The incidence of cardiovascular disease (CVD) is rapidly increasing worldwide. It is the leading cause of death and CVD highly contributes to the global burden of disease. Smoking, high cholesterol, high (systolic) blood pressure, diabetes and obesity are major CVD risk factors. There are indications that ethnic differences in the pattern of CVD mortality and morbidity exist between Turkish and Moroccan migrant groups and the western European population. However, in spite of the fact that Turkish and Moroccan migrant groups constitute a considerable part of the population in several European countries, they are often poorly represented in epidemiological studies. In the Netherlands, just as in the total European population, the Turkish are the largest ethnic minority group. With an absolute number of 384,000 residents they constitute 2.3% of the Dutch population. Moroccan migrants are the second largest ethnic minority group in the Netherlands and account for 2.1% (349,000) of the population. The fact that these groups are often underrepresented in studies investigating CVD and related risk factors has resulted in a limited amount of information on this topic. There is a particular lack of information on cardiovascular risk factors based on physical examinations to complement self-reported survey data. In this thesis the cardiovascular risk profiles of Turkish and Moroccan ethnic groups in western European countries, such as the Netherlands were studied.

CVD mortality, morbidity and risk factors among Turkish and Moroccan migrants in Europe

First of all, the available literature on CVD mortality, morbidity and risk factors among Turkish and Moroccan migrant groups in Europe was studied by means of a systematic review (chapter 2). Although the number of publications covering CVD and its determinants among these migrant groups has increased in the last decade, this overview clearly shows that their number is still limited. Performing research among migrant groups is challenging; low participation rates and small, selective samples make it difficult to project study results onto the total migrant population. Another limitation of many studies is the use of self-reported data. Furthermore, apart from the fact that migrant populations in different countries are not necessarily comparable, the comparability of studies is further hampered by differences in design and variations in the definition of ethnicity resulting in different subpopulations within migrant groups. Drawing sound conclusions on CVD mortality, morbidity and risk
profiles among Turkish and Moroccan migrants based on the available literature is, therefore, difficult. The number of publications studying CVD risk factors, especially obesity, is higher than those studying CVD morbidity and mortality patterns. It is tentatively concluded that obesity is more common among Turkish and Moroccan migrant groups in Europe than among the host populations of the countries they have migrated to. Their risk of having diabetes likewise appears to be higher than in the host populations. In the Turkish migrant population there is also a fair amount of evidence for unfavourable HDL cholesterol levels. Publications on low-grade systemic inflammation, as a CVD risk factor, among these migrant groups are lacking. The limited number of large high-quality studies in these major ethnic minority groups certainly calls for more research on this topic.

The Amsterdam Health Monitor Survey 2004

In order to fill the information gap regarding CVD risk among Turkish and Moroccan migrant groups, a population-based general health survey was carried out among the multicultural population (18+ yrs) of Amsterdam (chapter 3). In the study sample (n=1,736), Turkish and Moroccan migrant groups were over-represented (Turkish: n=454, Moroccan: n=374). The survey was conducted on location under supervision of a coordinator. Information on the general state of health of the respondents was gathered through health interviews (HIS), based on structured questionnaires, in the language of the respondent’s choice. A health examination (HES) was also conducted by a trained nurse to measure endogenous CVD risk factors. This physical examination included measurements of body height and weight, waist and hip circumferences, blood pressure as well as the collection of non-fasting blood samples to determine total and HDL cholesterol levels, glycosylated haemoglobin (HbA1c), glucose levels and C-reactive protein concentrations.

The total response rate was 44%, which is comparable to that of several other, similar studies. Although response rates were quite evenly distributed across ethnic groups, ethnic Moroccan residents of Amsterdam proved to be the most difficult group to reach. After comparing respondents with both non-respondents and the total population of Amsterdam, the sample appeared to be representative of the population on several indicators of health and socio-economic status.
The combination of HIS and HES on location under the direct supervision of a coordinator yielded a situation that was easy to control, in which any practical implementation problems could be tackled quickly and in which it was possible to intensively guide the interviewers and nurses. The interviewer is indispensable as an intermediary in research among these ethnic groups and requires intensive training, guidance, support and attention. The physical examination was demonstrated to be perfectly feasible, as only a very small proportion of the respondents did not take part in it. Taking blood samples did not produce any appreciable problems either. The inclusion of physical measurements enabled the collection of objective data on physical health and, therefore, improved estimates of prevalence rates of CVD risk factors, such as obesity, dyslipidemia, hypertension, diabetes and systemic inflammation among Turkish and Moroccan migrant groups.

**Endogenous risk factors for cardiovascular disease among Turkish and Moroccan ethnic groups**

Based on data from the Amsterdam Health Monitor Survey (AGM) 2004, the prevalence of several cardiovascular disease risk factors among Turkish and Moroccan migrant groups was studied in this thesis. The focus was on endogenous risk factors, namely obesity, hypertension, dyslipidemia, diabetes and systemic inflammation.

