age group. In most of the CHD cases (70%) the disease was already diagnosed before the check-up visit. Percentage of newly diagnosed CHD was 31.4% ($n = 11$) and 30.0% ($n = 3$) in males and females. Symptoms and signs of peripheral vascular disease (PVD) were noted in seven (2.2%) male and one (0.6%) female participant.

3.3. Risk factors of CHD

3.3.1. Diabetes mellitus

The prevalence of diabetes mellitus was higher in females in all age groups as compared to males (Table 5). An age dependent increase of the prevalence was observed reaching 12.2 (males) and 14.6% (females) in the 55–64 year age group when compared to the youngest age group (3.6 and 7.1%). OR of CHD could only be estimated in males (Table 6) as no CHD cases were reported in female participants due to the small sample size. In males, OR was calculated to be 3.05 ($P < 0.01$) before adjustment for age. However, after adjustment for age the OR decreased to 2.51 and lost significance ($P = 0.06$). The prevalence of diabetes mellitus showed a high dependency on BMI levels. There was a 3-fold higher percentage of diabetics in the obese group (BMI > 30) as compared to the group with normal weight (BMI < 25, Table 9).

Glucose levels and HbA1c levels were more unfavorable in female diabetics (glucose 154 ± 48 mg/dl in males vs 182 ± 76 mg/dl in females; hemoglobin A1c (HbA1c) 8.0 ± 1.9 vs 9.3 ± 3.1%, respectively), but without significant difference between genders. Significant differences were found in Lp(a) levels in males only. In contrast, ApoB levels were significantly higher in female diabetics, whereas differences were marginal in males. Diabetics showed a tendency towards higher TG levels as compared to non-diabetics in both genders.

3.3.2. Hypertension

Mean values for systolic and diastolic blood pressure were 132 and 84 mmHg in both genders. Overall, the prevalence of hypertension was 12.2 and 10.2% in males and females, respectively. The age dependent increase of blood pressure resulted in a prevalence of 20.3 and 23.5% in males and females, respectively, in the 55–64 year age group (Table 5). Since age dependency was obvious, in particular in females, the age adjustment markedly reduced their OR for CHD (Table 6) from 4.4 ($P = 0.03$) to 2.8 ($P = 0.19$). Obese males showed a three-fold higher percentage of hypertension when compared to normal male participants, whereas in females prevalence of hypertension only slightly differed between BMI categories (Table 9). Fibrinogen was strongly correlated with blood pressure leading to significantly higher fibrinogen levels in male participants with hypertension (Table 8). Even though differences were more pronounced in females the level of significance was not reached, probably due to the small sample size.

3.3.3. Smoking

As expected, smoking was much more frequent in males (41.9 vs 13.0% in females). In the 35–44 year age group in particular, more than 50% of males smoked (Table 5). The percentage of smokers constantly decreased with increasing age. Women showed no age dependency in smoking habits and, in contrast to males, the prevalence of smoking was lowest in the youngest age group (10.7%). Smoking did not appear to be a risk factor of CHD (Table 6). In women, the OR reached 1.76, but failed statistical significance. Mean values of blood parameters neither differed in men nor in women between smokers and nonsmokers. Among the laboratory parameters evaluated, HDL-C, ApoA-I and fibrinogen in particular were not negatively affected by smoking.

3.3.4. Obesity and physical inactivity

As shown in Table 2 the median of BMI was 29.7 in women versus 27.1 in men. Turkish women showed a remarkably high prevalence of obesity (BMI > 30). In 47.6% of the females body mass index exceeded 30, even though physical inactivity by questionnaire was not as frequent as in males (29 vs 35%). Only 15.5% of all females had a normal body weight (BMI < 25). The majority (55.9%) of males ranged between 25 and 30 with their BMI and therefore had to be considered as overweight. The 95th percentile of BMI was 38.9 in females and 33.6 in men. The prevalence of obesity continuously increased with age in men in parallel with physical inactivity by self assessment. There was a rather uniform distribution among all age groups in women which also paralleled physical activity by questionnaire.

Eight of ten females with clinically or suspected CHD belonged to the obese group. OR of obesity as a risk factor was highest among all parameters evaluated in women (5.8; $P < 0.05$).

Table 9 shows the interdependency between BMI and the clinical and laboratory parameters. Diabetes mellitus, hypertension, physical inactivity and hyperuricemia were apparently positively associated with obesity in both genders. Smoking showed a very clear inverse impact on BMI.

The ApoB concentrations were significantly higher in the obese group in men only (Table 8). Even though ApoA-I steadily decreased in women with increasing BMI, the mean values did not differ significantly. Consistently, a tendency to lower HDL-C and higher TG levels was also detectable in obese women. No obvious correlation could be found between BMI levels and hyperfibrinogenemia.

