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# Diet and Metabolic Risk Factors in Immigrant Women from the Middle East and Swedish-Born Women

*A Cross-Sectional Study of Women from Iran,  
Turkey and Sweden*

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**Abstract**

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The increasing number of immigrants in Sweden during the past decades has brought the health of different ethnic groups into focus. Many groups of immigrants in Sweden have a higher risk of cardiovascular disease (CVD) and coronary heart disease (CHD) than a Swedish reference group. The objective of this thesis was to study the health status and prevalence of metabolic risk factors among immigrant women from Iran and Turkey in comparison with native-Swedish women. The analyses are based on a cross-sectional study of first-generation immigrant women and women born in Sweden aged 35-64. The women underwent a clinical examination, including blood sampling and anthropometric measurements. Dietary intake was assessed by four repeated 24-hour food intake recalls.

The results show important ethnic differences in risk factors for CHD and the metabolic syndrome between the immigrant and the Swedish-born women. Immigrant women from Iran and Turkey are heavier, with a higher prevalence of abdominal obesity and an unfavourable lipid profile and a high degree of physical inactivity during leisure-time, which may predispose for a higher incidence of diabetes and atherosclerotic CVD. The associations between dietary variables and metabolic risk factors were generally relatively weak. The degree of underreporting of the energy was significant, especially among immigrant women, which might have attenuated possible associations. The fatty acid profile of the diet and in serum among the immigrant women indicated both favourable and unfavourable features, despite a higher prevalence of obesity and dyslipidemia compared to the Swedish-born women. Signs of oxidative stress and inflammation are evident in the immigrant women from the Middle East.

With reference to ethnical differences in metabolic risk factors, as demonstrated in this thesis, increased emphasis should be given to modifying the underlying factors such as overweight/obesity and physical inactivity associated with the metabolic syndrome in various immigrant groups.

*Keywords:* cardiovascular factors, metabolic risk factors, immigrants, Iranian, Turkish, Swedish, Middle East, dietary intake, underreporting, dietary fat, fat sources, antioxidant intake, oxidative stress, inflammation, C-reactive protein, isoprostanes

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*In memory of my father  
Mohammad Daryani*

*To Aidin*



*En människas hemtrakt finns inte  
på någon karta  
den finns blott  
i de människors hjärtan som älskar henne*

*Margot Bickel*



## List of Papers

The thesis is based on the following papers, which will be referred to in the text by their Roman numerals:

- I Achraf Daryani, Lars Berglund, Åsa Andersson, Tahire Kocturk, Wulf Becker, Bengt Vessby. Risk factors for coronary heart disease among immigrant women from Iran and Turkey, compared to women of Swedish ethnicity. *Ethn Dis* 2005;15:213-220
- II Achraf Daryani, Tahire Kocturk, Åsa Andersson, Brita Karlström, Bengt Vessby, Wulf Becker. Reported macro-nutrient intake and metabolic risk factors among immigrant women from Iran and Turkey compared to native-Swedish women. *Scandinavian Journal of Food and Nutrition*. *In press*
- III Achraf Daryani, Wulf Becker, Bengt Vessby, Agneta Andersson. Dietary fat intake, fat sources and fatty acid composition in serum among immigrant women from Iran and Turkey compared with women of Swedish ethnicity. *Scand J Nutr* 2005; 49(3): 106-115
- IV Achraf Daryani, Samar Basu, Wulf Becker, Anders Larsson, Ulf Risérus. Antioxidant intake, oxidative stress and inflammation among immigrant women from the Middle East living in Sweden: associations with cardiovascular risk factors. *Nutrition, Metabolism & Cardiovascular Diseases*. *In press*

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# Contents

Introduction.....	13
Diet and metabolic risk factors in immigrants .....	13
Coronary heart disease .....	14
The metabolic syndrome .....	15
Diet, the metabolic syndrome and coronary heart disease .....	17
Dietary fat and fatty acid composition in plasma and the metabolic syndrome .....	18
Inflammation and the metabolic syndrome .....	18
Lipid peroxidation and oxidative stress.....	19
Antioxidants .....	19
Physical activity .....	20
Health situation in the Middle East.....	22
Prevalence of the metabolic syndrome in Iran .....	23
Prevalence of the metabolic syndrome in Turkey .....	24
Diet in the Middle East .....	26
Meal patterns, food habits and cooking tradition of Middle Eastern immigrants.....	26
Aims.....	28
Study design, subjects and methods.....	29
Study design .....	29
Subject recruitment .....	29
Methods.....	29
Ethical consideration .....	33
Statistical analyses.....	33
Results.....	34
Paper I .....	34
Paper II .....	36
Paper III.....	38
Paper IV .....	42

Discussion.....	46
Main findings .....	46
Methodological consideration.....	49
Conclusion .....	53
Future perspectives .....	55
A public health perspective.....	56
Acknowledgements and thanks.....	59
References.....	62

## Abbreviations

AER	Acceptable energy reporters
BMI	Body mass index
CE	Cholesterol ester
CHD	Coronary heart disease
CVD	Cardiovascular disease
Chol	Cholesterol in serum
DBP	Diastolic blood pressure
E%	Energy percentage
FFA	Free fatty acids in serum
FIL	Food intake level
HDL	High density lipoprotein
hs-CRP	High-sensitivity C-reactive protein
Kcal	Kilocalorie
KJ	Kilojoule
LDL	Low density lipoprotein
MJ	Megajoule
MUFA	Monounsaturated fatty acid(s)
n-3, n-6, etc.	Fatty acids that have the first double bond at the 3 <sup>rd</sup> , 6 <sup>th</sup> , etc carbon atom from the terminal methyl (-CH <sub>3</sub> ) group
PAL	Physical activity level
PUFA	Polyunsaturated fatty acid(s)
SAD	Sagittal abdominal diameter
S-apo	Serum apolipoproteins
SBP	Systolic blood pressure
SFA	Saturated fatty acid(s)
TG	Triglycerides
VLER	Very low energy reporters
WHR	Waist-to-hip ratio
8-iso-PGF <sub>2α</sub>	8-iso-prostaglandin F <sub>2α</sub> (F <sub>2</sub> -isoprostanes)



# Introduction

## Diet and metabolic risk factors in immigrants

Over the last few decades, Sweden has undergone a change, from a relatively homogenous society to one of many different languages, religions, cultures and traditions. According to Statistics Sweden (SCB), on 31 December 2003 12% of the total population in the country was first-generation immigrants. In addition, there are about 800,000 people born in Sweden who have either one or both parents born in a foreign country. This means that 20% of the inhabitants in Sweden have at least some of their roots in an other country.

The increasing number of immigrants in Sweden during the past few decades has brought the health of different ethnic groups into focus. According to recent reports, immigrants in industrialised countries [1-4] such as Sweden constitute a vulnerable group in terms of health [5-8]. A recent report [8] showed a higher risk of cardiovascular disease (CVD) and coronary heart disease (CHD) in many groups of immigrants than in a Swedish reference group. Changes in lifestyle due to migration have a dominating influence on the disease pattern of immigrants. Data from other countries with a longer migrant tradition show the same pattern of health disorders. The classical studies have shown a higher prevalence of CHD [9] and CHD mortality [10] among Japanese men in Hawaii and mainland USA than in Japan. Changes in the prevalence of circulatory diseases, as well as of type II diabetes, are most probably an outcome of changes in lifestyle, including an altered psycho-social situation as well as altered physical activity patterns and changes in diet and nutritional status [11-14].

Some recent studies indicate that immigrants in Sweden seem to be more vulnerable to developing nutrition-related diseases than the native-born population [8, 15, 16]. However, we do not know enough about the reasons for these discrepancies or about the health status of different immigrant groups. To take steps to even out these discrepancies between people born in Sweden and those born abroad, we need more knowledge about the health status of different immigrant groups.

According to SCB, a large percentage (38%) of immigrants in Sweden in the year 1998 originated from countries outside of Europe, e.g. the Middle East, Southeast Asia and the horn of Africa. The second largest group (33%) originated from non-Nordic Europe, e.g. the former Yugoslavia and Eastern Europe.

The studies at hand included first-generation immigrant women born in a Middle Eastern country between the years 1933-1962 and living in the city of Uppsala. As of January 1996, a total of 1,086 women aged 35-64 years from the Middle East were living in Uppsala. Most (80%) of these women had emigrated either from Iran or Turkey. Because of limited available information on their health and nutrition status, we decided to concentrate on women born in these two countries.

## Coronary heart disease

In Sweden, as in most industrialized countries, CHD is the major cause of morbidity and mortality in older age groups. Hypertension, hyperlipidemia, diabetes and smoking are accepted risk factors for development of CHD. There is a lack however of representative and comparative data in the international literature demonstrating incidence rates of CVD and CHD in immigrant subjects compared to natives in most countries in Europe.

During the past ten years the mortality from CHD in Sweden has declined, but all groups in the society do not share this decrease. Certain sections of the labour force and immigrants to Sweden appear to have increased CHD mortality [8, 17, 18]. In a recent report Gadd et al. [8] showed a higher risk of CVD and CHD in many groups of immigrants than in the Swedish reference group. The highest incidence rates of CVD were found for immigrants from Finland, Poland, Bosnia, Turkey, Asia and Iraq, both sexes included, and among women from Iran (Table 1).

Table 1. *Age-standardised incidence rates of cardiovascular disease (CVD) per 1000 person-years in men and women aged 35-64 living in Sweden*

Country of birth	Incidence (adj. for age)	
	Men	Women
<b>Sweden</b> <sup>†</sup>	<b>12.8</b>	<b>6.7</b>
Finland	18.9	9.8
OECD countries	13.1	6.4
Southern Europe	13.9	8.2
Poland	16.7	8.2
Eastern Europe	14.2	6.6
Bosnia	16.2	11.8
Latin America	8.8	5.6
<b>Turkey</b> <sup>†</sup>	<b>17.8</b>	<b>10.7</b>
<b>Iran</b> <sup>†</sup>	<b>13.9</b>	<b>9.5</b>
Iraq, etc.	18.2	10.8
Asia	15.9	7.0
Africa	11.2	4.4

Gadd et al. [8]

<sup>†</sup> As these countries are the subject of this thesis, Sweden, Turkey and Iran are highlighted.

The incidence rates of CHD in the same study were highest among immigrants from Finland, Poland, Eastern Europe, Bosnia, Turkey, Iran and Iraq, both sexes included (Table 2).

Table 2. *Age-standardised incidence rates of coronary heart disease (CHD) per 1000 person-years in men and women aged 35-64 living in Sweden*

Country of birth	Incidence (adj. for age)	
	Men	Women
<b>Sweden</b> <sup>†</sup>	<b>5.6</b>	<b>2.1</b>
Finland	9.5	3.9
OECD countries	6.1	2.1
Southern Europe	7.4	3.0
Poland	6.9	2.3
Eastern Europe	9.2	5.5
Bosnia	4.7	11.8
Latin America	8.8	2.6
<b>Turkey</b> <sup>†</sup>	<b>11.1</b>	<b>5.0</b>
<b>Iran</b> <sup>†</sup>	<b>10.1</b>	<b>4.8</b>
Iraq, etc.	11.5	5.2
Asia	9.2	2.4
Africa	5.3	1.5

Gadd et al. [8]

<sup>†</sup> As these countries are the subject of this thesis, Sweden, Turkey and Iran are highlighted.

## The metabolic syndrome

### Definition, aetiology and prevalence

In 1988 Gerald M Reaven defined the existence of a syndrome (syndrome X) describing a cluster of metabolic disorders including glucose intolerance, hyperinsulinaemia, dyslipidemia and hypertension [19].

A few years later, in 1993, Björntorp collected strong evidence in a review article in which he powerfully argued that abdominal obesity was an included part of the abnormalities in the syndrome X [20]. In the same article, Björntorp also suggested that syndrome X should be named “the metabolic syndrome” due to the metabolic nature of the syndrome [20].

Although the term *metabolic syndrome* is now generally established, there is not yet universal agreement about the name of the condition. For example some authors suggest that the syndrome should be named “the dysmetabolic syndrome” [21] while other authors suggest “the insulin resistance syndrome” [22, 23].

In earlier proposed definitions by WHO [24] and the European Group for the Study of Insulin Resistance (EGIR) [25] insulin resistance was included

as a key feature of what they called the metabolic syndrome. A more recent clinical identification of the metabolic syndrome has been presented in the summary of the Third Report of the National Cholesterol Education Program (NCEP) [26] (Table 3). Due to difficulty in routinely measuring insulin sensitivity in a clinical setting, this definition does not include insulin resistance as a criterion of the metabolic syndrome.

In this thesis the term *metabolic syndrome* is used to express the definition of the metabolic syndrome according to above-mentioned Third Report of the National Cholesterol Education Program (NCEP) [26].