**Obesity, body fat distribution and socioeconomic status**

During the physical examination that was part of the AGM 2004 body height, body weight, waist and hip circumference were measured and Body Mass Index (BMI, kg/m²) as well as waist-to-hip ratio were computed. Based on these data overweight and body fat distribution were studied among Turkish and Moroccan migrants [chapter 4]. Furthermore, the effect of several socioeconomic factors on the prevalence of obesity among these ethnic groups was examined. The results showed that overweight (BMI ≥25 kg/m²) was more common among Turkish (72%) and Moroccan women (64%) and Turkish men (61%) when compared to Dutch men (44%) and women (45%), but not among Moroccan men (50%). Obesity (BMI ≥30 kg/m²) prevalence rates were more than twice as high among Turkish and Moroccan women than ethnic Dutch women. Differences in BMI could, for a large part, be explained by differences in level
of education and, among men, by unemployment. However, socioeconomic differences could not entirely account for ethnic differences. The association between BMI and waist circumference appeared to differ across ethnic groups. Among women, abdominal obesity was more common in the Turkish and Moroccan than the Dutch group. However, Turkish and Moroccan women with a lower BMI had a higher waist circumference, but migrant women with a relatively high BMI had a lower waist circumference than Dutch women. In Turkish women the same pattern was seen for waist-to-hip ratio. Among Turkish men, overweight was more common than among their Dutch counterparts, however, they did not have a higher waist circumference or waist-to-hip ratio than the Dutch. Moreover, when taking into account their relatively high BMI, they had a lower waist circumference and waist-to-hip ratio indicating that Turkish men had a more favourable fat distribution with less abdominal fat than Dutch men.

However, the prevalence of overweight is higher among Turkish and Moroccan migrants, especially women, when compared to the ethnic Dutch. Considering the effect that socioeconomic status has on ethnic differences in BMI, when aiming at diminishing ethnic differences in obesity prevalence, health promotion should also be aimed at reducing socioeconomic inequalities.

**Hypertension: prevalence, awareness and control**

The physical examination of the AGM 2004 also included duplicate measurements of systolic and diastolic blood pressure (chapter 5). These measurements showed that the prevalence of hypertension was considerably lower in Turkish (men 26% and women 22%) and Moroccan (men 26% and women 20%) than in Dutch individuals (men 49% and women 35%). Controlling for age and BMI attenuated these ethnic differences only in Turkish women. In all other groups ethnic differences persisted. Only Moroccan hypertensive women were less likely than Dutch women to be aware of their condition and to be treated for hypertension. There were no differences in hypertension control, in which treatment resulted in normal blood pressure levels, between ethnic groups, in both men and women.

The lower prevalence of hypertension among Moroccan men may contribute to the low cardiovascular disease (CVD) mortality reported among this group in the Netherlands. The differential risks in CVD mortality between Moroccan men and women may partly result from the lower hypertension awareness and
treatment rates in Moroccan women. Strategies aimed at improving the detection and treatment of hypertension among Moroccan women may improve the sex disparity in cardiovascular mortality between Moroccan men and women in the Netherlands.

**Dyslipidemia: total and high-density lipoprotein cholesterol**

The serum collected during the physical examination was used to assess non-fasting levels of total and HDL cholesterol *(chapter 6)*. Information on history of hypercholesterolemia, lifestyle and demographic background was gathered via the health interviews. The results showed that total cholesterol levels were lower and, as a result, hypercholesterolemia was less prevalent among the Moroccan (men: 4.7 mmol/L; women: 4.9 mmol/L) and Turkish (men/women: 5.0 mmol/L) than the Dutch (men: 5.5 mmol/L; women: 5.4 mmol/L) ethnic population. However, HDL cholesterol levels were also relatively low among these migrant groups. The resulting total/HDL cholesterol ratio was particularly unfavourable among the Turkish ethnic group.

Although total cholesterol levels are relatively low in Turkish and Moroccan migrants part of this advantage is off-set by the fact that HDL cholesterol levels are likewise relatively low in these groups, resulting in an unfavourable total/HDL cholesterol ratio, particularly in the Turkish population. Important factors in explaining these ethnic differences are the relatively high BMI and level of alcohol abstinence in these migrant groups.

**Diabetes**

Non-fasting blood glucose levels and glycosilated haemoglobin (HbA1c) levels combined with information on self-reported diabetes and use of anti-diabetic medicine collected during the AGM 2004 were used to determine whether individuals suffered from diabetes *(chapter 7)*. Ethnic differences in the prevalence of diabetes in the Amsterdam population were studied. The results showed that diabetes prevalence was significantly higher in Turkish (5.6%), and Moroccan (8.0%) than in Dutch individuals (3.1%). Controlling for age increased ethnic differences. The higher levels of diabetes among Turkish and Moroccan migrants could only in part be explained by their lower socioeconomic status and higher prevalence of obesity. The difference between Dutch and Moroccan individuals remained significant even after adjustments for multiple risk factors. The typical age of onset of diabetes in both Turks and Moroccans
was respectively one and two decades younger than in the ethnic Dutch population. Especially in the Moroccan ethnic group screening for diabetes should start at an earlier age (<45 years) than current guidelines indicate.