3.3.5. Family history of CHD

A family history of CHD was reported in 15.7% males and 22.4% females of the surveyed population. No impact of this parameter could be shown on CHD. A tendency towards a lower percentage of a positive family history was observed in women with increasing age. TC, TG, HDL-C, and LDL-C levels were slightly more unfavorable in men. LDL-C tended to be higher in female subjects with a positive family history.

3.3.6. Stress

Stressful situations in daily life were reported in 15.4 and 14.8% male and female participants, respectively (Table 5). A strong association between stress and CHD was suggested by an age adjusted OR of 3.0 ($P < 0.01$) in men, whereas women showed no such evidence. Interestingly, stress by self administered questionnaire was more frequent in the older age groups (20.3% of males and 20.6% of females).

Table 4
Prevalences of definite or suspected coronary heart disease (CHD) broken down by age in male and female Turkish health check-up participants in Germany

Age groups	Males			Females		
	Total	Cases with suspected or definite CHD		Total	Cases with suspected or definite CHD	
	n	*n*	%	*n*	*n*	%
35–44	56	1	1.8	56	1	1.8
45–54	186	15	8.1	63	4	6.3
55–64	74	17	23.0	34	14	14.7
Total	316	33	10.4	153	10	6.5
Adjusted prevalence			9.5			6.7

Table 5
Prevalence (%) of risk factors and pathological laboratory data broken down by age groups in male (m) and female (f) Turkish health check-up participants in Germany

	35–64 years (age adjusted)		35–44 years		45–54 years		55–64 years	
Count (*n*)	m (316)	f (153)	m (56)	f (56)	m (186)	f (63)	m (74)	f (34)
Diabetes mellitus	7.8	9.9	3.6	7.1	9.1	9.5	12.2	14.7
Hypertension	12.2	10.3	7.1	3.6	11.8	7.9	20.3	23.5
Smoking	41.8	13.0	51.8	10.7	37.6	14.3	32.4	14.7
Obesity (BMI >30)	21.4	47.6	12.7	48.2	23.5	51.6	31.5	41.2
Physical inactivity	34.7	29.1	26.8	30.4	37.1	25.4	43.2	32.4
Familial history of CHD	15.7	22.4	17.9	28.6	17.7	19.0	9.5	17.6
Stress	15.4	14.8	12.5	7.1	15.1	19.0	20.3	20.6
Dyslipoproteinemia	82.7	59.9	82.1	55.4	85.5	63.5	79.7	61.8
TC >240 mg/dl	36.6	37.5	30.9	25.0	44.5	40.0	34.3	52.9
TG >250 mg/dl	26.0	20.5	20.8	22.6	35.4	17.5	20.9	21.4
HDL-C <35 mg/dl	73.4	46.9	73.6	45.3	68.9	49.1	79.1	46.4
LDL-C >160 mg/dl	55.9	45.6	52.8	37.7	63.1	50.9	50.7	50.0
ApoA-I <100 mg/dl	47.6	31.0	51.2	27.9	44.8	38.8	46.2	25.0
ApoB >100 mg/dl	35.0	26.7	25.6	18.6	40.6	24.5	41.5	41.7
Lp(a) >30 mg/dl	16.1	16.1	20.9	16.3	11.5	18.4	15.4	12.5
Fibrinogen >450 mg/dl	56.3	59.6	50.0	58.6	54.5	52.6	68.3	70.6
Glucose >140 mg/dl	3.8	6.6	0.0	5.4	4.8	6.3	8.1	8.8
Hyperuricemia[a]	9.7	8.9	10.9	1.8	9.3	14.5	8.5	11.8

[a] Defined as uric acid >7.0 mg/dl in men and >6.0 mg/dl in women, respectively.

3.3.7. Laboratory parameters

Categorizing all individuals with LDL-C levels > 160 mg/dl and/or TG > 250 mg/dl and/or HDL-C < 35 mg/dl as dyslipoproteinemic revealed an extremely high percentage (82.7% males and 59.9% females) of individuals showing this pattern (Table 5). Low HDL-C levels mainly contributed to this findings in men (73.4%), whereas Turkish women showed comparable prevalence of low HDL-C (46.9%) and LDL-C levels < 160 mg/dl (45.6%).

