Dietary Patterns in Saudi Arabian Adults Residing in Different Geographical Locations in Saudi Arabia and in the UK in Relation to Heart Disease Risk

Thesis submitted for the degree of Doctor of philosophy

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June 2014

Abstract

The food situation in Saudi Arabia has markedly changed during the last two decades. A nutrition transition is taking place in the country in which traditional foods are being replaced by fast foods high in fat, sugar, and salt. Since one important modifiable risk factor of cardiovascular disease (CVD) is dietary intake is important to monitor these changes in order to estimate the potential effects of this dietary transition as CVD risk. Saudi Arabia has a wide geographical variation with its two major cities located in contrasting regions where local food availability is very different. Therefore, this study was designed to investigate dietary intake in two samples of adults living in different geographic locations (coastal and internal areas) of Saudi Arabia and also, those living abroad (in this case, in Newcastle, UK). 308 Saudi men and women aged 18 - 65 years were recruited from King Abdul-Aziz University, in the coastal city of Jeddah (50 men, 50 women), Umm Al Qura University, in the inland city of Makkah (73 men, 56 women) and those living abroad in Newcastle, UK (32 men, 47 women). All participants completed detailed three consecutive day food records and an assessment questionnaire that included question on lifestyle practices and socioeconomic status. Height and weight, waist and hip circumference were measured in order to calculate body mass index (kg/m^2), and waist/hip ratio. The mean (SD) ages of women and men were 31.1 years (7.35) and 32.2 years (8.27), respectively. BMI was lower in men and women from the coastal region 25.1 (2.76) than the inland region 26.3 (3.21), and for Saudis in Newcastle it was 25.6 (4.36) ($P < 0.05$). Smoking was more prevalent in the internal area (63%) than coastal area (34%) and (26%) in Saudi immigrants ($P < 0.001$). Men were more physically active than women in three cities. Dietary intake data across the three locations demonstrate that subjects from the coastal city had a significantly lower energy intake and SFA intake but higher intakes of MUFA and PUFA, fibre, selenium and vitamin A ($P < 0.05$). In contrast they ate significantly less carbohydrates, calcium, magnesium, sodium, potassium and zinc ($P < 0.05$). Altogether, the diet of internal city resembled the samples in Newcastle more than the coastal city diet because the levels of key nutrient and food intakes, such as energy, SFA, carbohydrates, calcium, magnesium, potassium and vitamin A, were similar. On the other hand, MUFA and PUFA intakes were different between the three cities ($P < 0.001$). Fatty acids intakes differed markedly between locations, with the coastal diet higher in omega 3 fatty acids 1.3 *vs*. 0.37 *vs.* 0.78 g/day compared with internal diet and Saudi immigrants diet, respectively ($P < 0.001$), while internal area had highest in *trans* fatty acids intake ($P < 0.001$). It is concluded that, the results indicate that the prevalence of

CVD risk factors in Saudi adults seems to be high. Food intake was statistically significantly correlated with CVD risk factors for the whole study population. There were differences between each location: people living close to the coastal area consumed more fish and therefore more total omega 3 fatty acids relative to individuals living in the internal areas of Saudi Arabia, in Makkah. This higher intake of total omega 3 fatty acids by individuals living in the coastal city of Jeddah may be one of the reasons for the city's lower rates of CVD. Nutrition education among internal residents is needed for improving diet quality and for increasing consumption of omega 3 fatty acids.

Declaration

I hereby declare that this thesis is of my own composition and has not been accepted in any previous application for a degree. All sources of information have been specifically acknowledged by means of referencing. All data were collected and analysed by the author.

Noha Al Moraie

Acknowledgement

Firstly, all my thanks are to Allah who has provided me with the strength and capacity to complete this thesis.

I would like to take this opportunity to express my sincere thanks to my supervisors, Professor Chris Seal and Dr Georg Lietz for their continual support, supervision, encouragement and guidance throughout my thesis. Thanks also go to Professor Paula Moynihan for her relevant contributions during the annual assessments of the project.

Also, I would like to thank the Saudi government (King Abdul Aziz University) for providing me with a full time research grant. I would like to thank the staff of the Saudi Arabian Cultural Bureau in London for their assistance and cooperation. Also, I give special thanks to all Saudi who participated in this study without the cooperation of those people this project could not have been possible. The cooperation of the staff of both King Abdul Aziz University and Umm Al Qura University is gratefully acknowledged and also for the students and their families in Newcastle, UK thank you.

Finally, I am grateful to my family: to my parents who have always supporting me. I hope that they are proud of me. To my husband Naif, who assisted and encouraged me in many ways, my children Layan and Thamer for their unconditional love, my brothers and sisters especially my sister Manal due to her support to me in various ways. I present my thanks and gratitude from all my heart to all my colleagues and friends.

Thank you

Noha

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List of Abbreviations

AA	Arachidonic Acid
ALA	Alpha- Linolenic Acid
AC	Arm Circumference
AMC	Arm Muscle Circumference
BMI	Body Mass Index
BMR	Basal Metabolic Rate
CHD	Coronary Heart Disease
CVD	Cardiovascular diseases
DBP	Diastolic Blood Pressure
DHA	Docosahexanoic Acid
DRI	Dietary Reference Intake
DRV	Dietary Reference Values
EAR	Estimated Average Requirement
EI	Energy Intake
EPA	Eicosapentaenoic Acid
FAO	Food and Agriculture Organization
FFQ	Food Frequency Questionnaire
GLA	Gama-Linoleic Acid
HDL	High Density Lipoproteins
LA	Linoleic Acid
LDL	Low Density Lipoproteins
MI	Myocardial Infarction
MUFA	Mono Unsaturated Fatty Acid
NS	Not Significant
PAL	Physical Activity Level
PUFA	Poly Unsaturated Fatty Acid
RNI	Reference Nutrient Intake
SBP	Systolic Blood Pressure
SD	Standard Deviation
SFA	Saturated Fatty Acid
SFT	Skin-fold Thickness
SPSS	Statistical Package for Social Science
SR	Saudi Riyals
WHR	Waist to Hip Ratio
WHO	World Health Organization

Chapter 1 Introduction

Cardiovascular disease (CVD) is the most significant cause of death on a global level. The World Health Organization (WHO) estimates that 17 million people around the world die of CVD each year (WHO, 2001/2002). CVD is a leading cause of death in both developed and developing countries. For example, in developed countries such as the United States of America (USA) CVD accounts for an estimated over 40% of the deaths of nearly 2.4 million Americans who die each year (Minino *et al*., 2011), while in the United Kingdom (UK), it accounts for around 200,000 deaths each year **(**British Heart Foundation Statistics Database, 2009). In developing countries morbidity due to CVD is double that of developed countries (WHO, 2003). CVD is the main cause of death in Arab Gulf countries and health statistics reveal that 28-30% of the total deaths in these countries are due to CVD (Executive Board of Health Ministers Council for Gulf Cooperation Council States, 2008). Furthermore, the statistics collected in the Kingdom of Saudi Arabia over the past forty years show an increase in deaths caused by CVD, including vascular diseases, coronary heart disease and stroke (Kumosani & Al Madany, 2002). The number of deaths due to CVD increased by 333 cases in only one year from 5392 cases registered in 2005 (Health Statistical Year Book, 2006). It is estimated that by the year 2030 the death rates from CVD will have further increased and will remain the leading cause of death in the world (WHO, 2008).

The reasons for the increasing incidence of diseases of the heart and vascular system include a wide range of factors such as lack of physical activity, obesity, diabetes and smoking, as well as a change in the pattern and quantity of food consumed (Houston *et al.*, 2009). Over the past several years Saudi Arabia has undergone major socioeconomic development which has led to changes in standards of living and lifestyle. There has been an accompanying drastic change in food consumption patterns in Saudi Arabia. The change includes both quantitative and qualitative variations in diet. In addition, the structure of the diet has shifted towards a high energy dense diet with higher saturated fatty acids (SFA) mostly of animal origin, added sugar in foods and a lower intake of dietary fibre, fish, fruit and vegetables (Khoja *et al.*, 2007). Osman and Al Nozha (2000) highlighted that it is essential to investigate interaction for planning and successful nutrition intervention strategies for primary prevention and control of CVD. Moreover, the knowledge of determinants of CVD risk factors in an adult population will increase when more data of the differences between groups or population are available. Studies both of risk factors status and change of social and economic developments are needed to achieve an understanding of differences in risk factors or changing circumstances (WHO, 2000).

Diet has been claimed to be the most prominent environmental factor attesting the risk of heart diseases among the general population worldwide. For example, clinical and epidemiological studies suggest a significant role for omega 3 fatty acids in preventing coronary heart diseases (CHD). Horrocks and Yeo (1999), mention that these are crucial fatty acids which the body cannot synthesise and therefore should be gained through food. There are three major types on omega 3 fatty acids that are ingested in foods and used by the body: Alpha linolenic acid (ALA), Eicosapentaenoic acid (EPA) and Docosahexaenoic acid (DHA). Once eaten, the body converts ALA to EPA and DHA (Holub, 2002). Fish is considered as a major source of omega 3 fatty acids, however, they can also be found in alternative sources such as vegetables, grains and oils. Plants are rich with ALA whereas fish oils are higher in EPA and DHA. It has been claimed that the SFA intake is the major CVD environmental factor (Amani & Sharifi, 2012). Intervention trials have revealed that cardiac decreases whenever the diet is rich with the fatty acids of omega 3, particularly ALA (Lanzmann-Petithory, 2001), therefore the ratio of SFA to polyunsaturated fatty acids (PUFA) is important in determining the health fullness of the diet.

Making informed recommendations at both the individual and the group level requires a careful assessment of the intake of omega 3 fatty acids (Al Numair *et al.*, 2005). It has been assumed that individuals are living near coastal areas are likely to consume more fish and consequently more omega 3 fatty acids than other inhabitants residing far away from the coast. One of the serious limitations when assessing the risks of the CVD and how they are related to diet intake and sources in Saudi Arabia is the shortage of data as well as a shortage in published materials on different population groups. Furthermore, to the knowledge of the researcher, there are few published research data available on the dietary intake of omega 3 fatty acids in Saudi Arabia. Well-designed research that investigates the consumption, and the source of dietary components that contain total omega 3 fatty acids and their effects on CVD risks will be of benefit the public in general, the participating groups as well as providing evidence for the development of improved public health systems.

Moving to a new country, the Saudis in the UK experience a totally different culture from their own which is likely to affect their overall lifestyle including their psychological, mental, nutritional health as well as their physical status (Papadaki *et al*., 2007). This major change in Saudi expat lifestyle, eating habits and patterns is because of acculturation as well as their desire to integrate into the new host community. Food consumption and dietary intake will have undergone modifications that are normally related to the availability of food items. A systematic review by Gilbert and Khokhar (2008) have identified that dietary habits change towards a more westernized food or mixed diet as opposed to a traditional diet in European populations. The living arrangements, financial resources, cost and social setting of the individuals living abroad are also among the critical factors in maintaining certain lifestyles and eating patterns (Papadaki *et al*., 2007). Concerning the dietary changes of international students, research has revealed that single students are more likely to eat less healthy foods than married students; married students consumed higher amounts of vegetables and fruit than those who were single (Perez-Cueto *et al*., 2009). Yoh *et al*. (2008) maintains that the everyday life activities are focused only on home duties, school and some social networking that may extend to other ethnic groups.

Research that collects and compares relevant information on the dietary intake effects on health can help to introduce more effective preventative measures that may reduce the CVD risks to the public in Saudi Arabia. Likewise, a raised public awareness concerning the significance of total omega 3 fatty acids as fundamental nutrients is expected through the proper investigation of their effects on the participants and among the population groups that live in the same or different environs. This research is expected to furnish such data as well as provide a comparison between geographical locations within Saudi Arabia. Moreover, it will also compare Saudi people at home and those living in Britain, who may have developed different lifestyles and dietary habits.

Chapter 2 Literature Review

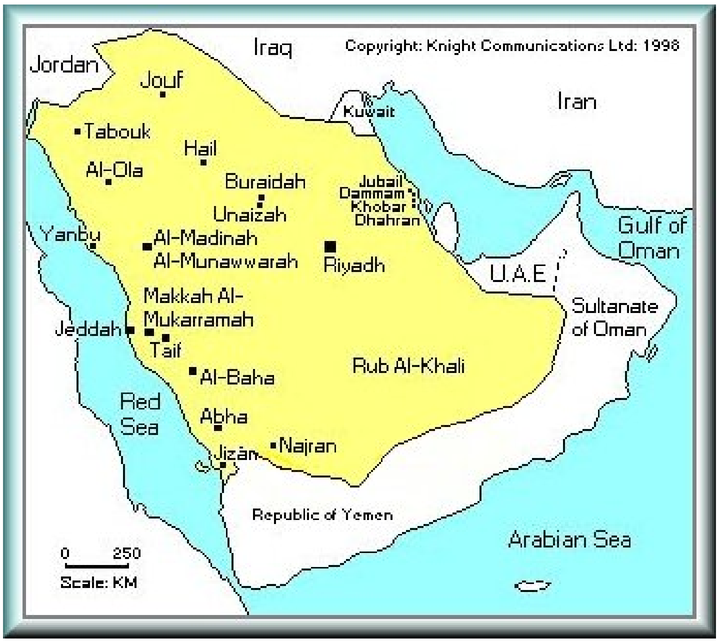
The aim of this chapter is to provide a summary of the published data relating to diet and its association with the risk factors of CVD. Part of this literature review will be presented in outline, with the remainder presented in more detail, determined by what is considered to be of greater relevance and importance to the current study.

2.1 CVD in Saudi Arabia

2.1.1 Demographic and geographical background

Saudi Arabia is the largest country in the Arabian Gulf (with a land area of 2,250,000 square kilometres), and lies in the south-western part of Asia. It comprises four-fifths of the Arabian Peninsula and extends from the Red Sea in the west to the Arabian Gulf in the east. Saudi Arabia is bordered to the north by Jordan, Iraq and Kuwait and to the south by Yemen and Oman and to the east by Bahrain, Qatar and the United Arab Emirates (Saudi Arabia Information Resource, 2010) (Figure 2.1).

Figure 2.1: Map of the Kingdom of Saudi Arabia*



*Saudi Arabia Information Resource, 2010.

The total population of Saudi Arabia according to the 2010 Census is 27,136,977. Of those, the Saudi native population is 18,707,576 consisting of 9,527,173 males and 9,180,403 females (Saudi Arabia Central Department of Statistics and Information, 2010). Saudi Arabia's terrain is varied but is generally barren and harsh, characterised by salt flats, gravel plains and sand dunes and few lakes or permanent streams. The Rub Al Khali in the south is the largest Sahara in the world. The south-western Asir Province contains, 9,000 feet mountain ranges while the western regions are coastal areas with a very distinct climate. The principal cities in the western coastal region of Al Garbia include Jeddah, Yunba, Debah, Hagel and Rabig. Dammam, Dhahran, Jubail and Khobar are the prominent cities and towns located in the eastern coastal region of Al Sharqia (Saudi Arabia Information Resource, 2010). All other regions are characterised as internal or interior regions.

2.1.2 Economic and cultural in Saudi Arabia

In the 1970s, Saudi Arabia was one of the least developed countries worldwide. Today it has achieved a high income level which is comparable to that of industrialized countries. The oil boom of the 20^{th} century has had a great impact on Saudi Arabia, enabling it to bypass the difficulties other industrialising countries face when developing their economies. The oil boom not only had an impact on the Saudi economy but also the rapid increase of wealth transformed Saudi society from a traditional to a commercial society. Moreover, Saudis enjoy a wide range of social benefits such as free education and health care, housing, interest free loans and pure drinking water. However, a nutritional shift has emerged among the population, namely a sequence of changes in dietary patterns, food intake and lifestyle (Statistical Yearbook, 2010). Being a Muslim country, the religious Muslim beliefs are wide spread in almost every aspect of Saudi life, particularly the economic and the social development (Al Dossary *et al*., 2008; Littlewood & Yousuf, 2000). Nearly, all aspects of the Saudi citizens are affected in a way or another by the Islamic believes including language, food, behaviour as well as healthcare. In addition, El Gilany and Al Wehady (2008) maintain that Islam is a religion that encourages the Muslim to maintain good health. For instance, the Islamic religion calls on Muslims to exercise on a regular basis, abstain from eating too much food, maintain reasonable personal hygiene, and not to smoke tobacco or drink any types of alcohol. However, due to various socio-cultural factors, not all Muslims observe these Islamic guidelines (for example smoking). Similarly, the rise of many liberal ideas in the Muslim countries has encouraged many young females to take up smoking in public places such as the restaurants and the cafes.

2.1.3 Prevalence of CVD in Saudi Arabia

The rapid economic growth of Saudi Arabia has led to significant lifestyle changes with effects on health, nutritional status and of disease patterns (Bani & Hashim, 1999). The oil boom encouraged new lifestyle patterns involving less physical work and greater mobility using new forms of transportation, as well as time saving technology leading to the reduction of physical activity (Kumosani *et al*., 2011). In addition, urbanization and economic growth led to a shift in eating habits and brought with it fast food with increased calories and high levels of fat, salt and sugars. This food combined with a sedentary lifestyle has led to an epidemic of CVD in Saudi Arabia (Kumosani *et al*., 2011).

CVD was the second most common cause of death in Saudi Arabia, in 2010 and 2011, representing 19.8 % of total deaths 29,275 (Health Statistical Yearbook, 2011). The statistics indicated in 2011 that men were at a higher risk compared to women. The distribution of deaths due to circulatory system diseases according to gender is presented in Table 2.1. The statistics also indicate a risk gradient, with the highest number of deaths in Makkah (17.7%) followed by Riyadh (13.5%) and Jeddah (9.5%). Distribution of deaths due to circulatory system diseases according to region is shown in Table 2.2 (Health Statistical Yearbook, 2003 & 2011). These differences in percentage may be due to the impact of geographic location, since both Makkah and Riyadh are in inland cities whereas Jeddah is a coastal city.

Table 2.1: Distribution of deaths due to circulatory system diseases according to gender, 2011*

Gender	Number	Percent (%)
Male	**3,206**	**10.9**
Female	**2,594**	**8.9**
Total	**5,800**	**19.8**

* Health Statistical Yearbook, 2011.

Table 2.2: Distribution of deaths due to circulatory system diseases according to region, 2003*

Regions (Description)	Number	Percent (%)
Riyadh (Internal City)	**867**	**13.5**
Makkah (Internal City)	**1137**	**17.7**
Jeddah (Coastal City)	**610**	**9.5**
Ta'if (Internal City)	**231**	**3.6**
Eastern (Coastal City)	**352**	**5.5**
Medinah (Internal City)	**558**	**1.6**
Northen (Internal City)	**100**	**8.7**
Aseer (Internal City)	**402**	**6.3**

* Health Statistical Yearbook, 2003.

2.2 CVD risk factors

On the international level, previous research has tried to find strategies that can effectively prevent CVD by identifying the risk factors that contribute to such diseases and adopting programmes of public health (Flynn *et al*., 2007; National Heart Foundation of Australia, 2008; National Vascular Disease Prevention Alliance, 2009). According to the National Vascular Disease Prevention Alliance (2009), the risk factors of CVD can be categorised into two major types: risk factors that can be modified and risk factors that cannot be modified. Khatib (2004) and the National Vascular Disease Prevention Alliance (2009) maintain that the former refers to physical inactivity, obesity, an unhealthy diet, hypercholesterolemia, tobacco use, hypertension, and all other factors that can be altered. The latter involves those inherited risk factors such as gender, socioeconomic status, age, social history, mental health, and CVD family history. According to Lloyd-Jones *et al*. (2009) and WHO (2010), around 80% of coronary heart diseases are the result of modifiable risk factors. Furthermore, Khatib (2004) and Lloyd-Jones *et al*. (2009) suggested that risk factors can be modified by techniques of self-management and lifestyle education. In 2008, the National Heart Foundation of Australia explained that such techniques of self-management include following appropriate medication, observing symptoms, and managing risk factors in one's lifestyle, particularly smoking and obesity.

2.2.1 Age and gender

Yen *et al.* (2010) showed that there is a rise in CVD incidence in men and women with age, although generally women develop CVD approximately 10 years later than men. Compared with men, women up to middle age are at a lower risk of developing CVD than men (Rosamond *et al.*, 2007). Research has revealed that a mixture of various environmental, genetic and hormonal factors may be the reason behind earlier CVD development in men (Mendelsohn & Karas, 2005; Ordovas, 2007; Pilote *et al*., 2007). Estrogen has been shown to have protective effect against the development of the risk factors of CVD and therefore it was considered the most frequently cited reason for the differences between both genders (Regitz-Zagrosek *et al*., 2006). Pilote *et al*. (2007) have suggested that estrogen contributes to the tendency of the premenopausal women to have lower plasma concentrations of triglyceride, lower systolic blood pressure as well as higher concentrations of HDL cholesterol than men. Another factor that is thought to contribute the lower degree of CVD incidence as well as mortality rates among women is that the smoking prevalence among women is lower than in men. The number of the female smokers worldwide is lower than the number of the smoking men (Pilote *et al*., 2007). In spite of the fact that hypertension, dyslipidemia and smoking are generally higher among men than women, the latter tends to have profiles that are less favorable for other main risk factors of CVD. The increasing obesity among women than men is another disturbing gender difference. Data obtained from WHO reveal that overweight (BMI ≥25 kg/m^2) is globally less common among women than men; however, obesity (BMI ≥30 kg/m^2) is less common among men than women.

2.2.2 Obesity

In Saudi Arabia, the population’s behavioural and social patterns as well as their overall lifestyle have recently changed in a dramatic way. To name one example, the eating behaviours of both adults and children have leaned towards the consumption of high amounts of unhealthy foods such as western fast foods, high fat foods and foods that are high in sugar (Musaiger *et al*., 2011). These eating behaviours have lead to a dramatic increase in diabetes and obesity among Saudis. Shara (2010) maintains the daily intake of fats among Saudis per capita is 143.3%. Saudis’ modern diets are currently characterised by high amounts of red meat, carbohydrates and sugar. According to WHO (2005), 7.6% of Saudi women have morbid obesity and 43.8% of them are overweight. Several recent studies indicate that the prevalence of obesity in the general population is high for both Saudi men and women compared with other Arab countries (Kumosani *et al*., 2011). A study by Madani *et al.* in 2000 highlighted the obesity situation in Saudi Arabia, indicating that it ranged from 14% in children less than 6 years old to approximately 38% in adults. Men are generally less prone to be obese or overweight than women. In a different study, using a national epidemiological survey, Al Nuaim (1997a) set out to investigate the prevalence of being overweight and its connection with the socio-demographic characteristics of 10,657 Saudis between the aged of 20 years and over. The mean age was 35.8 (14.3) and 50.8% of the sample were men. The overall prevalence of being overweight was 31.2% (33.1% for men and 29.4% for women). For obesity, the overall prevalence was 22.1% (17.8% for men and 26.6% for women). Statistically, multiple regression analysis revealed that income, education, region, residential area, gender and age significantly predicted obesity. Obesity was found to be lower in men than women, it increased with age, and obesity rates decreased among participants living in rural areas, whose lifestyles were traditional, as opposed to participants who lived in urban environments. Al Suliman (2008) and Al Qauhiz (2010) observed that rates of obesity and being overweight were increasing especially among women, with 70.5% in Saudis western region and 65.4% in the eastern area being affected. Al Rukban (2003) reported lower rates of 43.3% among Saudi men. Rasheed (1998) conducted a case-control study on obese as well as non-obese Saudi women to investigate their perceptions of exercise and their eating and body weight. The study revealed that participants had misconceptions regarding programs of weight control, exercise, eating behaviours and their effects on the weight status of the individual. The study also revealed that when Saudi women experience negative feelings, they, in response to such anger and stress, tend to eat more which may, in turn, affect their weight. Moreover, Rasheed (1998) mentioned that compared with the average woman in Europe, the Saudi woman is considered more obese. The researcher contended that this could be due to several reasons, such as a lifestyle of inactivity, a lack of physical activity, the traditional foods that are eaten and socioeconomic status. It is worth noting here that the Saudi woman is responsible for preparing family meals, which are normally made up of two or possibly more kinds of traditional foods that are normally rich in meat, fat and sugar. Rawas *et al.* (2012) maintains that cooking foods that suit all members of the family could prevent the Saudi woman from preparing healthy foods.

2.2.3 Diabetes mellitus

The spread of diabetes mellitus all over the world correlates with the aging of populations and changes in lifestyle. According to WHO (2003), 177 million of the world's population are developing diabetes, this number is expected to double by 2030. Diabetes ranked fourth among the causes that lead to death in Europe. Individuals with diabetes are 3-4 times more at risk than healthy individuals of developing major cardiovascular complications. More recently, diabetes is considered the most common cause of strokes and heart attacks. It is even considered a chief cause of peripheral neuropathy that leads to a high risk of amputation (20 times more likely than normal) and peripheral vascular diseases (Kumosani *et al*., 2011). In the Arab Gulf countries, diabetes is much more widespread among adults than among their counterparts in the west. One study found that the rate of diabetes (type 2) among adults ranged from 12% to 23% (Musaiger, 2002). In addition, the chance of developing diabetes increases with the advancement of age, a fact that is alarming in view of the increasing number of elderly people worldwide in general and in Saudi Arabia in particular (Kumosani *et al*., 2011). In Saudi Arabia, it was found that 28% of diabetes sufferers were unaware of their condition (Mabry *et al*., 2010a). At least one in five Saudis (more than three million individuals) were found to be diabetic in Saudi Arabia in a 2007 study (El Hadad *et al*., 2007). Previous surveys of the country have suggested that diabetes is present in epidemic proportions throughout the nation, with exceedingly high rates concentrated in urban areas (Al Zaid, 1997). In a national survey by Al Nozha *et al.* (2004), 17232 Saudi subjects aged between 30-70 years were assessed. 4004 were diagnosed to have diabetic (24%). Diabetes was more prevalent men and women living in urban areas with 25.5% compared to rural Saudis 19.5%. Furthermore, by comparing different regions of Saudi Arabia it can be observed that the highest prevalence is in the northern region at 28% followed by the eastern region then western region at 25%.

2.2.3 Hypercholesterolemia

Hypercholesterolemia is defined as the presence of high concentrations of cholesterol in the blood. It is not a disease *per se* but a metabolic derangement that can emerge secondary to many other illnesses and can contribute to many forms of disease, most notably CVD (Kumosani *et al*., 2011). A number of studies have reported the prevalence of hypercholesterolemia in the Saudi Arabian population. A study by Al Nuaim *et al*. (1996) indicated a prevalence of hypercholesterolemia in Saudi Arabia of 9% and 11% for men and women, respectively in a sample of 4500 Saudi subjects. A more recent study reported by Al Nozha *et al.* (2008) investigated 16819 Saudi participants aged between 30-70 years, and found a significant percentage of the study subjects with serum cholesterol of 5 mmol/l or higher. Prevalence of hypercholesterolemia among men was

55% and 53% for women, while the figure was 53.4% among urban Saudis and 55.3% for rural Saudis. Participants living in northern and eastern regions showed the highest prevalence of hypercholesterolemia followed by the western region with 24.4%. It has been argued that the increasing ageing of the population of Saudi Arabia and the lengthy exposure of the population to the western nutritional habits and lifestyles is reflected in the spread of obesity among Saudi citizens, which is expected to cause a further rise in hypercholesterolemia in the future (Kumosani *et al*., 2011). Coronary heart disease can be caused by many factors, with hypercholesterolemia being one of the main causes. Consequently, there is a practical need for a detailed study that investigates the prevalence of other potential risk factors, such as obesity, hypertension and smoking (Kumosani *et al*., 2011).

2.2.5 Hypertension

Hypertension is considered a risk factor of heart failure, stroke and CVD. In a review of the effects of high blood pressure that was published recently, it was stated that roughly 47% of heart diseases, 25% of other CVD, and 54% of strokes can be attributed to hypertension (Amani & Sharifi, 2012). Kumosani *et al*. (2011) demonstrated that body weight, access to treatment and dietary sodium intake are considered to be among the major causal factors for hypertension. Studies conducted in Saudi Arabia to investigate the prevalence of hypertension have revealed that numbers of individuals suffering from hypertension are consistently increasing. Such an increase may be ascribed to many factors, such as changes in the lifestyles of Saudis, higher levels of urbanisation, the increase of obesity, and the adoption of eating habits that can potentially cause hypertension. One study conducted as part of a major national research project on Coronary Artery Disease in Saudis (CADISS) by Al Nozha *et al.* (2007a) analysed the prevalence of hypertension among Saudis of both genders aged between 30 and 70 years in both rural and urban communities. The result of his study concluded that, in general, hypertension is increasing in prevalence in Saudi Arabia affecting more than a quarter of the adult Saudi population.

2.2.6 Cigarette smoking

Tobacco smoking is the most significant cause of early death that can be avoided in the USA. Of the 2.4 million yearly deaths, smoking is responsible for more than 440,000 of them. According to WHO (2010), many studies maintain that coronary heart diseases are often caused by cigarette smoking, often ending with heart attacks. It has been reported that the percentage of both men and women smokers has increased in Arab Gulf countries; the percentage of smoking men ranged between 20% and 50% whereas that of women was between 5% and 12%. Ward *et al*. (2004), interestingly, observed that use of shisha (the Arabic colloquial name for the water pipe) has dramatically spread in the Gulf region and started to be an acceptably social behaviour. Al Nozha *et al*. (2009) emphasise in their study the prevalence of smoking among Saudis and its relationship to CVD. In their study, 2217 participants of the 17350 they investigated turned out to be smokers, making a percentage of 12.8%. Of the smokers, 1555 were men and 662 were women. The geographical survey of the study also uncovered other interesting facts; smoking was much more widespread among Saudi citizens who lived in the north, west and east than the other regions of the kingdom. Reports from Siddiqui *et al*. (2001) consolidate such findings, where they demonstrated that smoking shisha and cigarettes has become an increasing habit among Saudi individuals. According to a WHO (2000) report, 7.4% of 30-year Saudi females smoked tobacco. Various types of tobacco are used in the shisha smoking; the most widely used being sweet flavoured with cappuccino and apple, which is locally recognised as Maassel (Maziak *et al*., 2004). Merdad *et al*. (2007) claim that lifestyle changes in terms of smoking have influenced female teenagers more than male teenagers. According to Merdad *et al*. (2007), women believe that smoking shisha is more stylish, prestigious and fashionable than smoking cigarettes. A study conducted in Jeddah to determine the prevalence of tobacco smoking among female students in colleges of medicine, dentistry, and art and science (Merdad *et al*., 2007) found that 10% of students were not aware of the relationship between smoking and heart disease, and that the prevalence of smoking was 14%. A total of 5% of the 14% were cigarette smokers, 8.7% used shisha and other tobacco products while 2.7% smoked both cigarettes and other tobacco products. Interestingly, the study revealed that 8.7% of the participants smoked the water pipe as well as other types of tobacco, in spite of their awareness that the water pipe has more harmful effects on them than cigarettes. Smoking shisha may be an entertaining activity in the social lives of Saudi women, yet such unhealthy practices may affect their health status and increase the risk of them developing CVD (Rawas *et al*., 2012).