In spite of the fact that definitions vary, it is clear that the metabolic syndrome is a common condition among both women and men. For example among US adults, the prevalence was reported to be 24% in men and 23% in women [27]. In European Caucasian pre-diabetic adults the prevalence is 64% in men and 42% in women and in diabetic subjects it is about 80% [28]. A recent study in healthy 60-year-old subjects in Stockholm County showed that the prevalence was 19% in men and 13% in women [29].

Table 3. Clinical definition of the metabolic syndrome\* according to NCEP

Risk factors	Defining level Men	Women
Abdominal obesity	waist girth>102 cm (>40 in)	>88 cm (>35 in)
High triglycerides	≥ 1.69 mmol/l (≥150 mg/dl)	≥ 1.69 mmol/l (≥150 mg/dl)
Low HDL cholesterol	<1.04 mmol/l (<40 mg/dl)	<1.29 mmol/l (<50 mg/dl)
High blood pressure	≥ 130/ 85 mmHg	≥ 130/ 85 mmHg
High fasting glucose	≥ 6.1 mmol/l (≥110 mg/dl)	≥ 6.1 mmol/l (≥110 mg/dl)

\* Metabolic syndrome = three or more components

The metabolic syndrome, which is strongly associated with type II diabetes, increases the risk of cardiovascular and all-cause mortality [28, 30]. The aetiology of metabolic syndrome is a combination of genetic, perinatal and environmental factors [31]. The latter may contribute more in our modern society than in the past, characterized as it is by a positive energy balance (↓ physical activity, ↑ energy intake), stress, alcohol intake and smoking [20, 31-36]. For a schematic overview, see Fig. 1.

Recent reports of the increasing prevalence of abdominal obesity and diabetes type II all over the world indicate that the metabolic syndrome will be an increasing health problem and that CVD will remain a major concern for public health in the future [37]. However, from the point of view of prevention and treatment of the metabolic syndrome, the target risk factors should be those associated with lifestyle, e.g. increased physical activity and improved diet as part of patient education programmes.

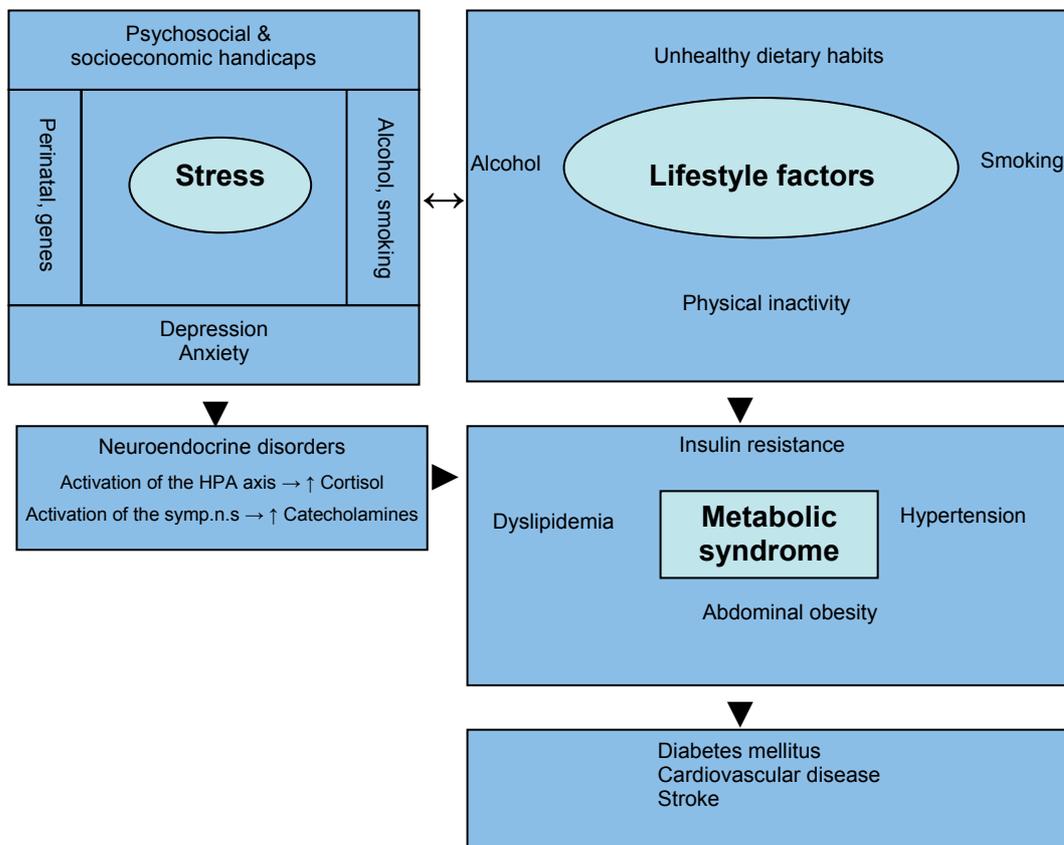


Figure 1. *The relationship between lifestyle factors, stress, and metabolic syndrome*

Abbreviations: HPA=hypothalamic-pituitary-adrenal; symp.n.s.=sympathetic nervous system

## Diet, the metabolic syndrome and coronary heart disease

For prevention and treatment of the metabolic syndrome and CHD, the most suitable diet seems to be one with reduced saturated fat content, which is partly replaced by vegetable fats (polyunsaturated and monounsaturated fatty acids) and an increased content of carbohydrate-rich foods, especially fruits and vegetables and food rich in dietary fibre, with a low glycaemic index [38, 39].

The affluent diet of Western Europe is often high in energy, rich in animal fat and sugars and poor in fibre-rich carbohydrates. In contrast, diets in the developing countries generally contain less fat and more fibre-rich

carbohydrates [40]. Several studies throughout the world show that dietary changes following migration to a more affluent area expose immigrants to an increased risk for diet-related chronic diseases such as diabetes type II, CVD, hypertension and obesity [28, 41-45]. This indicates that the metabolic syndrome will be a developing health problem even among immigrant groups. Increased prevalence of metabolic risk factors among immigrants in Sweden may also be an outcome of changes in other lifestyle factors such as physical activity in addition to diet [8, 15, 16]. Considering the relationships between the metabolic syndrome and lifestyle factors such as unhealthy dietary habits, physical inactivity and stress (Figure 1) a good understanding of lifestyle patterns, nutritional status and food habits among immigrants is essential in order to address the causative factors leading to increased metabolic risk factors in these groups in Sweden.

## Dietary fat and fatty acid composition in plasma and the metabolic syndrome

The dietary fat content and fatty acid composition, as well as fatty acid composition in serum lipids, have been documented as indicators for CHD risk and the metabolic syndrome [39, 46]. Several recent studies have underlined the importance of fat quality in the diet for the development of insulin resistance and other diseases related to the metabolic syndrome [39, 47-49]. Insulin resistance and related disorders are mainly associated with a high proportion of palmitic (16:0) and a low proportion of linoleic (18:2 n-6) acid, with a distribution of other fatty acids indicating an increased activity of  $\Delta 9$  (16:1/16:0) and  $\Delta 6$  (18:3 n-6/18:2 n-6) desaturase and a low activity of  $\Delta 5$  (20:4 n-6/20:3 n-6) desaturase [39, 50]. Laaksonen et al. [51] showed that individuals with a high proportion of 18:2 n-6 in plasma fatty acids had a lower risk for developing diabetes. This finding is in line with dietary epidemiology [52] which indicated that individuals with a low proportion of linoleic acid or vegetable fat in their diet have an increased risk of developing type II diabetes.

## Inflammation and the metabolic syndrome

Inflammation is associated with various diseases and has been suggested as part of the metabolic syndrome [53]. Several studies have shown a close link between obesity and the inflammation marker C-reactive protein (CRP) [54-56]. Epidemiological and clinical investigations have shown strong and consistent relationships between markers of inflammation and risk of future cardiovascular events [57]. Inflammation can be detected systemically by

measurement of inflammatory markers, of which the most reliable and accessible for clinical use is currently high-sensitivity C-reactive protein (hs-CRP). The use of hs-CRP as a measure of inflammation has permitted identification of an increased cardiovascular risk in individuals not considered to be at risk on the basis of traditional risk factors, and has been shown to add prognostic information to traditional risk assessment. Levels of hs-CRP of less than 1, 1-3 and greater than 3 mg/L are associated with lower, moderate and higher cardiovascular risks, respectively [58].

## Lipid peroxidation and oxidative stress

Lipid peroxidation is a free-radical generating process whereby lipids are oxidized without release of energy. The process starts with a reactive species that usually abstracts a hydrogen atom from the fatty acids. Polyunsaturated fatty acids are more prone to lipid peroxidation than saturated and monounsaturated fatty acids. Increased markers of lipid peroxidation have been observed in smokers and are known to be involved in a number of human pathologies including atherosclerosis [59, 60], hypercholesterolemia [61-63] and insulin resistance and diabetes-related complications [62, 64-66].

Oxidative stress is often seen as an imbalance between oxidants and antioxidants in favour of the oxidants, potentially leading to tissue damage. One of the most valuable of the currently available biomarkers of lipid peroxidation in the human body is the isoprostanes, which are specific products arising from the peroxidation of unsaturated fatty acid residues in lipids [67].

## Antioxidants

The body's antioxidant defence system consists of endogenous and exogenous antioxidants that work together at the molecular level to protect cell membranes, lipoproteins and DNA from the damaging effect of free oxygen radicals [68]. Exogenous antioxidants include nutrients and non-nutrients that enter the body through the diet. Dietary antioxidants can be divided into three groups, based on the mechanism of their actions: 1) vitamins and provitamins, which react directly with free radicals or quench reactive oxygen species: vitamin E ( $\alpha$ -tocopherol), vitamin C (ascorbic acid), and  $\beta$ -carotene; 2) vitamins that are coenzymes of antioxidant-regenerating enzymes (e.g. vitamin B<sub>1</sub>, vitamin B<sub>6</sub>, vitamin B<sub>12</sub> and niacin); and 3) minerals, which are structural components of antioxidant enzymes (copper, zinc, manganese and selenium) [69]. In addition to these nutrient

antioxidants, ordinary diet provides a larger group of non-nutrients with antioxidant activity (polyphenols, glucosinolates, indoles, etc.) [70].

Antioxidants play an important role in the pathogenesis of a number of age-related diseases. Epidemiological data support the belief that a high consumption of fruits and vegetables protects against degenerative disease such as cancer [71] and ischemic heart disease [72]. Some prospective observational studies have associated  $\alpha$ -tocopherol (vitamin E) [73],  $\beta$  carotene, or both, with reduction in cardiovascular events [74, 75]. However, some current large randomized controlled trials of the effects of vitamin E have been disappointing in terms of potential benefits of vitamin E supplementation on cardiovascular incidence [76-78].

## Physical activity

Several studies have confirmed that mortality and risk factors for CVD increase following immigration [5, 79, 80]. Lifestyle factors such as insufficient physical activity, less healthy eating habits, and smoking may well explain the increasing risk of cardiovascular disease apparent in certain immigrant groups [16].

In general a sedentary lifestyle is more common among those with a low level of education and income and those with an immigrant background. Johansson et al. have confirmed the importance of socioeconomic factors as determinants of physical activity [81]. Lower leisure-time physical activity has been shown to be strongly associated with low income [81]. A Swedish study showed that men born in Arabic-speaking countries and the “all-other-countries” category (Turkey, Iran, Eastern Europe and Vietnam) had higher odds ratios of having a sedentary leisure-time physical activity status than men born in Sweden. A similar pattern was observed in women [82].

The behaviour of the immigrants may be caused by either culturally determined factors inherited in the country of origin or current social and economic factors in the new country, or a mixture of the two. A Swedish population-based report based on a number of different studies discusses how health in the form of cardiovascular disease, cancer, mental ill-health, and lifestyle varies greatly between people born in Sweden and some groups of immigrants [16]. Table 4 shows certain life-style factors such as physical activity, overweight/obesity and smoking among immigrant groups living in Sweden compared to the reference group born in Sweden. The overall conclusion in this report is that men and women from OECD countries normally have similar lifestyles to Swedish-born people. All other immigrant groups show examples of different lifestyles in many respects.

The ethnical difference in physical inactivity between immigrants and Swedes is a CVD risk factor that could be influenced by intervention programmes aimed at specific ethnic subgroups of the population.

Table 4. *Prevalence of certain life-style factors (percentage) in immigrant men and women aged 27-60 living in Sweden, compared to the reference group born in Sweden*

Country of origin	Regular physical activity		Overweight/obesity, BMI $\geq$ 25		Daily smoking	
	Men	Women	Men	Women	Men	Women
<b>Sweden</b> <sup>†</sup>	<b>54</b>	<b>59</b>	<b>52</b>	<b>32</b>	<b>18</b>	<b>25</b>
OECD countries	49	59	45	30	22	30
Finland	43*	58	59	37	34*	32*
Southern Europe	49	35*	64*	55*	39*	31
Eastern Europe	55	37*	54	36	34*	27
Poland	44*	44*	56	27	40*	39*
<b>Turkey</b> <sup>†</sup>	<b>28*</b>	<b>20*</b>	<b>50</b>	<b>56*</b>	<b>57*</b>	<b>30</b>
<b>Iran</b> <sup>†</sup>	<b>43*</b>	<b>32*</b>	<b>45</b>	<b>40*</b>	<b>47*</b>	<b>12*</b>
Chile.	46*	34*	56	53*	37*	32
All other countries	39*	42*	48	39*	38*	25

The source of information: Survey of living conditions for 1996-1999, known as ULF.