Mean values of all laboratory parameters are shown in Table 7. The peak level of LDL-C was reached within the 45–54 year age group in males, while in females LDL-C levels continuously increased throughout all age groups. As a consequence of the rather unfavorable LDL-C and HDL-C levels both the TC/HDL-C and the LDL-C/HDL-C ratios were elevated, especially in males even though the prevalence of elevated TC levels did not reflect the elevation of LDL-C. A mild hypertriglyceridemia was associated with the obvious hypoalphalipoproteinemia. While HDL-C levels were negatively correlated with TG, the ApoA-I concentration constantly remained on a low level. These interactions between lipoprotein parameters resulted in a prevalence of 34.1% of males and 21.0% of females with a high risk lipoprotein pattern, defined as TG > 200 mg/dl and LDL-C/HDL-C > 5 [23].

LDL-C and Lp(a) levels significantly differed between male CHD cases and controls (data not shown). In females only, uric acid discriminated CHD cases, and significance remained even after adjustment for age and BMI levels. Neither HDL-C nor ratios of lipoproteins could discriminate between CHD cases and healthy individuals.

Fibrinogen levels were clearly elevated in the majority of the participants. Almost 60% of all Turks showed fibrinogen levels exceeding 450 mg/dl. The highest prevalence was found in the 55–64 year age group, where nearly 70% of all Turks showed hyperfibrinogenemia. Mean fibrinogen levels differed more in men between the control and the CHD group, [median and 5th–95th percentile: 474 (278–646) vs 520 (317–662) mg/dl], these differences, however, were not significant. A small sample size might be responsible for this finding. In women, corresponding values were 458 (87–639) and 497 (442–576) mg/dl in controls as compared to CHD cases respectively.

As low fibrinogen levels counteracted the OR of LDL-C and vice versa, low LDL-C levels outweighed the effect of a high fibrinogen level.

The greatest impact on fibrinogen levels was found in Turks with hypertension (Table 8). In this subset of participants a positive correlation was found in regression analysis between fibrinogen and both systolic and diastolic blood pressure (data not shown).

3.4. Risk factor pattern

Fig. 1 illustrates the interaction of the four most prominent risk factors, i.e. diabetes mellitus, hypertension, smoking, and DLP. There was a marked gender specific difference in the prevalence of participants devoid of all four risk factors. While in approximately 30% of the females none of these risk factors could be found, only 8% of the males showed this pattern. On the other hand, about 40% of all individuals studied had to be classified as dyslipoproteinemic irrespective of gender, but did not show any of the three remaining risk factors. The interaction of two risk factors was highest for the combination of DLP and smoking in both genders. The simultaneous occurrence of three risk factors was seen with a prevalence of about 3% in both genders.

4. Discussion

Several epidemiological studies in different ethnic groups showed an increase of morbidity and mortality rates in individuals migrating from developing countries with a lower prevalence of CHD to more industrialized regions [2–4,24,25]. For instance, in Indians migrating to the UK, the USA and other countries with advanced economic status a genetically caused low glucose tolerance seemed to lead to a more frequent manifestation of diabetes, which was consecutively associated with higher morbidity rates due to CHD.

Americans of Japanese origin belonged to a population with lower risk of CHD before migration. The adoption to the alimentary habits of the American population highly contrasted to the rather vegetarian cuisine of Japan with fish as the main source of protein intake. As a consequence CHD incidence also rose in American Japanese, even though unfavorable genetics were not a predisposing factor as was the case in the Indian population migrating to Western countries [25].

As Turks migrated in significant numbers to Germany and other countries in Western Europe an epidemiological investigation of commonly established risk factors of CHD seems to be interesting and relevant in this distinct population after migration. By adopting the study questionnaire to that of a primary prevention program (Check-up '35) conducted by the German health authorities our data became comparable to those obtained for the native German population. Data of about 7.8 million documented check-up visits in Germany were available within the time period of the present survey [13]. Thus, in addition to get information about the health status and risk factors of CHD in Turks living in Germany, the opportunity was given to compare two different ethnic populations exposed to a similar environment in terms of socio-economic status and general living conditions.

4.1. Aspects of integration

The Turkish people in the study reported a mean residence time of more than 10 years in Germany. This should have led to a high grade of integration and adoption to life style in Germany, associated with common problems of economic well-being like increasing consumption of meat. The positive correlation be-

Table 6
Age adjusted coronary heart disease (CHD) odds ratios (OR) and 95% confidence intervals (CI) of risk factors in male and female Turkish health check-up participants in Germany