2.2.7 Physical activity

After reviewing literature covering the physical inactivity of people in Saudi Arabia over the past two and a half decades, Al Hazzaa (2004) concluded that changes in the lifestyles of Saudi citizens have resulted in physical inactivity, which in turn has caused an increase in CHD risk. In a similar vein, Al Hazzaa (2004) also reported that 53.4% of Saudi men are at risk of developing CHD as a result of physical inactivity. More recently, similar findings have been reported by Shara (2010) for Saudi women. It has been found that the rates of physical activity among women of other countries are higher than seen in women in Saudi Arabia. In the study conclusion, Shara maintained that the high rates of physical inactivity among Saudi women may be attributed to the fact that few women play an active role in their society, which might pose barriers to the adoption of physical activity by subjects of the study. Another study by Al Nozha *et al*. (2007b) reported that physical inactivity among Saudi men and women was as high as 96%. Inactivity for women was shown to be 98% compared with men at 93.9%. In another interesting study conducted on Saudi Arabian women that investigated barriers to physical activity and healthy eating, Al Quaiz and Tayel (2009) found that among patients attending a clinic of primary health-care, who were the subjects of the study, not a single participant had reached the recommended level of physical activity according to the Centre for Disease Control (CDC). According to the study, the percentage of participants who were considered physically inactive was 82.4%; 87.6% of those identified were women. In addition, the study revealed that a shortage of resources like limited availability of exercising facilities, especially for women, was the chief cause of inactivity. A lack of energy and willpower came second. The study also highlighted lack of time, lack of willpower, lack of resources, and lack of social support as the major barriers to maintaining levels of physical activity. Al Quaiz and Tayel (2009) highlighted the benefits of exercising, having a healthy diet, providing appropriate physical exercise areas, and providing access to healthy foods, combined with understanding and awareness, stating that these ought to be essential concerns of Saudi individuals. These findings are significant for the Saudi woman, who has the main responsibility of selecting and preparing different kinds of foods for the entire Saudi family. Another significant fact is that there are no physical education classes or physical activities for Saudi females throughout their education, making them more susceptible to obesity than men. According to the latest WHO report (2010), Saudi women are more obese than men, at 44% and 26.4%, respectively. A further survey by Ng *et al*. (2011) has found that 28% of men and 44% of women were obese, and 66% of men and 71% of women were overweight or obese. In the conclusion of their study, Ng *et al*. maintained that obesity rates were higher among women in the region than men, while they appear to be rising more quickly in men than women (Ng *et al*., 2011). Furthermore, Badran and Laher (2011) maintain that desertification, the lack of vegetation and forestation, hot weather and exceptionally dry climate of Saudi Arabia generally leave

Saudi people nowhere to go but to remain indoors, which in turn encourage them to lead a sedentary lifestyle and reduces the time allocated to physical exercise.

2.2.8 Socioeconomic status

Research-based evidence indicates that not all sectors of the community equally match CVD mortality trends. A number of studies (Cooper, 2001; Gran, 1995; Lantz *et al*., 2001) have observed that factors such as the individual's income, socioeconomic status, formal educational level and occupation all have an impact on CVD morbidity and mortality rates among adults. It is no wonder that the most remarkable progress in CVD health has been seen in the wealthier classes and among highly educated individuals, whereas the same level of progress cannot be attained by lower socioeconomic groups (Lantz *et al*., 2001). Moreover, the latest observational studies have indicated that there is an association between individuals with low socioeconomic status and an increase in the prevalence of risk factors of CVD, such as high cholesterol, hypertension, cigarette smoking, inactive lifestyle, and unhealthy dietary habits (López-Azpiazu *et al*., 2003; Luepker *et al*., 1993; Sanchez-Villegas *et al*., 2003). It has been claimed that the dietary choices of an individual is the result of his/her social class and that this influences his/her CVD risk. In developing countries, families have adopted a westernised lifestyle when there is an increase in their income (Panagiontakos *et al*., 2008).

Badran and Laher (2011) maintain that in urban areas the growing effect of the Western media has led to a decrease in physical activity levels of individuals and encouraged the consumption of foods with higher nutrient density. As a result, the final outcome of increased westernisation and urbanisation is that individuals become overweight and obesity increases, which in turn leads to increased risk of CVD (Musaiger, 2011). The rapid economic developments witnessed in Arab countries over recent decades have led to noteworthy changes in many aspects of life. For example, comprehensive road networks have been developed for transportation and a wide variety of personal vehicles have become more available than before. Similarly, modern farm and home equipment and appliances have seen increased use. Likewise, televisions sets, personal computers, and various other electronic devices have become common in the modern home, a fact that has resulted in a more sedentary lifestyle and accumulation of more body fat (Badran & Laher, 2011). The last century has even witnessed a change in the nature of jobs. Farming, ploughing, animal husbandry, harvesting, planting and different types of heavy manual work have started to be replaced by more advanced technologies in almost all work sectors and now they normally require less physical effort (Bener, 2010). Levels of education also contribute to the prevalence of obesity and being overweight among individuals, either by lowering the overall income of the family or the level of knowledge regarding healthy foods, which in turn reduces parents' chances of passing their knowledge to the next generation. Indeed it has been documented that in Arab speaking countries, illiteracy may be a factor in the increased level of obesity among children, young people and adults. Moreover, the educational background of parents may be associated with children and young people becoming overweight or obese (Badran & Laher, 2011). There is a shortage of studies related to childhood obesity in Saudi Arabia and a need to carry out national-base studies on overweight and obesity among preschoolers, schoolchildren, and adolescents (Ng *et al*., 2011).

2.3 Diet and CVD

Diabetes, serum cholesterol, body weight and blood pressure are some of the risk factors of CVD that are influenced by dietary habits. The quality as well as the quantity of the diet is significant. In terms of quantity, which refers to the amount of energy consumed, it is recognised that ideally it should be balanced so that the energy intake is the amount that is needed to obtain (maintain) an appropriate body weight (Perk *et al*., 2012). Three different levels can be utilized to evaluate the influence of diet on CVD. Nutritional research has, for a significant period of time, focused on nutrients by investigating particular nutrients such as fatty acids. Looking at foods or groups of foods as examples, vegetables and fruits are easy to translate into dietary recommendations. Verschuren (2012) argues that since correlations and interactions between nutrients can affect their absorption and bioavailability, it is not sufficient to investigate single foods and nutrients. This approach to investigating dietary patterns could be seen as corresponding to change from the single risk factor evaluation to total risk profile evaluation. The most significant nutrients for the prevention of CVD are fibres, fatty acids which chiefly influence lipoprotein levels, vitamins, and minerals which chiefly influence blood pressure (Verschuren, 2012).

2.3.1 Fat and fatty acids intake

Since the 1950s, research into the prevention of CVD through dietary changes has focused on the total fat content and fatty acid composition of the diet (Verschuren, 2012). As for the CVD prevention field, Alissa and Ferns (2012) report that the composition in fatty acids of the diet is more significant than the total fat content. Verschuren (2012) mentions that, recently, knowledge about fatty acid subclasses, such as PUFA, monounsaturated fatty acids (MUFA) and SFA, and the particular fatty acids inside those subclasses, for example *trans* fatty acids and omega 3 fatty acids, and how they affect the fractions of lipoprotein inside the blood, has witnessed significant progress. Excessive dietary fat intake has been linked to an increased risk of CVD (McNaughton *et al*., 2009), although the type rather than the total intake of fat consumed is more important in attesting risk of CVD (Tyrovolas & Panagiotakos, 2010), through changes in lipid and lipoprotein profiles (Tarino *et al*., 2010).

Fats are considered a vital source of energy. Therefore, high intake of fats is connected with excessive intake of energy. The latter expectedly leads to an increase in the weight of the body, obesity and possibly other complications related to it, such as diabetes (Verschuren, 2012). Normally, a diet that offers 30% of its total energy as fat is recommended for the human body by the American Heart Association with cholesterol restricted to less than 300 mg/day (Krauss *et al*., 2000). Typical dietary fat comprises of the three groups of fatty acids characterised by the degree of saturation; SFA, MUFA and PUFA. Mean daily intakes of total fat (33% of total energy intake) with SFA (10% of total energy intake), MUFA (12% of total energy intake) and PUFA (6% of total energy intake) fatty acids have been recommended by the American Heart Association (Krauss *at al*., 2000). Furthermore, there are two main types of PUFA, the omega 3 and omega 6 series of fatty acids. These fatty acids cannot be converted into each other in the human body. The group of omega 6 fatty acids are synthesised from the essential fatty acid Linoleic Acid (LA), whereas omega 3 fatty acids are synthesised from the essential fatty acid Alpha-Linolenic Acid (ALA) (Gebauer *et al*., 2006). Omega 3 fatty acids are available in fatty fish such as salmon, mackerel, herring, and trout. They can also be derived from plants and are found in nuts, canola oil, flaxseed and flaxseed oil. In contrast, omega 6 fatty acids are obtained predominantly from the seeds of plants such as corn, sunflower, soybean and sesame. Simopoulos (1999), in a review of fatty acids in health and diseases, showed that the omega 3 fatty acids family includes ALA, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), which are linked to the hormone-like substances known as eicosanoids (Prostaglandin, Leukotriene and Thromboxanes). These can have a profound influence on heart disease (Wijendran & Hayes 2004). On the other hand, the omega 6 fatty acids family includes LA, gamma-linoenic acid (GLA) and arachidonic acid (AA) (Hibbeln *et al*., 2006). Eicosanoids have important functions in inflammation, immunity, platelet function, arterial function and blood pressure with different effects for the two families (Tapiero *et al*., 2002). Jung *et al*. (2008) explained that oils high in omega 6 fatty acids are converted into a type of eicosanoid known as thromboxane A2, which is a potent arterial constrictor. In contrast, oils high in omega 3 fatty acids are converted onto a closely related eicosanoid called thromboxane A3, which has a fraction of the potential to constrict the arteries and also can increase production of an important chemical, nitric oxide, which has a key role in arterial relaxation. Endo *et al*. (2006) have claimed that the omega 3 fatty acids derived from fish oils work by protecting the heart from disease due to their impact on reducing the proportion of total cholesterol, reducing low-density cholesterol (LDL) cholesterol and increasing HDL cholesterol. Mazier and Jones (1999) have indicated that dietary fat also has effects on triglycerides concentrations in serum where the highest concentrations of triglycerides occur when consuming higher levels of SFA, whereas the lowest concentrations were seen when consuming unsaturated fatty acids. Wijendran and Hayes (2004) concluded that omega 6 and omega 3 fatty acids may play a beneficial role in the prevention of heart disease and may be important to total energy balance. In this respect, oils which are rich in omega 3 (fish oil) appear to be more efficacious than oils rich in omega 6 (corn oil). Other studies have shown that consumption of fatty fish such as salmon and fish oil results in decreased LDL concentrations (Benatti *et al*., 2004) and causes a mild increase in HDL concentrations (Lee & Lip, 2003). Furthermore, Lavie *et al*. (2009) have stated that studies have shown that omega 3 fatty acids decrease serum triglycerides; that they reduce the risk of CHD as well as the risk of sudden death due to CVD and myocardial infarction (MI) whereas *trans* fatty acids and SFA may raise the risk of these diseases. Also, Lee *et al*. (2008) have pointed out that epidemiological studies show that ALA intake is inversely associated with markers of CVD risk including blood concentrations of cholesterol, LDL and triglycerides. Furthermore, total omega 3 fatty acids can lower triglycerides concentrations and inhibit endothelial cell activation (Brown & Hu, 2001). They can also reduce platelet aggregation and decrease the heart rate (Hu & Willett, 2002).

Chahoud *et al*., (2004) have indicated that *trans* fatty acids are produced during the process of hydrogenation of unsaturated fatty acids. These fatty acids are found in margarine and in oils maintained at high temperatures for long periods. Milan and Stanislav (2002) stated that consumption of *trans* fatty acids is associated with an increase in total cholesterol concentrations and the proportion of LDL and a reduction in HDL concentrations. In North America and Europe, epidemiological studies have revealed that there is a clear connection between the consumption of *trans* fatty acids and a high rate of cardiovascular mortality and morbidity (Mozaffarian *et al*., 2006). The same applies to concentrations of LDL cholesterol. It has been found that the effects that *trans* fatty acids exert on the causes of CHD are more prominent than the effects of SFA. In a meta-analysis conducted by Mozaffarian and Rimm (2006), it was shown that on average, the risk of developing CHD increased by 23% when *trans* fatty acid intake was higher than 2% of energy intake. It has been recommended by the American Heart Association that no more than 1% of an individual's total energy intake (approximately 1-3 g/day) should derive from *trans* fatty acids (Lichtenstein *et al*., 2006).

2.3.2 Minerals

Sodium intake and its effect on human blood pressure have undergone a long debate. It is generally accepted that higher amounts of sodium increase blood pressure. In a meta-analysis, He and MacGregor (2002) investigated a group of studies on blood pressure and interestingly found that on average, systolic blood pressure decreased by 3.1 mmHg in patients with hypertension and in normotensive patients by 1.6 mmHg when sodium intake is reduced to 1 g/day. Compared with the sodium intake recommended by WHO (2002), 1.7 g of sodium per day, which is equal to 5 g of salt per day, the salt intake of individuals in most western countries is considerably higher, reaching about 9-10 g/day. Likewise, it has been found that people in the Arabian Gulf region consume more sodium than they actually need (Musaigar, 2002). High amounts of salt can be found in almost all traditional Gulf dishes, fast foods and canned foods, whereas in western countries processed foods are considered the most significant contributor to everyday salt intake. Consequently, there is a significant opportunity for the food industry to help prevent CVD by reducing the content of salt in products (Verschuren, 2012). In a recent study that was conducted in the USA, it was established that if daily sodium intake were reduced by roughly 3 g/day, the incidence of CHD would be reduced by 5.9-9.6%, the occurrence of heart strokes would be reduced by 5.0-7.8%, and the frequency of death from any cause would be reduced by 2.6- 4.1% (Bibbins-Doming *et al*., 2010). Potassium, on the other hand, is one mineral that has a positive effect on blood pressure. In the diet, it can be mainly found in vegetables and fruits. It has been found that the amount of potassium intake largely affects the risk of stroke. Study by He and MacGregor (2001) found that the risk of stroke may be reduced by 40% depending on the quintile of potassium intake; therefore, aside from a reduction of sodium intake, an increase in potassium intake is a recommended change for the diet that can be adopted to reduce blood pressure.

2.3.3 Vitamins

Results obtained from the various observational and case-controlled studies that have been published indicate that there is an inverse relationship between a high intake of vitamins A and E, and the risk of CVD; the higher the vitamin intake, the lower the risk of CVD. It has been claimed potential effect can be ascribed to the vitamins with antioxidant properties. Nevertheless, subsequent intervention trials that were designed to investigate the causality of the observed relationship have failed to confirm the results from these studies (Vivekananthan *et al*., 2003). For that reason, it can be concluded that an increase in the intake of vitamins A and E, through dietor even supplements may be potentially beneficial for preventing CVD. In Saudi Arabia, a study by Alissa *et al*. (2005b) showed that a diet low in vitamin A may be a cardiovascular risk factor in a study with 130 Saudi participants with CVD. This study concluded that there was a relationship between vitamin A intake and coronary risk factors in a non-Caucasian population. Aguirre and May (2008) suggest that vitamin C has strong antioxidant functions which help to minimize the concentrations of reactive oxygen in tissue, slow down vascular smooth muscle proliferation and minimize the concentrations of oxidized LDL cholesterol. Results of EPIC studies concluded that eating food rich in vitamin C may by associated with lower risk of CVD and stroke (Myint *et al*., 2008). Knekt *et al*. (2004) report a number of studies which have investigated the role of dietary and supplementary vitamin C but which have produced mixed results. Most of the clinical studies conducted have not tested vitamin C on its own but within a mixture that includes vitamins A and E; however, no discernible influence on the results have been found in regard to the relationship with CVD (Cook *et al*., 2007; Sesso *et al*., 2008).

2.3.4 Fibre

Musaiger *et al*. (2012) emphasise that it is important for an individual to have foods that are rich in fibre because there is a well established relationship between the prevention of some chronic diseases and fibre in the diet. Fruits, vegetables, wholegrain products and legumes are considered essential sources of fibre. In a recommendation issued by the American Institute of Medicine in 2002 it was recommended that adults should consume an amount of 3.4 g fibre/MJ, which is equal to an intake of around 30- 45 g fibre/day (Musaiger *et al*., 2012). In the Arabian Gulf countries, it has been observed that consumption of wholegrain has markedly decreased; unfortunately, this decrease has been met with a tendency and reliance towards refined cereals and consequently a reduction in fibre intake. In Saudi Arabia, Musaigar (2002) found that foods that are based on vegetables are the main source of dietary fibre intake at 31%, cereal and related products were next in important at 26%, and fruits and related products came in third position.

2.3.5 Food group intake

2.3.5.1 Nuts and seeds

Musaigar (2002) found that various types of nuts consumed in the Arabian Gulf countries, such as almonds, walnuts, pine nuts and hazelnuts, in addition to the different types of seeds consumed, such as the seeds of muskmelon, sunflower and watermelon, are made a significant contribution to energy intake because of their high content of fat which ranges from 30% up to 60%. Craig (2010) mentions that nuts and seeds are not only energy rich but they also contain significant amount of vitamins as well. Magnesium and potassium, vitamins and unsaturated fatty acids that have been recommended for the protection they provide against heart diseases have been found to be contained in seeds and nuts (Azadbakht, & Rouhani, 2013). Nuts and seeds are recommended to be taken at least once or twice a week. Sabat´e and Ang (2009) recommend that more unsalted roasted nuts than salty nuts and seeds should be consumed, since the latter have a high content of sodium. Despite the recommendation to eat more nuts, it is worth noting that the over-consumption of nuts and seeds may cause an increase in energy consumed. However, Nettleton (1991) states that an increase in the consumption of some nuts, for example walnuts, provides the body with total omega 3 fatty acids, and increases the intake of ALA which is thought to protect against CHD (Azadbakht & Rouhani 2013; Kris-Etherton *et al*., 2003; Lemaitre *et al*., 2003).

2.3.5.2 Fish

The beneficial effects that eating fish is believed to have on CVD can be ascribed to the high content of omega 3 fatty acids. He *et al*. (2004a) mention that an estimate of pooled risk has revealed that eating fish on a weekly basis, even if just once, leads to a reduction in the risk of CHD by 15%. He *et al.* (2004b) conducted a meta-analysis study and found that the risk of developing stroke was reduced by 18% among individuals who ate fish 2 to 4 times a week, compared with those who ate fish less than once a month. The risk of CVD rapidly decreases among individuals who eat small to moderate amounts of fish, compared with those individuals who do not eat fish. Therefore, the impact an increase in fish consumption would have on the health of the population in general is potentially large. In one study, Mozaffarian and Rimm (2006) found that a modest increase in the consumption of fish from 1 to 2 times a week can reduce all cause mortality by 17% and the CHD mortality by 36%. Consequently, individuals are recommended to eat fish two times a week at least; ideally one of those meals should be of oily fish. The Arab Gulf Countries witnessed a slight increase in the intake of fish between 1990 and 2005; yet still, Musaiger *et al*. (2012) argue that the daily average per capita fish consumption is low when compared with the consumption of poultry and meat (between 24 to 52 g).

2.3.5.3 Fruits & vegetables

Fruits and vegetables must be a basic part of the daily diet of an individual for them to maintain a healthy body. Lock *et al*. (2005) argue that the regular consumption of fruits and vegetables helps prevent many of the chronic diseases that are related to diet. A number of meta-analysis studies have found significant health benefits from the consumption of fruits and vegetables. It has been reported that each extra serving of fruit and vegetables per day decreases the risk of developing CHD by approximately 4%. Likewise, the risk of having a stroke is reduced by 5% for each extra serving of fruit and vegetables (Dauchet *et al*. 2006). He *et al*. (2006) updated this estimate and reported a combined relative risk of stroke of 0.89 for those eating 3-5 servings of fruit and vegetables daily, compared with those eating less than three servings, and a combined relative risk of 0.74 for those eating more than five servings of fruit and vegetables per day. One serving was deemed to be approximately 80g. The protective effect of fruit and vegetables appeared to be slightly greater in the prevention of stroke compared with the prevention of CHD. One possible reason is the effect of fruit and vegetables on blood pressure, based on the fact that such foods are a key source of potassium. More research needs to be conducted to ascertain whether there are specific fruits or vegetables that are more efficacious in CVD prevention. The constituent elements within fruit and vegetables that may provide beneficial effects include minerals, fibre and antioxidants. The evidence on the health benefits of consuming fruits and vegetables has given rise to the recommendation to eat a variety of different fruit and vegetables and to eat at least 200 g of fruit (2-3 servings) and 200 g of vegetables (2-3 servings) per day (Verschuren, 2012). The consumption of fruit and vegetables by individuals in Arab Gulf countries is below the recommended allowances. WHO reported that more than 85% of adults in Arab Gulf countries consumed fewer than five servings of fruit and vegetables per day (Musaiger *et al*., 2012). Currently, in the UK the mean daily intake of fruit and vegetables is 245 g per person per day, or about 2 two portions (Bates *et al*., 2009).

2.3.5.4 Fast food

In recent decades, fast foods have started to be considered as contributors to increased CHD rates (Cheng, 2003; De Maria, 2003; Isganaitis & Lustig, 2005; Pereira *et al*., 2005). Guthrie *et al*. (2002) identify that the growth which the fast food industry has witnessed has resulted in higher consumption of ready-made foods, which normally have high levels of sodium as well as high SFA content but are low in fibre, iron and calcium. Prospective data collected from various western countries have revealed that weight gain is positively associated with the frequency of eating fast foods from restaurants (Duffey *et al*., 2007; French *et al*., 2000; Pereira *et al*., 2005). De Maria (2003) maintains that fast food is considered a factor that contributes towards increasing rates of obesity. Social and economic changes in the Arab world have caused a change in the traditional diets of the population, affecting their food habits and their consumption of energy (Musaiger *et al*., 2012). Similarly, the high incomes of individuals in the Arab Gulf countries have resulted in not only an increase in their demand for fast foods and convenience foods but also for eating ready-made meals outside of their homes (Miladi, 1998). For example, in Saudi Arabia between 1969 and 1994, calories and protein intakes increased from 1879 kcal to 2395 kcal and from 48g to 63.3g, respectively (Musaiger, 1987). The influence of fast food and the western diet in Arab Gulf countries has been huge. In Kuwait, western cuisines and fast food have increased in popularity, especially among young people (Musaiger *et al*., 2012). More recent food habits in almost all of the Arab countries have become characterised by high amounts of refined wheat flour, cholesterol, different types of soft drinks, high sugar and high SFA intake. Miladi (1998) suggested that due to their cheap prices, delicious tastes and availability all day long, individuals in the Arab Gulf countries have started to consume fast foods regularly. A number of studies conducted in many of the Arab Gulf countries (Al Hosani & Rugg-Gunn, 2000; Al Sadhan, 2003; Honkala *et al*., 2006) have observed high consumption of foods that are rich in added sugar among individuals, especially children and adolescents. In a study that was conducted in Saudi Arabia in 2006, Bello and Al Hammad found that canned fruit drinks as well as carbonated beverages represented 26% of the adult Saudi diet, and 25% of the daily fluid consumed by adolescents. Schmiduber and Shetty (2005) have suggested that the major factor behind the growth in the intake of sodium in these age groups of adolescents goes back to the increasing consumption of French fries, as well as other fast foods. In an earlier study that focussed on 1067 adolescent female students in Jeddah, Saudi Arabia, it was found that western and traditional junk food consumption had reached its peak in the kingdom, with average consumption being one to three times a week for approximately 64.3% of the investigated population (Shaath, 2008). Washi and Ageib (2010) conducted a similar study in Jeddah, Saudi Arabia, also on adolescent males and females, and found that 56.6% of their energy intake came from carbohydrates, 31.5% from fats, and 13% from protein. Al Rethaiaa *et al*. (2010) argue that such behavioural and dietary shifts have affected all age groups and both males and females in Saudi Arabia and the surrounding Gulf countries, especially young age groups who are considered vulnerable to obesity related diabetes mellitus Type 2.

2.3.5.5 Diet in Saudi Arabia

In general, the food situation in Saudi Arabia has markedly changed during the last two decades. For example, the traditional diet, which consists of dates, milk, whole wheat bread and vegetables and fruits, has changed to a more westernised diet, with an excess intake of high energy foods rich in fat and free sugars and poor in fruits, vegetables and fish (Khoja *et al.*, 2007). A nutrition transition is clearly taking place in Saudi Arabia in which traditional foods are being replaced by fast foods high in fat, sugar, and salt (Bani & Hashim, 1999). Moreover, the most commonly consumed foods are now fried foods which are often accompanied by carbonated drinks. Data from a food balance sheet showed that a high percentage of energy intakes came from animal foods with an increase in consumption of these foods of 143.3% in the period from 1971 to 1997 (Food and Agriculture Organization [FAOSTAT], 2000). Table 2.3 shows changes in dietary energy, protein and fat supply per person per day, from 1969 to 2009 in Saudi Arabia. According to the FAOSTAT food availability data and food consumption survey, daily energy, protein and fat consumption per capita has risen over the last three decades in Saudi Arabia. The per capita daily intake of energy has increased from 1900 to 3068 kcal. It is estimated that the dietary intake of protein has increased overall during this time from 49 to 85 g/day, and for dietary fat from 33 to 81 g/day (FAOSTAT, 2009).

Table 2.3: Changes in dietary energy, protein and fat supply/ person/ day, from 1969 to 2009 in Saudi Arabia*

	1969-1971	1979-1981	1995-1997	2001-2003	2002-2004	2005-2009
Energy, kcal	1900	2910	2800	2820	2800	3068
Protein, g	49	77	78	76	82	85
Fat, g	33	76	73	82	78	81

*(Food and Agriculture Organization, 2009)

There is little information available regarding the type of nutrients consumed in Saudi Arabia. Moreover, to date, there have been few comprehensive studies on dietary patterns in free-living Saudi adults which link diet with disease risk. A national survey by Al Nozha *et al*. (1996) used the 24-hour recall method and reported that the average daily consumption of energy, carbohydrates, dietary fibre, total fat and protein for Saudis of both genders were 3082 kcal, 300g, 24.4 g, 145 g and 115 g, respectively. These results were averaged from a range of age groups. In 1995, a study by Al Shagrawi *et al*. investigated the dietary fibre content of the Saudi diet and reported that low intake of dietary fibre for female students in King Saud University, Riyadh at 3.4 g/day. A study conducted by Alissa *et al*. (2005a) showed that among 303 male subjects (aged 15-80 years) the energy intake and percentage of energy for carbohydrate intake was low compared with UK reference nutrient intakes (RNI) and the percentage of energy from protein was higher than the RNI for all age groups. Abdel-Megeid *et al*. (2011) found that in a sample of 312 students attending King Saud University, Riyadh the mean energy intake was 11500 KJ/day for females and 14490 KJ/day for male students. Another study by Allam *et al*. (2012) documented the nutritional and health status of medical students at Taibah University in Medina, in north-western Saudi Arabia. The results showed that for 194 men and women the greatest energy intake was derived from carbohydrates at 72%, followed by fat at 19% and proteins at 8%. There are limited studies that have reported zinc, iron, calcium and selenium status among Saudi adults. Zinc status and selenium was investigated by Alissa *et al*. (2006a) in 130 patients with CVD and 130 free-living control adult Saudis. Results showed there were significant differences between the two groups for selenium and zinc intake; 42.07 *vs*. 47.38 µg /day and 8.67 *vs*. 9.44 mg/day, respectively. Abdel-Megeid *et al*. (2011) found the zinc intake was 9.8 mg/day for females and 11.2 mg/day for males. Iron status has been reported by Alissa *et al*. (2007) who assessed dietary iron in 270 Saudi male subjects without established CVD. Dietary iron intake was recorded as 18.9 mg/day and this was significantly related to dietary cholesterol and fibre intake, age, smoking habits, and serum total cholesterol concentration. Al Assaf and Al Numair (2007) investigated the body mass index and dietary intake of 117 Saudi adult males in Riyadh. A three days' food record indicated an intake of calcium for urban areas as 970 mg/day and for rural samples it was 795 mg/day. Iron intake was recorded at 11.8 mg /day and 12.5 mg/day for urban and rural subjects, respectively. In a study by Abdel-Megeid *et al*. (2011) it was found that iron intake and calcium intake was 15 mg/day, 800 mg/day for females, respectively and for males 16.1 mg/day, 991 mg/day, respectively.