\*= significant difference  $P \leq 0.05$  between immigrants and reference group (Sweden).

<sup>†</sup> As these countries are the subject of this thesis, Sweden, Turkey and Iran are highlighted.

## Health situation in the Middle East

Countries in the Middle East and North Africa are currently undergoing demographic and epidemiological transitions characterised by a decline in fertility and mortality, a reduction of communicable diseases such as malaria, tuberculosis and viral hepatitis and an increase in non-communicable diseases such as atherosclerosis, myocardial infarction, stroke and cancer. The rate of cardiovascular disease (CVD) in these countries has been rapidly increasing and CVD is now the leading cause of death (Table 5) [83], accounting for 25-45 percent of total deaths [84]. Because of aging populations, increased use of tobacco, more sedentary jobs, and diets higher in unhealthy fats (saturated and trans fats) and refined sugar, CVD now accounts for a growing burden of disease in the Middle East. Nearly 50 percent of all deaths in high-income countries and about 28 percent of death in low- and middle-income countries are the result of CVD (Table 5) [83].

Table 5. *Leading cause of burden disease, 2001*

Rank	Middle East & North Africa	World	High-income countries	Low- and middle-income countries
1	<b>Heart disease</b>	Low birth-weight, prematurity and birth trauma	<b>Heart disease</b>	Low birth-weight, prematurity and birth trauma
2	Low birth-weight, prematurity and birth trauma	Pneumonia, bronchitis and flu	Stroke	Pneumonia, bronchitis and flu
3	Traffic accidents	<b>Heart disease</b>	Depression	<b>Heart disease</b>
4	Pneumonia, bronchitis and flu	Stroke	Alzheimer's and other dementias	HIV/AIDS
5	Diarrhoea	HIV/AIDS	Trachea, bronchus and lung cancer	Stroke
6	Depression	Diarrhoea	Hearing loss, adult onset	Diarrhoea
7	Birth defects	Depression	Chronic lung disease	Depression
8	Stroke	Malaria	Diabetes	Malaria
9	Vision disorders, age-related	Chronic lung disease	Alcohol use disorders	Tuberculosis
10	Cataract	Tuberculosis	Arthritis	Chronic lung disease

The source of information: Mathers et al. [83]

## Prevalence of the metabolic syndrome in Iran

Several previous studies have reported the prevalence of individual cardiovascular risk factors among the Iranian population [85-90]. A recent study in Teheran investigated the prevalence of the metabolic syndrome [91] by applying ATP III criteria [26]. The study was a cross-sectional analysis of a longitudinal study in Teheran: The Tehran Lipid and Glucose Study (TLGS). A total of 9,846 Iranians (5,623 women and 4,223 men) participated in the study. The result showed that the metabolic syndrome is highly prevalent in Tehran's adults (>30%) [91] which is higher than that in most developed countries, like the USA (22%) [27]. As shown in Table 6 the prevalence increased with age in both sexes [91].

Table 6. *Age-specific prevalence of metabolic syndrome\* by sex in Tehran's adult population. TLGS†*

Metabolic syndrome (%)		
Study population, n =10,368		
Unadjusted prevalence	30.1%	
Age-standardised	33.7%	
Age Groups (n)	Women	Men
20-29 (1,398 ♀, 843 ♂)	9.3	9.8
30-39 (1,502 ♀, 1097 ♂)	24.3	16.3
40-49 (1,126 ♀, 805 ♂)	48.3	25.5
50-59 (847 ♀, 597 ♂)	64.1	33.9
60-69 (590 ♀, 624 ♂)	67.2	37.9
≥70 (1,608 ♀, 257 ♂)	67.1	34.5

\* Applying ATP III criteria [26]

† Tehran Lipid and glucose study [92]

The single most common metabolic risk factor among participants with the metabolic syndrome was low HDL cholesterol, followed by high TG, high blood pressure, abdominal obesity and hyperglycaemia [91] (Table 7).

Table 7. *Metabolic abnormality (%) among participants with the metabolic syndrome\**

Risk factors	Metabolic abnormality
Low HDL cholesterol	91
High triglycerides	87
Hypertension	72
Abdominal obesity	69
Hyperglycaemia	33

\* Applying ATP III criteria [26]

In general the metabolic syndrome was more common in women than in men (42% vs. 24%,  $p < 0.001$ ) [91]. Women are generally overweight and obese and are less physically active than men.

In a recent study, Esmailzadeh et al. investigated the prevalence of the metabolic syndrome in 3,036 Iranian adolescents (1,623 girls and 1,413 boys) aged 10-13 [93]. The results show a high prevalence of the metabolic syndrome in Iranian adolescents, 10.1%. Overall low HDL cholesterol and high serum triglycerides were the most common components of the metabolic syndrome. In accordance with age-modified standards of the ATP III metabolic syndrome criteria, previously used by B. Ahranjani [94], overweight subjects had the highest proportion of metabolic syndrome in girls and boys (43% vs. 41%) compared with those at high risk for overweight (15% vs. 11%) and those with normal weight (5% vs. 3%) [93].

## Prevalence of the metabolic syndrome in Turkey

There are few existing large population studies on the prevalence of the metabolic syndrome and its components in Turkey. In 2000, the Turkish Cardiology Association conducted a study on adult risk factors (TEKHARF), representing the whole country [95]. A recent study [96] investigated the prevalence of metabolic syndrome-related disorders by examination of blood pressure, body mass index, fasting blood glucose and serum lipids. This study was performed under the population study “The Healthy Nutrition for Healthy Heart Study”. More than 15,000 Caucasians over 30 years of age from seven main different regions of Turkey participated in the study. As shown in Table 8 the prevalence of obesity, hypertension and metabolic syndrome was higher in women than men, whereas diabetes mellitus was higher in men than women [96]. The International Diabetes Federation (IDF) worldwide definition was used for the diagnosis of the metabolic syndrome [97].

In another study, Ozsahin et al. investigated 1,637 adults (20-79 years old) in Adana, a southern province of Turkey. The study determined the prevalence of the metabolic syndrome according to ATP III criteria [26]. The results showed that the prevalence of the metabolic syndrome was approximately 33% and more common in women than men (39% vs. 24%) [98].

Table 8. *Prevalence of metabolic syndrome\* and related disorders*

	<b>Metabolic syndrome (%)</b>	<b>Diabetes Mellitus (%)</b>	<b>Obesity (%)</b>	<b>Hypertension (%)</b>
<b>Sex (n)</b>				
Women (10,680)	27.3	3.7	41.3	15.7
Men (4,788)	10.1	5.2	21.2	9.1
<b>Age Groups (n)</b>				
30-39 (4,422)	15.3	1.5	27.9	5.0
40-49 (4,656)	23.1	3.9	37.8	11.5
50-59 (3,081)	27.9	5.8	41.9	18.1
60-69 (2,136)	25.9	6.9	37.2	23.3
70-79 (1,015)	20.5	6.0	29.6	25.7
> 80 (125)	14.8	5.60	25.8	29.6

Sanisoglu et al. [96].

\* Applying IDF definition [97].

The metabolic syndrome is highly prevalent in developing countries like Iran (~30%) [91] and Turkey (~33%) [98], and this prevalence is higher than in most developed countries, like the USA (~23%) [99] and Sweden (~20%) [29, 100, 101]. The metabolic syndrome is more common in women than in men in Iran (42% vs. 24%) [91] and in Turkey (39% vs. 24%) [98]. The picture is different in developed countries, with a higher incidence rate in men than women. The prevalence in Swedish 60-year-old men and women is (30% vs. 15%) [100] and (34% vs. 21%) in 60-year-old French men and women [102].

The prevalence of the metabolic syndrome is higher in Iran and Turkey than in Sweden, and immigrants from these countries had higher risks of CHD and CVD than the Swedish-born majority population [8]. It is not clear whether these unhealthy profiles persist from the country of birth or are a result of acculturation processes, or both. Further research needs to compare the prevalence of the metabolic syndrome between immigrants in Sweden and their compatriots in their home countries (Iran, Turkey) to understand causative factors leading to higher metabolic risk factors in these groups in Sweden.

Irrespective of causative risk factors, cardiovascular disease is the number one cause of death world-wide [83] and it is obviously increased in people with the metabolic syndrome, as compared to those without. Therefore world-wide prevention and treatment of the modifiable risk factors, including unhealthy dietary habits, physical inactivity, overweight, obesity, blood pressure and dyslipidemia, are necessary for reducing morbidity and mortality and thus the financial burden on the health care system.

## Diet in the Middle East

There are several variants of the Middle Eastern diet, but some common components can be identified: high consumption of vegetables, fruits, legumes and grains; moderate consumption of milk and dairy products, mostly in the form of yoghurt; and low consumption of meat and meat products [103-106]. This pattern is especially true for the two Middle Eastern groups on which we focus in this study, namely immigrants from Iran and Turkey.

A diet based primarily on plant foods can offer the advantages of fewer calories from fat, particularly saturated fat. Use of hydrogenated vegetable oils however is also common in food preparation. Frequent use of legumes is considered beneficial to those with diabetes or cardiovascular disease. Other health-promoting foods consumed by Middle Eastern people include complex carbohydrate staples such as bread, rice and bulgur, frequent use of natural yoghurt and incorporation of many fruits and vegetables in the diet [103-106].

### Meal patterns, food habits and cooking tradition of Middle Eastern immigrants

The nations of the Middle East include Bahrain, Egypt, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Palestinian Territory, Oman, Qatar, Saudi Arabia, Sudan, Syrian Arab Republic, United Arab Emirate, and Yemen. Turkey, situated in the Near East, is sometimes also considered a Middle Eastern country because of its cultural and historical heritage from the Ottoman Empire, encompassing some 600 years of coexistence with Middle Eastern peoples. All these countries are homelands to thousands of immigrants to the Western countries. They bring with them a rich cultural heritage, which has an impact on the food habits of recipient countries and is just as much affected by them. Islam is the dominant religion, followed by Orthodox Christianity and Judaism, in the Middle East. The dietary laws of Islam, followed by many but not all Muslims, permit all foods except those specifically forbidden by the Koran. No product from the pig is used. Animals must be slaughtered in a prescribed manner. Alcoholic beverages and intoxicating drugs are not allowed except in case of medical necessity [107].

Even where a wide variety of foods is found, the typical diet relies heavily on a limited number of dominant foods in a three-meal pattern [103-106]:

Breakfast usually consists of tea or coffee, followed by bread with butter, jam, honey, soft cheese or yoghurt, sliced tomatoes and cucumbers and olives. A heavier meal would include eggs or legumes. The main meal typically includes a combination of vegetables, legumes, grains and meat, accompanied by bread and yoghurt. Seasonal fresh fruit will always be offered for dessert. A light evening meal of bread, cheese or yoghurt, eggs and olives often features a salad. During the cool season, lentil soup is a frequent menu item.

Middle Eastern food habits today give an important role to native products, such as wheat, legumes, fruits, vegetables and olives. *Fresh vegetables* contribute considerably to the diet on a seasonal basis. *Legumes* contribute notably to the diet and are used in numerous dishes which often are full of herbs and spices. *Fresh fruits* are eaten as snacks and desserts in season. Dates are specially valued; numerous varieties are used fresh and dried. Figs and apricots are made into jams. Olives are eaten with most meals, including breakfast. *Yoghurt and cheese* are made from sheep's or cow's milk. Plain yoghurt is used abundantly as a side dish and in soups, dips and cold drinks. *Meat from lamb* is the first choice among Middle Easterners. Chicken is also very popular and beef, veal and turkey are used. Christians eat pork but not Muslims or Jews. *Fish and seafood* are eaten, particularly in coastal areas. *Bread, rice and bulgur wheat* are used widely; barley and corn use varies with accessibility and local tradition. *Fats and oils* – olive, corn, sunflower, various nuts and butter – play a prominent role in Middle Eastern meals. Generous amounts of fats are used in food preparation. An example is seen in the typical method for cooking grain; for each cup of raw rice  $\frac{1}{4}$  cup of oil is typically added with the liquid. Preparation of many specialties involves a frying step, as well as baking or cooking in a sauce. For deep-frying corn, sunflower or nut oils are utilized. Olive oil is preferred in foods to be eaten cold and for frying fish. *Nuts and seeds* are used widely as snacks; pistachios, almonds, hazelnuts, walnuts, pine nuts, sesame seeds and seeds from squash and watermelon are also popular. *Coffee* is prepared very strong and heavily sweetened. *Tea*, usually sweetened, is very popular. Herbal teas are used, sometimes for therapeutic purposes. *Cold drinks* are made from fresh fruit, by diluting fruit syrups. Yoghurt is used as a cold drink. Sweetened hot milk is enjoyed during the cold season.