	Males				Females			
	OR	95% CI	χ^2	*P*-value	OR	95% CI	χ^2	*P*-value
Diabetes mellitus[a]	2.52	(0.90–6.41)	3.485	0.062	–	–	–	–
Hypertension	1.00	(0.34–2.55)	0.000	0.996	2.82	(0.52–12.46)	1.712	0.190
Smoking	0.98	(0.44–2.06)	0.004	0.950	1.86	(0.26–8.60)	0.534	0.465
Obesity (BMI >30)	1.61	(0.76–3.58)	1.743	0.187	5.84	(1.34–41.12)	4.484	0.034
Physical inactivity	0.57	(0.24–1.24)	1.857	0.414	0.95	(0.19–3.67)	0.006	0.938
Familial history of CHD	0.93	(0.30–2.43)	0.020	0.889	1.09	(0.16–4.91)	0.011	0.916
Stress	2.96	(1.31–6.48)	7.131	0.008	1.32	(0.19–5.91)	0.108	0.742
Dyslipoproteinemia[b]	0.80	(0.34–2.14)	0.227	0.634	1.40	(0.36–6.83)	0.216	0.642
TC >240 mg/dl	2.03	(0.97–4.29)	3.532	0.060	0.29	(0.04–1.28)	2.174	0.140
TG >250 mg/dl	0.73	(0.29–1.66)	0.517	0.472	2.29	(0.45–9.81)	1.180	0.277
HDL–C <35 mg/dl	0.94	(0.42–2.26)	0.022	0.883	2.61	(0.64–13.21)	1.652	0.199
LDL-C >160 mg/dl	1.48	(0.69–3.36)	0.967	0.325	0.81	(0.19–3.29)	0.087	0.769
ApoA-I <100 mg/dl	0.99	(0.44–2.22)	0.001	0.974	1.70	(0.36–7.94)	0.453	0.500
ApoB >100 mg/dl	1.22	(0.54–2.77)	0.231	0.974	1.19	(0.22–6.49)	0.039	0.844
Lp(a) >30 mg/dl	1.51	(0.46–4.20)	0.550	0.459	0.62	(0.03–4.39)	0.163	0.686
Fibrinogen >450 mg/dl	1.59	(0.49–6.08)	0.552	0.458	2.88	(0.41–57.68)	0.857	0.355

[a] No cases with CHD in women with diabetes mellitus were observed.

[b] Dyslipoproteinemia (DLP) was defined as low density lipoprotein-cholesterol (LDL-C) >160 mg/dl and/or triglycerides (TG) >250 mg/dl and/or high density lipoprotein-cholesterol (HDL-C) <35 mg/dl.

Table 7
Mean values of laboratory parameters in male and female Turkish health check-up participants in Germany[a]

	Total		35–44 years		45–54 years		55–64 years	
	Males ($n=316$)	Females ($n=153$)	Males ($n=56$)	Females ($n=56$)	Males ($n=186$)	Females ($n=63$)	Males ($n=74$)	Females ($n=34$)
TC	234 (47)	228 (42)	225 (37)	213 (43)	238 (46)	233 (40)	233 (53)	241 (39)
TG*	195 (93–498)	161 (68–392)	190 (190–511)	150 (62–365)	196 (93–534)	169 (74–414)	189 (98–345)	173 (82–537)
HDL-C	32.4 (8.5)	37.2 (11.9)	31.3 (8.5)	35.5 (9.3)	32.4 (8.4)	39.1 (15.4)	33.2 (8.9)	37.0 (7.2)
LDL-C	171 (46)	159 (43)	164 (42)	151 (43)	173 (44)	162 (44)	170 (56)	168 (41)
TC/HDL-C	7.7 (0.1)	6.6 (0.2)	7.7 (0.3)	6.5 (0.3)	7.8 (0.2)	6.6 (0.3)	7.5 (0.3)	6.7 (0.3)
LDL-C/HDL-C	5.7 (0.1)	4.7 (0.2)	5.6 (0.3)	4.7 (0.3)	5.7 (0.2)	4.7 (0.3)	5.5 (0.3)	4.8 (0.3)
ApoA-I	104 (23)	112 (28)	98 (20)	108 (17)	107 (25)	113 (34)	101 (20)	121 (29)
ApoB	96 (27)	89 (27)	90 (19)	83 (30)	98 (29)	89 (26)	94 (26)	98 (24)
Lp(a)*	9.2 (1–51)	9.5 (1–62)	10.7 (1–59)	7.9 (2–94)	9.2 (1–41)	9.2 (1–52)	8.3 (1–51)	11.5 (1–41)
Fibrinogen*	474 (278–656)	461 (92–636)	453 (278–646)	459 (351–581)	469 (278–621)	457 (72–649)	493 (254–754)	463 (300–641)
Glucose	89 (30)	94 (42)	79 (16)	92 (44)	90 (33)	93 (38)	95 (28)	99 (50)
Uric acid	5.3 (1.3)	4.4 (1.3)	5.3 (1.4)	4.0 (1.0)	5.3 (1.4)	4.6 (1.3)	5.3 (1.3)	4.5 (1.5)

[a] Values are shown in mg/dl ± standard deviation (S.D.).
* Parameters which are medians (5th–95th percentile).