Two publications in Saudi Arabia have been concerned with the intake of omega 3 fatty acids. However, neither of these pieces of research was carried out in the western region. In a study by Al Numair *et al*. (2005) it was noted that omega 3 fatty acid consumption and food sources differed between elderly men living in the coastal and internal regions of Saudi Arabia. 60 men from each region provided three day food records and completed food frequency questionnaires (FFQ). The intakes of total omega 3 fatty acids, ALA, EPA and DHA were found to be higher among elderly men living in coastal areas when compared with those living in the internal area. In 2011 a study conducted in Riyadh city to examine the effects of omega 3 and omega 6 fatty acids on blood lipids used a three days food records for a sample of 200 males aged from 19 to 50 years old (Al Numair *et al*., 2011). The results of this study showed that the average daily consumption of fatty acids were: ALA (0.81g/day), EPA (0.21 g/day), DHA (0.3 g/day), total omega 3 fatty acids (1.28 g/day), LA (6.18 g/day), AA (0.13 g/day) and omega 6 fatty acids (6.47 g/day). Al Numair *et al*. (2011) found there were negative correlations between intakes of total omega 3 fatty acids and plasma LDL cholesterol, and triglyceride concentrations ($P < 0.05$), positive correlations between intakes of omega 6 fatty acids and plasma LDL cholesterol, and triglyceride concentrations ($P < 0.05$). Al Numair *et al.* (2005) concluded that there is at present a lack of information in Saudi Arabia regarding the dietary intake of omega 3 fatty acids. Moreover, nutrition education and information relating to healthy eating habits is needed in order to encourage the increased consumption of omega 3 fatty acids. Indeed, Al Numair *et al.* (2005) have suggested that “further research is needed to study the effect of omega 3 fatty acids on CVD in both men and women of various ages in Saudi Arabia”.

2.4 Impact of relocation on dietary habits of Saudis living abroad

Changes in the lifestyles of Saudis who study abroad, particularly their dietary habits are normally attributed to their acculturation and integration into the community they have moved to. Change in the availability of certain food items is related to modifications in their food consumption and dietary intake. A number of studies have revealed that dietary habits are expected to alter to a more westernised diet or in favour of a mixed food diet at the expense of a traditional diet (Gilbert & Khokhar, 2008). Papadaki and Scott (2002) contend that factors such as financial resources, living arrangements and social setting play an important role in the decision to follow a certain lifestyle and eating pattern. With respect to the dietary changes of international students, a group of studies have revealed that single students are more likely to eat less healthy food than married ones. It has been found the diets of married students contain more fruit and vegetables than the diets of single students (Al Farhan, 2011). In a similar study, Perez-Cueto *et al*. (2009) found that single females consume lower amounts of sugar compared to their male counterparts. Changes in eating patterns, from conventional Saudi foods to a more westernised diet, may affect one's health in undesirable ways because westernised foods normally contain higher amounts of salt, saturated fat, calories, and sugar. Fast foods and ready-made meals have gained popularity due to their availability, price, reliability and variety (Al Farhan, 2011). Students in general and single Arab international students in particular do not normally cook at home; therefore they depend on such kinds of foods which, in turn, cause them to gain weight and become obese with the passage of time. It is a challenge for international students to follow their habit of eating traditional foods when they move to a different location, as traditional foods may be scarce or simply not available. Besides limited access to traditional foods, there are other factors that contribute to the challenge and make it hard, such as a lack of communication with the new community, cultural differences, a lack of means of transportation which hinders their mobility, the language barrier, and a lack of information about their surrounding environment, particularly when they relocate to an area that is new to them (Al Farhan, 2011). In addition, Yoh *et al.* (2008) mentions that there are still other factors that contribute to obesity and being overweight among many international students, such as a lack of nutrition education and a lack of physical activity.

Reeves and Henry (2000) conducted a study of Malaysian students to investigate their ability to modulate food intake after moving from a country where the energy density of food is low to a country where most foods have a high energy density. Fifty-six male and fifty-three female Malaysians who were studying at Oxford Brookes University, UK took part in the study; their mean average age was 22 years. Their food intake was measured using three day food records and questionnaires about food frequency at the beginning of their arrival in the UK, three months after their arrival, and then six months after their arrival. The study revealed that the participants' consumption of white and red meat underwent a decrease, although meat products, such as burgers and sausages were more frequently consumed in the UK than in their home country. In the UK, fish was found to be eaten less frequently, whereas an increase in the consumption of fruit and vegetables was observed. Furthermore, bread consumption underwent an increase, whereas their consumption of noodles and rice was decrease. Notably, the participants' consumption of coffee and tea increased while that of fruit juices and soft drinks decreased. As for alcohol consumption, it did not change since most of the students were Muslims who did not drink alcohol. It was found that the meal that changed the most was breakfast. Cereal or toast replaced noodles or rice for breakfast for many of the students who had moved to the UK. However, their dinner did not differ much from what they used to consume while in Malaysia.

Another study investigated changes in dietary habits following the temporary migration of 235 international students to Belgium (Perez-Cueto *et al*., 2009). The study also observed dietary changes in relation to gender differences. The apparent unavailability of healthy food products hindered the students' choice of healthy foods, particularly for men. Consequently, Perez-Cueto *et al*. (2009) believe that the relationship between the accessibility of healthy foods and gender should be considered when informing short-term migrating populations about healthy food alternatives that are available for them while staying in a culture that differs from their own in terms of dietary habits and foods. In another study that was conducted in Glasgow, UK, on Greek immigrants, it was found that students' consumption of legumes, raw vegetables, poultry, juices, fresh fruits, fish and meats underwent a significant decrease (Kremmyda *et al*., 2008). The study also revealed that students' consumption of soft and frozen drinks, dips, alcoholic beverages, biscuits, sauces, mayonnaise, savouries and snacks witnessed an increase. The unavailability and the higher costs of some foods, such as good quality meat, milk, and fresh fish, affected the students' choices of foods. The median daily fruit and vegetable consumption dropped from 363 g in Greece to 124 g in the UK, a rate that is much lower than the daily allowance (400 g) recommended by WHO. The higher cost of food, food item un-palatability, and a lack of time to prepare food were the main reasons behind the changes in the students' dietary patterns. These factors coincided with the ease at which they could access convenience foods, as well as the limited availability of certain foods in Glasgow (Kremmyda *et al*., 2008). Papadaki and Scott (2002) maintain that the combined effects of such barriers and factors have left immigrants with no choice but to replace the traditional dietary habits of their home countries with foreign dietary habits. Satia-Abouta *et al.* (2002) believes that groups that have migrated should be supported to keep up their traditional eating patterns, and guided to take up healthy practices of the new nation they have moved to. A number of studies have emphasised the need to create programmes that promote good health and nutrition at the level of the international community. Georgiou *et al*. (1997) contend that such awareness programmes can help to reduce the tendency to gain weight and minimize the risk of obesity and other chronic diseases.

2.5 Assessment of dietary intake

Lee and Nieman (2010) suggest that methods of dietary assessment are especially designed to quantitatively yield nutrient intake estimates. Dietary intake assessment methods encompass a combination of retrospective as well as prospective recording of daily intake. Generally, the most commonly used methods for assessing dietary intakes are four: 24-hour recall, diet history, food records, and FFQ (Lee & Nieman, 2010).

2.5.1 Twenty-four hour recall

Casey *et al*. (1999) describe that for a 24-hour recall, a detailed questionnaire is used to investigate and ascertain the individual's intake of foods during the preceding 24-hours. Lee and Nieman (2010) confirm that recall of diet over the last 24-hours is a technique that is frequently used, and that it normally requires a trained interviewer to be successful. In such a technique, the individual recalls the intake of food from memory. Using a series of open-ended questions that are repeated systematically, the interviewer asks the participants to recall and describe all the food and drink items that they have consumed within the previous 24-hour period (Nelson, 2000). The participant may use photographs or food models to estimate the sizes of portions or the interviewer might allocate average weights to foods (Foster *et al.,* 2006; Nelson *et al.,* 1997). This procedure of measurement can be conducted on a single basis or can be repeated a number of times to investigate food intake at specific times during the study. Recalls can be conducted via the telephone or through face-to-face interviews (Lee & Nieman, 2010). The 24-hour recall technique is advantageous in many ways. It is less time consuming, can to some extent be easily administered, and can help to assess the average intake of large populations (Casey *et al*., 1999). Ervin and Smiciklas-Wright (1998) mention one particular merit of this method in that the burden on the interviewer as well as the respondent is minimal. Likewise, the method is efficient in terms of reducing cost, maximising results and saving time. The aforementioned advantages of the 24-hour recall make it a convenient technique to be used in the assessment of dietary nutrients. Nelson (2000), mentions that quickness and ease of administration are considered to be the main advantages of the 24-hour recall method. On the other hand, the participant's memory, his/her ability to recall the foods he/she has consumed and describing portion sizes play an important role in the success of this procedure (Nelson, 2000).

2.5.2 Dietary record

The respondent in the dietary record method records the beverages and foods consumed. Moreover, the quantity of the consumed amounts can be monitored via weighing, estimation that utilizes household utensils (tablespoons or cups), or models of food (Biro´ *et al*., 2002) or that make full use of a collection of pictures (Black *et al*., 1993). On the whole, a three day record randomly collected so that it can cover variations across weekdays or seasons is advocated to gather information about average food consumption and how it is distributed within individuals among the group (Bingham *et al.*, 1988). At the time of consumption, the reporting has to be conducted on paper or can be recorded via a dicta-phone. Lee and Nieman (2010) suggest that prior to the collection of data the investigated individuals need to receive adequate training in regard to how to describe their diet, the specifications and amounts of consumed foods, and even how they are cooked. Data collected from the report can be triangulated with interviews that are conducted following the first day as well as at the end. Biro´ *et al*. (2002) mention that this will help, if the interviewer is a skilled one, to complete any missing items and amounts, clarify the collected entries and produce more accurate reports. Since interviews do not depend on memory and recalling of the respondent, missing data about foods can be expected to be minimal. The dietary record method is considered to be reasonably accurate with respect to foods consumed. The weighing method is often utilised in conjunction with dietary assessment methods. The method of recording needs reasonable co-operation from participants, who also need to be encouraged (Biro´ *et al*., 2002).

2.5.3 Food frequency questionnaires (FFQ)

FFQs depend on the use of a list of food items from which participants choose that which is considered a characteristic intake across a specific period of time. They usually include a range of 50-150 or possibly more food items (Lee & Nieman, 2010). FFQ techniques, like the 24-hour dietary recall method, are dependent on the memory of the participant. However, unlike the 24-hour recall method, FFQs give prompts that can enable the respondent to make a choice from the ordinary food items that are consumed. The method is advantageous in that it puts a minimum amount of burden on the participant and can be conducted after the survey. The FFQ is the most common form of diet recording in very large studies because of the ease of use by mail rather using in person or by telephone. For example, the European Prospective Investigation of Cancer FFQ (EPIC FFQ) (Bingham *et al*., 1997) or the Harvard University FFQ (Harvard School of Public Health, 2011) were designed with an emphasis on cognitive ease for the respondents. However, the limited number of foods that the questionnaire can contain is considered a limitation of the FFQ, and some errors have been found in regard to selected nutrient intakes in studies that have employed this method (Day *et al.,* 2001). In addition, it has been reported that there is a tendency among individuals to overvalue their consumption of certain food categories, especially vegetables, compared with diaries that record weighed food (Livingstone *et al.*, 1992; Bingham & Day, 1997). This method can also be difficult for individuals whose answers to questions regarding their usual dietary intake vary greatly across a long period of time (Gibson, 1990).

2.5.4 Diet history

Diet history is a method that depends on an open-ended interview technique to examine an individual's habitual food intake. On the whole, it involves a series of standard questions addressed to the respondent in regard to the daily average of his/her customary eating patterns over a specified period of time, investigating the kinds of foods consumed the frequency of their consumption and their portion sizes. The diet history method has been shown to be a valid source of energy intake estimate on a group level when a seven day weighed record is used (Livingstone *et al.,* 1992), although to some extent lower than the FFQ method using a seven day weighed record (Jain *et al.,* 1996). However, the main disadvantage of this method is that it is time consuming and depends on the memory of the respondent (Livingstone & Robson, 2000).

For the purposes of the present study, an investigation into the range of studies published in English between 2000 and 2013 was undertaken, using PubMed Central and Google Scholar search. Key words used include: dietary intake, assessment methods, 24-hour recall, FFQ, dietary food record, diet history, CVD and Saudi Arabia. Over 200 papers were identified primarily. The titles and abstracts of these articles were then reviewed to cover:

- The general background on dietary intake assessment methods in Saudi Arabia, for healthy adults or for those with CVD and associated risk factors.

Twenty-four papers were selected and information extracted included descriptions of study samples, gender, city, dietary method and the outcomes of nutrients, which were used. Table 2.4 summarises the dietary intake assessment methods used in research for Saudi Arabia. It can be noticed that there is little published data available on dietary food recording methods, in both men and women in Saudi Arabia. Dietary food records, with estimates of portion size have provided relatively accurate quantitative information on consumption (Hackett *et al.*, 1983).

The method is also relatively low in cost and is less disturbing to the daily activities of the subjects than other methods such as a weighed food diary. However, an important disadvantage on this method can affect both types of food chosen and the quantities consumed (Biro´ *et al*., 2002; Lee & Nieman 2010). This is a weakness, when the aim is to measure typical dietary behaviour such as fish, fruit and vegetables.

Table 2.4: Summary of dietary intake assessment methods research in Saudi Arabia

Authors/ year of publication	City	Participants	Age mean (SD)	Age range	Dietary method	Nutrients
(Washi, 2000)	Riyadh	150 (M)	20 (1.30)		24-hour	Energy, carbohydrate, portion, Fat, SFA, MUFA, fibre, minerals & vitamins
(Alissa *et al*., 2005a)	Jeddah	303 (M)		15-80	FFQ	Energy, carbohydrate, portion, Fat, SFA, MUFA & cholesterol
(Alissa *et al*., 2005b)	Jeddah	130 (M)	55.3 (11.5)		FFQ	Vitamins A, C & E
(Al Numair *et al*., 2005)	Eastern region	120 (M)	66 (2.23)		3 day FD FFQ	Omega 3, ALA, EPA & DHA
(Alissa *et al*., 2006a)	Jeddah	130 (M)	55.3 (11.5)		FFQ	Selenium, copper & zinc
(Alissa *et al*., 2006b)	Jeddah	140 (M)	21 (3.10)		FFQ	Macronutrient
(Al Numair, 2006)	Riyadh	100 (M+F)		20-54	3 day FD	Copper & zinc
(Alissa *et al*., 2007)	Jeddah	270 (M)	48.4 (1.2)		FFQ	Energy, carbohydrate, portion, Fat, SFA, MUFA, cholesterol, fibre & iron
(AL Assaf, 2007)	Riyadh	234 (M+F)			24-hour	Iron
(Al Assaf & Al Numair, 2007)	Riyadh	117 (M)	32.1 (6.25)		3 day FD	Energy, carbohydrate, portion, Fat, SFA, USFA, minerals & vitamins
(Al Bassan *et al*., 2007)	Riyadh	212 (F)		18-40	24-hour	Energy, carbohydrate, portion & Fat
(Al Saif *et al*., 2007)	Riyadh	100	56.6 (10.9)		24-hour FFQ	Flavonoids
(Al Shoshan, 2007)	Riyadh	112 (F)	26 (1.85)		24-hour	Caffeine
(Bahijri *et al*., 2007)	Jeddah	145		7-50	24-hour FFQ	Fluoride
(Alissa *et al*., 2009)	Jeddah	140 (M)		16-87	FFQ	Energy, Fat, SFA, cholesterol, MUFA, PUFA, selenium & iodine
(Al Hamdan *et al*., 2009)	Riyadh	53 (M+F)		18-60	Diet history FFQ	Energy, carbohydrate, portion & Fat
(Al Numair, 2009)	Al Qassim	239 (M+F)	27.7 (7.9)		3 day FD	Protein & B_6
(Sadat-Ali *et al*., 2009)	Al Khobar	200 (M)		25-50	FFQ	Vitamin D
(Abdel-Megeid *et al*., 2011)	Riyadh	312 (M+F)	21.1 (2.8)		3 day FD	Energy, carbohydrate, portion, Fat, SFA, MUFA, fibre, minerals & vitamins
(Al Numair *et al*., 2011)	Riyadh	200 (M)		19-50	3 day FD	Omega 3 & omega 6
(Al Otaibi, 2011)	Al Hssa	74 (F)		23-56	24-hour	Energy & Fat
(Allam *et al*., 2012)	Al Madina	194 (M+F)	21.1 (1.85)		24-hour	Energy, portion, minerals & vitamins
(Al Daghri *et al*., 2012)	Riyadh	47 (M+F)	45.7		24-hour FFQ	Macro-micronutrient & amino acids
(Al Othman *et al*., 2012)	Riyadh	260			24-hour FFQ	Selenium

SD: Standard Deviation. M: Male; F: Female. SFA indicates saturated fatty acids; MUFA, monounsaturated fatty acids; PUFA, polyunsaturated fatty acids. FFQ: Food frequency questionnaires**.** EPA: eicosapentaenoic acid; DHA: docosahexaenoic acid. 3 day FD: 3 day food diary.

2.6 Aims, Objectives and Hypotheses of the Study

2.6.1 Aims

The aims of the present study were:

- To measure and describe the dietary patterns of representative samples of the Saudi population living in three different locations, a coastal city and an inland city in Saudi Arabia and in Newcastle upon Tyne.
- To compare the dietary patterns across the three populations.
- To investigate the relationships between dietary food intake and coronary risk factors in the western region of Saudi Arabia (both coastal and inland cities) in both men and women without overt CVD.
- To investigate the relationships between dietary food intake and coronary risk factors in the Saudi population living in Newcastle upon Tyne within the UK in both men and women without overt CVD.
- To determine differences in total dietary intake as attested by age, gender and socioeconomic background for each of the three populations.
- To explore the relationships between the dietary intake of total fat, omega 3 fatty acids and long chain polyunsaturated fatty acids in different regions of Saudi Arabia as indicators of the risk of CVD.

2.6.2 Objectives

To achieve the above aims, the objectives of this study were:

- To conduct a study to measure dietary intake in university employees working in the western Saudi Arabian coastal city of Jeddah and in the western an inland city of Makkah.
- To conduct a study to measure dietary intake in the Saudi population of Newcastle upon Tyne in the UK.
- To undertake a measure of dietary intake and anthropometric indices of Saudi adults and ask each of these adults to complete a three day estimated dietary food record in order to provide detailed dietary information.
- To interview participants in order to clarify the information provided in food diaries.
- To use a survey questionnaire in order to collect personal information, and data relating to medical, social and dietary habits.

- To estimate the daily energy intake and the daily intake (in grams / day and percentage contribution to the daily energy intake) of the following macronutrients: Protein, fat, SFA, MUFA, PUFA and carbohydrate. In addition the daily fibre intake, sodium, potassium (g/day), daily cholesterol intake (mg/day), daily intake (mg/day) of calcium, iron, magnesium, zinc, vitamin C and vitamin E and the daily intake of vitamin A and selenium (µg/day) of the subjects will be measured.
- To estimate the daily intake of the following fatty acids: LA (g/day), ALA (g/day), *trans* fatty acid (g/day), AA (g/day), EPA (g/day) and DHA (g/day).
- To compare and report any significant differences between the intakes of males and females and with the UK RNI in each setting.
- To determine the subjects' socioeconomic characteristics.
- To test the association between food intake and CVD risk factors and the socioeconomic characteristics of the population sampled in the study.
- To compare consumption of food groups (nuts and seeds, fish, fruit and vegetable, fast food and traditional Saudi food) among the study subjects.
- To test the association between food group intake and CVD risk factors and the socioeconomic characteristics of the population sampled in this study.
- To investigate the intake of omega 3 fatty acids and long chain polyunsaturated fatty acids in two samples living in two diverse geographical locations (coastal and internal cities) in Saudi Arabia.
- To investigate and compare the intake of omega 3 fatty acids and long chain polyunsaturated fatty acids in the Saudi population living within Saudi Arabia (Jeddah and Makkah) with those living abroad (Newcastle upon Tyne, UK).

2.6.3 Hypotheses

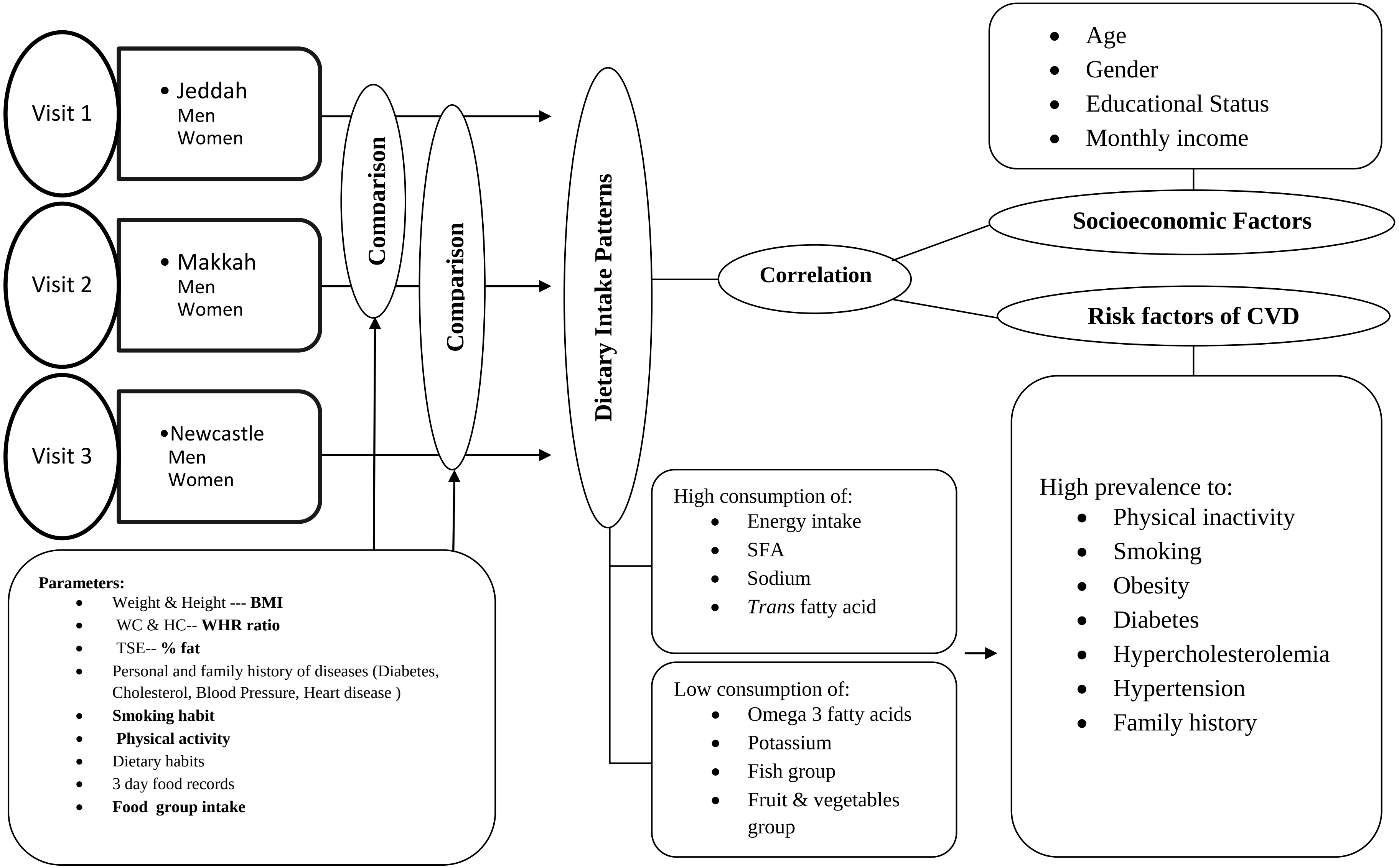
The hypotheses to be tested in the present study are as follows:

- There are relationships between dietary food intakes and CVD risk factors.
- There are differences in total dietary intake with regards to age, gender and socioeconomic background.
- An increased intake of omega 3 fatty acids and long chain polyunsaturated fatty acids has a beneficial effect on a range of CVD risk factors.
- There are relationships between dietary intake of total fat, omega 3 fatty acids and long chain polyunsaturated fatty acids in different regions of Saudi Arabia as

indicators of the risk of CVD. Moreover, Jeddah being a coastal city is characterized as having a population with higher fish consumption and a relatively lower death rate from CVD when compared with Makkah, an inland city with a population characterized as having a lower fish intake and relatively higher death rate from CVD.

- There are differences in dietary intake and food habits between Saudi living away from home country compared with those lived in Saudi Arabia.

Figure 2.2: Links between dietary lifestyle and demographic parameters and hypotheses in relation with CVD risks



Chapter 3 Overall Study Methodology

3. Study design

3.1 Ethical approval

This study received ethical approval from the Newcastle University Ethical Committee (Appendix A). Written information which included the aims of the study, the use and application of the data, an assurance regarding the willingness to take part and a statement regarding the security of personal information was given to each participant (Appendix B). All participants signed a consent form to participating in the study (Appendix C). All subjects were free to withdraw from the study at any time. The questionnaire, information sheet and consent form were written in English and were also translated into Arabic.

3.2 Statistical power of the study and sample size

The statistical power of the study was calculated with the assistance of the researcher supervisors Professor Chris Seal, Dr Georg Lietz and Dr Simon Kometa (research computing specialist ISS) at Newcastle University. The study group size was estimated by least standardized difference by using expected changes in the total of omega 3 fatty acids. However, there are few published data concerning dietary food intake particularly the dietary intake of omega 3 fatty acids in Saudi Arabia. Therefore, the primary outcome variable from the study, to determine differences in total omega 3 fatty acids intake between coastal and internal areas, was used (the main hypothesis). Statistical power was calculated using Minitab 17, on the basis of a 5% significance level, with a standard deviation = 0.620, a difference between the mean total intake of omega 3 fatty acids in both cities = 0.93 g/day and a power of 95%. A sample size of 26 participants per city subgroup was required. In addition, a previous study which determined omega 3 fatty acids intake in different regions was consulted (Al Numair *et al*., 2005). A study of omega 3 fatty acid intake among elderly men (n = 120) living in coastal and internal regions in Saudi Arabia had determined a mean daily omega 3 intake in internal area to be 0.79 g/day with a standard deviation of 0.13 while the mean daily omega 3 intake in a coastal area was determined to be 2.18 g/day (Al Numair *et al*., 2005). Based on these data, in the present study with 100 adults in each area, the study was calculated to have 90% power to detect a difference in the mean total intake of omega 3 fatty acids of 0.28 g/day assuming a significance level of 5%.

3.3 Study participants

Participants from both coastal and internal cities were recruited in the western region of Saudi Arabia, sampling both men and women, who did not have overt CVD and who fell within an age range of 18 - 65 years. Based on the prevalence of CVD in Saudi Arabia, which is described in section 2.1.3, the statistics indicate a risk gradient, with the highest number of deaths in Makkah (17.7%) and Jeddah (9.5%) (Health Statistical Yearbook, 2003 & 2011). These differences in percentage may be due to the impact of geographic location. Makkah is an inland city with a population characterized as having a lower fish intake and relatively higher death rate from CVD, whereas Jeddah is a coastal city, and characterized as having a population with higher consumption of fish (more total omega 3 fatty acids) and a relatively lower death rate from CVD. Participants without overt CVD rather than participants with CVD were chosen because they would not be able change their dietary habits and their lifestyle, due to the diseases. There is a difference in CVD risk between genders, which increases markedly with age (Yen *et al.*, 2010). This study focused on the 18 to 65 years old age range. Each potential participant was sent a letter of invitation from the general practice of the Employee Affairs Director. Individuals were recruited from two communities: Study 1 drew participants from King Abdul Aziz University in the city of Jeddah (a coastal city); Study 2 sampled individuals from Umm Al Qura University in the city of Makkah Almukarramah (a city in the interior of the country). Each of the two universities was visited by the researcher. Four people in each university acted as research assistants (two trainers conducted the interviews and two individuals with nursing backgrounds conducted the anthropometrics measurements). Two were males who would collect anthropometrics measurements from men subjects as is expected within Muslim culture. The assistants helped with the preparation of the materials needed for the data collection. Data collection in these two studies took place during the summer over a period of three months from July to September in both 2010 and 2011. Care was taken to ensure this took place before the observance of Ramadan, a time when people fast and therefore change their food habits (See schedule given in Appendix D).

Study 3 participants were recruited from the Saudi population of Newcastle upon Tyne as representatives of those living in the UK. Both genders were sampled between the ages of

18 and - 65, though students who had been residing less than six months in Newcastle were excluded. Correspondence with the subjects was by e-mail, informing them of the aims and explained the purpose of the study. The participant was invited to attend an interview in a private location within Newcastle University or at (the researcher's home or the subjects' home). Data collection took place between May and July of 2012.

3.4 Questionnaire design

3.4.1 Demographic details

Each volunteer was asked to complete an interviewer administered questionnaire focusing on demographic characteristics. It included general information on age, gender, family income per month, education level, marital status and both the personal and family medical histories of the participants.

3.4.2 Social habits

A questionnaire was developed to identify certain lifestyle choices such as smoking and physical activity which may have an influence on diet and health. This asked, for example, for information relating to the frequency and duration of exercise and smoking states. Smoking habits were characterised as non-smoker, former smoker and current smoker. Current smokers were further categorized into those who smoked less than 20 cigarettes per day, those who smoked 20 or more cigarettes each day and those who smoked using shisha (water pipe). Physical activity was assessed through questions focussing on the frequency and type of exercise that individuals regularly preformed. Individual activities included walking, running, swimming and other types of exercise. The respondents chose one of following frequency categories for each activity: never, 1-3 times per week, 4-7 times per week or more than 7 times per week. The average time per session for the activities was broken down into three categories: Less than 30 minutes; 30-60 minutes and more than 60 minutes. Three categories of physical activity were used: Inactive; moderately active and active consistent with the recommendations of the American Heart Association consensus statement on the primary prevention of coronary diseases and from the USA Surgeon General's report of 1996 and Al Nozha *et al.* (2007a).

3.4.3 Dietary habits

The next section of the questionnaire was about normal dietary habits. Subjects were asked several questions to help determine their dietary habits such as whether they ate breakfast, how many meals they normally ate per day, their main meals and how frequently they ate outside their homes. The final section of the questionnaire dealt with food records more detail in section 3.7. Nutrient intake was reported as an average for three consecutive days. The questionnaire forms used in this study were prepared and designed in the School of Agriculture, Food and Rural Development, Newcastle University by the researcher based on previous similar studies (see Appendix E). An English version of the questionnaire was translated into Arabic so that language would not be a barrier for the participants (Appendix F).