Immigrant groups naturally bring their own dietary habits to their new country. However they may modify their diets for various reasons [108-110]. It has been suggested that such change following migration may not be beneficial to health. Therefore a good understanding of the nutritional status and food habits among immigrants is essential in order to address the causative factors leading to increased metabolic risk factors in these groups in Sweden.

# Aims

The overall aims of the present thesis were to investigate the health status and prevalence of metabolic risk factors as well as certain nutrition-related risk factors for chronic conditions such as obesity, diabetes type II and the metabolic syndrome among immigrant women from two Middle Eastern countries (Iran and Turkey) in comparison with native-born Swedish women, all residing in Uppsala.

The specific aims were:

- To investigate whether women born in Iran and Turkey, who were first-generation immigrants in Sweden, were likelier to display a higher prevalence of CHD/CVD risk factors than native-born Swedish women (Paper I);
- To investigate the nutrient intake and relationships between the estimated intake and metabolic risk factors (Paper II);
- To study the dietary fatty acid composition in more detail in relation to the food sources from which the dietary fatty acids were derived; to relate the reported dietary fatty acid composition to the fatty acid composition in serum cholesterol esters, and the fatty acid composition in serum to metabolic variables (Paper III);
- To investigate dietary antioxidant intake, plasma concentrations of tocopherols, oxidative stress (F<sub>2</sub>-isoprostanes) and inflammation (CRP); to investigate if oxidative stress or pro-inflammatory markers were associated with cardiovascular risk factors (Paper IV).

# Study design, subjects and methods

## Study design

All analyses in this study are based on a cross-sectional study of first-generation immigrant women born in Iran and Turkey living in Uppsala, residents in Sweden for at least three years, and a group of women born in Sweden aged 35-64. The fieldwork was carried out during 1997-2000.

## Subject recruitment

Collaboration was sought with Statistics Sweden (SCB), for drawing a random sample of 90 women originating from Iran and Turkey who fulfilled the above-mentioned criteria. A group of 90 women born in Sweden residing in Uppsala during the same time period was also selected at random. The sample, 180 immigrant women and 90 native-Swedish women, were initially contacted through SCB with a letter of invitation describing the nature of the study and seeking their collaboration. Non-respondents received two additional letters as reminders. Those who agreed to participate were approached by post and telephone and asked to fill out a questionnaire and invited to come for a free health screening and clinical examination.

## Methods

### Health screening and sampling (Papers I-IV)

Participants were screened at the Metabolic Research Unit of the Department of Geriatrics of Uppsala University. The examination was directed at measuring the prevalence of obesity, type II diabetes, hypertension and a clustering of metabolic risk factors indicative of the metabolic syndrome.

The clinical examination with blood sampling was conducted in the morning after an overnight fast. The participants were asked to restrain from smoking or moist snuff and to avoid alcohol and vigorous physical activity the day before the clinical examination.

#### *Anthropometric measurements*

Height was measured to the nearest 0.5 centimetre and body weight measured on a digital scale to the nearest 0.1 kg without shoes in light indoor clothing. Body mass index was calculated as the ratio of the body weight (in kg) divided by the height (in metres) squared. The waist and hip circumference were measured in a supine position. Waist circumference was measured midway between the lowest rib and the iliac crest, and hip circumference at the widest part of the hip, so as to calculate the waist-to-hip ratio (WHR). The sagittal abdominal diameter (SAD) was measured as the height of the stomach (cm) when lying on the back on a firm examination table with the knees bent.

#### *Blood pressure and heart rate*

Blood pressure was measured in the right arm with the subject in a supine position after a 5-minute rest, by indirect auscultation and with a mercury sphygmomanometer. The pulse rate was recorded by palpation of the radial pulse over 30 seconds before blood pressure measurement.

#### *Serum lipids (Papers I, II, III)*

Total cholesterol and triglycerides levels in serum were assayed by enzymatic techniques, using a Monarch apparatus (Instrumentation Laboratories; Lexington, MA, USA). HDL-cholesterol was separated by precipitation with a magnesium chloride and phosphotungstate solution [111]. LDL cholesterol was calculated according to the formula of Friedewald [112]:  $LDL = \text{serum cholesterol} - \text{HDL cholesterol} - (0.45 \times \text{serum triglycerides})$ . The concentrations of serum apolipoproteins (apo) A-1 and B were determined by immuno-turbidimetry in a Monarch apparatus.

#### *Serum free fatty acids (Paper I)*

Serum FFA (free fatty acids) was determined by an enzymatic-colorimetric method using a commercial kit (Wako Chemicals GmbH, Neuss, Germany) applied for a Monarch centrifugal analyser.

#### *Glucose and insulin (Papers I, II, III)*

Blood glucose concentration was measured by the glucose oxidase method [113]. Serum insulin was analysed using an enzyme immunoassay, ELISA-kit (Mercodia AB, Uppsala, Sweden) in a Coda Automated EIA analyser (Bio-Rad Laboratories AB, Scandinavia).

#### *Fatty acid composition (Paper III)*

The fatty acid composition of serum cholesterol esters (CE) was determined by gas-liquid chromatography (GLC), described in detail in Boberg et al. [114]. The relative amount of each (% of total fatty acids) was quantified by

integrating the area under the peak and dividing the result by the total area for all identified fatty acids. The fatty acid composition (14:0 to 22:6 n-3) was expressed as a percent of the total fatty acids identified.

The sum of n-3 PUFA (18:3 n-3, 20:5 n-3, 22:5 n-3 and 22:6 n-3) and the sum of n-6 PUFA (18:2 n-6, 18:3 n-6, 20:3 n-6 and 20:4 n-6) were calculated from the primary data. The fatty acid composition presented in the diet is based on the fatty acids included in The Swedish National Food Administration (SNFA) database. The percentage of the dietary fatty acid composition was calculated for each individual fatty acid. The data presented covers the same fatty acids as analysed in serum cholesterol esters with the exception of 15:0, 18:3 n-6 and 20:3 n-6. The dietary sources of fatty acid classes and individual fatty acids were calculated and the contribution from different food groups was expressed as a percentage of the total daily fat intake.

#### *Plasma tocopherols (Paper IV)*

Serum levels of  $\alpha$ ,  $\beta$  and  $\gamma$ -tocopherol were assayed by high performance liquid chromatography using a fluorescence detector, as described by Öhrvall et al. [115]. Tocopherol levels were adjusted for the sum of total cholesterol and triglycerides, as suggested by Thurnham et al. [116].

#### *F2-Isoprostanes (Paper IV)*

As a marker of systematic oxidative stress, we measured urinary levels of free 8-iso-prostaglandin  $F_{2\alpha}$  (8-iso-PGF $_{2\alpha}$  F2-isoprostane). The contents of free 8-iso-PGF $_{2\alpha}$  was determined by using a validated radioimmunoassay with a specific antibody raised against free 8-iso-PGF $_{2\alpha}$  as described previously [117]. Urinary contents of 8-iso-PGF $_{2\alpha}$  is adjusted to creatinine and expressed as nmol/mmol creatinine.

#### *C-reactive protein (CRP) in plasma (Paper IV)*

Plasma high-sensitivity CRP was measured using a rabbit antihuman CRP (Dako A/S, Glostrup, Denmark) as capture antibody, rabbit antihuman CRP (peroxidase conjugated, Dako p0227) and Human CRP high control (DAKO xo926) as standard, and TMB one substrate (Dako S1600) as substrate. The detection limit was 0.1  $\mu$ g/L (inter-CV= 8%).

### Classification of the metabolic syndrome

The ATP III definition of the metabolic syndrome was used in these studies [26].

## Dietary intake

### *Estimation of dietary intake (Papers II, III and IV)*

Dietary assessments are described in detail in Paper II. Briefly, dietary data were collected from all subjects using the standardized 24-hour dietary recall, administered four times including one personal visit and three telephone interviews, on a weekend day and three weekdays, respectively. The method is open-ended and a standardized protocol was used [118]. The recalls were carried out within a 1-year sampling period. The interviewers, trained dietitians/nutritionists (one for each language), conducted the recall and gave all instructions to the subjects.

### *Calculation of energy and nutrient intake*

Because of the different food traditions of the studied groups, careful efforts were made to describe recipes and cooking style, and specific ethnic foods were included where necessary. Standard recipes were used to describe dishes eaten outside the home. After conversion to weight units, the food items were coded and energy and nutrient intake were calculated using a commercial dietary analysis software (MATs, Rudans lättdata, Västerås, Sweden) including the SNFA food composition database, *PC-kost* [119]. The evaluation of dietary variables comprised the following quantitative variables: intake of energy (MJ) and nutrients (weight units). The relative quality of the diet was expressed as a percentage of the total energy (E%) obtained from each of the macronutrients.

Total fat was calculated as well as the amount and proportions of saturated, monounsaturated and polyunsaturated fatty acids. Food intake level (FIL) was calculated as total reported energy intake divided by predicted basal metabolism rate (EI/BMR) [120].

## Classification of underreporters

In the literature underreporters have been classified according to various definitions. In this study, underreporting was assessed based on evaluation of the FIL, in relation to an estimated physical activity level (PAL). Underreporters were identified by Goldberg's equation. Goldberg et al. (1991) introduced the relation of reported energy intake (EI) to basal metabolic rate (BMR) as a criterion by which underreporting can be detected [121]. The FIL cut-off level chosen in this study was 1.06, which corresponds to a PAL, below which underreporting is statistically credible for a 4-day period. A subject was classified as a "very low energy reporter" (VLER) when the FIL was less than the Goldberg cut-off and as an "acceptable energy reporter" (AER) when the FIL was equal to or more than the Goldberg cut-off.

## Physical activity

### *Estimation of physical activity (Paper II)*

Physical activity at work and during leisure time was determined according to the question, “How much physical activity do you have during work/leisure time”? Physical activity at work was scored on an increasing scale: 1, very light, mainly sitting; 2, light, mainly walking or standing; 3, moderate, e.g. cleaning and 4, heavy work, e.g. heavy industrial work. Physical activity during leisure time was scored on an increasing level: 1, very light, no activity; 2, light, walking; 3, moderate, regular activity approximately once a week; 4, active, regular activities more than once a week and 5, very active, strenuous activities several times a week.

The PAL was estimated for each subject according to a method developed on the basis of available literature on how PAL corresponds to different levels of physical activity [122, 123].

## Ethical consideration

The Ethical Committee of the Medical Faculty of Uppsala University, Sweden, approved the study. All subjects had given their informed consent before entering the studies.

## Statistical analyses

The statistical analyses were performed using the statistical programme packages SAS for Windows (SAS Institute, Cary, NC, USA). The basic statistical analysis is comparisons between two groups of immigrant women and a group of Swedish-born women. For continuous variables an analysis of variance model was performed. When the overall F-test of all three groups was statistically significant at the 5% level the three pair-wise comparisons were performed. For variables with skewed distributions (Shapiro Wilk's  $W$ -test $<0.95$ ) a logarithmic transformation was made before the statistical analysis. To test the association between continuous variables Spearman's rank correlation and Spearman's partial rank correlation were used. Univariate linear regressions were used to assess relationships between serum antioxidants, oxidative stress and inflammation variables, and cardiovascular risk factors. These analyses were performed within groups and for all groups combined. The results are presented as means  $\pm$  standard deviation (SD). For categorical variables the three groups were compared using Fisher's Exact Test. All tests were two-sided and a p-value of  $<0.05$  was regarded as statistically significant, except for in Paper III, where significance level of  $p<0.01$  was used.

## Results

One hundred fifty-seven women (71 from Iran, 36 from Turkey and 50 Swedish-born) agreed to participate and completed the screening process. Response rate was low (40%) among Turkish women, intermediate (54%) among Swedish women, and highest (79%) among Iranian women. The mean age of the native-Swedish women was significantly higher than that of immigrant women so risk factor levels have been adjusted for age.

### Paper I

#### Education and some lifestyle factors

As illustrated in Table 9, Turkish women had the lowest level of educational skill. Further, unemployment was significantly higher in both immigrant groups than in native-Swedish women. Iranian women reported significantly less physical activity during leisure time compared with Swedish-born women.

Table 9. *Percentage of women of Iranian, Turkish and Swedish origin reporting education, unemployment, smoking and physical activity. Mean±SD*

	Iranian n=71	Turkish n=36	Swedish n=50
Education (illiteracy), %	0	26 <sup>b</sup>	-
Low education level (0-6 years), %	11	60 <sup>b</sup>	-
Unemployment, %	52 <sup>a</sup>	69	20 <sup>c</sup>
Smokers, %	21	17	10
Ex-smokers, %	27 <sup>a</sup>	43	55
Low physical activity during leisure time, %	49 <sup>a</sup>	34	18
High & moderate physical activity at work, %	14	28	22

a=significant difference (p<0.05): Iranian versus Swedish women; b=significant difference: Iranian versus Turkish women; c=significant difference: Turkish versus Swedish women; - =no data. P adjusted for age.