**C-reactive protein: low-grade systemic inflammation**

C-reactive protein (CRP) is a sensitive, non-specific systemic marker for inflammation and tissue damage in the human body. It is a relatively novel CVD risk factor and has been independently associated with incident cardiovascular disease (CVD) and traditional CVD risk factors. The remaining serum from the blood samples that were collected during the AGM 2004 were used to determine high-sensitive CRP levels (chapter 8). Mean CRP levels, excluding acute inflammation, were found to be higher among Turkish migrants (men: 2.1 mg/L; women: 2.9 mg/L) and Moroccan women (2.9 mg/L) compared to the Dutch (men: 1.7 mg/L; women: 2.3 mg/L). Known CRP determinants, such as sex, age, BMI and smoking, could not explain ethnic differences in mean CRP levels. ‘High CVD risk’ CRP levels (3 mg/L ≥ CRP ≥ 10 mg/L) were also more prevalent in these groups. Traditional CVD risk factors accounted for most of the ethnic differences in ‘high CVD risk’ CRP levels among men, but not among women. It was concluded, that their relatively high CRP levels put Turkish and Moroccan migrants at higher risk of future cardiovascular events, especially women. However, more research is needed to gain insight into the exact role of CRP in ethnic differences in CVD risk.

**Discussion and conclusion**

Given the lack of studies on CVD risk among Turkish and Moroccan migrant groups in Europe, this study adds valuable information on several major CVD risk factors among these ethnic groups. The main findings of this study point at an unexpected and seemingly paradoxical CVD risk factor profile in the Turkish and Moroccan ethnic group compared to the Dutch ethnic group (Figure 1). On the one hand, prevalence rates of overweight and obesity are high among Turkish men, and even alarmingly high among women with a Turkish and Moroccan ethnic background. Considering the strong correlation between obesity and diabetes risk, the fact that diabetes rates are also higher in the Turkish and Moroccan ethnic groups was to be expected. The prevalence of low-grade systemic inflammation as indicated by elevated CRP levels is
Prevalence of cardiovascular disease risk factors among Dutch, Moroccan and Turkish ethnic groups

**MEN**

- Obesity
- Hypercholesterolemia
- Low HDL cholesterol
- Hypertension
- Diabetes*
- High CRP levels

**WOMEN**

- Obesity
- Hypercholesterolemia
- Low HDL cholesterol
- Hypertension
- Diabetes*
- High CRP levels

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**Figure 1**

Prevalence of cardiovascular disease risk factors among Dutch, Moroccan and Turkish ethnic groups

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Prevalence rates stratified by sex (18+ yrs), except for * total unstratified prevalence (18-70 yrs)

diabetes, self-reported diabetes with anti-diabetic medication / non-fasting glucose >11.0 mmol/L + HbA1c >48 mmol/mol; high CRP levels, 3 mg/L ≤CRP <10 mg/L; hypercholesterolemia, self-reported high cholesterol with lipid lowering medication use or total cholesterol ≥6.5 mmol/L; hypertension, SBP ≥140 mmHg or DBP ≥90 mmHg; low HDL cholesterol, HDL cholesterol <1.0 mmol (men)/ <1.2 mmol/L (women); obesity, BMI ≥30 kg/m²
likewise relatively high among Turkish and Moroccan migrants as compared to the Dutch. On the other hand, however, hypertension rates are lower in the Turkish and Moroccan ethnic group and high levels of total cholesterol are also less common in these groups compared to the Dutch, although low HDL cholesterol levels are likewise more common compared to the Dutch ethnic group.

The combination of HIS and HES has led to a substantial amount of objective data to complement self-reported data on several major CVD risk factors among Turkish and Moroccan migrant groups. Although we were not able to collect fasting blood samples or perform repeated measurements, a valuable amount of information has been gathered on obesity and body fat distribution, hypertension, dyslipidemia, diabetes, and low-grade systemic inflammation among these migrant groups. Given the challenging nature of including these ethnic minority groups in epidemiological research, we consider the response rate (45%) to be reasonable. Moreover response rates were fairly evenly distributed across ethnic groups and the absolute number of individuals included in each ethnic group is substantial.

The unexpected paradoxical CVD risk factor profile in Turkish and Moroccan migrants urgently calls for more research on CVD risk among these major ethnic minority groups. These studies should have a strong focus on enhancing response rates in Turkish and Moroccan ethnic groups and data should be collected via objective methods. In more practical terms, a focus should be on developing culturally appropriate CVD risk prevention strategies, that acknowledge the apparent ethnic differences in CVD risk profiles. The alarmingly high prevalence of overweight in these groups, however, urges for action. Health promotion strategies, again culturally appropriate, aimed at prevention of obesity and future cardiovascular events, are much needed.