3.4.4 Piloting the questionnaire

A pilot questionnaire was used to identify any problems with content, language, or layout. A small sample of 10 people, aged between 25 and 36 years, and exclusive from the study population were given a copy of the first version of the questionnaire and invited to make comments about its ease of use in order to obtain information concerning any issues or difficulties the later respondents may encounter. These comments were used to create the final version of the study questionnaire. These data were not included as part of the main study.

3.4.5 Study procedure for questionnaire

Copies of questionnaires were prepared for each university in the study. Then, the researcher and assistants distributed the questionnaire. The questionnaire form was completed by the participants. Following the collection of the questionnaires, and during the interview stage, the researcher scanned the answers quickly and asked the subjects to complete any missing or incomplete sections. This method helped to minimise missing data.

3.5 Anthropometric measurement

Anthropometric measurements (Appendix G) were taken after the completion of the questionnaire. Measurements were conducted by nurses trained by the researcher and all the instruments were calibrated daily. The participants were asked to remove their shoes, socks, any heavy clothing and all items that would increase their weight such as belts, mobile telephones and wallets. Standing height was measured once to the nearest 0.1 cm using a height rule taped vertically to a wall, without shoes and head coverings. Weight was measured once using an electronic scale to the nearest 0.1 kg. Body mass index (BMI, kg/m^2) was then calculated. Participants were divided by obesity parameters which were defined as: Underweight (BMI < 18.5); normal (BMI 18.5 to < 25); overweight (BMI 25 to < 30) and obese (BMI > 30.1) (WHO, 2000).

Several anthropometric methods of estimating body fat distribution were used: Waist circumference (WC) was measured at the point midway between the lowest rib margin and the iliac crest. Subjects were asked to breathe normally, and to breathe out gently at the time of the measurement to prevent them from contracting their muscles or for holding their breath. Hip circumference (HC) was measured with participants at the widest point over the greater trochanters. Without indenting the skin, the tape measure was distributed horizontally around the hips over the buttocks at the point of maximum circumference. Both WC and HC were measured using a plastic measuring tape to the nearest 0.1 cm. Waist-to-hip ratio (WHR) was calculated as WC divided by HC. WHR relative fat distribution can be estimated from this measurement. WHR was dichotomized as non-obese with cut off values of < 0.80 for females and < 0.95 for males (Lean *et al.*, 1995). High risk WC was defined as > 88 cm and > 102 cm for females and males respectively (Molarius *et al.*, 1999). Skin-fold thickness measured on the triceps (TSF) was determined using a Harpenden skin-fold caliper (Holtain Ltd., Bryberian, Crymmych, Pembrokeshire) to the nearest 1 mm at the midpoint of the left upper arm. Skin-fold measurements were performed in triplicate. Arm circumference (AC) (midway between acromion and olecranon processes was measured to the nearest 0.1 cm, and arm muscle circumference (AMC) calculated as AC - (3.14 x TSF) (cm) at the some point on the upper arm (Barbara *et al.*, 1981).

Body fat measurement was calculated using the following equations according to Durnin and Womersley (1974):

Body density for male (D) = 1.1143 – 0.0618 × log of skin-folds

Body density for female (D) = 1.1278 – 0.0775 × log of skin-folds

Fat % = $(\frac{4.95}{D} - 4.5) \times 100$

3.6 Blood pressure measurement

Blood pressure was measured twice for each participant using an automatic sphygmomanometer (Omron automatic blood pressure monitor, Germany). Measurements were performed by trained nurses. Participants were seated and rested for at least 5 minutes prior to blood pressure measurement. The interval between the two measurements was at least 3 minutes, and the measurements were recorded to the closest 2 mmHg. The mean of the two measurements was used. Hypertension was defined as a systolic blood pressure above 140 mmHg and or a diastolic blood pressure above 90 mmHg (American Heart Association, 2006). Blood pressure measurement were taken in participants in study 2 (Makkah) and study 3 (Newcastle).

3.7 Assessment of dietary intake

The food consumed by participants was recorded by the individuals themselves over three consecutive days which included two week days and one weekend day. Furthermore, including data collected from a weekend and week days, helps to control day-to-day variability in dietary intake (Thompson & Byers, 1994). This study collected data for three consecutive days, (including one weekend day), which contributes to the reliability and validity of the dietary findings (Gersovitz *et al*., 1978). Instructions to help the participants to complete the diary were given. Each diary consisted of an example page which showed the participant how to estimate the portion size of food and drink and three pages on which to record intake of food and beverages. Each page included an area to record the day and date of study, the time at which items were consumed, how the item was cooked and the amount consumed. Figure 3.1 illustrates a sample page from a food diary. The researcher met the subjects within the universities, in order to explain the purpose of the food diary. The subjects were asked to carry the food diary with them at all times during the three day period and to record the food and beverages consumed at the time of consumption. In addition, subjects were asked to record all food and drink consumed by estimating using household measures (for example, cups, plates and tablespoons) and these records were verified by the researcher during the interview using a photographic food atlas (Nelson *et al.*, 1997).

Figure 3.1: The sample page from the food diary

Day (1): Monday		Date: 1-2-2010	
When	**Where**	**Food / Drink description and preparation**	**Portion size**
6.35	Home	Whole milk with sugar Toast with butter Jam Cream cheese	Mug – 1 teaspoon 1 slice-1 teaspoon 1 tablespoon 1 tablespoon
10.15	Office	Tea with sugar Fatayer with spinach	Mug -2 teaspoon 2 slice
2.00	Home	Lamb, grilled with butter Ruz mandi Konafah with cream Apple	200 g 10 tablespoon 5 tablespoon 1
5.10	Home	Cola drink Sambousak with meat	200ml 3
7.30	Home	Arabic coffee Dates	3 small cups 5
9.20	Home	Arabic bread Honey Labneh	1 slice 2 tablespoon 4 tablespoon
11.00	Home	Whole milk	Mug

3.7.1 Interview

Subsequent to the completion of the food diary (approximately one week), interviews were scheduled, in order not to compromise the participants ability to remember their dietary intake. Each participant was interviewed about the content of their diet. The interviews took place on an individual basis and where appointments were held at college or workplace a private room was made available. The interview was used to ensure all foods eaten over the three day period had been recorded, and to verify the data recorded in the diary was accurate such as type of foods, description, brand names, cooking methods, time of intake, place where the food was consumed and portion size. Portion sizes were estimated serving sizes in units of weight, household measures or by using a photographic food atlas (Nelson *et al.*, 1997). The interviews took approximately 30 minutes. All information provided by the subjects was kept confidential. Participants were thanked for their co-operation and for participating in the study. After completion of the diet interviews, the researcher examined all the food diaries and recipes in order to collect information on any new food items.

3.7.2 Dietary analysis

Nutrient intakes were compared with UK Recommended Dietary Intake levels. Food intake was converted to nutrient intake using WinDiets program (Robert Gordon's University, Aberdeen, UK). The nutrient values of each item of food and drink were obtained from the food tables which are in this program for UK and USA foods. McCance and Widdowson food tables were used for western foods, sixth edition (McCance & Widdowson, 2002). For Gulf foods, food composition tables for Arab Gulf countries were used (Al Kanhal *et al*., 1994; Al Kanhal *et al*., 1998; Al Kanhal *et al*., 1999a; Al Kanhal *et al*., 1999b; Musaiger, 2006). For Saudi foods that were not listed in the available food tables, three strategies were used. Firstly, some Saudi food and drinks were matched to similar food and drinks available in the UK and USA food composition tables. Secondly, in cases where there were no similar food and drinks in the UK and USA food composition tables, Saudi recipes were consulted in order to estimate the amount of each nutrient present whilst considering the number of portions suggested by the recipe. Each nutrient was then entered separately using the corresponding amount and by considering the portion size reported by the subjects. Due to variation in composition of the dishes from one household to another, the general description of the main ingredients used in the dishes was used. However, each participant was asked to give their family ingredients in order to check for any unusual ingredients and to homogenize the data. For example, using a Saudi recipe for "*Kabsa*", a traditional and popular dish consumed daily, the dish was deemed to be composed of rice, meat (chicken, mutton, beef or camel) onions, tomatoes, carrots, salt, spices and vegetable oil or animal fat. The amount of each ingredient was initially determined (two recipes were used for mutton and chicken). Following this, these amounts were divided by the number of portions as stated in the recipe. The results were then added as a new code to the WinDiets database to be used in calculating the nutrient intake. The final strategy for a small number of new foods items that were not in the available food tables, involved collecting samples for analysis for nutrient content at Newcastle University.

3.7.3 Collection of food samples

Two new foods items that were not in the available food tables required the collection of samples from Saudi Arabia. These collected dried samples were kept in plastic containers before being transported to the UK and used for analyzed for nutrient content at Newcastle University. The samples were sent to food test laboratories for analysis (see Appendix H). The resulting data was entered into the WinDiets program in order to calculate the nutrient intake.

3.7.4 Estimation of food portion sizes

Currently there is no specific food portion size in Saudi Arabia. Therefore, subjects were asked to record a statement using household measurements and recipes in their food diary. In order to help the subjects estimate the food portion sizes, during the interviews the researcher used examples of different sizes of domestic measures or quantities (including cups, mugs, plates, and spoons) to quantify the food eaten. A list of all types of food and drinks mentioned in the food diaries was made. Dietary information from local supermarkets was collected in order to help in estimating the food portion sizes. Branded food, drinks and confectionery recorded in the food diaries were assessed using information available in supermarkets and shops in Saudi Arabia. For the Saudi food and drinks where a direct match was not found in UK or USA food tables, a best match was used. Moreover, many of the Saudi food and drinks were the same as those available in the UK or USA and many drinks and confectionery consumed by the subjects were made in the UK or USA. However, for foods reported which were not found in the UK or USA food tables, Saudi recipes were consulted in order to estimate the amount of each substance present whilst considering the number of portions suggested by the recipe as described above. Any weight recorded which appeared suspect for that food was checked with the raw data in the participants' food diaries. The estimation of the intake amounts of food and drink for the food diaries was made by associating the additional information collected during the dietary interview. Each food item was then entered, considering the portion size reported by the subjects, from the food portion size sold in supermarkets and shops in Saudi Arabia, and from the food portion sizes guide book (Crawley *et al.*, 2002). Food and drink items from the diaries were entered into WinDiets. Where participants had written portion sizes in grams, (having weighed the food, or if the portion size was labelled on the packaging) this information was entered. Occasionally, participants provided the food's brand name and size, and the researcher used this to obtain the actual portion's weight in grams from the product packaging or the manufacturers. Otherwise, portion sizes were estimated using Food Portion Sizes (Crawley *et al*., 2002).

3.7.5 Coding, using WinDiets

The WinDiets program (Robert Gordon's University Aberdeen, version 2010) is a nutrient database including more than 50,000 codes for foods and recipes. WinDiets based on the Royal Society of Chemistry's database of food (McCance & Widdowson, 2002), the data bank is a flexible system permitting continuous updating of existing values and the addition of new single or composite foods (from UK, USA and international food tables). WinDiets also enables the creation of 'recipes', whereby the user can enter individual ingredients to create a recipe that can then be searched for and used in data entry in the same way as other foods in the database. The program has missing values for some foods, especially for the long chain of PUFA composition and omega 6 fatty acids (about 15% of the data is missing). A three day food diary was transformed using WinDiets in order to analyse the food records and to calculate the mean daily amounts of the various nutrients analysed in this study. Training in WinDiets was undertaken by the researcher under the supervision of Professor Chris Seal and Dr. Georg Lietz at Newcastle University. Also, approaches on how to clarify portion sizes were discussed. Food codes and weights of foods were entered manually by the researcher from the participants' diaries. Information about the time of intake of food and drinks was defined as meal (breakfast, lunch and dinner) or snack (any item consumed between meals). For new dishes which were made up of several components, each component was allocated the relevant food code from the database and the weights were calculated as a proportion of the total product weight. Approximately 53 codes were added to this database for home-made recipe dishes and new food items or products found in the dietary records. As a safeguard, the WinDiets database will not accept any unusual code. A double checking procedure was applied to food diary entries in order to reduce any potential errors. In addition, during the coding phase of the study, five percent of each group already coded were randomly selected and re-entered to compare the differences in nutrient intake. This process provided the study with a measure of reliability for the dietary data and to increase awareness of potential errors during coding. Nutritional analysis was then carried out as described above.

3.7.6 Derived outcome variables from dietary assessment

In view of the studies in Chapter 2, and the fact that there were associations between nutrients\food groups with a risk of CVD, there is a summary with regards to this relationship in Appendix I. The outcome variables for the dietary food diaries were daily intakes of energy in (kcal) and (MJ) , daily intake (g/day) and percentage contribution to daily energy intake of total fat, SFA, MUFA, PUFA, protein and carbohydrate, daily fibre intake, sodium, potassium (g/day), daily cholesterol intake (mg/day), daily intake (mg/day) of calcium, iron, magnesium, zinc, vitamin C and vitamin E and daily intake of vitamin A and selenium (µg/day). The daily intakes of the following fatty acids were also determined: omega 3 fatty acids (alpha-linolenic acid (ALA) (18:3) (g/day), eicosapentaenoic acid (EPA) (20:5) (g/day) and docosahexaenoic acid (DHA) (22:6) (g/day)). In addition the omega 6 fatty acids were determined (linoleic acid (LA) (18:2) (g/day) and arachidonic acid (AA) (20:4) (g/day)) and *trans* fatty acid (g/day).

An average across the three days of the assessment was calculated for all nutrients. The percentage contribution to daily energy intake of total fat, SFA, MUFA, PUFA, protein and carbohydrate was calculated using the following equations according to Thomas (2001):

Fat energy % = [(total daily fat intake (g/day) × 9) / total daily energy intake (kcal/day))] ×100

SFA energy % = [(total daily SFA intake (g/day) × 9) / total daily energy intake (kcal/day)] ×100

MUFA energy % = [(total daily MUFA intake (g/day) × 9) / total daily energy intake (kcal/day)] ×100

PUFA energy % = [(total daily PUFA intake (g/day) × 9) / total daily energy intake (kcal/day)] ×100

Protein energy % = [(total daily protein intake (g/day) × 4) / total daily energy intake (kcal/day)] ×100

Carbohydrate energy % = [(total daily carbohydrate intake (g/day) × 4) / total daily energy intake (kcal/day)] ×100

Since dietary recommendations for the whole Saudi population have not been established, UK RNI were used as references. Macro and micronutrient levels were recorded as categorical variables to help identify intake above or below the Dietary Reference Intake (DRI) level (Institute of Medicine, 2000).

3.7.7 Food groups intake

Data from the three day food records was used to create a food list. The numbers of food list recorded by participants during the three day period was 376. Food items were group into 13 food groups (Table 3.1). Food grouping was based on the similarities of ingredients and/or nutrient profiles. Some individual food items were kept as separate categories because it was inappropriate to incorporate them into a certain food group.

Examples included coffee, tea, salad dressing and condiments. Five food groups were examined with reference to their association with CVD risk factors (see Appendix I): (1) Nuts and seeds: This included almonds, brazil nuts, hazelnuts, walnuts, pistachios, peanut, peanut butter, tahini, sunflower seeds, mixed nuts and raisins; (2) Fish and sea-food: Fried, boiled and grilled, fillets, fish sticks, fish sandwiches and tuna; shrimp, lobster and crab; (3) Fruit and vegetables: This group comprised of 75 individual items. Food records were collected during the summer season in Saudi Arabia which is harvest time for several foods such as dates, watermelons and cantaloupe. (4) Fast food: This included 54 food items such as fast food sandwiches, pies, pizza, fried potatoes and potatoes chips, soda and other foods considered western in nature. (5) Traditional Saudi food: This category comprised 42 food items that are commonly consumed by the Saudi population, for example, *Saiyadiah*, *Molokhiyah, Ruz bukhary, Mutabaq* with meat or with banana and *Kabsa*. For examples *Kabsa* a food with high calorie and fat content (142 kcal/100 g; Musaiger, 2006), which can be prepared at home or people can buy it from traditional shops. The foods in this group are served for lunch or dinner with a smaller number of dishes consumed for breakfast. The outcome variables from food groups were: the total weight of each five food groups as consumed per person (g/day). The percentage of consumption of the five food groups as meals and snacks ate by participants at least on one day from the three days.

Table 3.1: List of food items in each food group

Food group	Components
Grains	Rice, pasta, noodles, breakfast cereals, bread
Fish and sea-food	Fried and boiled, fillets, fish sticks, fish sandwiches and tuna; shrimp, lobster and crab
Meat and poultry	All types of red meat and poultry, cooked, fried or boiled
Dairy products	All types of milk, yoghurt, cheese
Fruit and vegetables	All type of fruit and vegetables including fresh, juices, bottled and dried
Nuts and seeds	Nuts and seeds both salted and roasted
Fast food	Sandwiches, burgers, pizza, pie
Sweets	Honey, jam, sugar, chocolate candy and fudge
Fats and oils	Butter, vegetable oil, olive oil, corn oil
Dressing	Mayonnaise, all types of salad dressing
Coffee and tea	All types of coffee or tea
legumes	Beans, lentils, chickpeas
Traditional Saudi food	All Saudi food

3.7.8 Validation of dietary assessment

Validation of dietary recording in this study was achieved by using a ratio of energy intake with estimated energy needs based on a predicted Basal Metabolic Rate (BMR) (Schofield *et al.,* 1985). This step was conducted in order to identify the subjects who may have under-reported or over-reported their energy intakes. Garrow *et al.* (2000) has defined BMR as "the energy expenditure of an individual lying at physiological and mental rest in a thermo neutral environment, or it is the energy expended by the body at rest to main bodily function like respiration, heartbeat, body temperature and other body functions or can be defined as the amount of energy consumed while inactive". The age, gender, weight, height, environmental temperature and exercise habits can influence BMR (Garrow *et al.,* 2000).

BMR was calculated by using the Schofield equations for 19 years and older for each gender (Schofield *et al*., 1985):

Males aged 18 to 29 years = 15.0 × weight (kg) + 690

Females aged 18 to 29 years = 14.8 × weight (kg) + 690

Males aged 30 to 60 years = 11.4 × weight (kg) + 870

Females aged 30 to 60 years = 8.1 × weight (kg) + 842

Males aged > 60 years = 11.7 × weight (kg) + 585

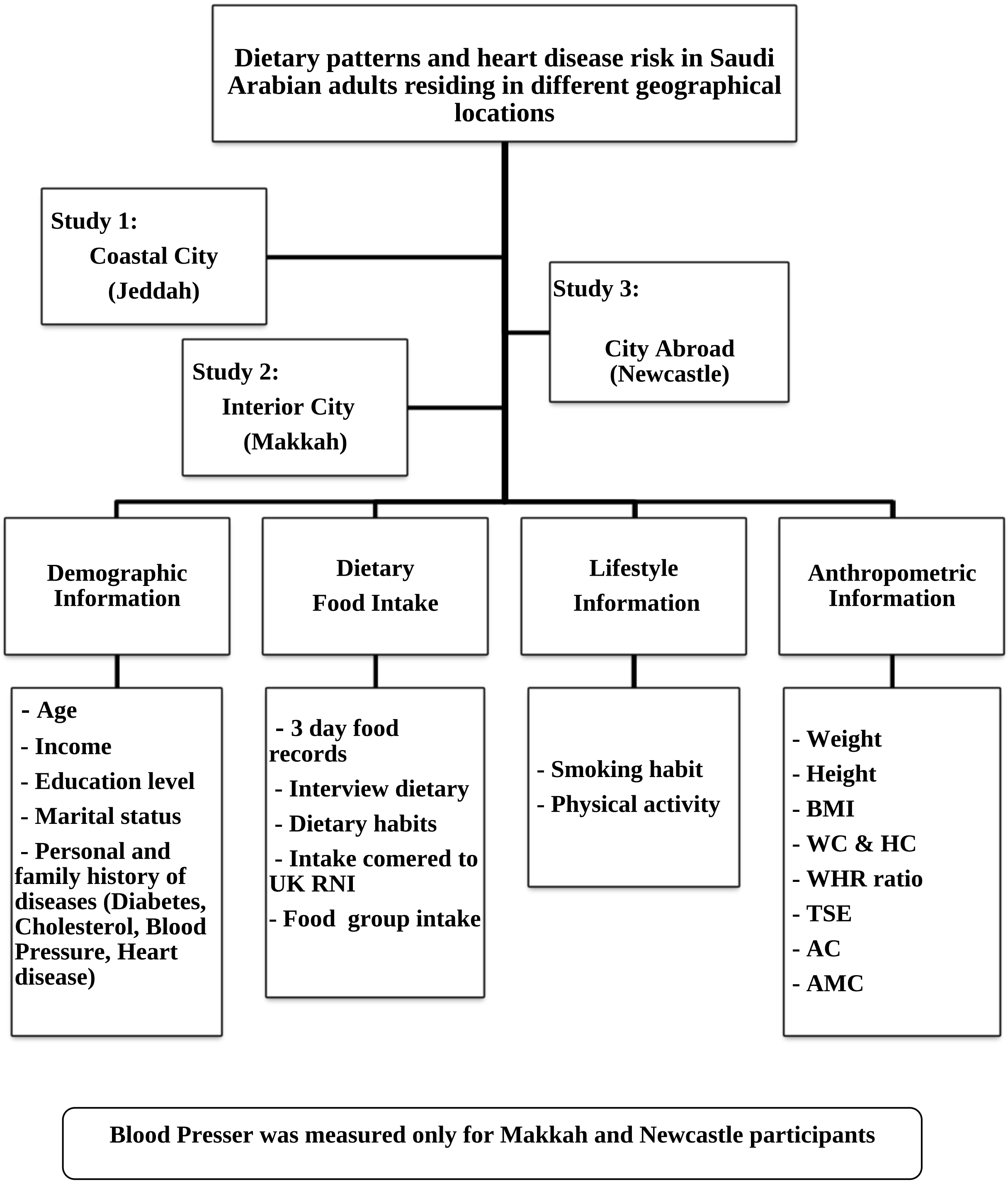
Females aged > 60 years = 9.0 × weight (kg) + 656

Thomas (2001) defined Physical Activity Level (PAL) as the energy required for physical movements which contributes to 20-40% of total daily energy. Garrow *et al.* (2000) suggested a lower cut off point of the ratio of total energy intake to BMR of 1.1. PAL was calculated by dividing the total daily energy intake by BMR (Thomas, 2001).

3.8 Socioeconomic factors

Since differences in nutrient intake can be affected by age, gender and socioeconomic background, this information was also collected. Socioeconomic status was defined by gender, monthly income at the time of data collection and educational status. For educational status, participants were asked to indicate the highest level of schooling using the following categories: low (illiterate or writing and reading), medium (primary school or elementary and secondary schools) and high (undergraduate degree or above). Current monthly income was categorized as follows: low (1 to 3000 SR), medium (3001 to 9000 SR) and high (more than 9001 SR) (currency 5.83 RS = 1£; 01/09/2013). The participants' education level and monthly income were used to calculate a socioeconomic status score for each subject, giving scores of 1 for low, 2 for medium and 3 for high. Socioeconomic status scores as a scale of 2 to 6 were divided into three categories low (2-3), medium (4-5) and high (6) (Khashoggi *et al.*, 1993; Al Numair, 2006). Figure 3.2 shows an overview of the process of data collection.

Figure 3.2: Overview of the process of data collection



3.9 Statistical analysis

All data analyses were carried out using the Statistical Package for the Social Sciences (SPSS) for Windows, version 19 (SPSS Inc., Chicago, IL, USA). The normality of distribution of the data in this thesis was assessed using a One-Sample Kolmogorov-Smirnov Z test. For continuous variables that were normally distributed, data are presented as means, with standard deviation (SD), and 95% Confidence Intervals (CI). For continuous variables that were not normally distributed, data were log-transformed to achieve normal distribution. Data have been presented with geometric means, median and 95% CI. Comparisons of categorical variables between groups, such as between men and women, or between cities were carried out using the exact versions of the non-parametric Chi square test. Comparisons between groups were carried out using in-dependent *t* tests. In some cases, alternative non-parametric tests were used, for example Mann-Whitney tests. A non-parametric test was used when data were not normally distributed. All differences were considered significant if *P*- values were < 0.05. Between groups (> 2) analysis were tested using one-way analysis of variance (ANOVA) to determine whether there were any significant differences between the means of three or more independent groups, for example, between the three cities. Tukey *post-hoc* tests were conducted to examine how each city differed from each other and for skewed data using Kruskal Wallis tests. Comparisons between cities in nutrient intakes or anthropometric measurement were adjusted by age, gender using regression analysis.

Bivariate correlations between dietary intake and risk factors of CVD and socioeconomic status were measured using Pearson's ranking (for normally distributed data) or Spearman's rank correlations (for non-normally distrusted data). Correlations (*r*) were used to evaluate the strength and direction of the relationship between energy, total fat, SFA, MUFA, PUFA, protein and carbohydrate, fibre, cholesterol, calcium, iron, magnesium, sodium, potassium, selenium, zinc, vitamin A, C, and E and the risk factors of CVD: such as age, gender, BMI, (self-reported: diabetes, hypercholesterolemia, hypertension), family history, smoking status, physical activity and socioeconomic status including education and monthly income. A multivariate analysis, using stepwise multiple regression analysis was used to model the association between each food group with all independent variables with *P* values up to 0.1 to demonstrate their contribution to the food intakes. The dependent variables investigated were groups of nuts and seeds, fish and sea-food, fruit and vegetables, fast food and traditional Saudi food. The independent variables included in the models were the risk factors of CVD listed above: age, gender, BMI, diabetes, high blood cholesterol, high blood pressure, family history, smoking status, physical activity and socioeconomic status including education and monthly income. Also, a multivariate general linear model analysis was used to test relationships among dietary intake and CVD risk accounting for significant covariates selected in stepwise multiple regressions. The statistical procedures used for the analysis of data are detailed in each of the following chapters.

Chapter 4

Study1: Dietary Patterns and Risk of Heart Disease in Male and Female living in Coastal City (Jeddah)

4.1 Introduction

Jeddah is the second largest city in Saudi Arabia after the capital Riyadh and it is largest city in the western region of Saudi Arabia. Jeddah located on the coast of the Red Sea. Jeddah is the major sea port on Saudi Arabia and the principal gateway to the holy cities. Its population is around 3.5 million and it is considered one of the most beautiful examples of modern architecture in the world (Ministry of Culture and Information in Saudi Arabia, 2008). There has been a large transformed for the city over the last three or four decades from homogeneous to a heterogeneous urban environment (Gazzaz, 1992). Therefore Jeddah is one of the fastest developing cities in Saudi Arabia. The rapid economic growth of the city has led to significant change in lifestyle of the people with effects on health, nutritional status and of disease patterns.

For CVD, one of these diseases, the Ministry of Health reported that in 2003, Jeddah had the highest number of death due to CVD with 610 in the total number of 6410 deaths from this disease. The number of deaths in male was higher than that in females. The highest percentages of death were focused in the age group 55-64 years (21%), 65-70 years (24.4%) and ≥ 75 years (23.8%), as predicted for an ageing population (Health Statistical Yearbook, 2003).

4.2 Study aims and objectives

4.2.1 Aims

- To measure and describe the dietary patterns of representative samples of the Saudi population living in a coastal city in Saudi Arabia.
- To investigate the relationships between dietary food intake and CVD risk factors in the city of Jeddah, in the western region of Saudi Arabia in both men and women without overt CVD.
- To determine differences in total dietary intake as attested by age, gender and socioeconomic background.

- To explore the relationships between the dietary intake of total fat, omega 3 fatty acids and other fatty acids in Jeddah in the western coastal city of Saudi Arabia as indicators of the risk of CVD.

4.2.2 Objectives

- To conduct a study to measure dietary intake in university employees working in the western Saudi Arabian coastal city of Jeddah.
- To undertake a measure of dietary intake and anthropometric indices of Saudi adults and ask each of these adults to complete a three day estimated dietary food record in order to provide detailed dietary information.
- To use a survey questionnaire in order to collect their personal information, and data relating to medical, social and dietary habits.
- To determine daily intake of: energy, protein, fat, SFA, MUFA, PUFA, carbohydrate, fibre, cholesterol, calcium, iron, magnesium, sodium, potassium, zinc, vitamin C, vitamin E, vitamin A and selenium.
- To estimate the daily intake of the following fatty acids: LA, ALA, total *trans* fatty acids, AA, EPA and DHA.
- To compare and report any significant differences between the intakes of males and females and with in UK RNI.
- To determine the subjects' socioeconomic characteristics.
- To test the association between food intake and CVD risk factors and the socioeconomic characteristics of the population in this study.
- To compare consumption of food groups (nuts and seeds, fish, fruit and vegetable, fast food and traditional Saudi food) among men and women in this study.
- To test the association between intake by food group and CVD risk factors and the socioeconomic characteristics of the population sampled in this study.

4.3 Methods

4.3.1 Study subjects

Participants were recruited in King Abdul-Aziz University in the city of Jeddah, in the western region of Saudi Arabia, sampling both men and women without overt CVD within an age range of 18-65 years. All participants were fully informed of the purpose of the study by using information letter and signed the consent form to participate in the study.

This study was approved by the Ethical Committee of Newcastle University, as described in Sections 3.1 & 3.3.

4.3.2 Demographic and anthropometric information

Each participant was asked to complete an interviewer administered questionnaire concerning demographic characteristics, general information (age, family income per month, education level and marital status), medical information, family history of heart disease and diabetes, lifestyle choices such as smoking and physical activity. The final part of the questionnaire about normal dietary habits was followed by a diet diary. Food intake was recorded for three consecutive days which included one weekend day. The questionnaire designs were described previously in the methods section 3.4.

For anthropometric purposes, the following were measured: Height (m), weight (kg), BMI, (kg/m^2) was calculated, WC (cm), HC (cm), WHR (cm), triceps skin-fold thickness (mm), percent body fat (%). All anthropometric measurements were made by two specially trained nurses (Section 3.5).

4.3.3 Dietary assessment

Volunteers were asked to complete a three days food diary. The food consumed was recorded by volunteers on three consecutive days, two week days and one weekend day. Foods consumed in three day food diaries were coded and entered into the WinDiets program (Robert Gordon's University, Aberdeen, UK) based on McCance and Widdowson, (2008) food tables to estimate the daily energy intake, daily intake and the percentage of energy from protein, carbohydrates, total fat and SFA, MUFA and PUFA. An average across the three days of the assessment was calculated and nutrient intakes were compared with Recommended Dietary Intake levels. Data collection in this study occurred from July 2010 to September 2010 (Section 3.7).