Table 8
Comparison of means in lipids, lipoproteins, apolipoproteins, Lp(a) and fibrinogen in male and female Turkish health check-up participants according to risk factors[a]

		n	TC	TG*	HDL-C	LDL-C	Lp(a)*	Fibrinogen*	ApoA-I	ApoA-II	ApoB
Males											
Diabetes mellitus	Yes	28	235 (45)	218 (99–614)	33 (10)	168 (43)	13 (2–45)	466 (72–576)	107 (20)	23 (6)	99 (18)
	No	288	234 (46)	185 (93–483)	32 (8)	171 (46)	8 (1–53)	475 (287–656)	104 (23)	22 (5)	95 (27)
Hypertension	Yes	43	243 (49)	205 (84–498)	34 (8)	175 (48)	13 (1–43)	500 (394–631)[b]	104 (21)	22 (4)	99 (26)
	No	273	233 (46)	191 (96–497)	32 (9)	170 (46)	8 (1–55)	466 (274–656)	104 (23)	21 (5)	95 (26)
Smoking	Yes	123	237 (43)	194 (91–498)	32 (8)	173 (43)	7 (1–50)[b]	474 (254–637)	101 (22)	21 (6)	97 (28)
	No	193	232 (48)	196 (95–496)	33 (9)	169 (48)	11 (1–56)	481 (292–671)	106 (24)	22 (5)	95 (25)
Obesity	Yes	72	231 (43)	223 (95–531)	33 (9)	166 (39)	7 (1–55)	467 (319–616)	102 (17)	21 (5)	98 (29)[b]
	No	244	235 (47)	184 (93–483)	32 (8)	172 (48)	10 (1–55)	475 (274–656)	104 (24)	22 (5)	94 (25)
Physical inactivity	Yes	114	233 (52)	195 (93–483)	35 (9)[c]	170 (52)	8 (1–59)	478 (319–671)	107 (27)[b]	21 (5)	97 (29)
	No	202	235 (42)	194 (99–531)	31 (8)	171 (43)	10 (1–50)	474 (243–631)	102 (20)	22 (6)	94 (24)
Family history of CHD	Yes	50	239 (47)	207 (105–531)	32 (8)	174 (46)	6 (1–55)	486 (308–646)	99 (18)	21 (6)	93 (21)
	No	266	233 (46)	187 (93–483)	33 (9)	170 (46)	10 (1–55)	474 (278–656)	105 (24)	22 (5)	96 (27)
Stress	Yes	52	236 (42)	177 (93–400)	32 (8)	172 (39)	12 (1–33)	504 (254–637)	106 (23)	20 (5)[b]	92 (25)
	No	264	234 (47)	198 (95–511)	32 (9)	170 (47)	8 (1–55)	474 (278–656)	104 (23)	22 (5)	96 (27)
Females											
Diabetes mellitus	Yes	15	229 (40)	191 (116–537)	37 (7)	167 (45)	14 (4–102)[b]	421 (92–577)	115 (28)	24 (6)	107 (42)[b]
	No	138	227 (42)	157 (68–365)	37 (12)	158 (43)	9 (1–53)	462 (87–639)	112 (28)	23 (6)	86 (24)
Hypertension	Yes	16	228 (33)	186 (125–329)	33 (6)	155 (35)	6 (2–41)	538 (462–606)	103 (12)	20 (3)	94 (20)
	No	122	227 (43)	157 (68–392)	38 (12)	159 (44)	10 (1–62)	457 (87–639)	114 (29)	24 (6)	88 (28)
Smoking	Yes	20	245 (49)[b]	176 (63–638)	37 (14)	167 (48)	13 (1–66)	438 (72–634)	109 (27)	24 (9)	95 (29)
	No	133	225 (40)	159 (69–329)	37 (12)	158 (42)	10 (1–61)	462 (266–639)	113 (28)	23 (6)	88 (27)
Obesity	Yes	74	224 (40)	164 (73–392)	35 (7)	155 (25)	11 (2–94)	462 (87–639)	109 (23)	23 (6)	90 (31)
	No	79	231 (44)	162 (68–365)	39 (15)	163 (45)	7 (1–61)	459 (300–607)	116 (31)	24 (7)	87 (24)
Physical inactivity	Yes	44	224 (42)	168 (84–418)	38 (14)	151 (42)	10 (1–62)	468 (72–634)	114 (35)	23 (7)	90 (31)
	No	109	229 (42)	157 (63–392)	37 (11)	162 (43)	9 (2–61)	458 (275–638)	112 (25)	24 (6)	88 (26)
Family history of CHD	Yes	37	228 (40)	151 (63–365)	36 (10)	167 (45)	13 (2–62)	510 (72–667)	108 (18)	23 (4)	88 (23)
	No	116	227 (43)	166 (69–392)	37 (13)	157 (42)	8 (1–61)	457 (284–636)	114 (30)	24 (7)	88 (29)
Stress	Yes	23	235 (37)	191 (74–338)	37 (9)	167 (42)	10 (0–61)	466 (87–606)	116 (21)	23 (4)	103 (46)[b]
	No	130	226 (43)	157 (67–414)	37 (12)	158 (43)	10 (1–66)	461 (92–639)	112 (29)	23 (7)	86 (23)