## Disorders associated with the metabolic syndrome

Both immigrant groups had a significantly higher BMI and sagittal abdominal diameter (SAD) than the Swedish-born women. The waist circumference was significantly higher in Turkish women than in women from Iran and Sweden (Table 10).

It was found that both Turkish and Iranian women had significantly higher triglyceride levels than the native Swedes. However, Swedish-born women had significantly higher HDL cholesterol levels than the two other groups. The LDL/HDL ratio was significantly higher in Iranian women than Swedish-born women. Insulin levels were significantly higher in Turkish women than Swedish-born women (Table 10).

Table 10. *Clinical characteristics of the subjects in Papers I, II, III, and IV. Mean±SD*

	Iranian n=71	Turkish n=36	Swedish n=50
Age (year)	47.1±8.1 <sup>a</sup>	45.7±7.3	51.1±9.0 <sup>c</sup>
BMI (kg/m <sup>2</sup> )	26.3±4.6 <sup>a</sup>	28.4±4.1 <sup>b</sup>	24.7±3.3 <sup>c</sup>
SAD (cm)	21.9±2.7 <sup>a</sup>	23.3±2.4 <sup>b</sup>	21.5±2.3 <sup>c</sup>
Waist (cm)	81.9±10.2	86.3±8.6 <sup>b</sup>	80.3±9.2 <sup>c</sup>
SBP (mm/Hg)	117±16.1	119.4±19.9	122.2±19.1
DBP (mm/Hg)	71.3±9.7	72.46±11.6	73.50±8.8
Chol (mmol/l)	5.18±0.09	5.23±0.77	5.79±0.86
TG (mmol/l)	1.39±0.61 <sup>a</sup>	1.37±0.52	0.96±0.52 <sup>c</sup>
LDL (mmol/l)	3.23±0.83	3.29±0.80	3.68±0.90
HDL (mmol/l)	1.32±0.33 <sup>a</sup>	1.33±0.32	1.68±0.38 <sup>c</sup>
LDL/ HDL	2.65±1.08 <sup>a</sup>	2.62±0.90	2.35±0.93
Glucose (mmol/l)	5.32±1.60	5.70±1.25	5.49±2.25
Insulin (mU/L)	8.19±5.13	9.39±3.98	7.29±5.02 <sup>c</sup>

BMI, body mass index; SAD, sagittal abdominal diameter; DBP, systolic and diastolic blood pressures; Chol, serum cholesterol; TG, triglycerides; LDL, low-density lipoprotein cholesterol; HDL, high density lipoprotein cholesterol. a=significant difference (p<0.05): Iranian versus Swedish women; b=significant difference: Iranian versus Turkish women; c=significant difference: Turkish versus Swedish women. P adjusted for age.

The metabolic syndrome was three times more prevalent in the Turkish women (30%) than in the native-Swedish women (10%), as reflected by a greater prevalence of abdominal obesity and low HDL cholesterol. A similar tendency, but only significant for low HDL cholesterol, was found for the Iranian women (Table 11).

Table 11. *The proportion (%) of individuals with disorders associated with the metabolic syndrome for each group*

	Iranian n=71	Turkish n=36	Swedish n=50
Abdominal obesity Waist girth>88 cm	20	43 <sup>b</sup>	18 <sup>c</sup>
Low HDL cholesterol <1.29 mmol/l	50 <sup>a</sup>	60	22 <sup>c</sup>
High triglycerides ≥1.69 mmol/l	25	20	12
High blood pressure ≥130/85 mm Hg	6	14	8
High fasting plasma glucose≥6.1 mmol/l	4	19 <sup>b</sup>	13
<i>Metabolic syndrome*</i> <i>3≥ risk factors</i>	13	30 <sup>b</sup>	10 <sup>c</sup>

a=significant difference (p<0.05): Iranian versus Swedish women; b=significant difference: Iranian versus Turkish women; c=significant difference: Turkish versus Swedish women.

\*The metabolic syndrome is defined as having three or more risk factors [26].

## Paper II

### Estimated nutrient intake and physical activity

Native-Swedish women reported a higher energy intake than did Turkish and Iranian women. Comparison of the relative distribution of energy from macronutrients (energy percent, E%) showed that the proportions of energy obtained from total fat and SFA were significantly lower in Iranian than in native-Swedish women. The proportion of energy obtained from MUFA was significantly higher in Turkish than in native-Swedish women, while the proportions derived from PUFA and sucrose was significantly higher in both immigrant groups than in native-Swedish women (Table 12).

The proportion obtained from total carbohydrate was significantly higher in Iranian women than in the native-Swedish group. The intake of dietary fibre was significantly higher in the native-Swedish than the immigrant groups. The intake of alcohol was significantly higher in the native-Swedish than in the Iranian or Turkish women, who had a very low consumption.

The degree of underreporting was significant, especially among immigrant women. When FIL<1.06 was applied as cut-off limit the prevalence of underreporting was 65%, 47% and 20% for Iranian, Turkish

and Swedish women, respectively. There were no major differences in energy distribution of the macro-nutrient between VLER and AER, indicating that the dietary data reflected the qualitative composition in spite of the underreporting of energy intake.

The estimated physical activity level, PAL<sub>est</sub>, was significantly lower in Iranian women than in the two others groups (Table 12). The Iranian women reported significantly lower physical activity during leisure time than did native-Swedish women.

Table 12. Average daily intake of energy and macro-nutrient intake according to reported 24-hour food recalls for each group and three pair-wise comparisons. Mean±SD

	Iranian n=71	Turkish n=36	Swedish n=50
Energy, MJ	5.6±1.1 <sup>a</sup>	5.7±1.6	7.5±1.5 <sup>c</sup>
Fat, g	46±12 <sup>a</sup>	56±21 <sup>b</sup>	67±15 <sup>c</sup>
E%	31±5 <sup>a</sup>	35±6 <sup>b</sup>	33±4
SFA, g	17±5 <sup>a</sup>	21±10 <sup>b</sup>	29±7 <sup>c</sup>
E%	11±2 <sup>a</sup>	13±3	14±2 <sup>c</sup>
MUFA, g	17±5 <sup>a</sup>	21±8 <sup>b</sup>	24±6 <sup>c</sup>
E%	11±2	13±3 <sup>b</sup>	12±2 <sup>c</sup>
PUFA, g	10±4	10±3	10±4
E%	6±2 <sup>a</sup>	6±2	5±2 <sup>c</sup>
Cholesterol, mg	173±70 <sup>a</sup>	206±101	283±92 <sup>c</sup>
Protein, g	52±11 <sup>a</sup>	50±15	71±13 <sup>c</sup>
E%	16±2	15±2	16±2 <sup>c</sup>
Carbohydrates, g	174 <sup>a</sup>	165±43	209±49 <sup>c</sup>
E%	53±6 <sup>a</sup>	50±6 <sup>b</sup>	47±5
Dietary fibre, g	16±4 <sup>a</sup>	15±5	18±5 <sup>c</sup>
Sucrose, g	30±15	32±11	31±14
E%	9±4 <sup>a</sup>	10±2	7±2 <sup>c</sup>
Alcohol, g	1±2 <sup>a</sup>	0.2±0.1	7±8 <sup>c</sup>
E%	0.4±1 <sup>a</sup>	0.1±0.3	3±3 <sup>c</sup>
FIL <sub>est</sub>	0.96±0.2 <sup>a</sup>	1.01±0.33	1.26±0.26 <sup>c</sup>
PAL <sub>est</sub>	1.66±0.14 <sup>a</sup>	1.71±0.12 <sup>b</sup>	1.72±0.12

E%=energy percent; FIL<sub>est</sub>=estimated food intake level; PAL<sub>est</sub>=estimated physical activity level; a=significant difference (p<0.05): Iranian versus Swedish women; b=significant difference: Iranian versus Turkish women; c=significant difference: Turkish versus Swedish women. P adjusted for age.

### Association between metabolic variables and diet

A significant positive association was seen between HDL-cholesterol and SFA (E%), while total cholesterol correlated negatively with PUFA (E%), P/S and M/S ratio. After adjusting for alcohol intake, BMI and physical activity during leisure time, only the negative association between total cholesterol and P/S remained significant. TG was positively related to body weight with a correlation coefficient of 0.41 (p<0.001), while no significant

association was seen between TG and either total fat or carbohydrate consumption expressed as energy percent.

### Associations between fasting insulin level and metabolic variables

A positive association between insulin and metabolic variables (body weight, BMI, and WHR) was observed, while no associations were seen with the dietary variables. The associations did not change after adjusting for alcohol intake and physical activity during leisure time.

## Paper III

### Fatty acid composition in diets

In the immigrant group diets, the proportions of main SFA (4:0-10:0, 12:0, 14:0, 16:0, 18:0, respectively) were lower than in the Swedish group, whereas the proportion of the major PUFA linoleic acid (18:2 n-6) was higher than in the Swedish group. In addition, the sum of n-6 PUFA (18:2 n-6 and 20:4 n-6) was higher in the immigrant groups than in the Swedish group, resulting in a higher n-6/n-3 ratio in the immigrant groups. Furthermore, in the Turkish group, the proportion of the major MUFA oleic acid (18:1 n-9) was higher than in both of the other two groups.

### Dietary fat sources

As illustrated in Figures 2 a, 2 b, 2 c, and 2 d, food group categories such as edible fats, dairy products and meat dishes were generally the major contributors of total fat, SFAs and MUFAs among all women. Vegetable dishes contributed a higher percentage of the total fat among the immigrant women than among the Swedish women, while the opposite was true for cereal- and sausage-based products and dishes. For PUFA, vegetable dishes, together with edible fats, were major contributors among the immigrant women, while it was edible fat among the Swedish women. In the Turkish group vegetable dishes contributed with a much larger proportion of MUFA than in the other two groups.

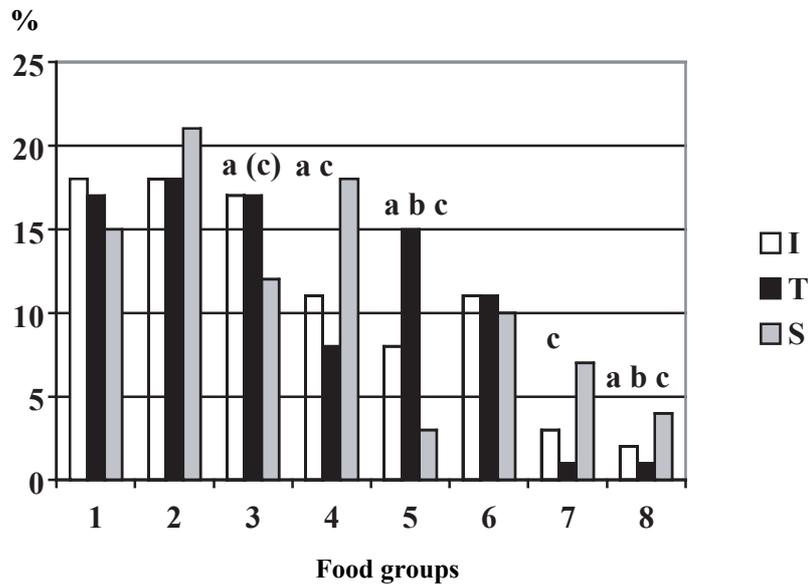


Figure 2 a

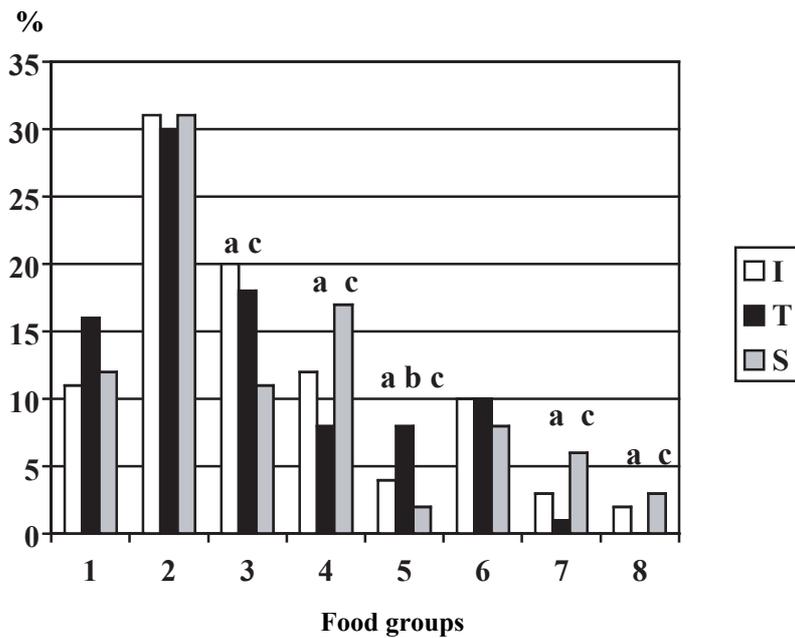


Figure 2 b

Figures 2 a, and 2 b. Different food groups and their contribution (%) of **total dietary fat** (Fig. 2 a) and **saturated fatty acids** (Fig. 2b), in Iranian (I, n=70), Turkish (T, n=35) and Swedish (S, n=49) women. 1: edible fats; 2: dairy products; 3: meat dishes; 4: cereal-based products; 5: vegetable dishes; 6: starch-based products and breads; 7: sausage-based dishes; 8: fish and fish-based dishes. Pair-wise comparisons: a: significant difference ( $p \leq 0.01$ ), Iranian versus Swedish women; b: significant difference, Iranian versus Turkish women; c: significant difference: Turkish versus Swedish women.