4.3.4 Statistical analysis

Data are presented as means (SD), median and 95% CI for normally distributed data. Variables that were not normally distributed, data were log-transformed to achieve normal distribution. Data are presented as geometric means, median and 95% CI. Data were analysed using SPSS Inc., version 19, Chicago, IL, USA. Comparisons between groups, such as between men and women, were carried out using non-parametric Chi square test. A χ^2 test was used for comparison of categorical data. Differences in the food intake between groups were carried out using in-dependent-samples *t*-tests. Associations between dietary food intakes and individual risk factors were assessed using Pearson's correlation coefficients. Multiple regression analysis was used to determine the variables independently association between risk factor of CVD and intake by food groups. All differences were considered significant if *P*-values were < 0.05.

4.4 Results

4.4.1 Demographic and anthropometric data

From approximately 200 surveys were distributed to the volunteers, about 100 returned completed questionnaire and food diaries. There were 50 men (50%) and 50 women (50%). Mean and (SD) of the anthropometric variables are presented in Table 4.1 which shows a progressive increase in mean BMI, WC and WHR with age in both sexes up to 65 years. There were significant differences between males and females in height, weight, WHR, HC, BMR and body fat ($P < 0.001$). The mean (SD) ages of women and men subjects were 32.4 (7.4) years and 30.9 (9.6) years, respectively. The sample was divided into four categories. Approximately 53% of participants were in the age range 18 -30 years, , about 32% of the sample between 31- 40 years, 12% of participants were between 41 - 50 years, whereas those aged between 50 - 65 years constituted only 3% of the sample.

Table 4.2 summarizes the demographic characteristics for both genders. With respect to marital status, 52% of subjects were married, with a higher percentage of women than men being married ($P < 0.05$). Of the total sample, 50% of men and 68% of women reported a higher (University or above) education level. Only 2% in both genders were illiterate but overall there were no differences between men and women. All participants were working in the university. The distribution of monthly income was different for men and women, with more men in the low income bracket than women, but also more men with a monthly income more than 12000 RS ($P < 0.001$).

4.4.2 Socioeconomic factor

In the present study, the participants' education level and monthly income were used to assess the socioeconomic status of the subjects since there is no governmental classification of areas in Saudi Arabia based on socioeconomic information. The majority of men and women were classified as of medium socioeconomic status, with 62% of women and 64% of men in this category. 16% of the women had a low socioeconomic status and 16% of the men had high socioeconomic status. A chi-square test was used to compare the socioeconomic status for female and male and there were significant differences between participants (χ^2 =24.042, $P < 0.001$, for difference between genders).

Table 4.1: Anthropometric characteristics of the study subjects (mean and (SD))

Variables	Females (*n* = 50)					Males (*n* = 50)				
	18-30	31-40	41-50	51-65	All	18-30	31-40	41-50	51-65	All
Age (years)	26.4 (2.61)	34 (2.92)	45.7 (3.41)	-	32.4 (7.41)	24.9 (2.61)	34.4 (2.30)	44.7 (0.91)	58 (4.30)	30.9 (9.62)
n (%)	23 (46)	19 (38)	8 (16)			30 (60)	13 (26)	4 (8)	3 (6)	
Height (cm)	160 (6.15)	161 (5.08)	156 (5.43)	-	160 (5.80)	173 (4.81)	174 (6.56)	174 (8.30)	171 (4.61)	173 (5.47)
Weight (kg)	62.4 (8.59)	64.9 (5.90)	65.8 (5.96)	-	63.9 (7.28)	72.6 (8.63)	79.3 (11.98)	83.7 (7.41)	73.6 (1.15)	75.3 (9.87)
BMI (kg/m^2)	24.4 (2.70)	24.9 (1.71)	27 (2.52)	-	25 (2.41)	24.1 (2.71)	26.2 (3.31)	27.6 (2.51)	25.3 (1.51)	25.04 (3.01)
Estimated BMR (kcal/d)	1402 (87.6)	1397 (61)	1338 (60.1)	-	1388 (76.5)	1530 (86.8)	1551 (124)	1540 (82.4)	1379 (22.6)	1527 (100)
WC (cm)	84 (4.61)	89 (7.51)	93.2 (8.01)	-	87.4 (7.22)	85.4 (10.41)	92.4 (12.11)	98.5 (10.31)	102 (7.81)	89.3 (11.71)
HC (cm)	98.5 (6.54)	103 (4.87)	104 (3.94)	-	101 (5.97)	90.4 (6.32)	93.6 (9.15)	93.7 (8.05)	96.6 (1.52)	91.9 (7.21)
WHR (cm)	0.85 (0.04)	0.86 (0.05)	0.98 (0.05)	-	0.86 (0.04)	0.93 (0.08)	0.98 (0.07)	1.04 (0.06)	1.05 (0.06)	0.97 (0.11)
Body fat (%)*	29.9 (3.37)	32.4 (2.40)	37.5 (3.51)	-	32.1 (4.01)	18.5 (3.51)	23.2 (4.06)	27.2 (3.21)	27.5 (0.81)	20.9 (4.81)
TSF (mm)	18.1 (2.65)	19.8 (1.86)	20.7 (1.54)	-	19.1 (2.41)	11.3 (3.27)	12.8 (3.45)	17 (3.76)	11.7 (0.50)	12.2 (3.54)
AC (cm)	29.3 (1.84)	31.1 (2.24)	32 (1.60)	-	30.4 (2.21)	27.6 (2.53)	30.3 (3.40)	31.2 (2.75)	29.3 (0.57)	28.7 (3.01)
AMC (cm)	23.6 (1.86)	24.9 (1.97)	25.4 (1.44)	-	24.4 (1.96)	24 (2.03)	26.2 (2.61)	25.9 (1.61)	25.6 (0.58)	24.8 (2.30)

SD: Standard Deviation. BMI: Body Mass Index. BMR: Basal Metabolic Rate calculated using Schofield *et al*. equations (1985). WC: Waist circumference. HC: Hip Circumference. WHR: Waist: Hip Ratio. TSF: Triceps Skin-fold. AC: Arm Circumference. AMC: Arm Muscle Circumference. * Calculated from TSF (Durnin & Womersley, 1974).

Table 4.2: Demographic characteristics of the study subjects by gender

Characteristics	Females (*n* = 50)		Males (*n* = 50)		χ^2	*P*
	No.	%	No.	%		
Education						
Illiterate	1	2	1	2		
Writing & Reading	2	4	-	-		
Primary	2	4	1	2	7.942	N.S
High School	11	22	23	46		
University or Above	34	68	25	50		
Monthly income (RS)*						
1 – 3000	8	16	13	26		
3001 - 6000	13	26	20	40		
6001 – 9000	18	36	5	10	15.546	< 0.001
9001 – 12000	9	18	4	8		
More than 12000	2	4	8	16		
Marital status						
Single	16	32	30	60		
Married	32	64	20	40	9.03	< 0.05
Widowed or Divorced	2	4	-	-		
Socioeconomic status						
Low	8	16	10	20		
Medium	31	62	32	64	24.042	< 0.001
High	11	22	8	16		

N.S: not significant.
*Riyal Saudi (currency 5.83 RS = 1£).

4.4.3 Comparison of cardiovascular risk factors between genders

Prevalence of cardiovascular risk factors among males and females is shown in Table 4.3. BMI was categorized according to WHO (2000) described previously in the methods section 3.5. BMI values ranged from 17 to a maximum of 35.5 kg/m^2 across both genders. About one thirds of the subjects were overweight (*n* =36) or mildly obese (*n*=6). On the other hand, the other CVD risk factors reported by the subjects were: diabetes (*n* =11), hypercholesterolemia (*n* =12), hypertension (*n* =18) and heart disease (*n* =9). There were no significant differences between men and women in BMI classification (P = 0.17), diabetes (P = 0.11), high blood cholesterol (P = 0.53), and personal history of cardiovascular disease (P = 0.081). However, significantly more women reported high blood pressure compared with men (28% *vs.* 8%, respectively, $P < 0.05$). A family history of diabetes and heart diseases was found in 52% and 11%, of the study population respectively. Male participants were significantly more active than women ($P < 0.05$) with 78% of women reporting no physical activity. Cigarettes were the most common type of tobacco smoked by subjects. Only one female participant smoked whereas 50% of men were current smokers.

Table 4.3: Prevalence of cardiovascular risk factors according to gender

Risk factors	Females (*n* = 50)		Males (*n* = 50)		χ^2	*P*
	No.	%	No.	%		
BMI Classification						
Underweight	-	-	1	2	1.795	N.S
Normal	29	58	28	56		
Overweight	19	38	17	34		
Obese	2	4	4	8		
Diabetes*						
Normal	42	84	47	94	2.554	N.S
Diabetic	8	16	3	6		
High blood cholesterol*						
Normal	43	86	45	90	0.379	N.S
Hypercholesterolemia	7	14	5	10		
High blood pressure*						
Normal	36	72	46	92	6.775	< 0.05
Hypertension	14	28	4	8		
Heart disease*						
Normal	43	86	48	96	3.053	N.S
Heart disease	7	14	2	4		
Family history						
Diabetes	27	54	25	50	1.592	N.S
Heart diseases	8	16	3	6		
Smoking status						
Non-smoker	46	92	15	30	37.780	< 0.001
Ex-smoker	-	-	5	10		
Current (<20 cigarette)	1	2	20	40		
Current (>20 cigarette)	-	-	5	10		
Shisha	3	6	5	10		
Physical activity						
Inactive	39	78	23	46	13.307	< 0.05
Moderately active	10	20	17	34		
Active	1	2	10	20		

N.S: not significant.
* Self-reported

4.4.4 Dietary data

Table 4.4 shows dietary habits in both genders. The majority of participants ate three meals per day (78% of women and 60% of men). The main meal of the day was lunch for 92% of females, and 80% of males. More women never ate breakfast (22% *vs*. 4%) and more men had breakfast daily (52% *vs*. 24%) ($P < 0.05$). Most of the participants, 90% of women and 88% of men ate food outside their home at some time during the week ($P < 0.05$).

Table 4.4: Prevalence of dietary habits according to gender

Eating patterns	Females (*n* = 50)		Males (*n* = 50)		χ^2	*P*
	No.	%	No.	%		
Meals (no./day):						
1 or 2	10	20	19	38		
3 or 4	39	78	30	60	3.96	N.S
More than 5	1	2	1	2		
Main meal:						
Breakfast	1	2	4	8		
Lunch	46	92	40	80	2.993	N.S
Dinner	13	26	18	36		
Eating breakfast:						
Daily	12	24	26	52		
Sometimes	27	54	22	44	11.899	< 0.05
Never	11	22	2	4		
Eating outside (per week):						
Never	5	10	6	12		
Once or twice	39	78	22	44		
Three or four times	6	12	13	26	16.408	< 0.05
More than four times	-	-	9	18		

N.S: not significant

With the exception of MUFA, iron, vitamins A, C and E, data for daily dietary intakes of nutrients were normally distributed and are shown in Tables 4.5 and 4.6 as mean, (SD), and 95% CI. On an average, participants consumed 2005 kcal/day (8.4 MJ/day) with 50.5% of daily energy from carbohydrate, 16.5% from protein and 35.8% from fat. SFA, MUFA and PUFA contributed 12.4%, 12.4% and 6.9%, respectively, of the total energy intake. The daily intakes of carbohydrate, fat and protein were for males; 247 g/day, 76.5 g/day and 83.7 g/day respectively, and for females were 258 g/day, 83.8 g/day and 80.4 g/day respectively. The mean daily intakes of SFA, MUFA and PUFA were for males; 26.1 g/day, 26.1 g/day and 14.2 g/day respectively, and for females were 29.5 g/day, 28.2 g/day and 16.6 g/day respectively. Females had significantly higher dietary intakes than males with respect to energy, SFA, PUFA and fibre ($P < 0.05$). The dietary cholesterol intake was within the recommendation guidelines of < 300 mg/d. Mean calcium intake was 663 (200) mg/day, which was around the dietary recommended intake for both males and females of this age. In contrast, mean intakes of fibre, magnesium, potassium and selenium (10.1 (5.04) g/day, 240 (72.14) mg/day, 2.6 (0.85) g/day and 53.7 (28.77) µg/day, respectively) were found to be below recommended intakes (Department of Health, 1991). The mean sodium intake was 2.9 (0.98) g/day, which was above the recommendation suggested by the Department of Health of 1.6 g/day. Data for iron and vitamins A, C and E were log-transformed and geometric means are presented after back-transformation. Daily intake of iron for females was 14.2 (95% CI 12.3, 16.2) mg/day and 12.9 (95% CI 11.8, 14.2) mg/day for men. Mean vitamin A intake for males at 561 (95% CI 447, 703) µg/day, was below the dietary recommended intake for males (700 µg/day), while for females it was within the recommended intake (623 µg/day). There were no statistically significant gender differences for daily intakes of iron, vitamins A, C and E (Table 4.6).

Geometric mean, median and 95% CI for daily intake of fatty acids for subjects by gender are shown in Table 4.7. The mean daily intake of total omega 3 fatty acids was 1.30 g/day, mainly in the form of ALA (1.01 g/day), with 0.27 g/day in the form of EPA and DHA. Total omega 3 fatty acids contributed 0.58 % to the daily energy intake. No differences were observed among males and females in omega 3 fatty acids intake. The geometric mean for daily intake of total omega 6 fatty acids for females was 2.99 g/day while for males it was 3.6 g/day, mainly in the form of AL (2.8 g/day for females and 3.4 g/day for males), with 0.14 and 0.10 g/day for females and males, respectively in the form of AA. Total omega 6 fatty acids contributed 1.75% of the daily energy intake across males and females. There was a statistically significant difference in the mean total daily intake of omega 6 ($P < 0.05$) and AL fatty acid ($P < 0.05$) between males and female. The geometric mean for daily intake of *trans* fatty acid for female was 2.29 g/day and 2.7 g/day for male. *Trans* fatty acids contributed 1% for females and 1.2% for males to the daily energy intake. There were no statistically significant gender differences for daily *trans* fatty acids intakes.

Table 4.5: Mean, standard deviation (SD), median and 95% Confidence Intervals (CI) for daily energy intake and daily intake of macronutrients for subjects by gender

Nutrient	Overall			Females			Males			*P*
	Mean (SD)	Median	95% CI	Mean (SD)	Median	95% CI	Mean (SD)	Median	95% CI	
Energy (MJ/d)	8.4 (1.36)	8.2	8.1, 8.7	8.6 (1.55)	8.2	8.1, 9.1	8.2 (1.11)	8.1	7.9, 8.5	< 0.05
Energy (kcal/d)	2005 (325.21)	1941	1941, 2070	2051 (372.73)	1945	1945, 2157	1959 (265.31)	1927	1883, 2034	< 0.05
Total fat (g/d)	80.2 (20.8)	77.3	76.1, 84.3	83.8 (22.96)	79	77.3, 90.4	76.5 (18.08)	74	76.5, 71.4	N.S
% of daily energy	35.8			36.5			35.1			N.S
SFA (g/d)	27.8 (9.21)	26.4	25.9, 29.6	29.5 (10.48)	29	26.5, 32.4	26.1 (7.46)	25.2	24, 28.2	< 0.05
% of daily energy	12.4			12.8			12			N.S
MUFA (g/d)	26.5*	26.5	26.02, 29.3	28.2 (8.14)	27.2	25.8, 30.4	26.1*	26.1	23.9, 28.3	N.S
% of daily energy	12.4			12.3			12.4			N.S
PUFA (g/d)	15.4 (6.12)	15.3	14.2, 16.6	16.6 (6.91)	15.5	14.6, 18.5	14.2 (5.02)	14.6	12.8, 15.6	< 0.05
% of daily energy	6.9			7.2			6.5			N.S
Cholesterol (mg/d)	256 (98)	251	237, 276	243 (87.72)	238	218 268	269 (107)	263.5	238, 299	N.S
Protein (g/d)	82.1 (18.13)	79.4	78.4, 85.6	80.4 (19.93)	75.2	74.7, 86.1	83.7 (16.17)	82.1	79.1, 88.3	< 0.05
% of daily energy	16.5			15.7			17.2			< 0.05
Carbohydrates (g/d)	252 (49.71)	250	242, 262	258 (48.54)	259	244, 272	247 (50.72)	243	232, 261	N.S
% of daily energy	50.5			50.7			50.3			N.S
Fibre (g/d)	10.1 (5.04)	9.4	9.1, 11.1	11.3 (5.53)	10.8	9.8, 12.9	8.8 (4.16)	8.5	7.6, 9.9	< 0.05

SFA indicates saturated fatty acids; MUFA, monounsaturated fatty acids; PUFA, polyunsaturated fatty acids.
*Geometric means.
$P < 0.05$ variables were compared by *t* test.
N.S: not significant.

Table 4.6: Mean, standard deviation (SD), median and 95% Confidence Intervals (CI) for daily intake of micronutrients for subjects by gender

Nutrient	Overall			Females			Males			*P*
	Mean (SD)	Median	95% CI	Mean (SD)	Median	95% CI	Mean (SD)	Median	95% CI	
Calcium (mg/d)	663 (200)	623	623, 702	682 (219)	633	620, 745	644 (176)	613	594, 694	N.S
Iron (mg/d)	13.6*	13.1	12.5, 14.7	14.2*	13.2	12.3, 16.2	12.9*	12.7	11.8, 14.2	N.S
Magnesium (mg/d)	240 (77.14)	233	225, 255	243 (85.37)	235	219, 268	237 (68.66)	224	217, 256	N.S
Sodium (g/d)	2.9 (0.98)	2.8	2.7, 3.1	3.01 (0.93)	2.9	2.7, 3.2	2.8 (1.03)	2.7	2.5, 3.2	N.S
Potassium (g/d)	2.6 (0.85)	2.5	2.4, 2.8	2.7 (0.97)	2.6	2.4, 3.01	2.5 (0.71)	2.4	2.3, 2.7	N.S
Selenium (µg/d)	53.7 (28.77)	51	48.1, 59.4	47.6 (24.57)	43	40.6, 54.5	59.9 (31.47)	56	51.03 68.9	< 0.05
Zinc (mg/d)	8.2 (2.31)	8.1	7.8, 8.7	7.9 (2.17)	7.5	7.3, 8.5	8.6 (2.41)	8.4	7.8, 9.2	N.S
Vitamin A (µg/d)	591*	603	513, 682	623*	642	520, 746	561*	519	447, 703	N.S
Vitamin C (mg/d)	51.4*	58.4	43.6, 60.6	54.5*	59.5	43.3, 68.5	48.5*	48.3	38.01, 61.9	N.S
Vitamin E (mg/d)	4.8*	4.6	4.4, 5.3	4.9*	4.6	4.3, 5.6	4.8*	4.8	4.2, 5.4	N.S

*Geometric means.
$P < 0.05$ variables were compared by *t* test.
N.S: not significant.

Table 4.7: Geometric mean, median and 95% Confidence Intervals (CI) for daily intake of fatty acids for subjects by gender

Nutrient	Overall			Females			Males			*P*
	Mean	Median	95% CI	Mean	Median	95% CI	Mean	Median	95% CI	
Total n-3 PUFAs (g/d)	1.3	1.1	1.1, 1.5	1.37	1.2	1.03, 1.7	1.2	1.1	0.99, 1.4	N.S
% of daily energy	0.58			0.60			0.55			
ALA (g/d)	1.01	1.1	0.89, 1.13	0.97	1.1	0.83, 1.11	1.1	1.1	0.86, 1.26	N.S
EPA (g/d)	0.13	0.01	0.06, 0.2	0.17	0.01	0.05, 0.31	0.09	0.01	0.03, 0.15	N.S
DHA (g/d)	0.14	0.001	0.07, 0.22	0.21	0.0001	0.07, 0.36	0.07	0.0001	0.03, 0.13	N.S
Total n-6 PUFAs (g/d)	3.9	2.7	3.25, 4.56	2.99	2.08	2.4, 3.5	4.8	3.6	3.6, 5.9	< 0.05
% of daily energy	1.8			1.31			2.20			
LA (g/d)	3.7	2.6	3.1, 4.3	2.8	1.9	2.2, 3.4	4.6	3.4	3.5, 5.7	< 0.05
AA (g/d)	0.2	0.10	0.11, 0.20	0.14	0.09	0.08, 0.19	0.17	0.10	0.11, 0.24	N.S
Total n-6: total n-3 PUFAs	4.2	2.8	3.4, 5.1	3.3	2.2	2.4, 4.1	5.2	3.7	3.8, 6.5	< 0.05
Total n-3: total n-6 PUFAs	0.55	0.35	0.42, 0.68	0.70	0.44	0.47, 0.94	0.40	0.26	0.28, 0.52	< 0.05
Trans fatty acid (g/d)	2.5	2.3	2.2, 2.8	2.3	2	1.8, 2.7	2.7	2.6	2.3, 3.2	N.S
% of daily energy	1.1			1			1.2			

n-3, omega 3; ALA, alpha-linolenic acid (18:3n-3); EPA, eicosapentaenoic acid (20:5 n-3); DHA, docosahexaenoic acid (22:6 n-3); n-6, omega 6; LA, Linoleic acid (18:2 n-6); AA, arachidonic acid (20:4 n-6).
$P < 0.05$ variables were compared by *t* tests.
N.S: not significant.

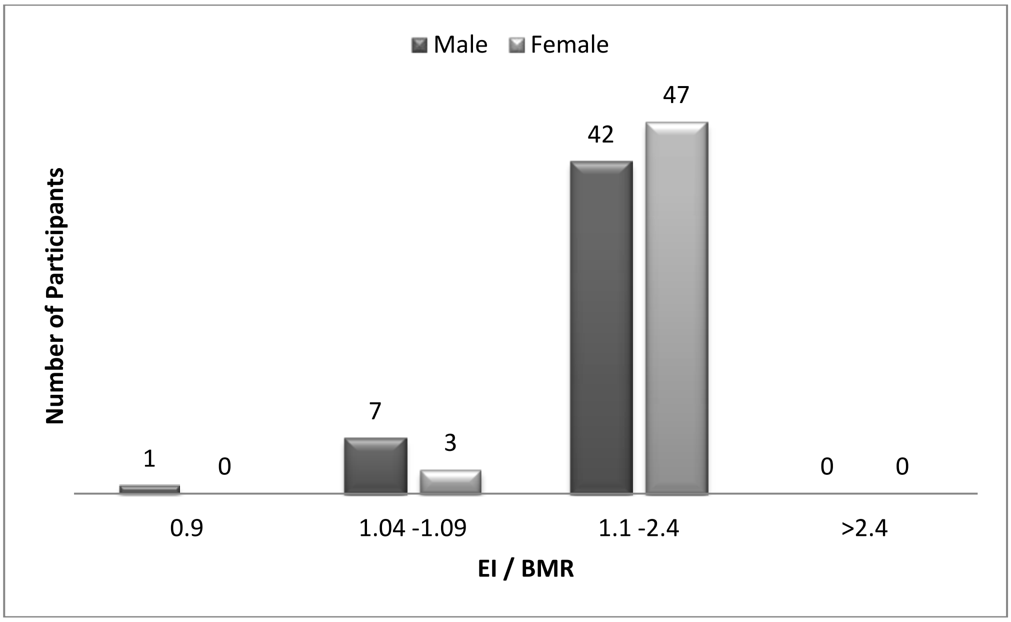
4.4.5 Validation of dietary data

Table 4.8 shows the mean of energy intake (EI), estimated Basal Metabolic Rate (BMR) and EI: BMR of study subjects according to age and gender. The mean BMR for the males was 1527 kcal/day and 1388 kcal/day for the females as expected for tier different body size. Estimated BMR also reduced with age in both males and females, as expected with reducing average body weight and changes in body composition with age (Smith & Young, 2010). The mean EI: BMR for male was 1.2 and 1.4 for females, suggesting that in some cases in male volunteers were under-reporters whereas on average the females were identified as normal-reporters, as shown in the distribution in Figure 4.1.

Table 4.8: Mean energy intake (EI), estimated Basal Metabolic Rate (BMR) and EI: BMR of study subjects

	overall	Female					Male				
		18-30 (23)	31-40 (19)	41-50 (8)	51-65	All (50)	18-30 (30)	31-40 (13)	41-50 (4)	51-65 (3)	All (50)
Energy intake (kcal/d)	2005	1865	2143	2367	-	2051	2071	1832	1734	1687	1959
BMR (kcal/d)	1467	1402	1397	1338	-	1388	1530	1551	1540	1379	1527
EI:BMR	1.3	1.3	1.5	1.7	-	1.4	1.3	1.1	1.1	1.2	1.2

Figure 4.1: Distribution of Participants for the Ratio of Energy Intake (EI) to Basal Metabolic Rate (BMR)



4.4.6 Comparison with UK Dietary Reference Values for food energy and nutrients (DRV)

Nutritional requirements vary according to age and gender. Tables 4.9, 4.10 show the percentage of subjects with macronutrient and micronutrient intakes above and below DRV according to gender. Data indicate that nutrient intake for some subjects were below or above the established UK RNI. Nutrients that were above the RNI for both male and female subjects were total fat, SFA, MUFA, PUFA, protein, carbohydrates and sodium. On the other hand, the nutrients which did not meet the UK RNI for both males and females were potassium and selenium (78%, 72% and 74%, 74%, of RNI respectively).

Figure 4.2 shows the nutrient intake (fat, SFA, MUFA, PUFA, protein, carbohydrates and fibre) and the corresponding RNI of the study subjects by gender.

Of the other nutrients such as energy, the majority of male subjects (86%) had lower intake than the UK Estimated Average Requirement (EAR) for energy. While 44% of the female subjects had energy intake lower than the EAR with 46% exceeding the recommendation. Figure 4.3 shows the energy intake and EAR of the study subjects by gender. Similarity for calcium, magnesium and zinc the majority of males (62%, 72% and 56%, respectively) had intakes lower than RNI, whereas for females the values were slightly lower at 44%, 52% and 32%, respectively, with 42%, 30% and 50%, respectively consuming above the RNI. Cholesterol intake was within the UK recommendation for 74% of males and 80% of females. No men consumed less than the RNI for iron intake, with 80% exceeding the RNI. In contrast 52% of women consumed less than the RNI and only 30% consumed more than the RNI. Vitamin A intake was below the UK RNI for 66% of males but was above the UK RNI for 60% of females. Mean vitamin C intakes were equal to or above the UK RNI for the majority of males and females subject with (62% and 78%, respectively). Figures 4.4, 4.5 and 4.6 shows nutrient intake (cholesterol, calcium, iron, magnesium, sodium, potassium, selenium, zinc, vitamin A and C) and RNI of the study subjects by gender.

Table 4.11 illustrates the percentage of subjects below, achieving or exceeding RNI and AI for fatty acids intakes according to gender. Total omega 3 fatty acids intakes were above the RNI for 70% of men and 80% of women. However, fatty acids were consumed below the RNI or AI for the majority of both male and female subjects for ALA, EPA+DHA, LA and *trans* fatty acids intakes. Figures 4.7 presents the fatty acids intakes and RNI or AI of the study subjects by gender.

Table 4.9: Percentage of subjects below, achieving or exceeding EAR* for energy and RNI for macronutrient intake**

Nutrient	DRV		Male			Female		
	Males	Females	< DRV %	= DRV %	> DRV %	< DRV %	= DRV %	> DRV %
Energy (MJ/d)*	10.60	8.10 8.00***	92	6	2	38	22	40
Energy (kcal/d)*	2550	1940 1900***	86	14	-	44	10	46
% of daily energy from total fat**	35	35	-	-	100	-	-	100
% of daily energy from SFA**	11	11	-	-	100	-	2	98
% of daily energy from MUFA**	13	13	-	2	98	-	-	100
% of daily energy from PUFA**	6.5	6.5	-	4	96	-	8	92
Cholesterol (mg/d)**	< 300	< 300	-	74	26	-	80	20
Protein (g/d)**	55.5 53.3***	45 46.5***	-	2	98	-	2	98
% of daily energy from carbohydrates**	50	50	-	-	100	-	-	100
Fibre (g/d)**	12	12	80	6	14	58	14	28

SFA indicates saturated fatty acids; MUFA, monounsaturated fatty acids; PUFA, polyunsaturated fatty acids.
*Estimated Average Requirements for energy intake and % of subjects below, achieving or exceeding this value.
**Reference Nutrient intake 19-50 y, ***50+ y (Department of Health, 1991).