[a] Values are shown in mg/dl ± standard deviation (S.D.).
[b] $P<0.05$;
[c] $P<0.001$, indicating differences between presence and absence of risk factors.
* Parameters which are geometric means (5th–9th percentile).

tween meat intake and income indicates that the Turkish cuisine providing meat as a common component is less affected by considerations about health when a comparison is made with other more industrialized countries.

On the other hand, the German health system provides more opportunities for preventive care than in Turkey. However, information about this subject is rare among Turks, who are not familiar with the public health system in Germany. Participation rates for check-up examinations are not available for Turks living in Germany, but it is not very likely that they would exceed those of Germans (approximately 20%) even though risk factor levels and CHD prevalence appear to be comparable. An increasing demand on preventive care in older people is observed, which is a common phenomenon also seen in the native German population [13]. The low rate of Turkish women participating in the present check-up was unexpected. Perhaps, the different cultural tradition explains the low participation rate of female Turks in this survey. German women, in comparison, came to the check-up examinations more often than German men.

Table 9
Prevalence (%) of body mass index (BMI) associated variables in Turkish men (m) and women (f) according to levels of BMI

	BMI <25		BMI 25–30		BMI >30	
	m (*n* = 69)	f (*n* = 24)	m (*n* 181)	f (*n* = 56)	m (*n* = 74)	f (*n* = 75)
Age (mean ± S.D.)	48 (7)	47 (8)	50 (6)	49 (8)	52 (6)	48 (7)
Diabetes mellitus	5.9	4.2	7.3	7.1	16.2	13.5
Hypertension	5.9	8.3	12.9	7.1	21.6	13.5
Smoking	48.5	25.0	39.9	14.3	28.4	8.1
Physical inactivity	29.4	8.3	36.0	32.1	40.5	32.4
Hyperuricemia[a]	9.0	4.2	9.6	9.1	12.2	11.0
Dyslipoproteinemia	75.5	54.2	87.1	53.6	81.1	67.6
TC >240 mg/dl	31.3	50.0	42.7	36.4	36.5	32.9
TG >250 mg/dl	17.2	19.0	30.9	22.9	36.6	19.7
HDL-C <35 mg/dl	68.3	19.0	72.6	54.2	70.4	49.3
LDL-C >160 mg/dl	50.8	50.0	61.3	41.7	54.3	46.5
ApoA-I <100 mg/dl	51.8	11.1	46.3	28.6	41.0	38.6
ApoB >100 mg/dl	35.7	44.4	37.5	16.7	37.7	26.3
Fibrinogen >450 mg/dl	53.1	41.7	58.6	67.7	59.1	59.5

[a] Defined as uric acid >7.0 mg/dl in men and >6.0 mg/dl in women, respectively.

4.2. CHD

When comparing the results of the present study to data of CHD prevalence in Turkey including urban regions of Turkey, Turks living in Germany appear to have a higher CHD morbidity. The age-adjusted prevalence of CHD reported by Onat et al. [7] for 35–64-year-old male Turks in Turkey was 5.8% for men and 5.0% for women, respectively. In the survey the prevalence of CHD in Turkish men was comparable to that found in the male German check-up population [13] aged 35–64 years (10.5% in both). Slightly lower prevalence of CHD in this age group was diagnosed in Turkish women in comparison to female Germans (7.2 vs 6.5%). After adjusting for differences in age distributions CHD prevalence of male Turkish check-up participants prevailed with 9.5 versus 8.5% in Germans. The corresponding results in women were 6.7% in Turks and 5.6% in Germans. Thus, Turkish women predominated mainly because of their slightly higher CHD prevalence in the two lower age groups. Analysis of single decades also revealed differences among age groups. The age depending increase in prevalence of CHD was steeper in Turks resulting in slightly higher prevalence rates in the 45–54 years decade in men (8.1% Turks vs 7.9% Germans) and women (6.3% Turks vs 5.1% Germans). In the 55–64 years decade this increase continued more obviously in males (23.0% Turks vs 18.8% Germans) than in females compared to German check-up participants (14.7% Turks vs 13.1% Germans). The peak of the German population suffering from CHD is located beyond the age of 65 years. This age is not reached by most of the Turkish participants, yet. These findings were in agreement with angiographical observations of an earlier onset of CHD in the majority of Turkish men as compared to Germans (unpublished observations of the authors). Extrapolating the slope of CHD prevalence could lead to the assumption that inequality in morbidity rates of comparable age groups will further spread, when the percentage of elderly Turks will increase during the next years.