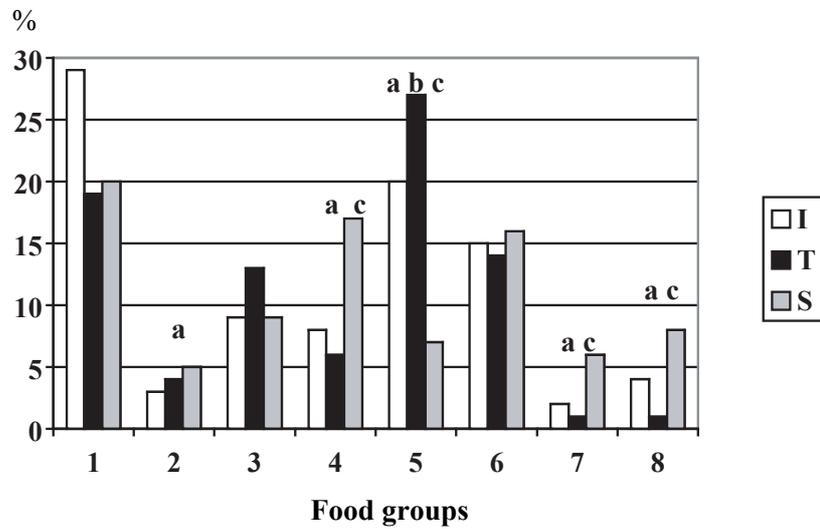


Figure 2 c

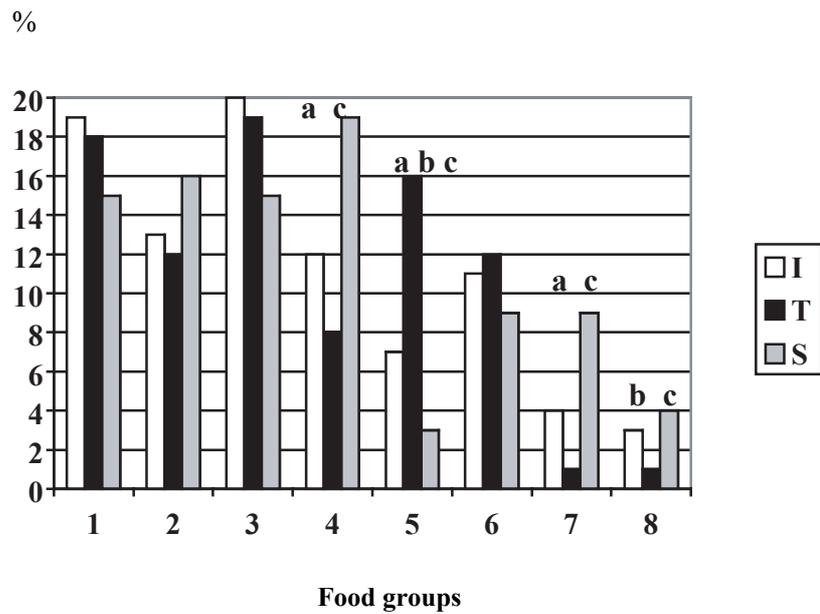


Figure 2 d

Figures 2 c, and 2 d. Different food groups and their contribution (%) of **polyunsaturated fatty acids** (Fig 2 c) and **monounsaturated fatty acids** (Fig. 2 d) in Iranian (I, n=70), Turkish (T, n=35) and Swedish (S, n=49) women. 1: edible fats; 2: dairy products; 3: meat dishes; 4: cereal-based products; 5: vegetable dishes; 6: starch-based products and breads; 7: sausage-based dishes; 8: fish and fish-based dishes. Pair-wise comparisons: a: significant difference ( $p \leq 0.01$ ), Iranian versus Swedish women; b: significant difference, Iranian versus Turkish women; c: significant difference: Turkish versus Swedish women.

## Fatty acid composition in serum

Regarding the proportion of SFAs in serum CE, there were differences between the Iranian and the Swedish group, but not between the Turkish and Swedish group. The proportions of the minor SFAs (14:0, 15:0, 18:0) in serum CE were lower in the Iranian group than in the Swedish group, but no difference was observed for 16:0. Regarding the proportions of MUFAs and PUFAs, both immigrant groups differed from the Swedish group. In the immigrant groups the proportions of both 16:1 n-7 and 18:1 n-9 were lower than in the Swedish group. Moreover the immigrant groups showed higher proportions of all individual n-6 PUFAs and of the sum of n-6 PUFAs in serum compared to the Swedish women, as well as a higher n-6/n-3 ratio. The opposite is shown for the sum of the n-3 PUFAs, where a lower proportion in serum CE was observed in the immigrant group than in the Swedish group (Table 13).

Table 13. *Fatty acid composition (%) in serum cholesterol esters for each group. Mean±SD*

Fatty acid	Iranian n=71	Turkish n=36	Swedish n=50
14:0	0.89±0.21 <sup>a</sup>	0.93±0.21	1.16±0.21
15:0	0.21±0.04 <sup>a</sup>	0.23±0.04 <sup>b</sup>	0.23±0.04
16:0	11.71±0.77	11.61±0.78	11.94±0.62
18:0	0.77±0.15 <sup>a</sup>	0.82±0.21	0.85±0.20
16:1 n-7	3.41±1.40 <sup>a</sup>	3.29±1.11	3.95±0.81 <sup>c</sup>
18:1 n-9	18.93±2.31 <sup>a</sup>	18.86±2.05	21.7±1.07 <sup>c</sup>
18:2 n-6	52.21±4.64 <sup>a</sup>	52.18±4.74	48.77±2.50 <sup>c</sup>
18:3 n-3	0.92±0.29 <sup>a</sup>	0.98±0.29	1.11±0.24
18:3 n-6	0.99±0.36 <sup>a</sup>	1.03±0.34	0.77±0.26 <sup>c</sup>
20:3 n-6	0.87±0.18 <sup>a</sup>	0.88±0.16	0.68±0.13 <sup>c</sup>
20:4 n-6	7.02±1.40 <sup>a</sup>	7.13±1.40	5.88±1.00 <sup>c</sup>
20:5 n-3	1.30±0.68 <sup>a</sup>	1.35±0.61	2.06±0.98 <sup>c</sup>
22:6 n-3	0.82±0.22	0.73±0.23 <sup>b</sup>	0.89±0.23 <sup>c</sup>
Total n-3	2.99±0.1 <sup>a</sup>	3.04±0.9	4.06±1.2 <sup>c</sup>
Total n-6	61.09±4.2 <sup>a</sup>	61.2±3.8	56.09±2.1 <sup>c</sup>
n-6/n-3	22.6±7.9 <sup>a</sup>	22.5±8.6	15.0±4.5 <sup>c</sup>
16:1/16:0	0.29±0.11	0.28±0.08	0.33±0.07
18:3 n 6/ 18:2 n-6	0.019±0.01 <sup>a</sup>	0.020±0.01	0.016±0.01 <sup>c</sup>

a=significant difference (p<0.01): Iranian versus Swedish women; b=significant difference: Iranian versus Turkish women; c=significant difference: Turkish versus Swedish women. P adjusted for age.

### Correlations between fatty acid composition in the diet and in serum cholesterol esters

Positive relationships between fatty acid composition in diet and serum CEs were found for the proportions of 14:0 ( $r = 0.29$ ,  $p = 0.0003$ ), 18:0 ( $r = 0.32$ ,  $p < 0.0001$ ) and 18:2 n-6 ( $r = 0.25$ ,  $p = 0.002$ ) calculated for all three groups together ( $n=156$ ). There was a borderline significance for 22:6 n-3 ( $r=0.20$ ,  $p=0.015$ ).

### Correlations between metabolic variables and fatty acid composition in serum

For those metabolic variables (BMI, SAD and TG) that differed between the immigrants and the Swedish group correlations were observed with some of the fatty acid in serum CEs, calculated for all groups together. SAD and BMI was both positively correlated with 16:1/16:0 ratio (estimated delta 9 desaturase activity) ( $r=0.38$ ,  $p<0.0001$ ,  $r=0.25$ , and  $p=0.002$ , respectively) and 18:3 n-6/18:2 n-6 ratio (estimated delta 6 desaturase activity) ( $r=0.30$ ,  $p=0.0002$ , and  $r=0.23$ ,  $p=0.003$ , respectively). The SAD tended to be negatively correlated with 18:2 n-6 ( $r=-0.20$ ,  $p=0.015$ ). There was a positive correlation between TG and the 16:1/16:0 ratio ( $r=0.29$ ,  $p=0.0003$ ) and the 18:3 n-6/18:2 n-6 ratio ( $r=0.31$ ,  $p<0.0001$ ). In addition, a negative correlation was found between total cholesterol in serum and 18:2 n-6 ( $r=-0.29$ ,  $p=0.0003$ ).

## Paper IV

### Dietary intake of antioxidants and other nutrients

As shown in Paper II, the reported daily energy intake was lower among the Turkish and Iranian women than among the Swedish-born women (Table 12). Therefore the intakes of nutrients were energy-adjusted and expressed per MJ. In the immigrant groups the mean daily energy-adjusted intake of magnesium and selenium was lower than in the Swedish group whereas the intakes of  $\alpha$ -tocopherol, ascorbic acid and folate were higher than in the Swedish group (Table 14).

Table 14. Mean daily intake of energy and selected micronutrient/MJ according to reported 24-hour food recalls for each group and three pair-wise comparisons. Mean±SD

	Iranian n=71	Turkish n=36	Swedish n=50
Energy, MJ	5.6±1.1 <sup>a</sup>	5.7±1.6	7.5±1.5 <sup>c</sup>
Vitamin A, RE, mg	79±173	67±53	88±39
β Carotene, mg	334±165	322±205	318±235
α-tocopherol, mg	1.2±0.4 <sup>a</sup>	1.30±0.4	0.91±0.2 <sup>c</sup>
Ascorbine acid, mg	18±9 <sup>a</sup>	18±17	11±5 <sup>c</sup>
Thiamine, mg	0.2±0.3	0.2±0.02	0.2±0.00
Riboflavin, mg	0.2±0.00	0.2±0.1	0.2±0.1
Niacin eqv. , mg	2±0	2±0	2±0
Vitamin B6, mg	0.2±0.1	0.25±0.1	0.2±0.0
Vitamin B12, µg	0.6±0.7	0.4±0.3	0.6±0.3
Folate, µg	41±10 <sup>a</sup>	42±9	29±6 <sup>c</sup>
Magnesium, mg	35±6 <sup>a</sup>	34±7	39±6 <sup>c</sup>
Zinc, mg	1.3±0.3	1.3±0.3	1.3±0.3
Selenium, µg	3.6±1 <sup>a</sup>	3.1±1.3	4.±1.4 <sup>c</sup>

a=significant differences (p<0.05): Iranian versus Swedish women, b=significant differences: Iranian versus Turkish women and c=significant differences: Turkish versus Swedish women.

### Tocopherol levels in serum

The serum α-tocopherol levels were lower in the Turkish group than in the Swedish group, whereas the β-tocopherol levels were higher than in the Swedish group. Serum γ-tocopherol levels were higher in the Iranian group than in the Swedish group (Table 15). In the whole population, the level of serum α-tocopherol was not correlated to the reported energy adjusted dietary intake of α-tocopherol (r=-0.03, p=0.65).

## Systemic oxidative stress

Of the three groups, the Turkish women had the highest level of systemic oxidative stress, as assessed by urinary levels of 8-iso-PGF<sub>2α</sub>, which was significantly different from those of Iranian women ( $p < 0.05$ , Table 15). There were however no significant differences in the levels of 8-iso-PGF<sub>2α</sub> between immigrant groups and the Swedish group. In the whole population, the level of urinary F<sub>2</sub>-isoprostanes was significantly correlated to fasting insulin concentrations ( $r = 0.25$ ,  $p = 0.003$ ,  $n = 139$ ) but not to other metabolic syndrome components. This correlation was also significant when analysing the Iranian women separately ( $r = 0.25$ ,  $p = 0.04$ ,  $n = 67$ ) or when analysing the two immigrant groups together ( $r = 0.31$ ,  $p = 0.002$ ,  $n = 97$ ).