Table 4.10: Percentage of subjects below, achieving or exceeding RNI* for micronutrient intakes

Nutrient	RNI		Male			Female		
	Males	Females	< RNI %	= RNI %	> RNI %	< RNI %	= RNI %	> RNI %
Calcium (mg/d)*	700	700	62	14	24	44	14	42
Iron (mg/d)*	8.7	14.8 8.7**	-	20	80	42	6	52
Magnesium (mg/d)*	300	270	72	10	18	52	18	30
Sodium (g/d)*	1.60	1.60	6	8	86	4	-	96
Potassium (g/d)*	3.50	3.50	78	18	4	72	12	16
Selenium (µg/d)*	75	60	74	6	20	74	4	22
Zinc (mg/d)*	9.5	7.0	56	16	28	32	18	50
Vitamin A (µg/d)*	700	600	66	12	22	20	20	60
Vitamin C (mg/d)*	40	40	38	14	48	22	10	68

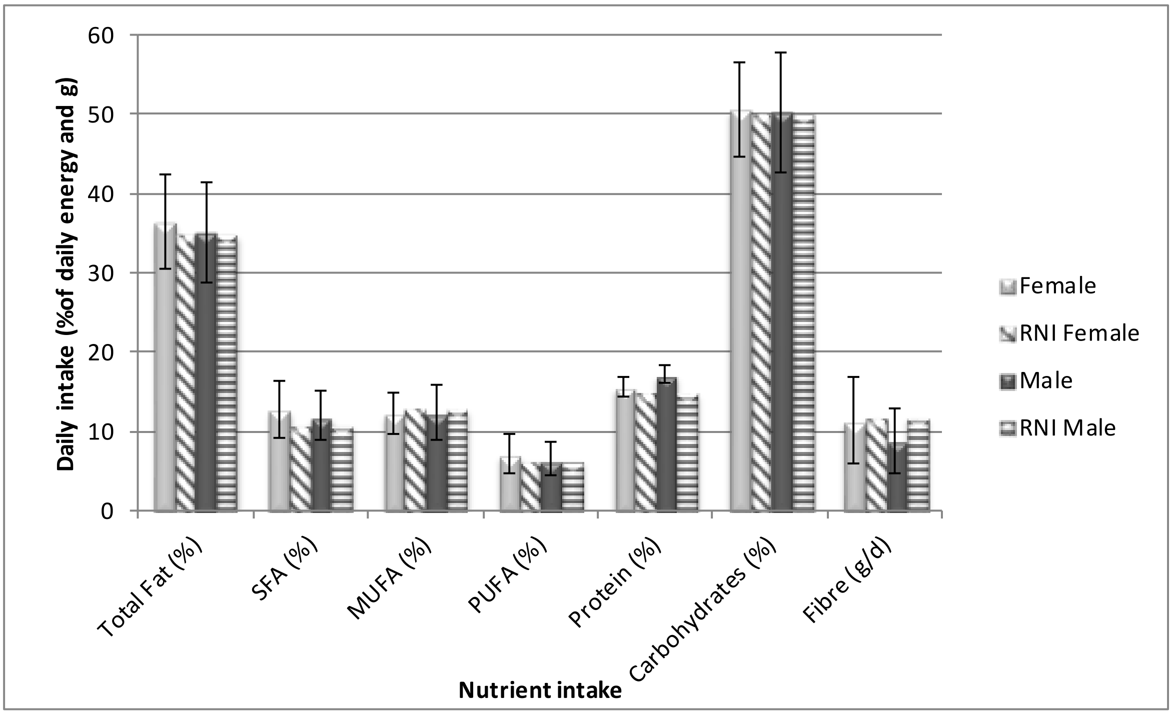
*Reference Nutrient intake 19-50 y, **50+ y (Department of Health, 1991).

Table 4.11: Percentage of subjects below, achieving or exceeding RNI*, adequate intake (AI) for fatty acids intakes

Nutrient	AI		Male			Female		
	Males	Females	< AI %	= AI %	> AI %	< AI %	= AI %	> AI %
% of daily energy from n-3 PUFAs*	0.2	0.2	14	16	70	10	10	80
ALA (g/d)**	1.6	1.1	60	32	8	46	40	14
EPA+DHA (g/d)**	0.45	0.45	92	4	4	82	-	18
% of daily energy from n-6 PUFAs*	1	1	24	14	62	34	32	34
LA (g/d)**	17	12	94	4	2	100	-	-
Total n-3: total n-6 PUFAs***	0.4	0.4	58	22	20	38	20	42
% of daily energy from *trans* – FA*	2	2	72	12	4	84	4	12

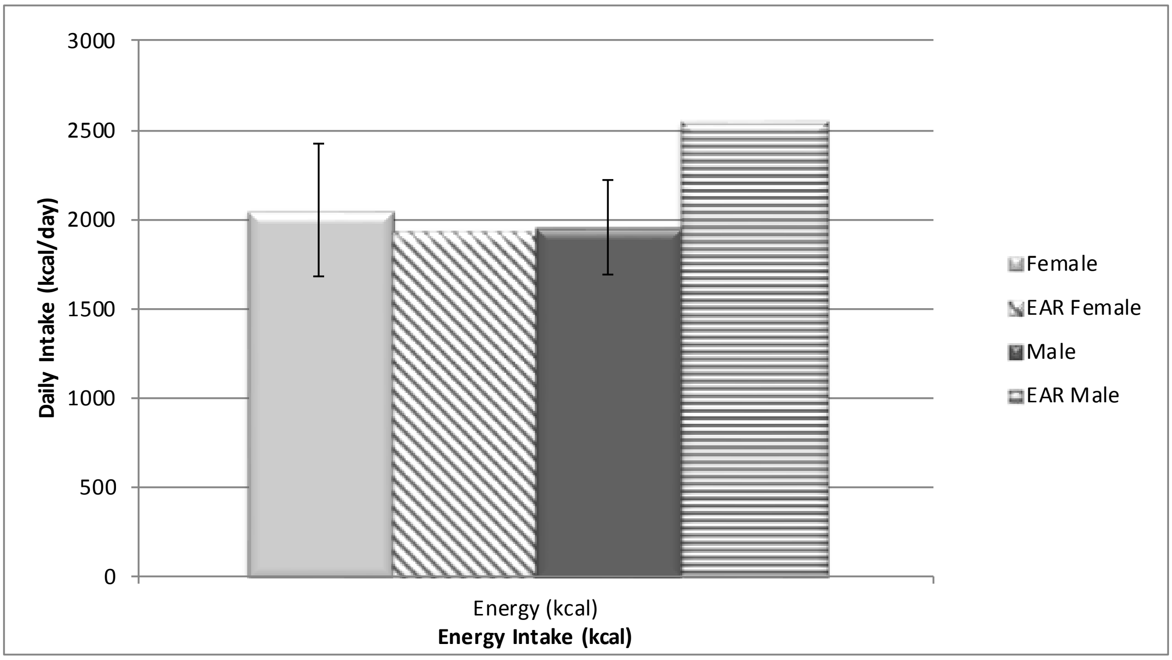
ALA, alpha-linolenic acid (18:3n-3); EPA, eicosapentaenoic acid (20:5 n-3); DHA, docosahexaenoic acid (22:6 n-3); LA, Linoleic acid (18:2 n-6); *trans*- FA, *trans* fatty acid.
*Reference Nutrient intake 19-50 y, (Department of Health, 1991).
** (Dietary Reference Intake, 2002)
*** (UK Scientific Advisory Committee on Nutrition, 2004).

Figure 4.2: Nutrient intake (fat, SFA, MUFA, PUFA, protein, carbohydrates and fibre) and RNI* of the study subjects by gender



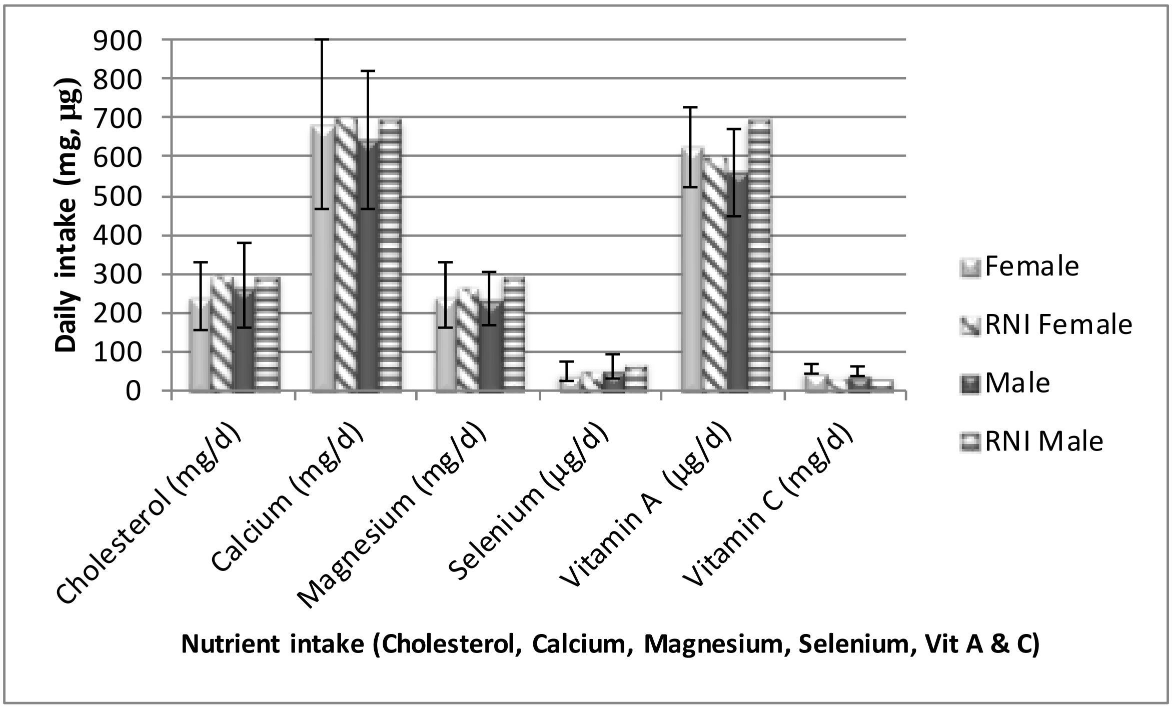
*Reference Nutrient Intake 19-50 y, (Department of Health, 1991).

Figure 4.3: Energy intake and EAR* of the study subjects by gender



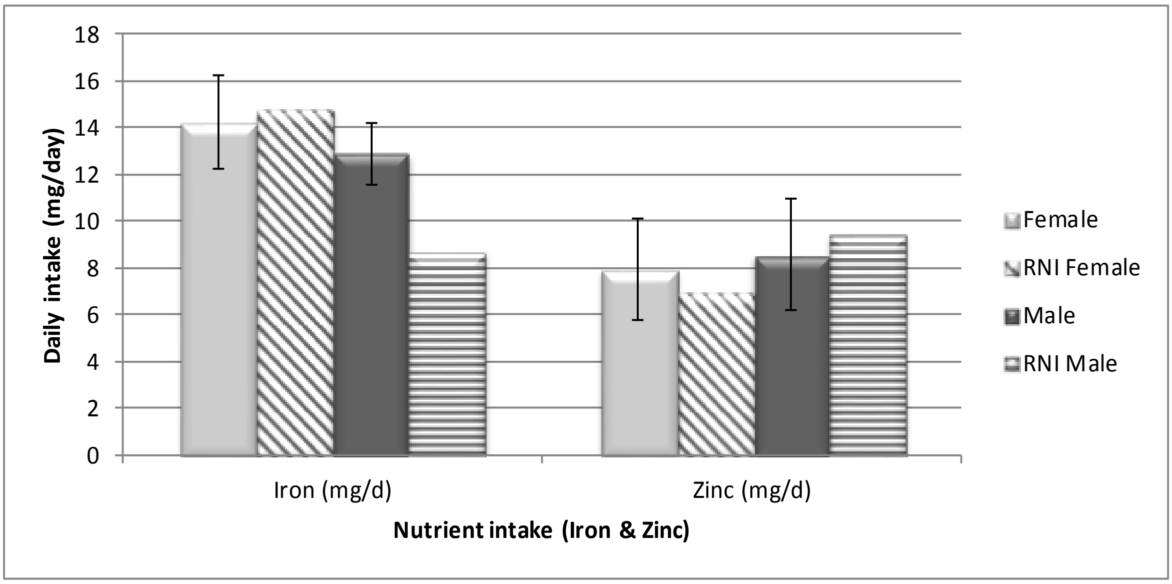
*Estimated Average Requirements for energy 19-50 y, (Department of Health, 1991).

Figure 4.4: Nutrient intake (cholesterol, calcium, magnesium, selenium, vitamin A and C) and RNI* of the study subjects by gender



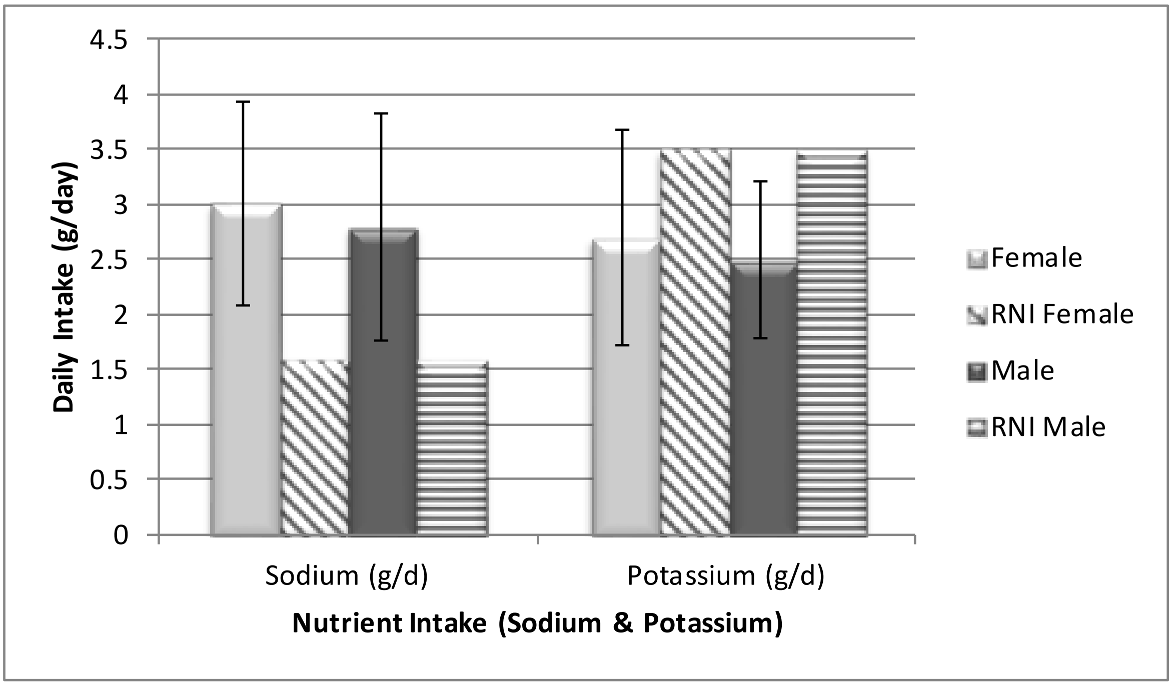
*Reference Nutrient Intake 19-50 y, (Department of Health, 1991).

Figure 4.5: Iron and Zinc and RNI* of the study subjects by gender



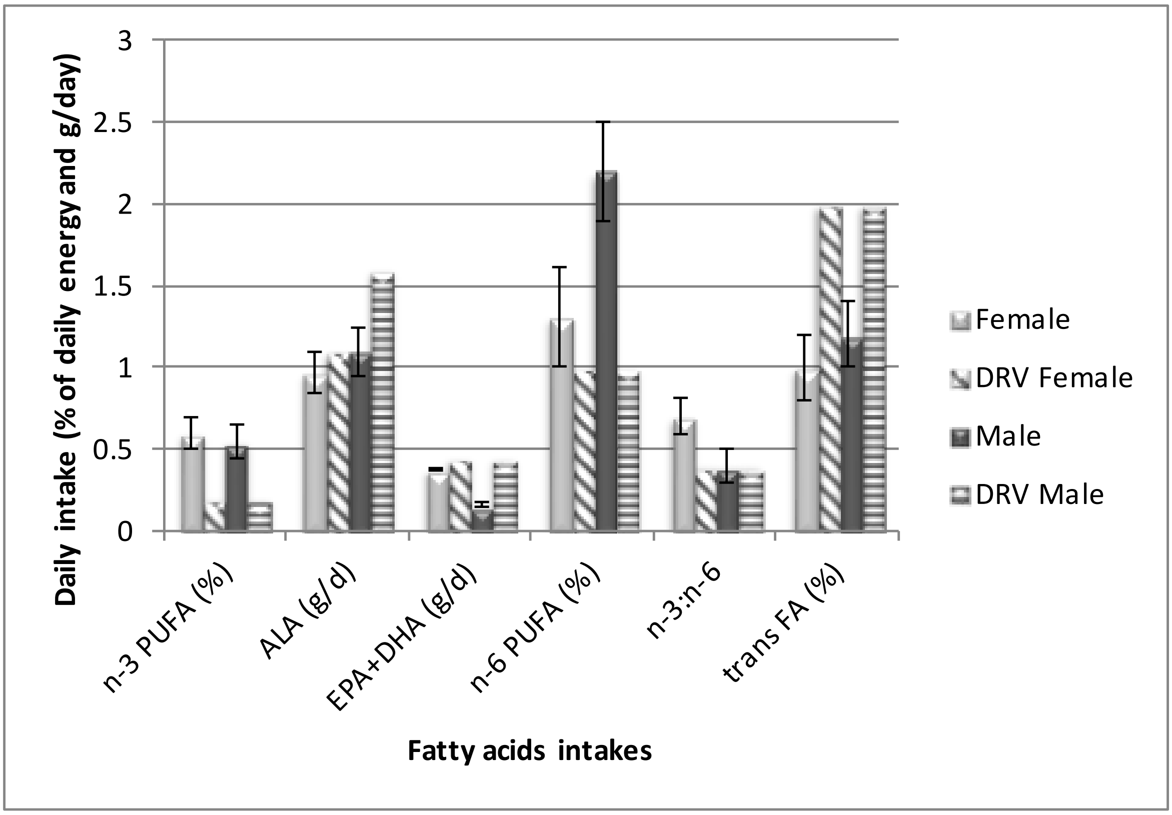
*Reference Nutrient Intake 19-50 y, (Department of Health, 1991).

Figure 4.6: Sodium and Potassium and RNI* of the study subjects by gender



*Reference Nutrient Intake 19-50 y, (Department of Health, 1991).

Figure 4.7: Fatty acids intakes and RNI*, adequate intake (AI) of the study subjects by gender**



*Reference Nutrient intake 19-50 y, (Department of Health, 1991).
** (Dietary Reference Intake, 2002), (UK Scientific Advisory Committee on Nutrition, 2004)

4.4.7 Relationship between nutrient intake and other factors

In terms of dietary components, Tables 4.12, 4.13 and 4.14 show the correlation coefficients between food intakes with socioeconomic factors and CVD risk factors in the study subjects.

4.4.7.1 Relationship between nutrient intake and socioeconomic status

Among study subjects, there were statistically significant negative associations for energy intakes (MJ, kcal) with education and monthly income (P = 0.028, P = 0.005, respectively). Carbohydrate intakes were also negatively correlated with the income of participants (P = 0.007), while fibre intakes was negatively correlated with educating (P < 0.001). Moreover, there were significant negative associations between total fat intakes and PUFA intakes with monthly income (P = 0.039, P = 0.014, respectively). In SFA intakes was negatively correlated with education (P = 0.039). Higher education and higher total family monthly income were negatively associated with daily intake of total omega 6 fatty acids and AA intakes (r = - 0.295, P = 0.003; r = - 0.219, P = 0.029 and r = - 0.201, P = 0.045; r = - 0.340, P = 0.001, respectively).

4.4.7.2 Relationship between nutrient intake and CVD risk factors

Parameters used for the assessment food intake and CVD risk factors were investigated for their relationship for all study subjects. Carbohydrates intakes were positive association with history of diabetes (P = 0.039). Dietary intakes of fibre was positively correlated with age (P < 0.001), gender (P = 0.010), BMI (P = 0.009), history of hypercholesterolemia (P = 0.042) and family history (P = 0.028). There were statistically significant positive associations between total fat intakes and history of hypercholesterolemia (P = 0.044). In addition, there were statistically significant associations between dietary calcium intakes with age (P = 0.021), BMI (P = 0.035), history of hypertension (P = 0.041) and history of hypercholesterolemia (P = 0.045). Potassium intake was positively correlated with age and history of hypertension (P = 0.003, P = 0.019, respectively). Moreover, there were significant associations between iron intakes and magnesium intakes with age (P = 0.041, P = 0.020, respectively). In all participants, there were positively correlation between sodium intakes and physical activity (r = 0.261, P = 0.009). Selenium intakes was associated with gender (P = 0.031), and vitamin A was weakly associated with history of hypercholesterolemia (P = 0.048) and physical activity (P = 0.037). Vitamin C was negatively associated with smoking status (P = 0.014). Subject age was significant positively association with vitamin C (P = 0.002). Subject age had a significant negatively association with total omega 6, LA and *trans* intake (P = 0.017, P = 0.011, P = 0.001 respectively). Total omega 6 and LA intakes was associated with gender (P = 0.010, P = 0.007 respectively), and LA intakes was negatively associated with BMI (P = 0.027). Moreover, total omega 6 and LA intakes were positive association with physical activity (P = 0.023, P = 0.012 respectively). Smoking was negatively associated with AA fatty acid intake (r = - 0.241, P = 0.016).

Table 4.12: Correlation coefficients between energy intakes and intakes of macronutrients with socioeconomic factors and CVD risk factors in the study subjects

Factors	Energy (MJ)		Energy (kcal)		Protein (g)		Carbohydrates (g)		Fibre (g)		Total fat (g)		SFA (g)		MUFA (g)		PUFA (g)		Cholesterol (mg)	
	r	***P***	***r***	***P***	***r***	***P***	***r***	***P***	***r***	***P***	***r***	***P***	***r***	***P***	***r***	***P***	***r***	***P***	***r***	***P***
Gender	0.141	0.162	0.143	0.156	-0.092	0.364	0.120	0.235	**0.256**	**0.010**	0.175	0.081	0.186	0.066	0.057	0.575	0.194	0.054	-0.132	0.189
Age	0.029	0.778	0.028	0.780	0.176	0.080	0.011	0.914	**0.420**	**0.000**	-0.017	0.863	0.149	0.140	-0.099	0.328	-0.018	0.858	-0.067	0.507
Education	**-0.220**	**0.028**	**-0.219**	**0.028**	-0.104	0.304	-0.191	0.058	**-0.392**	**0.000**	-0.163	0.106	**-0.207**	**0.039**	-0.058	0.565	-0.191	0.057	-0.063	0.537
Monthly income	**-0.279**	**0.005**	**-0.279**	**0.005**	-0.024	0.812	**-0.269**	**0.007**	-0.132	0.190	**-0.206**	**0.039**	-0.151	0.134	-0.143	0.157	**-0.246**	**0.014**	-0.166	0.098
BMI	0.072	0.479	0.072	0.477	0.126	0.210	0.041	0.084	**0.261**	**0.009**	0.039	0.701	0.157	0.118	-0.068	0.499	-0.028	0.785	-0.098	0.331
History of diabetes	0.102	0.314	0.099	0.325	0.024	0.810	**0.207**	**0.039**	-0.047	0.643	-0.055	0.590	-0.051	0.612	-0.089	0.381	-0.012	0.906	0.039	0.702
History of hypertension	0.118	0.243	0.118	0.243	0.146	0.146	0.032	0.753	0.084	0.405	0.117	0.245	0.081	0.425	0.083	0.413	0.143	0.157	-0.006	0.952
History of hypercholesterol emia	0.142	0.160	0.143	0.156	0.008	0.935	0.051	0.614	**0.204**	**0.042**	**0.202**	**0.044**	0.169	0.093	0.135	0.182	0.163	0.105	0.134	0.184
Family history	0.016	0.877	0.016	0.874	-0.016	0.872	-0.035	0.733	**0.219**	**0.028**	0.075	0.461	0.087	0.387	0.151	0.133	-0.018	0.855	0.173	0.085
Smoking status	0.075	0.458	0.074	0.463	-0.077	0.447	0.161	0.109	0.084	0.408	0.004	0.969	0.108	0.286	-0.100	0.322	-0.023	0.817	-0.078	0.441
Physical activity	-0.028	0.785	-0.028	0.783	0.084	0.405	-0.083	0.414	-0.183	0.068	-0.010	0.923	-0.035	0.733	0.090	0.375	-0.072	0.478	0.171	0.089

SFA indicates saturated fatty acids; MUFA, monounsaturated fatty acids; PUFA, polyunsaturated fatty acids. Pearson's correlation coefficients were calculated for all study subjects. Statistical significant correlation coefficients are indicated in bold font.

Table 4.13: Correlation coefficients between intakes of micronutrients with socioeconomic factors and CVD risk factors in the study subjects

Factors	Calcium (mg)		Iron (mg)		Magnesium (mg)		Sodium (g)		Potassium (g)		Selenium (μg)		Zinc (mg)		Vitamin A (μg)		Vitamin C (mg)		Vitamin E (mg)	
	r	***P***	***r***	***P***	***r***	***P***	***r***	***P***	***r***	***P***	***r***	***P***	***r***	***P***	***r***	***P***	***r***	***P***	***r***	***P***
Gender	0.097	0.335	0.085	0.517	0.041	0.686	0.058	0.564	0.101	0.318	**-0.216**	**0.031**	-0.132	0.189	0.128	0.205	0.074	0.466	-0.006	0.951
Age	**0.230**	**0.021**	**0.205**	**0.041**	**0.233**	**0.020**	-0.022	0.827	**0.291**	**0.003**	0.130	0.198	0.101	0.317	0.025	0.804	**0.300**	**0.002**	0.095	0.347
Education	0.042	0.680	-0.043	0.074	0.039	0.700	0.067	0.506	-0.027	0.788	-0.030	0.763	-0.040	0.693	0.156	0.122	-0.019	0.852	-0.005	0.959
Monthly income	0.104	0.305	0.034	0.735	0.107	0.288	-0.014	0.894	0.182	0.070	-0.013	0.896	0.002	0.985	0.014	0.892	0.129	0.201	0.027	0.791
BMI	**0.211**	**0.035**	0.169	0.092	0.048	0.639	0.021	0.837	0.078	0.442	-0.072	0.476	0.093	0.358	-0.004	0.972	0.166	0.098	0.073	0.469
History of diabetes	0.157	0.118	0.069	0.496	-0.004	0.965	-0.059	0.560	0.050	0.625	-0.046	0.651	0.074	0.466	0.152	0.121	0.097	0.336	0.109	0.280
History of hypertension	**0.204**	**0.041**	0.101	0.316	0.169	0.092	-0.014	0.890	**0.234**	**0.019**	-0.089	0.386	0.111	0.271	0.071	0.485	0.108	0.286	0.170	0.091
History of hypercholesterolemia	**-0.201**	**0.045**	-0.020	0.844	-0.126	0.212	-0.109	0.279	-0.011	0.911	0.002	0.985	-0.026	0.795	**-0.198**	**0.048**	-0.017	0.865	-0.071	0.481
Family history	-0.039	0.699	0.115	0.257	-0.002	0.983	0.147	0.143	0.075	0.461	-0.016	0.878	0.166	0.100	-0.026	0.798	0.023	0.823	-0.095	0.345
Smoking status	0.045	0.658	0.039	0.700	-0.009	0.927	-0.030	0.770	0.081	0.421	-0.111	0.270	-0.091	0.366	-0.70	0.488	**-0.230**	**0.014**	0.002	0.986
Physical activity	-0.104	0.301	-0.024	0.813	-0.130	0.196	**0.261**	**0.009**	-0.140	0.166	0.151	0.132	0.085	0.401	**0.209**	**0.037**	-0.074	0.467	0.072	0.476

Pearson's correlation coefficients were calculated for all study subjects. Statistical significant correlation coefficients are indicated in bold font.

Table 4.14: Correlation coefficients between intakes of fatty acids with socioeconomic factors and CVD risk factors in the study subjects

Factors	Total n-3 PUFAs (g)		ALA (g)		EPA (g)		DHA (g)		Total n-6 PUFAs (g)		LA (g)		AA (g)		*Trans* fatty acid (g)	
	r	***P***	***r***	***P***	***r***	***P***	***r***	***P***	***r***	***P***	***r***	***P***	***r***	***P***	***r***	***P***
Gender	0.044	0.666	-0.026	0.795	-0.099	0.328	-0.053	0.603	**-0.256**	**0.010**	**-0.269**	**0.007**	-0.037	0.713	-0.167	0.097
Age	0.059	0.560	-0.618	0.866	-0.110	0.274	-0.060	0.552	**-0.238**	**0.017**	**-0.253**	**0.011**	0.076	0.451	**-0.329**	**0.001**
Education	-0.053	0.603	-0.104	0.302	-0.007	0.941	0.054	0.591	**-0.201**	**0.045**	-0.165	0.102	**-0.340**	**0.001**	0.030	0.771
Monthly income	0.021	0.839	-0.049	0.629	0.018	0.857	-0.005	0.963	**-0.295**	**0.003**	**-0.257**	**0.010**	**-0.219**	**0.029**	-0.145	0.150
BMI	0.044	0.664	0.025	0.861	-0.144	0.513	-0.070	0.487	-0.195	0.052	**-0.221**	**0.027**	0.117	0.247	-0.149	0.140
History of diabetes	0.167	0.097	0.114	0.260	0.047	0.645	0.042	0.675	-0.079	0.433	-0.112	0.268	0.087	0.390	-0.083	0.413
History of hypertension	0.073	0.471	0.071	0.486	0.152	0.131	0.046	0.651	-0.040	0.695	-0.003	0.973	-0.003	0.979	-0.023	0.821
History of hypercholesterolemia	0.036	0.721	0.016	0.878	-0.102	0.313	0.020	0.845	0.063	0.531	0.045	0.656	0.090	0.373	0.038	0.706
Family history	-0.008	0.934	0.102	0.314	-0.185	0.650	-0.061	0.544	-0.139	0.169	-0.149	0.139	-0.010	0.920	-0.062	0.541
Smoking status	-0.019	0.851	-0.060	0.556	-0.155	0.123	-0.022	0.832	-0.167	0.097	-0.161	0.110	**-0.241**	**0.016**	0.133	0.187
Physical activity	-0.010	0.925	0.043	0.669	0.083	0.412	0.028	0.780	**0.227**	**0.023**	**0.249**	**0.012**	-0.004	0.972	0.177	0.079

n-3, omega 3; ALA, alpha-linolenic acid (18:3n-3); EPA, eicosapentaenoic acid (20:5 n-3); DHA, docosahexaenoic acid (22:6 n-3); n-6, omega 6; LA, Linoleic acid (18:2 n-6); AA, arachidonic acid (20:4 n-6). Pearson's correlation coefficients were calculated for all study subjects. Statistical significant correlation coefficients are indicated in bold font.

4.4.8 Intake by food groups

The foods were listed in groups to represent all major food groups consumed by the participants (see Table 3.1 for food group). Five food groups were examined for possible associations with CVD risk factors. Reported mean intakes for food groups and the number and percentage of volunteers consuming the food group on one or more days during the completion of food diary are shown in Table 4.15. In total, 22% of study subjects ate nuts and seeds groups on at least day from the three day record, whereas 42% of the participants ate fish and sea-food on one or more days of the food record. Almost all participants had fruit and vegetables and traditional Saudi food during the food record and about 80% had consumed fast food during this period. The intake of fast food for women was 287 g/day, and for men it was 368 g/day. The intake of fruit and vegetables was different for men and women, with women having a higher intake of fruit and vegetables than men ($P < 0.05$), and also more women had a higher intake of traditional Saudi food than men ($P < 0.05$).