4.3. Smoking

Smoking is a widespread habit among various populations of developing countries [26]. Especially in young Turkish men a high percentage of current smokers is found. With respect to findings in Turkey [27], however, higher prevalence rates were expected in the cohort. The attitude towards smoking in middle-aged

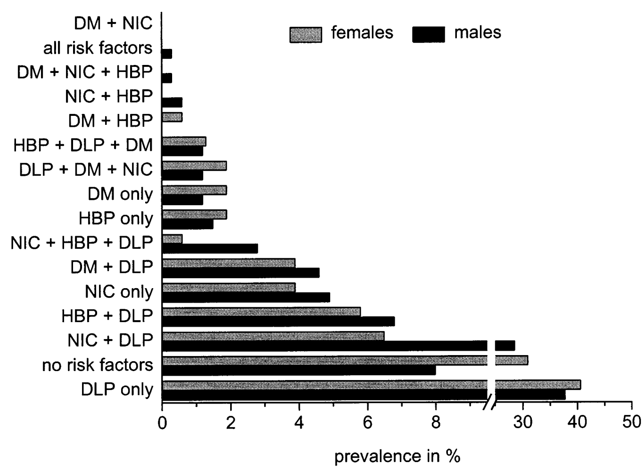

Fig. 1. Prevalences of risk factor pattern (DM, diabetes mellitus; NIC, tobacco consumption; HBP, hypertension; DLP dyslipoproteinemia) in male and female Turkish health check-up participants in Germany.

Turkish women (35–44 years) in Germany strongly differed from that of female Germans of the same age group, who tend to adopt the smoking habits of male Germans. Turkish women of the age group 35–44 years smoked less compared to the two older decades. Data of a survey in Turkey regarded smoking as a risk factor of borderline significance [27]. Unfortunately, the check-up forms did not provide information about ex-smokers. This lack of information might be responsible for the apparent ‘benefit’ of smoking suggested by the low OR for smoking in men.

4.4. Hypertension

Hypertension rates have been shown to be relatively low in Turkey [27]. This is also in keeping with our findings. Data of German check-up participants corresponded to those of the German Monitoring of Cardiovascular Disease Study (MONICA) centers with a prevalence of about 25% without gender specific differences [28]. Compared to the prevalences of the MONICA study, which comprises mainly European regions, Turkish cohorts would range in the lowest quintile of MONICA populations. Thus, it seems that there are population specific differences which even persist under comparable environmental conditions.

4.5. Obesity

The Framingham Study established obesity as an independent risk factor for CHD, especially in women [29], which was also observed in this study. In accordance with data from Turkey [27], obesity proved to be the most important risk factor in Turkish women. Obesity was the risk factor accompanied with a remarkable impact on the prevalence of CHD in women. However, the validity of these results is diminished by the small sample size. In fact, no cases of CHD were observed in non-obese women. The distribution of body fat, i.e. the appearance of a visceral obesity, is known to be more predictive for the development of vascular disease [30]. Unfortunately, it was not possible to collect data for waist to hip ratio, for example. Therefore, it is impossible to judge whether the clusters of additional risk factors found especially in Turkish women with a BMI >30 should be summarized as a so-called metabolic syndrome with visceral obesity as the main pattern of body fat distribution. Although the association with hypertension and diabetes mellitus was higher in males, diabetes in women slightly predominated because of the high prevalence of obesity. Interestingly a high percentage of younger women exhibited signs of diabetes. Diabetes mellitus seems to be a more serious problem among Turkish women with a 30% higher prevalence compared to German individuals [13], most likely because of its relationship to obesity. When looking for reasons besides alimentary aspects one has to take into consideration a higher birth rate and less susceptibility for ideals of beauty demanded by the Western fashion magazines. The influence of smoking on body weight was inverse in both men and women and probably also contributed to higher BMI in women, because Turkish women did not smoke. One should be aware that lower BMI caused by smoking counteracts the benefit of having a desirable weight [31]. This environmental influence might be worsened by a genetically determined predisposition towards obesity [32] and should be further elucidated by appropriate investigations.

In men the association between diabetes and CHD could clearly be proved, which is also the main risk factor in male Turks in Turkey [27].