## Inflammation

Turkish women had the highest level of plasma CRP among the three groups, which was significantly different from those of the Iranian and Swedish women (Table 15). The differences disappeared after adjusting for BMI, but remained unchanged after adjusting for age. There were no significant correlations between the level of CRP and dietary intake of antioxidant nutrients, serum  $\alpha$ -tocopherol or F<sub>2</sub>-isoprostanes.

In the whole population, the level of CRP was correlated to cardiovascular risk factors, but not to micronutrient intake or serum  $\alpha$ -tocopherol. All these correlations were significant also when analysing the Iranian women separately, except for fasting insulin and fasting glucose. In the Turkish group, the levels of CRP were correlated only to waist circumference ( $r = 0.41$ ,  $p = 0.01$ ), BMI ( $r = 0.38$ ,  $p = 0.02$ ) and TG ( $r = 0.43$ ,  $p = 0.001$ ). In the Swedish group CRP was correlated to cardiovascular risk factors, except for serum cholesterol and HDL cholesterol. When analysing the two immigrant groups together, CRP levels were positively correlated to TG ( $r = 0.50$ ,  $p = < 0.0001$ ,  $n = 105$ ), serum cholesterol ( $r = 0.25$ ,  $p = 0.009$ ,  $n = 105$ ), BMI ( $r = 0.47$ ,  $p = < 0.0001$ ,  $n = 105$ ) and waist circumference ( $r = 0.53$ ,  $p = < 0.0001$ ,  $n = 104$ ) and were negatively correlated to HDL cholesterol ( $r = -0.21$ ,  $p = < 0.03$ ,  $n = 105$ ).

Table 15. *Differences in serum vitamin-E status, oxidative stress and inflammation markers. Mean ±SD*

	Iranian n=71	Turkish n=36	Swedish n=50
$\alpha$ -tocopherol mg/mmol*	1.36±0.21	1.28±0.16	1.43±0.20 <sup>c</sup>
$\beta$ -tocopherol mg/mmol *	0.02±0.01	0.02 ±0.00	0.01±0.00 <sup>c</sup>
$\gamma$ -tocopherol mg/mmol *	0.10±0.05 <sup>a</sup>	0.09±0.04	0.07±0.04
Isoprostanes nmol/mmol of creatinine	0.23±0.10	0.29±0.12 <sup>b</sup>	0.25±0.09
CRP, mg/L	2.68±2.6	3.75±3.0 <sup>b</sup>	2.20±2.5 <sup>c</sup>

CRP=C-reactive protein. a=significant difference (P<0.05): Iranian versus Swedish women, b=significant difference: Iranian versus Turkish women and c=significant difference: Turkish versus Swedish women. \*corrected for the sum of total cholesterol and triglycerides.

## Discussion

All the analyses in this study were based on a cross-sectional study of 107 first-generation immigrant women aged 35-64 from Iran (n=71) and Turkey (n=36), living in the city of Uppsala and residents of Sweden for at least three years, compared with a group of ethnic Swedish women living in Uppsala (n=50). The studies were conducted in 1998-2000.

### Main findings

#### Risk factors for CHD

A major finding was that immigrant women displayed a higher prevalence of risk factors for CHD and the metabolic syndrome. The study showed a less beneficial cardiovascular risk profile among immigrant women than among Swedish-born women. The women who were born in Turkey, most of whom had Kurdish ethnicity, had substantially higher BMI, larger waist circumference, higher waist/hip ratio and sagittal abdominal diameter, higher levels of serum triglycerides and lower HDL cholesterol concentrations compared to native-Swedish women. The same tendency, but only significant for BMI, sagittal abdominal diameter, triglycerides, HDL-cholesterol and a higher LDL/HDL ratio, were seen for women born in Iran.

It is well-known that obesity is associated with diabetes, cardiovascular disease and all-cause mortality [124-128]. A 20-year follow-up of women in a prospective population study in Gothenburg, Sweden, showed that increased triglyceride concentrations and abdominal adiposity were associated with sharply increased risks of death from myocardial infarction and from all causes [129]. Both waist circumference and the sagittal abdominal diameter, indicating increased abdominal adiposity, were higher in immigrant women than native-Swedish women.

It is important to consider differences in ethnicity and lifestyle when comparing risk factors for CVD. Finnish immigrants, for instance, are found to have an increased risk of hypertension and hypercholesterolemia compared with native Swedes while Mediterranean men have an increased tendency to smoke and become overweight [17]. A Swedish population-based study revealed that Bosnian women refugees aged 42-59 had substantially higher levels of general and abdominal obesity, higher levels of

TG and lower levels of HDL-cholesterol [130]. Similar results are reported in the present study. Thus female immigrants from Iran and Turkey seem to have similar risk factors as refugees from the Balkan Peninsula.

### Dietary intake and composition

The estimated mean daily energy intake varied between immigrant women and Swedish women. Compared with the Swedish Nutrient Recommendations (SNR-1997) for an average intake for women in the present age groups, the calculated mean energy intake was 38% lower in the Iranian group, 36% lower in the Turkish group and 17% lower in the Swedish group. For a discussion of methodological aspects see Paper II.

Our data also show some differences in the intake of the dietary fatty acids among immigrant women and Swedish women. The Swedish women reported a significantly higher intake of total, saturated and monounsaturated fatty acids and cholesterol and lower intake of polyunsaturated fatty acids than the immigrant groups. This reflects the different food tradition with respect to types of fats used, e.g. vegetable oils or solid fats. The Swedish women reported a significantly higher alcohol intake than the immigrant groups. A majority of Iranian, Turkish and Kurdish people are of Muslim faith and most of them adhere to the Islamic prohibitions against alcoholic drinks (Koran, 2:219) explaining why alcohol consumption is virtually negligible in these groups.

### Dietary and serum fatty acids and metabolic risk factors

The present studies show differences in the fatty acid composition in the diets as well as in serum cholesterol esters between the immigrants and Swedish-born women.

A noticeable finding was a higher relative content of PUFA in the diet among the immigrant groups than in the Swedish group. This difference was confirmed in serum where the proportion of 18:2 n-6 was clearly higher among the immigrants than among the Swedish-born women. In addition, a positive correlation was found between the reported intake and the proportion of 18:2 n-6 in serum cholesterol esters.

It has repeatedly been shown that the relationship between fatty acid composition in the diet and in body tissue is most obvious for particular PUFAs such as 18:2 n-6 [39, 131-134]. Thus the reported dietary fat quality in our study was reflected in serum, a finding which verifies an acceptable quality of reported food intake.

Furthermore the higher proportion of n-6 PUFA in the diets of both immigrant groups compared with the Swedish group resulted in a higher ratio of n-6/n-3, which was observed in the diet as well as in serum. Despite a similar proportion of total n-3 PUFA in the diets, the level in serum

cholesterol esters was lower among the immigrants compared with the Swedish women. This may be explained by the higher proportion of dietary 18:2 n-6 in the immigrant groups, since a higher n-6/n-3 ratio may result in a lower level of biosynthesis of long chain n-3 PUFA as a result of the competition of the same enzyme system for desaturation and elongation [39, 135].

The high proportion of 18:2 n-6 in serum as well as in the diet among the immigrant groups is explained by a high consumption of vegetable oils such as sunflower oil, maize oil and oil blends (mainly rapeseed oil) as edible fat and in the vegetable dishes. In the immigrant groups these food groups contributed with the largest part of PUFA (edible fat 29% and 19%, and vegetable dishes 20% and 27% of total PUFA among the Iranian and Turkish women, respectively). Sunflower oil and maize oil are particularly rich in linoleic acid and are natural ingredients for traditional cooking in Iran. This is one explanation for the high proportion of PUFA in the diet especially among the Iranian women. In the Turkish group the proportion of the major MUFA oleic acid (18:1 n-9) in the diet was higher than in both of the other groups. This is explained by the use of olive oil, rich in oleic acid, as a common ingredient in Turkish cooking. Among the Swedish women the edible fat mainly consists of spreads, liquid margarine (based on rapeseed oil) and rapeseed oil. The data from the food records support the use of different fat products characteristic for the different groups of women and indicate that immigrant women in this study stay with the traditional cooking and use of traditional fat products even after immigration.

The fatty acid profile of the diet and serum among the immigrant women is compatible with a favourable cardiovascular and metabolic profile. In contrast, the clinical investigation indicated a more unfavourable situation with an increased risk, compared with the women born in Sweden. There are no clear-cut explanations for these apparent discrepancies, but the differences in body weight, SAD and physical activity, in addition to the dietary fat composition, may contribute.

### Oxidative stress, inflammation and cardiovascular risk factors

The Turkish women had increased F<sub>2</sub>-isoprostane levels, a marker of systematic oxidative stress, compared with women from Iran, and they also had higher levels of CRP than women from Iran and Sweden. These results are of interest because cardiovascular risk is highly prevalent in our immigrant population, particularly in Turkish women, who have also been found to be at greater risk of CVD than Swedish women (paper I and [7]). Because oxidative stress and inflammation may play a role in the pathophysiology of obesity-related diseases, also shown in a Swedish population [136, 137], our findings underline the need for preventive

measures and further support a high-risk state of certain groups of immigrant women from the Middle East.

Although both BMI and isoprostanes were higher among the Turkish women, no correlation between these factors was seen in these women and in the group as a whole. This differs from some other studies which found an association of F2-isoprostanes or lipid peroxidation products with BMI [138-140]. The different results might be due to the fact that other ethnic study populations were investigated in this study. However in the present study the F2-isoprostane levels were correlated to fasting insulin concentrations in the group as a whole and in the two immigrant groups together, which might reflect a link between oxidative stress and insulin sensitivity, as indicated from an intervention study [141]. That relation was independent of BMI, supporting the present association with insulin rather than with BMI.

CRP was however related to several risk factors in the group as a whole and in the Swedish and Iranian women separately. In the Turkish women CRP was only related to TG, BMI and waist girth. The latter finding is interesting and might suggest that inflammation, but not oxidative stress, is driven by obesity in the Turkish women. Several studies have shown a close link between obesity and CRP [54-56]. As shown in previous studies [142-144], CRP levels were correlated with several cardiovascular and metabolic risk also in the present population. As CRP is a powerful predictor of cardiovascular disease risk [145], the present cross-sectional data are in line with such associations. In addition to other cardiovascular risk factors that were elevated in Turkish women (Paper I), the higher CRP levels and oxidative stress probably put them at further higher risk compared to the Swedish women.

## Methodological consideration

### Attendance rate

Participation was lowest among the Turkish women (40%) and highest among the Iranian (79%). The diverging response rates of the immigrant groups probably reflect the fact that the two populations are very disparate in several aspects, e.g. regarding origin (urban-rural), education and cultural and socio-economic background in the home country. Many women from Iran in this study had emigrated from a big city, where access to diverse health service systems was readily available. On the other hand many of the women from Turkey in fact had Kurdish ethnicity and had emigrated from small rural communities, usually with a rather poor standard of living. This discrepancy is also evident in the level of education and the considerable difference in Swedish language skills between two immigrant groups. Inability to speak the host society's language is an important factor

complicating integration into the host society. The low participation rate in the Turkish group may also suggest that the recruitment method used in this study was not optimal. It may have been better to approach the participants through their own organizations and to offer oral rather than written information. Written information is obviously not an ideal recruitment method in a group with a rural background and a high degree of illiteracy and low level of education.

The low response rate, particularly of women born in Turkey, can be interpreted as a limitation. However, the random sampling method used among these two largest Middle-Eastern immigrant groups in Uppsala gave high reliability, especially because of the use of a common database covering all local female immigrants from Turkey. Therefore, we believe that the studied samples are reasonably representative despite the low response rate among Turkish women living in the area. In agreement with our study, results from other Swedish studies also show a low attendance rate for Turkish/Kurdish women [8, 146-148].

## Dietary survey

### *24-h recall*

Dietary data from all subjects were collected using a standardized 24-h dietary recall method. Four interviews were conducted to cover intra-individual variation in dietary intake over time. The method was chosen as it was judged to be the most suitable for a survey including both immigrants and Swedish-born subjects; it is an open-ended and interactive method using the subject's native language. Results of various studies employing different methodologies and investigating different populations showed that underestimation of dietary intake seem to be a common problem. Black et al. categorized underreporting by dietary assessment method. These data indicate that underreporting of energy intake is especially prevalent when 24-hour recalls are used [149]. The major conclusions of the present study, also confirmed by others, are that it seems extremely difficult to obtain plausible energy intakes with 24-hour recalls and the risk of differential underreporting seems obvious. The present study underlines the difficulty in obtaining valid data from different ethnic groups.

### *Underreporting*

Underestimation of the reported energy intake seemed to be a greater problem among immigrant women than among Swedish-born women. Several studies show that underreporting is more prevalent among subjects with a high body mass index (BMI) than with normal BMI [150-156]. This is also seen in the present study. As illustrated in Figure 3, BMI was negatively significantly correlated to energy intake ( $r=-0.26$ ,  $p<0.001$ ,

n=154) in the whole population. The immigrant women in this study have a higher BMI than the Swedish-born subjects, which could contribute to the underreporting.