Table 4.15: Percentage, mean and 95% Confidence Intervals (CI) for intake by food group of the study subjects by gender

Food groups	Overall			Females			Males			*P*
	n (%)	Mean (g/d)	95% CI	*n (%)*	Mean (g/d)	95% CI	*n (%)*	Mean (g/d)	95% CI	
Nuts and seeds	22 (22)	5.2	2.7, 7.7	13 (26)	5.6	2.5, 8.6	9 (18)	4.8	0.6, 8.9	N.S
Fish and sea-food	42 (42)	32.6	23.3, 42.1	20 (40)	31.2	18.1, 44.4	22 (44)	34.2	20.4, 47.9	N.S
Fruit & vegetables	97 (97)	205	173, 237	50 (100)	226	191, 260	47 (94)	185	130, 239	< 0.05
Fast food	79 (79)	327	274, 381	39 (78)	287	219, 354	40 (80)	368	285, 451	N.S
Traditional Saudi food	91 (91)	271	233, 308	46 (92)	331	270, 392	45 (90)	211	172, 249	< 0.05

$P < 0.05$ variables were compared by Mann-Whitney tests.
N.S: not significant.

4.4.9 Relationship between intake by food group and other factors

Table 4.16 shows the association between intake by food groups with socioeconomic factors and CVD risk factors in the study subjects.

4.4.9.1 Relationship between intake by food group and socioeconomic status

Multiple regression models were applied to examine the independent association of selected indicators of socioeconomic status with the five food groups identified in this study. Among study subjects, consumption of fish and sea-food was positively associated with monthly income (P = 0.016). Whereas, it was negatively associated with consumption traditional Saudi food and level of education (ß = -0.294, 95% CI -111.9,-23.6, P = 0.003).

4.4.9.2 Relationship between intake by food group and CVD risk factors

With respect to age there was a positive association with consumption of fruit and vegetables (P = 0.001) and a negative correlation with consumption of fast food (P = 0.001). Fast food consumption was also positively associated with BMI (P = 0.032) but negative associated with physical activity (P = 0.035). Consumption of traditional Saudi food was significantly affected with gender (ß = 0.294, 95% CI 28.3, 192.9, P = 0.009), and BMI (ß = 0.211, 95% CI 1.1, 27.9, P = 0.035) but negatively associated with physical activity (ß = -0.230, 95% CI -116.9, -9.7, P = 0.021).

Table 4.16: Association between intake by food group with socioeconomic factors and CVD risk factors in the study subjects as assessed by multivariate linear regression**

Factors	Nuts and seeds		Fish and sea-food		Fruit & Vegetables		Fast food		Traditional Saudi food	
	ß	95% CI	ß	95% CI	ß	95% CI	ß	95% CI	ß	95% CI
Gender:										
Women	0.053	-4.8, 7.6	-0.114	-33, 11.9	0.080	-47, 98.5	-0.107	-174, 60	**0.294**	**28, 192**
Men	0.044	-2.3, 4.4	-0.121	-1.1, 10.1	0.020	-34, 66.1	-0.110	-112, 25	**0.193**	**1.1, 70.3**
Age (years)	0.041	-0.37, 0.4	0.108	-0.9, 2.1	**0.487**	**4.0, 14.2**	**-0.468**	**-22, -6.4**	**0.279**	**1.9, 10.4**
Education:										
High	-0.077	-6.3, 3.9	0.003	-18, 18.8	**0.220**	**-17, 102**	-0.007	-98, 94.6	**-0.294**	**-111, -23**
Low	0.023	0.12, 2	0.001	-11, 12.1	**-0.192**	**-7.7, -0.1**	0.011	1.1, 12	**0.199**	**2.1, 6.7**
Monthly income:										
High	-0.099	-3.9, 1.9	**0.241**	**1.7, 16.5**	-0.171	-56, 12.3	-0.007	-56.9, 59	-0.097	-53.6, 24
Low	0.345	0.11, 32	**-0.211**	**-27.9, 1.1**	0.035	-102,135	0.117	1.2,134	-0.111	-43.1, 23
BMI (kg/m^2)	-0.096	-1.5, 0.66	-0.144	-6.3, 1.4	0.018	-11,13.6	**0.214**	**1.8, 39.8**	**0.211**	**1.1, 27.9**
History of diabetes*	-0.083	-12.1, 5.7	0.015	-30, 34.6	0.009	100, 109	0.060	-120,217	-0.117	-184, 51
History of hypertension *	0.198	-1.1, 12.7	0.040	-20.7, 29	-0.037	-94.9, 67	0.028	113, 142	-0.042	-110,73
History of hypercholesterolemia*	0.024	-9.3, 11.1	0.159	-15, 58.6	0.035	-102,135	-0.013	-201,182	0.0107	-75, 193
Family history*	-0.033	-4.3, 3.1	-0.143	-22.7, 4.4	0.054	32, 55.5	-0.011	-74, 66.8	0.048	-37, 61.8
Smoking status:										
Current smoker	-0.043	-6.5, 4.4	-0.014	-21, 18.7	0.179	-9.2, 119	-0.058	-134, 73	0.078	-44, 101
Non smoker	0.036	-6.1,8.2	0.060	-7.7,13	-0.193	-14,135	-0.039	-144,204	-0.144	-167,38
Physical activity:										
Active	0.030	-3.9, 5	-0.099	-23.1, 9.4	0.104	-28, 76.6	**-0.212**	**-158,-6.13**	**-0.230**	**-116,-9.7**
Inactive	-0.199	-9.3,1.2	0.164	-2,12.8	-0.041	-62.6,44	**0.199**	**23, 149**	-0.037	-85.6,62

ß and 95% CI are significant at $P < 0.05$, indicated in bold font. *Yes *vs.* No
**All the socioeconomic and CVD risk factors were run in one multivariate model.

4.5 Discussion

The change in dietary habits, lifestyle and life expectancy in Saudi Arabia has led to a remarkable change in disease trends in the country especially for CVD (Kumosani *et al*., 2011). The present study was undertaken to examine the current dietary intake and to examine the relationship between diet, socioeconomic status and CVD risk among men and women in the coastal city of Jeddah, in Saudi Arabia. The results from this study demonstrate that potential CVD risk factors were present in a considerable proportion of the study subjects such as obesity, low physical activity, smoking, and hypertension and consumption of a high-fat diet. More than one third of the subjects were either overweight or mildly obese (42%). In addition, physical inactivity was very common among females (78%), and was still present in about half of the men investigated. This is most likely as a result of the wide spread use of housemaids or limited availability of exercising facilities for girls and women in Saudi Arabia (El Hazmi & Warsy, 1997). In mach earlier study in Dammam, Saudi Arabia, the prevalence of obesity was 31.1% among females and 16.1% among males (Binhemd *et al*., 1991), which confirms the suggestion that overweight and obesity rates have increased significantly in recent years. According to Binhemd *et al.* (1991) the high proportion of obesity was also attributable to some socio-cultural factors in Saudi communities. For example, physical inactivity in their study was common especially in females at a similar rate compared with this study and the consumption of local cultural foods high in energy, saturated fat and cholesterol was also observed (Binhemd *et al*., 1991). One of the main risk factors for CVD is smoking which was very prevalent in 60% of men (cigarette and / or shisha) in the current study. Other studies have high prevalence although not as high as in this group, for example, 40% of men and 8.2% of women in a study by Saeed *et al.* (1996); in the study by Al Nuaim (1997b) the prevalence of smoking was 21% of men *vs.* 1% of women; 19.2% of men *vs.* 8.4% of women in the study reported by Abalkhail *et al.* (1998) and in the study by Al Nozha *et al.* (2009) with 22.7% of men *vs.* 10% of women.

Few studies have focused on measuring dietary intake of Saudi adults using three day food records. In the present study, the daily energy intake observed was 1959 kcal/day for males and 2051 kcal/day for females. The figure for men was lower than the UK EAR for 19-59 year-olds of 2550 kcal/day, while in women intakes were in line with the UK EAR of 1940 kcal/day (Department of Health, 1991). A study by Alissa *et al.* (2005a) also reported that the energy intake of 303 Saudi male subjects aged between 15-80 years was 1848 kcal/day, whereas a much lower energy intake of 1606 kcal/day has been reported in

Saudi subjects (Abahusain *et al*., 1999). The data in the present study suggests good compliance with diet according in women and slight under-reporting in some men as shown in Table 4.8 giving confidence in the data obtained. The major source of daily energy intake for participants in the current study was carbohydrates (50.4%), followed by fat (35.8%) and protein (16.5%). This contribution to energy intake from macronutrients contrary to general guidelines for food consumption; for carbohydrate (between 55% and 75%), fat (between 15% and 30%) and protein (between 10% and 15%) (WHO, 2003), but there are in line with many westernised diet. The results of this study showed that the mean daily energy intake of SFA (12.4%), MUFA (12.4%) and PUFA (6.9%) are within the UK recommendation of the Department of Health (1991). Energy intake from total fat (35.8%) in this study was similar to that described previously for Saudi population, with 38% by Alissa *et al.* (2005a), 38.6% by Alissa *et al.* (2005b); 38.3% by Alissa *et al.* (2006b) which is above the recommendation suggested by the WHO (2003). According to the Food and Agriculture Organization (FAOSTAT) food availability data and food consumption survey, daily protein and fat consumption per capita has risen over the last 3 decades in Saudi Arabia. It is estimated that dietary of protein intakes have increased overall during this time from 49 to 85 g/day, and for dietary fat from 33 to 81 g/day. Interestingly, the study conducted by Al Assaf and Al Numair (2007) observed higher daily intakes of carbohydrate, fat, protein, SFA and USFA among male subjects compared with the current study. However, it is important to note that the study by Al Assaf and Al Numair (2007) analyzed the dietary intake of subjects using a 24-hour recall method, which is more prone to error than a prospective food record. Moreover, their study was conducted in Riyadh, Saudi Arabia, where some of the traditional dishes typical for the western region of Jeddah are not usually consumed (people living close to the coastal area might have been consuming more fish and fish dishes such as Saiyadiah).

Few studies have investigated the dietary intake of omega 3 fatty acids in Saudi Arabia. To the knowledge of the researcher, only one study of omega 3 fatty acids intake among elderly men (n = 120) living in coastal and internal regions in eastern regions of Saudi Arabia has been published (Al Numair *et al*., 2005). Mean intake of total omega 3 fatty acids in the elderly men in coastal region in the study was 2.18 g/day. However, the intake of ALA was about 10% low in elderly men in coastal region 0.90 g/day than intake of men in Jeddah city 1.01, 95% g/day. However, it is difficult to compare between the results of different studies due to the use of different diet-recording methodologies in addition to the different sample numbers and age groups. Burdge (2006) stated that long chain omega 3 fatty acids can be formed from ALA in the body; however, in humans this conversion is not efficient, suggesting intake from dietary sources is important. The mean daily intakes of ALA and LAwere lower than those recommended by the Institute of Medicines Food Nutrition Board, in their Dietary Reference Intake Report (2002) (ALA; 1.6 g/day for men and 1.1 g/day for women, LA; 17 g/day for men and 12 g/day for women 19 to 50 years of age). The average ratio of omega 3 to omega 6 fatty acids was 0.55. In the general population the recommendation for dietary intake of total long chain omega 3 fatty acids can be achieved by increased oily fish consumption to two occasions per week (Krauss *at al*., 2000). Several major organizations including the WHO (2003) and the UK Scientific Advisory Committee on Nutrition (2004) have all provided guidelines that address increasing consumption of fish. In total, of the study subjects 42% ate fish and sea-food at least on one day from the three days record. However, the present study was cross-sectional and it was difficult to approximate whether it was representative of a long term dietary pattern, which might contribute to a subject's habitual consumption of fish. Many studies have reported significant association between a high dietary intake of omega 3 fatty acids and reduced CVD risk factors such as a reduction of plasma triacylglycerol levels (Sacks & Katan, 2002), blood pressure (Geleijnse *et al.*, 2002), and platelet aggregation (Hornstra, 2001), so increased awareness and approaches to increase oily fish consumption are important.

The results of the present study add to the current evidence suggesting that dietary food intake may have a significant impact on CVD risk factors and is affected by socioeconomic status, as assessed by education, income and age for male and female adult Saudis. Higher education and higher total family monthly income were negatively associated with daily intake of energy (r = - 0.219, P = 0.028 and r = - 0.279, P = 0.005, respectively). This suggests that lower income leads to consumption of high energy dense foods. Since three quarters of participants (89%) ate outside their home, there is an indication that fast food consumption is contributing to this trend. In this study, 79% of the participants ate fast foods on at least on one day from the three days record. In this study observed a negative relationship between total fat intake and higher monthly income (r = - 0.206, P = 0.039), as well as between SFA intake and education (r = - 0.207, P = 0.039). Data from other surveys in the UK concur with this finding; participants with higher education were more likely to consume a healthy diet higher in fibre, oily fish, fruits and vegetables (Hamer & Mishara, 2010). The findings of the food groups' intake showed inverse associations between fast food intake and age. On the other hand, there were positive associations between consumption of traditional foods and age. This can be explained by the fact younger Saudi subjects followed the unhealthy fast food pattern but older Saudi subjects followed the more traditional foods pattern. Similar results have been observed in other studies (Esmaillzadeh and Azadbakht, 2008; Rezazadeh *et al*., 2010). In relation to lifestyle factors, there were statistically significantly inverse associations between physical activity and fast food consumption and with traditional Saudi food; younger people who ate more fast food were less physically active, and older people who ate traditional Saudi food were less active. Furthermore, subjects were either overweight or mildly obese (42%) had a higher adherence to the fast food and with traditional Saudi food.

4.6 Summary and Conclusions

The aims of this part of the study were achieved:

- Complete information was available for 100 participants 50 men (50%) and 50 women (50%). The mean (SD) ages of women and men were 32.4 (7.4) and 30.9 (9.6) years, respectively.
- The majority of men and women reported as medium socioeconomic status, with 62% of women and 64% of men.
- There were no significant differences between men and women in BMI classification, presence of diabetes, high blood cholesterol, or personal history of cardiovascular disease ($P > 0.05$). However, significantly more women reported high blood pressure compared with men ($P < 0.05$).
- Physical activity was low and men were more active than women ($P < 0.05$).
- Smoking was more prevalent in men (60%) than women (8%).
- The results show marked differences in diet composition between men and women which may affect CVD risk. Also, there were interactions observed between diet intake and risk of CVD and socioeconomic background.
- On average, participants consumed 2005 calories per day with 50% of energy from carbohydrate, 16% from protein and 36% from fat.
- Women had significantly higher dietary intakes than men with respect to energy, SFA, PUFA and fibre ($P < 0.05$).
- The mean daily intake of total omega 3 fatty acids was 1.30 g/day, mainly in the form of ALA (1.01 g/day), with 0.27 g/day in the form of EPA and DHA. No differences were observed between gender in intake of total omega 3 fatty acids

and *trans* fatty acids. However, there was a statistically significant difference in the mean total daily intake of omega 6, which was higher in men than women.

- Higher education and higher total family monthly income were negatively associated with daily intake of energy ($P < 0.05$).
- There was a statistically significantly negative association between total fat intake and higher monthly income ($r = -0.206$, $P = 0.039$), as well as between SFA intake and education ($r = -0.207$, $P = 0.039$).
- In considering consumption of food groups, women consumed a diet that was relatively high in fruit and vegetables and traditional Saudi food compared with men.
- There was a statistically significantly positively association between BMI and intake of fast food and with intake of traditional Saudi food.

Chapter 5

Study 2: Dietary Patterns and Risk of Heart Disease in Male and Female living in internal City (Makkah)

5.1 Introduction

The holy city of Makkah is one of the three largest cities of Saudi Arabia with a population of 1.9 million (Ministry of Culture and Information in Saudi Arabia, 2008). Makkah is a city in the western region located more than 80 km inland from Jeddah. It is considered the holiest city in Islam visited by more than four million pilgrims from all parts of the world to perform Hajj and Umrah. This means that Makkah has a population mix of several different ethnicities and nationalities. This mixture of races has had a major impact on Makkah traditional food (Ministry of Culture and Information in Saudi Arabia, 2008).

The Ministry of Health reported that in 2003 the city of Makkah had the highest number of deaths due to CVD in the country, with 1137 deaths in total number of 6410. The number of deaths in males was higher (647) than that in females (490). The highest percentages of death were focused in the age group 55-64 years (22.3%), 65-70 years (27%) and ≥ 75 years (26%) (Health Statistical Yearbook, 2003).

5.2 Study aims and objectives

5.2.1 Aims

- To measure and describe the dietary patterns of representative samples of the Saudi population living in an inland city in Saudi Arabia.
- To investigate the relationships between dietary food intake and coronary risk factors in the city of Makkah, in the western region of Saudi Arabia in both men and women without overt CVD.
- To determine differences in total dietary intake as attested by age, gender and socioeconomic background.
- To explore the relationships between the dietary intake of total fat, omega 3 fatty acids and other fatty acids in Makkah in the western inland city of Saudi Arabia as indicators of the risk of CVD.

5.2.2. Objectives

- To conduct a study to measure dietary intake in university employees working in the western Saudi Arabian inland city of Makkah.
- To undertake a measure of dietary intake and anthropometric indices of Saudi adults and ask each of these adults to complete a three day estimated dietary food record in order to provide detailed dietary information.
- To use a survey questionnaire in order to collect their personal information, and data relating to medical, social and dietary habits.
- To determine daily intake of: energy, protein, fat, SFA, MUFA, PUFA, carbohydrate, fibre, cholesterol, calcium, iron, magnesium, sodium, potassium, zinc, vitamin C, vitamin E, vitamin A and selenium.
- To estimate the daily intake of the following fatty acids: LA, ALA, total *trans* fatty acids, AA, EPA and DHA.
- To compare and report any significant differences between the intakes of males and females and with the UK RNI.
- To determine the subjects' socioeconomic characteristics.
- To test the association between food intake and CVD risk factors and the socioeconomic characteristics of the population in this study.
- To compare consumption of food groups (nuts and seeds, fish, fruit and vegetable, fast food and traditional Saudi food) among men and women in this study.
- To test the association between intake by food group and CVD risk factors and the socioeconomic characteristics of the population sampling in this study.

5.3 Methods

5.3.1 Study subjects

Participants were recruited in Umm Al Qura University in the City of Makkah Almukarramah, in the western region of Saudi Arabia, using both men and women without overt CVD within an age range of 18-65 years. This study was approved by the Ethical Committee of Newcastle University. An information letter including the aims and the methods of the study were explained. The possibility of leaving the study at any time was also assured. All the participants were asked to sign the consent form to participate in the study. The full study design is described in section 3.1 to 3.3.

5.3.2 Demographic and anthropometric information

Every individual in the study was subjected to:

- A structured questionnaire which included: general information (age, family income per month, education level, marital status, present and family medical history, smoking history, physical activity and dietary habits). The final section of the questionnaire was a food record. The questionnaire designs were described previously in the methods section 3.4.
- Anthropometric measurements were undertaken by two specially trained nurses: height (m) and weight (kg) from which BMI, (kg/m^2) was calculated; WC (cm), HC (cm), WHR (cm), and triceps skin-fold thickness (mm) from which percent body fat (%) was calculated (Section 3.5).
- Blood pressure was measured twice for each participant using an automatic sphygmomanometer (Omron automatic blood pressure monitor, Germany). The measurements were recorded to the closest 2 mmHg. The mean of the two measurements was used (Section 3.6).

5.3.3 Dietary assessment

The food consumed was recorded by volunteers on three consecutive days, two week days and one weekend day and nutrient intakes was compared with Recommended Dietary Intake levels. Food intake was converted to nutrient intake using the WinDiets program (Robert Gordon's University, Aberdeen, UK). The percentage of energy from protein, carbohydrates, total fat and SFA, MUFA and PUFA was calculated for each day. An average across the 3 days of the assessment was calculated. Data collection in this study occurred from July 2011 to September 2011(Section 3.7).

5.3.4 Statistical analysis

All the data were managed using SPSS Inc., version 19, Chicago, IL, USA for data entry and analysis. The statistical significance level was established at 5%. Before statistical analysis all data were examined for normality of distribution and residues. For comparisons of categorical variables between groups, such as between men and women, were performed by using Chi square test. Differences in the food intake between groups were carried out using in-dependent samples *t* tests. Correlation between the foods intakes, CVD risk factors, socioeconomic status in both groups were assessed using Pearson coefficients (r). Multiple regression analysis was used to assess for associations of dietary intake by food group with CVD risk factors and socioeconomic factors.

5.4 Results

5.4.1 Demographic and anthropometric data

The final sample consisted of 129 participants, 73 (57%) men and 56 (43%) women. The mean and (SD) of the anthropometric variables are presented in Table 5.1. The mean (SD) age of the women was 31.9 (8.56) years and for men it was 32.4 (7.4) years. Approximately 50% of participants were in the age range 18 -30 years, about 34% of the sample between 31- 40 years, 11% of participants were between 41- 50 years, whereas those aged between 50 - 65 years constituted only 5% of the sample. For all measurements there were increases in mean BMI, WC, WHR and body fat with age in both sexes up to 65 years. In-dependent samples *t* test revealed there were significant differences between men and women in height, weight, WHR, WC, HC, BMR and percentage of body fat ($P < 0.001$). Table 5.2 shows the mean (SD) of blood pressure of the study subjects by age and gender. The average systolic blood pressure was 122 (8.75) mmHg and the average diastolic pressure was 80.4 (5.74) mmHg for female subjects. Whereas, in male subjects the average systolic pressure was 122 (4.47) mmHg and the average diastolic pressure was 81.2 (3.88) mmHg. There were few cases of hypertension in the participants (11%) but the majority of participants 89% had blood pressure values in the normal range. Detailed demographics of the sample are presented according to gender in Table 5.3. The majority of the study population was married 53%, 45% were single and 2% widowed or divorced. Chi-square tests revealed there was no significant ($P > 0.05$) difference between education, monthly income and marital status of female participants and male participants.

5.4.2 Socioeconomic factor

The majority 73% of women were of the medium socioeconomic status, while of men it was only 32%. 20% of the women and 40% of the men were in the high socioeconomic status group. The low socioeconomic status was composed of 7% and 28% women and men, respectively. Chi-square tests revealed there was highly significant ($P < 0.001$) difference between men and women in socioeconomic factors

Table 5.1: Anthropometric characteristics of the study subjects (mean (SD))

Variables	Females (n = 56)					Males (n = 73)				
	18-30	31-40	41-50	51-65	All	18-30	31-40	41-50	51-65	All
Age (years)	26.03 (2.76)	33.6 (2.46)	45.6 (2.38)	55	31.9 (8.56)	26.7 (2.61)	35.1 (2.80)	45.1 (1.72)	54.2 (3.20)	33.21 (7.99)
n (%)	31 (55)	15 (27)	8 (14)	2 (4)		33 (45)	30 (41)	6 (8)	4 (6)	
Height (cm)	157 (6.71)	160 (6.10)	159 (4.31)	155	158 (6.2)	172 (3.9)	171 (4.05)	171 (4.7)	170 (9.52)	171 (4.35)
Weight (kg)	60.9 (7.73)	70.6 (10.30)	77.7 (7.20)	85.5	66.8 (11.4)	72 (4.92)	78.1 (7.23)	82.5 (13.30)	84.7 (5.12)	76.1 (7.86)
BMI (kg/m^2)	24.7 (2.07)	27.67 (3.14)	30.6 (2.99)	35.5	26.7 (3.94)	24.4 (1.09)	26.5 (2.48)	28.2 (3.01)	29.4 (2.57)	25.90 (2.49)
Estimated BMR (kcal /d)	1384 (81.8)	1446 (106)	1458 (69)	1481	1414 (97.4)	1513 (49.3)	1532 (70.76)	1525 (132)	1502 (68.4)	1521 (67.9)
WC (cm)	83.5 (8.99)	85.3 (11.72)	93.5 (3.74)	101	86 (10.03)	86.06 (7.14)	93.8 (6.48)	102 (7.20)	103 (9.74)	91.5 (8.96)
HC (cm)	97.9 (7.59)	101 (8.47)	102 (2.07)	114	99.8 (7.78)	90.2 (6.43)	91.8 (4.65)	93 (3.57)	96.2 (4.50)	91.4 (5.57)
WHR (cm)	0.85 (0.04)	0.84 (0.09)	0.91 (0.04)	0.88	0.86 (0.06)	0.95 (0.04)	1.02 (0.055)	1.02 (0.10)	1.07 (0.06)	1 (0.07)
Body fat (%)*	30.25 (2.76)	35.56 (3.94)	41.8 (3.68)	49.9	34.1 (6.26)	19.28 (1.73)	23.7 (3.10)	28.08 (3.73)	31.6 (3.43)	22.5 (4.39)
TSF (mm)	18.7 (2.31)	19.2 (1.50)	21.5 (0.89)	21.2	19.3 (2.26)	10.8 (1.81)	13.3 (2.17)	14.6 (2.09)	16.2 (2.75)	12.4 (2.57)
AC (cm)	29 (2.38)	30.6 (2.09)	33.5 (1.60)	32.5	30.2 (2.70)	26.5 (1.60)	28.4 (1.69)	29.1 (1.16)	31.2 (3.77)	27.7 (2.17)
AMC (cm)	23.2 (1.87)	24.6 (1.87)	26.7 (1.52)	25.8	24.1 (2.19)	23.1 (1.44)	24.2 (1.45)	24.5 (0.87)	26.1 (3.08)	23.8 (1.69)

SD: Standard Deviation. BMI: Body Mass Index. BMR: Basal Metabolic Rate calculated using Schofield *et al*. equations (1985). WC: Waist circumference. HC: Hip Circumference. WHR: Waist: Hip Ratio. TSF: Triceps Skin-fold. AC: Arm Circumference. AMC: Arm Muscle Circumference. * Calculated from TSF (Durnin & Womersley, 1974).

Table 5.2: Mean and Standard deviation (SD) of blood pressure of the study subjects by gender

	Females (*n* = 56)					Males (*n* = 73)				
	18-30 (31)	31-40 (15)	41-50 (8)	50-65 (2)	All	18-30 (33)	31-40 (30)	41-50 (6)	50-65 (4)	All
SBP (mmHg)	120 (1.62)	120 (4.18)	131 (20.17)	128	122 (8.75)	120 (2.29)	124 (4.61)	125 (5.16)	127 (8.88)	122 (4.47)
DBP (mmHg)	79.5 (2.87)	79.6 (5.86)	85.1 (11.16)	81	80.4 (5.74)	80 (1.73)	81.8 (4.09)	83.6 (8.23)	83.2 (4.03)	81.2 (3.88)

SBP, Systolic Blood Pressure (mmHg).
DBP, Diastolic Blood Pressure (mmHg).
Normal SBP < 140 and DBP < 90.

Table 5.3: Demographic characteristics of the study subjects by gender

Characteristics	Females (*n* = 56)		Males (*n* = 73)		χ^2	*P*
	No.	%	No.	%		
Education						
Illiterate	-	-	-	-		
Writing & Reading	-	-	-	-		
Primary	-	-	-	-	6.408	N.S
High School	10	18	28	38		
University or Above	46	82	45	62		
Monthly income (RS)*						
1 – 3000	20	36	22	30		
3001 - 6000	11	19	10	14		
6001 – 9000	13	23	10	14	6.874	N.S
9001 – 12000	6	11	17	23		
More than 12000	6	11	14	19		
Marital status						
Single	24	43	34	47		
Married	30	53	39	53	0.057	N.S
Widowed or Divorced	2	4	-	-		
Socioeconomic status						
Low	4	7	21	28		
Medium	41	73	23	32	22.880	< 0.001
High	11	20	29	40		

N.S: not significant.
*Riyal Saudi (currency 5.83 RS = 1£).

Table 5.4: Prevalence of cardiovascular risk factors according to gender

Risk factors	Females (n = 56)		Males (n = 73)		χ^2	*P*
	No.	%	No.	%		
BMI Classification						
Underweight	1	2	-	-	0.835	N.S
Normal	17	30	26	36		
Overweight	31	55	41	56		
Obese	7	13	6	8		
Diabetes*						
Normal	50	90	64	87	0.080	N.S
Diabetic	6	10	9	13		
High blood cholesterol*						
Normal	49	88	63	86	0.040	N.S
Hypercholesterolemia	7	12	10	14		
High blood pressure*						
Normal	50	89	65	89	0.002	N.S
Hypertension	6	11	8	11		
Heart disease*						
Normal	54	96	72	99	0.676	N.S
Heart disease	2	4	1	1		
Family history						
Diabetes	36	64	37	51	0.137	N.S
Heart diseases	8	14	10	14		
Smoking status						
Non-smoker	38	68	13	18	56.607	< 0.001
Ex-smoker	-	-	14	19		
Current (<20 cigarette)	3	5	20	27		
Current (>20 cigarette)	1	2	25	35		
Shisha	14	25	19	26		
Physical activity						
Inactive	52	93	46	63	21.563	< 0.001
Moderately active	3	5	21	29		
Active	1	2	6	8		

N.S: not significant.
* Self-reported

5.4.3 Comparison of cardiovascular risk factors between genders

Prevalence of cardiovascular risk factors among males and female is shown in Table 5.4. There were no gender differences in BMI category. However, the percentages of overweight and obese were high in both genders at 56%, and 8%, respectively of the men and 55%, and 13%, respectively of the women. 12% of participants reported that they had diabetes and 13% had hypercholesterolemia. Additionally, 2% of participants reported that they had been diagnosed with heart disease. 57% of the total participants reported having a family history of diabetes while, 14% reported a family history of heart diseases. No significant differences between men and women were seen in BMI classification, diabetes, high blood pressure (P > 0.05). Male participants were significantly more active than women (χ^2 = 21.563, P < 0.001) with 93% of women reporting no physical activity. Cigarettes were the most common type of tobacco smoked by subjects. Current smoking (cigarettes, shisha) was reported by 62% and 26%, respectively of males, while in female subjects only 7% smoked cigarettes and 25% smoked shisha. 25% of male subjects both smoked cigarettes and shisha. There were highly significantly differences between genders in smoking habits (χ^2 = 56.607, P < 0.001).