4.6. Stress

Psychological factors seemed to play an important role as well. Despite the rather subjective way of classifying individuals as permanently exposed to stress, a marked psychosomatic component, especially in male Turks in Germany, has already been described by other authors [33].

4.7. Fibrinogen

This is the first study reporting fibrinogen levels in Turks. Several studies confirmed fibrinogen to be an independent risk factor for CHD [34,35]. In this study concentrations of fibrinogen were remarkably higher than those reported for other populations [36]. Although the data represent the results of a cross-sectional study, the same counteracting interaction could be found between LDL-C and fibrinogen as described in the European Concerted Action on Thrombosis and Disabilities (ECAT) and Prospective Cardiovascular Münster Study (PROCAM) [37,38]. As fibrinogen plays a role both in promoting atherosclerosis and as an acute phase reactant [39], reasons for the high concentrations in Turks have to be further elucidated.

4.8. Lipids and lipoproteins

DLP was the one risk factor, which was seen to an extremely high extent in men and women. The criteria chosen to define DLP probably contributed to this finding, as most other investigators only took one parameter into consideration—usually TC—for estimating the proportion of hyperlipidemic individuals. TC levels were found remarkably higher in Turks living in Germany compared to observations in urban regions of Turkey [10]. Yet, TC levels were in the range observed by the German speaking centers of the MONICA project, in which corresponding mean values ranged from (males/females) 240/236 to 221/216 mg/dl [40]. As Turks showed a marked reduction of HDL-C the TC/HDL-C ratio further increased in Turks. In our survey, male Turks with TC >240 mg/dl showed a slightly higher OR for CHD than Onat et al. [27]. Nevertheless, the OR also failed to reach statistical significance.

Two aspects have to be considered with respect to this issue: (1) there is evidence from several epidemiological studies that a relative massive hypercholesterolemia is necessary for a substantial population risk for atherosclerotic disease. Since populations with such a distinct CHD risk exhibit in general a mean TC level over 220 mg/dl [41,42], which seems to be a threshold value, the estimation of a predictive value might be limited for the Turkish population. (2) As the Turkish population now living in Germany was most likely a low cholesterol population before migration, the duration of exposure to hypercholesterolemia has to be considered as crucial for the manifestation of CHD. A reliable estimate of the lag time until the occurrence of clinical symptoms, however, is almost impossible. Since the exposure time to hypercholesterolemia is probably shorter than for the corresponding German population the possibility should be considered that many Turkish immigrants are predisposed to develop clinical symptoms of CHD in the near future. More sensitive methods of diagnosing atherosclerosis such as the use of invasive imaging methods, would have been necessary to present proof for this assumption.

Another interesting aspect of the survey were the extremely low HDL-C levels in both genders. While TC levels underestimated the proportion of dyslipidemic participants, both TC/HDL-C and LDL-C/HDL-C ratios revealed a very unfavorable constellation.

Low HDL-C levels seem to be specific for populations from Turkey and near or far Eastern countries such as Pakistan [43]. The Turkish Heart Study (THS) [8] was the first epidemiological study that also measured HDL-C in different geographical regions of Turkey. In their survey, Mahley et al. described remarkably low HDL-C levels, which, however, were slightly higher than those found in our study of Turks in Germany. As TG levels were noticeably lower in the THS, HDL-C was analyzed in a subset of our participants with TG levels <150 mg/dl. In this subset HDL-C levels of 35.9 ± 8.4 mg/dl in men and 40.2 ± 10.5 mg/dl in women were found, which was in the range of HDL-C levels measured in Turkey, but was still remarkably lower than other data available for Caucasian populations [44,45]. Environmental factors can only in part explain this finding. Moderate alcohol consumption and smoking are supposed to have opposing effects on HDL-C levels. Reported alcohol consumption was very low in the study and therefore not considered in the analyses. Data from a survey conducted in 1983 in German workers with a subgroup of Turkish males [46] could already show that the differences in HDL-C levels persisted even if a subset of non-drinking and non-smoking Germans and Turks was compared. The data also showed no evidence for a significant life-style effect on HDL-C.

Even though the role of low HDL-C levels is clearly established as a cardiovascular risk factor there is still little knowledge regarding the mechanisms. Genetic factors may also be of importance. Familial HDL-deficiency syndromes have not been described as common cause of low HDL. However, in populations such as the Turks with a high degree of consanguinity in some parts of the country, heterozygosity for HDL deficiency syndromes may determine the HDL levels of an entire population. Further studies are needed focusing on apolipoproteins and lipoprotein subspecies in order to more clearly define the reasons for the ‘low HDL-syndrome’ found in Turks.

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