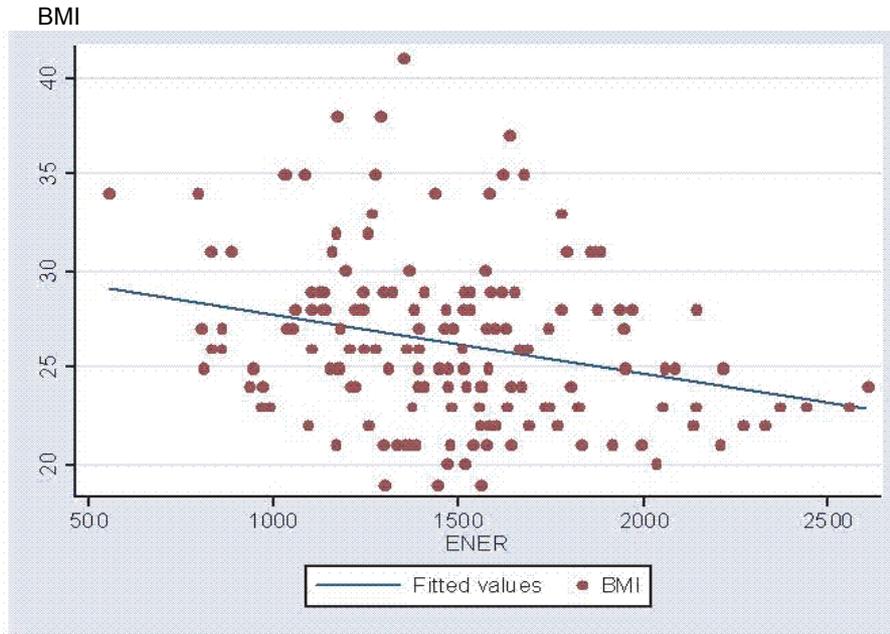


Fig 3. Correlation between BMI and energy intake (kcal) in whole group.

Koçturk [157] described how difficult it is to take nutritional history from immigrants from Turkey. The fact that it is culturally considered improper to talk about the food one eats is one reason. Coming from a country/region where not all people have abundant access to food, people are traditionally reluctant to discuss their diet, regardless of whether they consider it to be better than the average or to expose the poverty of their food if they believe the opposite to be true. As a result of the patriarchal nature of society, women are especially reluctant to show themselves as conspicuous consumers of food. It may therefore be embarrassing for immigrants from rural Turkey to be directly confronted with a question regarding their food intake, which may contribute to underestimation. The other reason may be the existence of frequent snack meals. If a variety of small amounts of food has been consumed throughout the day it becomes difficult to remember every item. The problem is further complicated by the fact that certain food items such as candy, sugar, nuts and even fruit are not considered “real” food. Snack meals are culturally not considered as energy and/or nutrient-giving sources of food, which means that consumption of snacks are likely to be overlooked by the subjects [157-159].

Despite the apparent underestimation of the daily energy intake we did not find any major difference in dietary composition between subjects with extensive underreporting and those having a more adequate energy intake, e.g. with respect to distribution of energy-providing macronutrients. This seems to indicate that the dietary data reflected the qualitative composition.

The impact of underreporting on dietary composition and relations between diet and clinical variables is shown in numerous studies. Rosell et al. [160] showed that inaccurate dietary data can introduce spurious associations with metabolic parameters. They suggested that association between dietary variables and the metabolic syndrome may be greatly affected by underestimation of the dietary intake. Various studies showed that associations can be changed when “underreporters” are excluded [150, 151, 155]. In the study by Rosell et al. [160] the dietary composition of the underreporters was found to differ from the normal reporters, e.g. they reported a lower level of total and saturated fat.

Although underreporting did not seem to influence the gross dietary composition in the present study, the degree of general underreporting among the immigrant groups was higher than among the Swedish women, which might have influenced the strength and magnitude of the observed relations between diet and metabolic variables. It could be speculated that underreporters may represent subjects with poorer health, which limits the possibility of finding association between diet and metabolic factors.

## Conclusion

The present study shows important ethnic differences in CHD/CVD and metabolic syndrome risk factor patterns in two groups of immigrant women from the Middle East compared to Swedish-born women:

- Immigrant women from Iran and Turkey are heavier than women born in Sweden and have a higher prevalence of abdominal obesity.
- Immigrant women have an unfavourable serum lipid profile, illustrated by higher levels of serum triglycerides, lower HDL-cholesterol concentrations and higher LDL/HDL ratios compared with Swedish-born women.
- Immigrant women from Iran and Turkey have a high degree of physical inactivity during leisure time, which may predispose for a higher incidence of diabetes and atherosclerotic cardiovascular disease.
- Turkish women had a significantly higher prevalence of the metabolic syndrome indicators than Swedish-born women, illustrated by a higher prevalence of abdominal obesity, low HDL cholesterol and fasting glucose. A similar tendency, but only significant for low HDL cholesterol was found for Iranian women.
- While the fatty acid profile in the diet and in serum among the immigrant women indicated both favourable and unfavourable implications, a higher prevalence of obesity and dyslipidemia was observed in immigrants compared with Swedish-born women.
- The role of antioxidant status is unclear, whereas signs of oxidative stress and inflammation are evident in the immigrant women. Oxidative stress and low-grade inflammation may be related to higher prevalence of obesity and the metabolic syndrome, especially in immigrant women from Turkey.

The data indicate unhealthy trends in CHD/CVD and metabolic syndrome risk factors pattern among immigrant women, which highlight the need for

more programmes of health promotion and lifestyle changes. The results suggest however that public health campaigns have not reached first-generation immigrants to the same extent as Swedish-born women. It is hoped that the present study will contribute to an effort aimed at prevention of CVD among these immigrant groups. In Sweden, increasing emphasis is placed on the importance of primary health care in the prevention of disease. To optimise preventive efforts, it is suggested that immigrant women, representing specific risk groups, should be provided with diverse counselling about physical activity, diet and social support as a part of patient education programme.

Finding facial symptoms of the metabolic syndrome at an early stage might provide the opportunity to act in a timely manner to prevent or setback cardiovascular disease and diabetes type II by changing lifestyle. To this end, it is reasonable to suggest prevention programmes using simple systematic risk factor screening (anthropometric measurements) for quick identification and treatment of high risk individual in areas with a high immigrant population.

To the extent that is practicable, it is desirable that preventive programmes should be presented in the own native language of the participants. Unfortunately the lack of culturally adapted educational material is a major problem in Sweden. It is highly desirable that education material currently in use in primary health care is adapted reconsidering concepts, methods and food habits that are of relevance for the immigrant culture in question. In addition further investigations, including variables such as psychological stress, to which immigrants are more exposed than others, are needed.

## Future perspectives

The prevalence of risk factors for CHD and the metabolic syndrome has so far only been studied in immigrant women. The relation needs to be studied in immigrant men as well.

The fatty acid profile of the diet and serum among the immigrant women is compatible with a favourable cardiovascular and metabolic profile. In contrast, the clinical investigation indicated a more unfavourable situation with an increased risk, compared with the women born in Sweden. There are no clear-cut explanations for these apparent discrepancies but the differences in BMI and SAD as well as physical activity may contribute. Further work is needed to investigate these divergences.

The role of antioxidant status is unclear and our results did not consistently agree with the hypothesis that a lower antioxidant intake is closely related to metabolic disorders and cardiovascular risk in these groups of women. Larger studies are needed to clarify the importance of antioxidant intake in relation to metabolic risk factors among immigrant women.

Further work is needed to elucidate associations between diet, lifestyle and metabolic risk factors in these groups of women.

## A public health perspective

The number of immigrants suffering from cardiovascular disease and diabetes is increasing rapidly [8, 161, 162], calling for action from the primary health care system and the society.

The metabolic syndrome has been reported to be associated with lifestyle factors such as weight control [163], diet [163-167], physical activity [168], smoking and alcohol habits [169], education [170], social inequality [171], social isolation [172] and psychosocial stress [31, 32, 35].

This study showed an increased risk of features of the metabolic syndrome among two groups of immigrant women with less healthy dietary habits, low physical activity, low education and unemployment. The results indicate that the primary prevention should not only consider biological risk factors, but must also take lifestyle factors as well as psychosocial and socioeconomic conditions into consideration, in order to identify persons at high risk for development of cardiovascular disease and diabetes.

### The need for information to immigrants and to health care personnel

The vast majority of the lifestyle factors contributing to the poorer health of many immigrant groups can be influenced [16]. The responsibility for those factors that influence public health, i.e. living conditions, lifestyle and environment, is divided among various sectors and different levels in society. Successful public health work requires active efforts on the part of municipalities, county councils and voluntary organizations [173].

#### *1) Information to immigrants*

Today's society requires a very active and well-informed consumer who can resist the constant attraction to eat and drink. To make it possible for the individual to maintain a health-oriented lifestyle, it is a prerequisite that he/ or she develops personal knowledge and skills. A large portion of the health promotion information that is currently distributed does not necessarily reach certain groups within society. These groups often consist of members from a culture outside the traditional Swedish cultural sphere and therefore have the need for culturally adapted information [174].

## *2) Information to health care personnel*

It is important to take into account that health care personnel need more knowledge about other cultures in order to be able to influence the habits of immigrants [175-177]. Being more aware of the total picture would make it easier for them to give useful good advice. The attitude of the personnel must be one of interest in immigrant habits and ways of thinking, since this attitude also increases the wish to change the person concerned. It is however important to know about ethnic groups' different approaches towards body ideals (for instance, obese woman and children are attractive in some immigrant groups), religions "ideas" (women should cover their hair and body for other men), and physical activity (the forest is an unfamiliar environment for some immigrant groups, therefore many women are afraid of and avoid taking walks in the forest on their own).

## The population approach

It is not obvious which strategy would be most successful for reaching immigrant groups with messages regarding health. Taking advantage of all local resources could be very useful [178]. These include the local health care staff, municipal employees (employed in schools, leisure time activities, social welfare, open pre-schools especially those mainly frequented by immigrant groups), local adult education institutes, voluntary organisations, local ethnic organisations, shopping centres and staff in grocery stores in housing areas with a high immigrant population, local ethnic grocery stores and the media.

The primary care health system seems to reach all socio-economic groups, including the less privileged [179]. According to several studies, citizens in Sweden seem to comply when their family physicians and nurses call them to examinations [180-182]. In many immigrant cultures, people have similar attitudes and show great respect and confidence in health care personnel, which means that there is good opportunity for primary health care to reach these groups of people. Adults affect their children and their respective behaviours so if we want the second generation's best we will also have to focus on the parents [183, 184]. It is necessary to take into consideration the fact that obese women and children are desirable for people from agricultural societies and that their attitude towards obesity remains very much the same here in Sweden. A method of quickly targeting people in the risk zone may be to focus on obese parents.

Preventive programmes for lifestyle-related diseases should be further developed and implemented for overweight individuals and others with risk factors for diseases associated with unhealthy dietary habits and physical inactivity. The Norsjö programme [178] is a good model of Swedish intervention. This intervention programme combines a population-oriented

strategy, focusing on health promotion activities, and an individually-oriented strategy inviting every citizen of 30, 40, 50 and 60 years of age to a health survey at his or her primary care centre. The health examination produces a health profile and thereby a basis for individual counselling. Weinehall et al. concluded that an inexpensive community-based cardiovascular disease (CVD) preventive programme is a possible way of supporting long-term changes in risk factors in a population [185]. This suggestion raises the question of whether general population screening should be performed, or if it is more cost-effective to focus on the screening of those at high risk of developing the metabolic syndrome.

Inclusion of some school education regarding food and physical activity is recommended. With the help of a preventive effort we should try to inform and stimulate adult immigrant students to improve their habits regarding food and drink in combination with increased physical activity.

The counselling steps to increase the level of leisure-time physical activity among certain ethnic groups in Sweden may be taken through contacts and co-operation with ethnic organisations in Swedish society. Walking groups, swimming and bicycle projects for women would be a good thing for many adults.

Immigrant organisations can be used as a forum for spreading information. The responsible authority should find and co-operate with local ethnic organisations; this co-operation might be able to press important issues. The local ethnic associations need to organise health information for their members. Several immigrant organisations run local radio stations that could broadcast health programmes.

Linkworkers provide a cultural bridge in various domains which may facilitate communication between the different leading actors and the selected ethnic minority communities. Ethnic minority linkworkers can be used for well-defined health promotion projects and should act as a bridge to local health agencies for that community. The literature suggests that linkworkers can make a valuable contribution in many services in areas with ethnic minorities [186-188]. Ewert et al. suggested including linkworkers as key persons in a successful integration project [189].

The conclusion we can reach is that more attention must be paid to the differences between different immigrant groups. All immigrants can not be viewed as a homogenous group. In spite of these heterogeneities, increased emphasis should be given to using practical education to raise immigrants' knowledge about unhealthy lifestyles and how to change them. It is difficult however to create urgent lifestyle changes among healthy adults without considerable effort from society.

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