5.4.4 Dietary data

Table 5.5 shows dietary habits in both genders. The majority of the subjects ate three meals per day (66% of women and 82% of men). There were significant differences between men and women in number of meals they normally ate per day (χ^2 = 5.195, P < 0.05). The main meal of the day was lunch for 82% of females, and 85% of males. Most of the participants 91% female 96% male ate food outside their home at some time during the week.

Table 5.5: Prevalence of dietary habits according to gender

Eating patterns	Females (n = 56)		Males (n = 73)		χ^2	P
	No.	%	No.	%		
Meals (no./day):						
1 or 2	18	32	11	15	5.195	< 0.05
3 or 4	37	66	60	82		
More than 5	1	2	2	3		
Main meal:						
Breakfast	5	9	9	12	0.940	N.S
Lunch	46	82	62	85		
Dinner	13	23	25	34		
Eating breakfast:						
Daily	26	46	38	52	3.491	N.S
Sometimes	24	43	33	45		
Never	6	11	2	3		
Eating outside (per week):						
Never	5	9	3	4	1.912	N.S
Once or twice	30	54	36	49		
Three or four times	16	29	26	36		
More than four times	5	8	8	11		

N.S: not significant

A one-Sample Kolmogorov test showed that data for intake of energy, total fat, SFA, MUFA, PUFA, cholesterol, protein, carbohydrate, fibre, calcium, sodium, potassium, zinc, selenium, vitamin A and E were normally distributed. Data for these food components are presented as mean, (SD), and 95% CI in Table 5.6 and 5.7. The mean and (SD) for energy intake was 2295 (251) kcal/day in females and for males subject it was 2256 (208) kcal/day. On average across men and women, participants consumed 2273 kcal/day (9.5 MJ/day) with 55.4% of energy from carbohydrate, 15.2% of energy from protein and 32.9% of energy from fat. SFA contributed 14.4% of the total energy intake. Males had significantly higher dietary intakes than females with respect to SFA ($P < 0.05$). The dietary cholesterol intake was within the recommendation guidelines of < 300 mg/day. The mean for MUFA and PUFA intake levels were as follows: 21.1 (5.91) g/day, 9.1 (2.33) g/day and 22.8 (6.11) g/day, 7.1 (2.17) g/day for females and males respectively, with 8.8% of total energy from MUFA and 3.1% of total energy from PUFA for all study participants. Females had significantly higher PUFA intake than males ($P < 0.001$). Daily intake of iron for females was 15.2 (4.96) mg/day and 14.2 (4.31) mg/day for men. Mean calcium intake was 803 (183) mg/day, which was above the dietary recommended intake for both males and females of this age range. In contrast, mean intakes of fibre and selenium (8.9 (3.20) g/day and 43.1 (16.58) µg/day, respectively) were found to be below recommended intake (Department of Health, 1991). The mean sodium intake was 4.4 (1.23) g/day, which was above the recommendation suggested by the Department of Health of 1.6 g/day. The mean intake of vitamin A for males was 515 (208) µg/day, and therefore below the dietary recommended intake for males (700 µg/day), while in females intake was similar to the recommendation at 596 (241) µg/day. The mean vitamin E intake for all study subjects 4.5 (1.37) mg/day. In-dependent *t* tests revealed there were significantly differences between males and female in calcium intake ($P < 0.001$), zinc intake ($P < 0.05$) and vitamin A intakes ($P < 0.05$) (Table 5.7).

Data for vitamin C were not normally distributed, so were log transformed before analysis and geometric means presented. Mean vitamin C intake for males was 51.1 (95% CI 49.1, 68.6) mg/day, while in females it was 57.9 (95% CI 43.1, 60.8) mg/day. There were no statistically significant gender differences for daily intakes of vitamin C (Table 5.7).

The data show in Table 5.8 that the daily intake of total omega 3, ALA, EPA, total omega 6, LA were higher in females than in males. The mean daily intake of total omega 3 fatty acids for females was 0.41 g/day and it was 0.33 g/day for males, mainly in the form of ALA (0.41 g/day for females and 0.33 g/day for males), with 0.007 g/day for females and 0.005 g/day for males in the form of EPA and DHA. Total omega 3 fatty acids contributed 0.16% and 0.13% for females and males, respectively to daily energy intake. Females had significantly higher dietary intakes than males with respect to total omega 3, ALA and

EPA ($P < 0.05$). The daily intake of total omega 6 fatty acids for females was 3.4 g/day while the males it was 2.02 g/day, mainly in the form of LA (3.3 g/day for females and 2 g/day for males), with 0.02 and 0.02 g/day for females and males, respectively in the form of AA. Omega 6 fatty acids contributed 1.3% for females and 0.80% for males to total daily energy intake. There was a highly statistically significant difference in the mean total daily intake of omega 6 and LA fatty acid ($P < 0.001$) between males and female. The geometric mean for daily intake of *trans* fatty acid for females was 3.5 g/day and it was 4.2 g/day for males. *Trans* fatty acids contributed 1.4% for females and 1.7% for males to total daily energy intake. No differences were observed among males and females in *trans* fatty acids intake ($P = 0.068$).

Table 5.6: Mean, standard deviation (SD), median and 95% Confidence Intervals (CI) for daily energy intake and daily intake of macronutrients for subjects by gender

Nutrient	Overall			Females			Males			*P*
	Mean (SD)	Median	95% CI	Mean (SD)	Median	95% CI	Mean (SD)	Median	95% CI	
Energy (MJ/d)	9.5 (9.61)	9.4	9.3, 9.7	9.6 (1.07)	9.5	9.35, 9.93	9.4 (0.87)	9.3	9.2, 9.6	N.S
Energy (kcal/d)	2273 (228)	2233	2233, 2312	2295 (251)	2278	2227, 2361	2256 (208)	2213	2207, 2304	N.S
Total fat (g/d)	83.1 (14.94)	82.5	80.5, 85.7	81.1 (15.10)	79.9	77.1, 85.1	84.7 (14.72)	85.1	81.3, 88.1	N.S
% of daily energy	32.9			31.7			33.7			< 0.05
SFA (g/d)	36.3 (8.20)	36.5	34.8, 37.7	34.1 (7.68)	33.7	32, 36.1	38.1 (8.22)	37.8	36.1, 39.9	< 0.05
% of daily energy	14.4			13.3			15.1			< 0.001
MUFA (g/d)	22.1 (6.12)	22.7	21.1, 23.1	21.1 (5.91)	22.3	19.4, 22.6	22.8 (6.11)	23.6	21.4, 24.2	N.S
% of daily energy	8.8			8.3			9.2			< 0.05
PUFA (g/d)	7.9 (2.43)	8	7.5, 8.4	9.1 (2.33)	9.5	8.4, 9.7	7.1 (2.17)	6.5	6.6, 7.6	< 0.001
% of daily energy	3.1			3.6			2.8			< 0.001
Cholesterol (mg/d)	252 (80.03)	248	238, 266	245 (75.93)	237	225, 265	257 (83.21)	260	237, 276	N.S
Protein (g/d)	86.2 (16.79)	84.8	83.3, 89.1	87.5 (17.77)	85.9	82.7, 92.2	85.3 (16.06)	83.9	81.5, 89.1	N.S
% of daily energy	15.2			15.3			15.1			N.S
Carbohydrates (g/d)	315 (42.67)	315	307, 322	323 (42)	332	312, 334	308 (42.37)	301	298, 318	N.S
% of daily energy	55.4			56.3			54.6			N.S
Fibre (g/d)	8.9 (3.26)	8.3	8.3, 9.5	8.9 (2.62)	8.4	8.2, 9.6	8.9 (3.69)	8.2	8.1, 9.8	N.S

SFA indicates saturated fatty acids; MUFA, monounsaturated fatty acids; PUFA, polyunsaturated fatty acids.
$P < 0.05$, $P < 0.001$ variables were compared by *t* test.
N.S: not significant.

Table 5.7: Mean, standard deviation (SD), median and 95% Confidence Intervals (CI) for daily intake of micronutrients for subjects by gender

Nutrient	Overall			Females			Males			*P*
	Mean (SD)	Median	95% CI	Mean (SD)	Median	95% CI	Mean (SD)	Median	95% CI	
Calcium (mg/d)	803 (183)	792	771, 834	867 (178)	820	820, 915	753 (171)	732	713, 793	< 0.001
Iron (mg/d)	14.6 (4.61)	13.8	13.8, 15.4	15.2 (4.96)	14.6	13.4, 16.5	14.2 (4.31)	13.1	13.2, 15.2	N.S
Magnesium (mg/d)	264 (52.49)	254	255, 273	272 (54.31)	265	258, 287	257 (50.44)	247	245, 269	N.S
Sodium (g/d)	4.4 (1.23)	4.5	4.2, 4.6	4.2 (1.35)	4.03	3.8, 4.6	4.5 (1.11)	4.5	4.2, 4.8	N.S
Potassium (g/d)	3.1 (0.79)	3.01	2.9, 3.2	3.1 (0.75)	3.1	2.9, 3.3	3.03 (0.82)	2.8	2.8, 3.2	N.S
Selenium (µg/d)	43.1 (16.58)	41	40.2, 46.04	42.4 (14.42)	40	38.5, 46.2	43.7 (18.13)	43	39.4, 47.9	N.S
Zinc (mg/d)	9.9 (2.23)	9.8	9.5, 10.3	9.3 (2.9)	8.9	8.6, 9.9	10.3 (1.91)	10.3	9.9, 10.8	< 0.05
Vitamin A (µg/d)	550 (226)	527	511, 590	596 (241)	558	531, 660	515 (208)	505	467, 564	< 0.05
Vitamin C (mg/d)	54.1*	57	47.8, 60.9	57.9*	56.6	49.1, 68.5	51.1*	58.1	43.1, 60.8	N.S
Vitamin E (mg/d)	4.5 (1.37)	4.3	4.3, 4.8	4.6 (1.37)	4.3	4.2, 5.1	4.5 (1.37)	4.2	4.1, 4.8	N.S

*Geometric means.
$P < 0.05$, $P < 0.001$ variables were compared by *t* test.
N.S: not significant.

Table 5.8: Geometric mean, median and 95% Confidence Intervals (CI) for daily intake of fatty acids for subjects by gender

Nutrient	Overall			Females			Males			P
	Mean	Median	95% CI	Mean	Median	95% CI	Mean	Median	95% CI	
Total n-3 PUFAs (g/d)	0.37	0.35	0.33, 0.41	0.41	0.38	0.35, 0.47	0.33	0.31	0.28, 0.38	< 0.05
% of daily energy	0.14			0.16			0.13			
ALA (g/d)	0.36	0.34	0.32, 0.4	0.41	0.37	0.35, 0.47	0.33	0.30	0.28, 0.37	< 0.05
EPA (g/d)	0.005	0.001	0.003, 0.007	0.005	0.005	0.004, 0.01	0.004	0.001	0.001, 0.007	< 0.05
DHA (g/d)	0.002	0.00	0.0004, 0.0034	0.002	0.00	0.001, 0.003	0.001	0.00	0.00, 0.004	N.S
Total n-6 PUFAs (g/d)	2.62	2.2	2.3, 2.9	3.4	3.1	2.9, 3.9	2.02	1.9	1.6, 2.3	< 0.001
% of daily energy	1.03			1.3			0.80			
LA (g/d)	2.6	2.1	2.2, 2.9	3.3	3.1	2.9, 3.8	2	1.9	1.6, 2.3	< 0.001
AA (g/d)	0.019	0.010	0.016, 0.023	0.02	0.02	0.01, 0.03	0.02	0.01	0.01, 0.02	N.S
Total n-6: total n-3 PUFAs	7.5	6.6	6.7, 8.3	8.6	8.02	7.6, 9.6	6.6	5.5	5.5, 7.8	< 0.001
Total n-3: total n-6 PUFAs	0.20	0.15	0.15, 0.25	0.14	0.12	0.12, 0.15	0.25	0.18	0.17, 0.33	< 0.001
trans fatty acid (g/d)	3.9	3.4	3.5, 4.2	3.5	3.2	2.9, 4.1	4.2	3.6	3.7, 4.7	N.S
% of daily energy	1.5			1.4			1.7			

n-3, omega 3; ALA, alpha-linolenic acid (18:3n-3); EPA, eicosapentaenoic acid (20:5 n-3); DHA, docosahexaenoic acid (22:6 n-3); n-6, omega 6; LA, Linoleic acid (18:2 n-6); AA, arachidonic acid (20:4 n-6).
$P < 0.05$, $P < 0.001$variables were compared by *t* tests.
N.S: not significant.

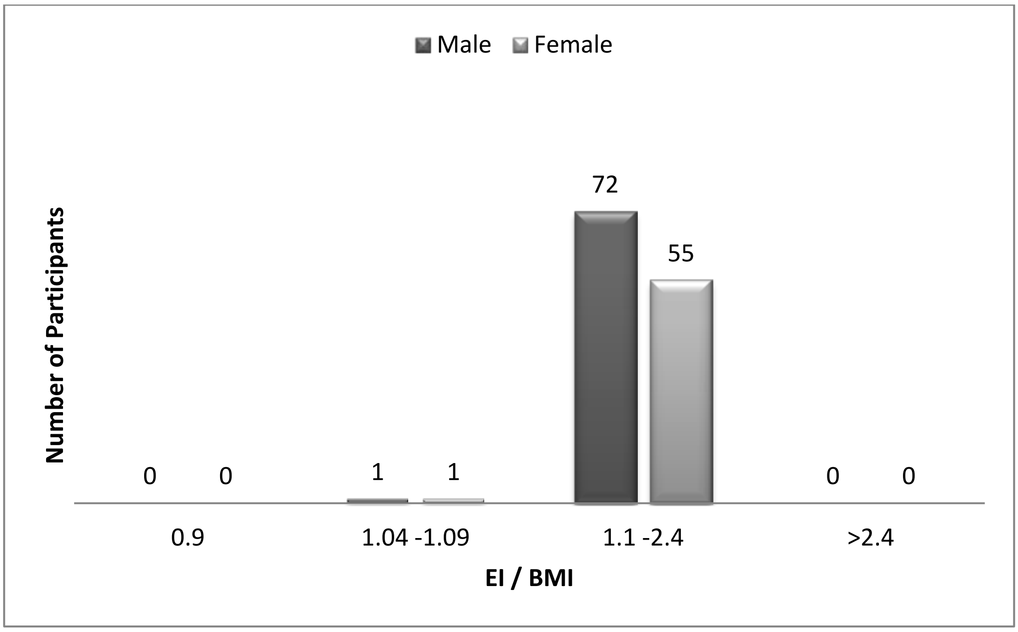
5.4.5 Validation of dietary data

Table 5.9 shows the mean reported EI of participants with the mean estimated BMR and calculated total EI: BMR of females and males together and separately. The mean estimated BMR for the males was 1521 kcal/day and it was 1414 kcal/day for the females. Females were more likely than males to report higher energy intake at age 18-30 and 51-65 years old. There was only one case of under-reporting in both males and females. The mean EI: BMR for males was 1.4 and it was 1.6 for females, suggesting that overall study subjects were identified as normal-reporters. Over-reporting was not evident in participants. Figure 5.1 shows the distribution of participants for the Ratio of Energy Intake (EI) to Basal Metabolic Rate (BMR).

Table 5.9: Mean energy intake (EI), estimated Basal Metabolic Rate (BMR) and EI: BMR of study subjects

	overall	Female					Male				
		18-30 (31)	31-40 (15)	41-50 (8)	51-65 (2)	All (56)	18-30 (33)	31-40 (30)	41-50 (6)	51-65 (4)	All (73)
Energy intake (kcal/d)	2273	2361	2241	2144	2269	2294	2247	2276	2250	2190	2256
BMR (kcal/d)	1474	1384	1446	1458	1481	1414	1513	1532	1525	1502	1521
EI:BMR	1.5	1.7	1.5	1.4	1.5	1.6	1.4	1.4	1.4	1.4	1.4

Figure 5.1: Distribution of Participants for the Ratio of Energy Intake (EI) to Basal Metabolic Rate (BMR)



5.4.6 Comparison with UK Dietary Reference Values for food energy and nutrients (DRV)

Table 5.10, 5.11 shows the percentage of subjects with macronutrient and micronutrient intakes above and below the DRV according to gender. Data indicate that nutrients intakes for some subjects were below or above the established UK RNI according to age and gender. For energy intake the majority of male subjects (88%) had intakes lower than the UK EAR. In contrast, the majority of female subjects (86%) had energy intake higher than the EAR. Figure 6.2 shows the energy intake and EAR of the study subjects by gender.

Nutrients that were consumed at levels above the RNI for all male and female subjects were total fat, SFA, MUFA, protein, carbohydrates and sodium. On the other hand, nutrients for which consumption did not meet the UK RNI for both female and male were fibre, potassium and selenium (by 84%, 70%, 78% and 77%, 75%, 95%, respectively of subjects). For calcium and zinc the majority of males (52% and 59%, respectively) had intakes higher than the RNI, while in females 78% calcium and 73% zinc had intakes higher than the RNI. Cholesterol intake was below the UK recommendation for 77% of males and 70% of females. Iron intake was above the UK RNI for 96% of male subjects, while for female subjects 50% exceeded the RNI but 43% consumed less than the UK RNI. Vitamin A intake was below the UK RNI for 73% of males and 54% of females. Mean vitamin C intakes were above the UK RNI for the majority of males and females subject with (55% and 62%, respectively), although 30% of both men and women failed to achieve the RNI for this vitamin. Figures 5.3, 5.4, 5.5 and 5.6 illustrated nutrient intake (fat, SFA, MUFA, and PUFA, protein, carbohydrates, fibre, cholesterol, calcium, magnesium, vitamin A, C selenium, iron, zinc, sodium and potassium) and RNI of the study subjects by gender:

Table 5.12 illustrates the percentage of subjects below, achieving or exceeding RNI and AI for fatty acids intakes according to gender. For all fatty acids examined no subjects met the RNI and AI for fatty acids intakes recommendations. Figures 5.7 shows the fatty acids intakes and RNI or AI of the study subjects by gender.

Table 5.10: Percentage of subjects below, achieving or exceeding EAR* for energy and RNI for macronutrient intake**

Nutrient	DRV		Male			Female		
	Males	Females	< DRV %	= DRV %	> DRV %	< DRV %	= DRV %	> DRV %
Energy (MJ/d)*	10.60	8.10 8.00***	88	4	8	7	7	86
Energy (kcal/d)*	2550	1940 1900***	85	7	8	5	4	91
% of daily energy from total fat**	35	35	-	-	100	-	-	100
% of daily energy from SFA**	11	11	-	-	100	-	-	100
% of daily energy from MUFA**	13	13	5	3	92	14	2	84
% of daily energy from PUFA**	6.5	6.5	26	16	58	11	7	82
Cholesterol (mg/d)**	< 300	< 300	77	8	15	70	9	21
Protein (g/d)**	55.5 53.3***	45 46.5***	-	-	100	-	-	100
% of daily energy from carbohydrates**	50	50	-	-	100	-	-	100
Fibre (g/d)**	12	12	77	4	20	84	7	9

SFA indicates saturated fatty acids; MUFA, monounsaturated fatty acids; PUFA, polyunsaturated fatty acids.
*Estimated Average Requirements for energy intake and % of subjects below, achieving or exceeding this value.
**Reference Nutrient intake 19-50 y, ***50+ y (Department of Health, 1991).

Table 5.11: Percentage of subjects below, achieving or exceeding RNI* for micronutrient intakes

Nutrient	RNI		Male			Female		
	Males	Females	< RNI %	= RNI %	> RNI %	< RNI %	= RNI %	> RNI %
Calcium (mg/d)*	700	700	36	12	52	11	11	78
Iron (mg/d)*	8.7	14.8 8.7**	1	3	96	43	7	50
Magnesium (mg/d)*	300	270	75	9	16	52	9	39
Sodium (g/d)*	1.60	1.60	-	-	100	4	-	96
Potassium (g/d)*	3.50	3.50	75	3	22	70	7	23
Selenium (µg/d)*	75	60	95	1	4	78	13	9
Zinc (mg/d)*	9.5	7.0	34	7	59	6	21	73
Vitamin A (µg/d)*	700	600	73	11	16	54	9	37
Vitamin C (mg/d)*	40	40	29	16	55	29	9	62

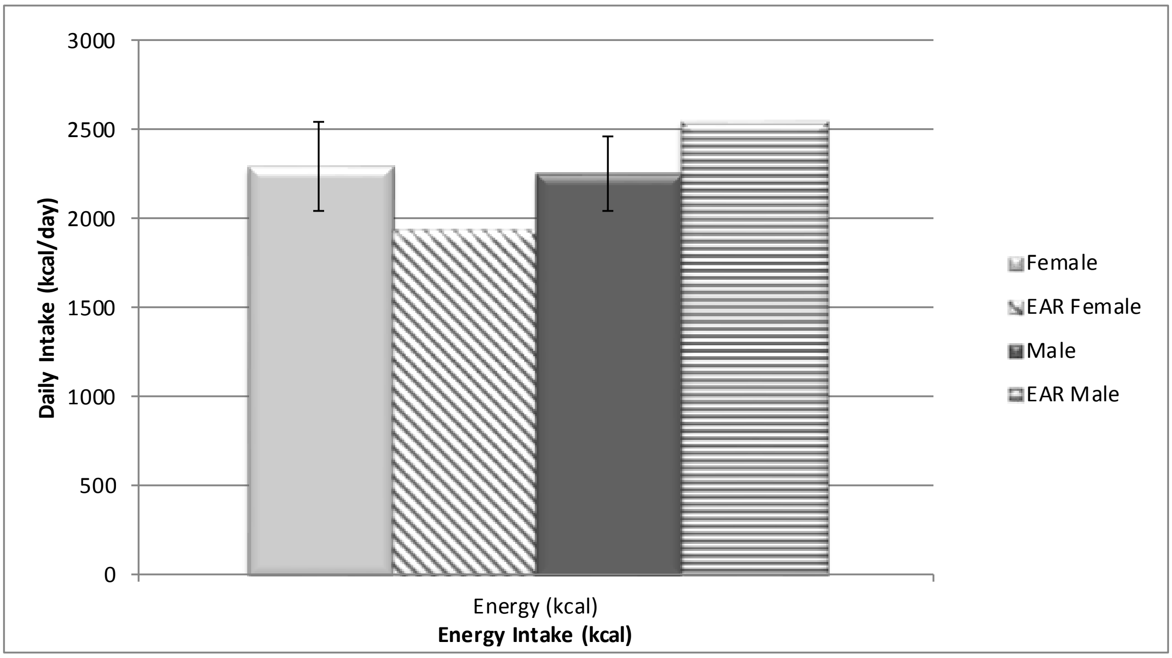
*Reference Nutrient intake 19-50 y, **50+ y (Department of Health, 1991).

Table 5.12: Percentage of subjects below, achieving or exceeding RNI*, adequate intake (AI) for fatty acids intakes

Nutrient	AI		Male			Female		
	Males	Females	< AI %	= AI %	> AI %	< AI %	= AI %	> AI %
% of daily energy from n-3 PUFAs*	0.2	0.2	77	12	11	70	23	7
ALA (g/d)**	1.6	1.1	100	-	-	98	2	-
EPA+DHA (g/d)*	0.45	0.45	100	-	-	100	-	-
% of daily energy from n-6 PUFAs*	1	1	65	30	5	38	30	32
LA (g/d)**	17	12	100	-	-	100	-	-
Total n-3: total n-6 PUFAs***	0.4	0.4	89	7	4	98	2	-
% of daily energy from *trans* – FA*	2	2	56	21	23	64	16	20

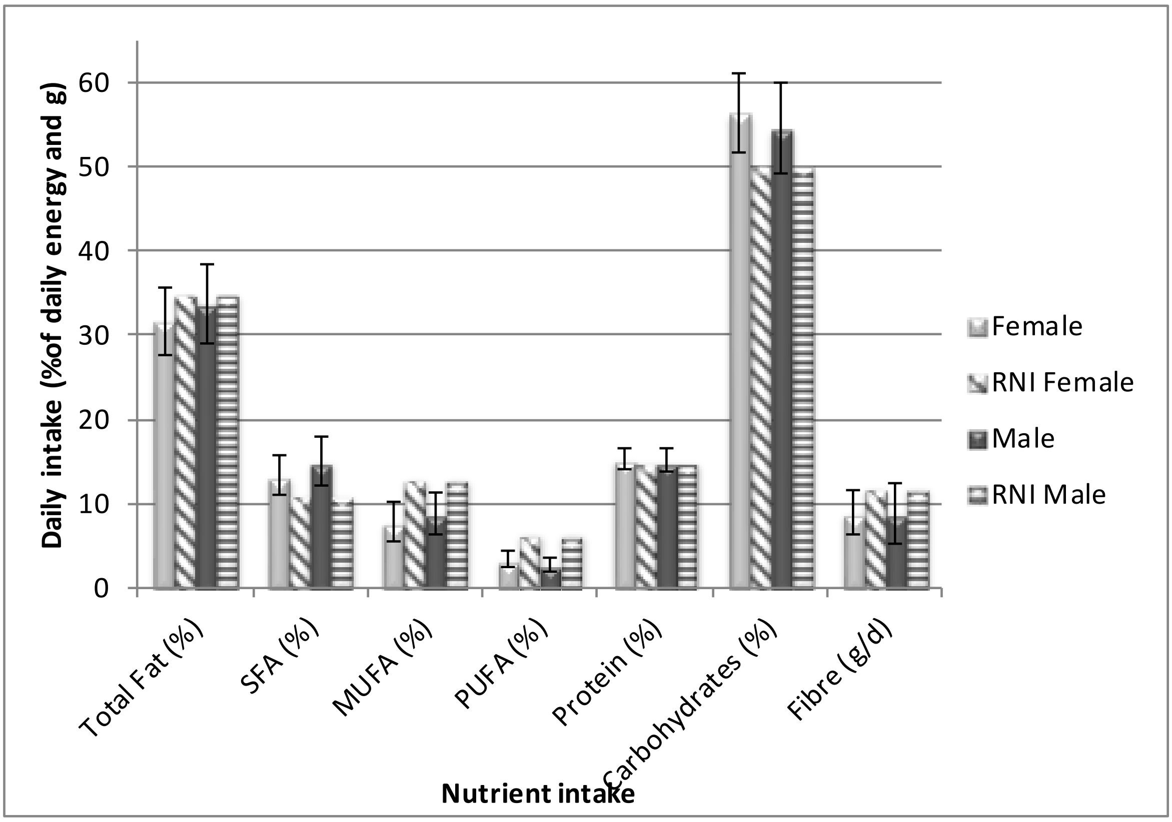
ALA, alpha-linolenic acid (18:3n-3); EPA, eicosapentaenoic acid (20:5 n-3); DHA, docosahexaenoic acid (22:6 n-3); LA, Linoleic acid (18:2 n-6); *trans*- FA, *trans* fatty acid.
*Reference Nutrient intake 19-50 y, (Department of Health, 1991).
** (Dietary Reference Intake, 2002)
*** (UK Scientific Advisory Committee on Nutrition, 2004).

Figure 5.2: Energy intake and EAR* of the study subjects by gender



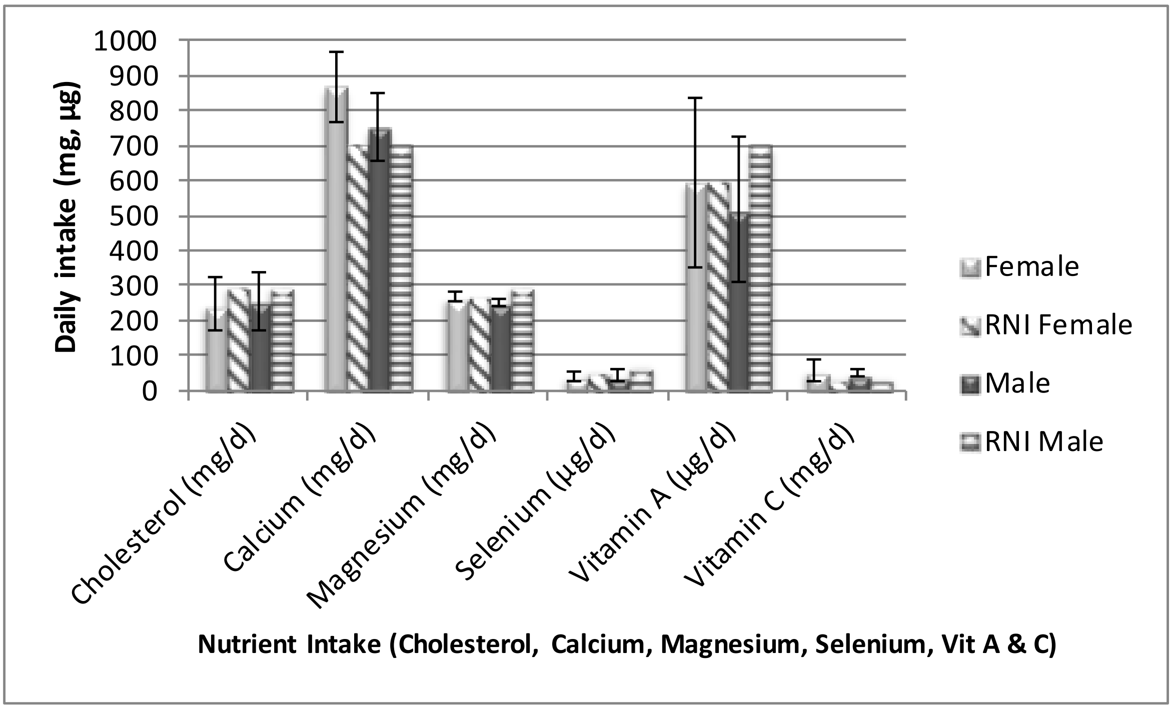
*Estimated Average Requirements for energy 19-50 y, (Department of Health, 1991).

Figure 5.3: Nutrient intake (fat, SFA, MUFA, PUFA, protein, carbohydrates and fibre) and RNI* of the study subjects by gender



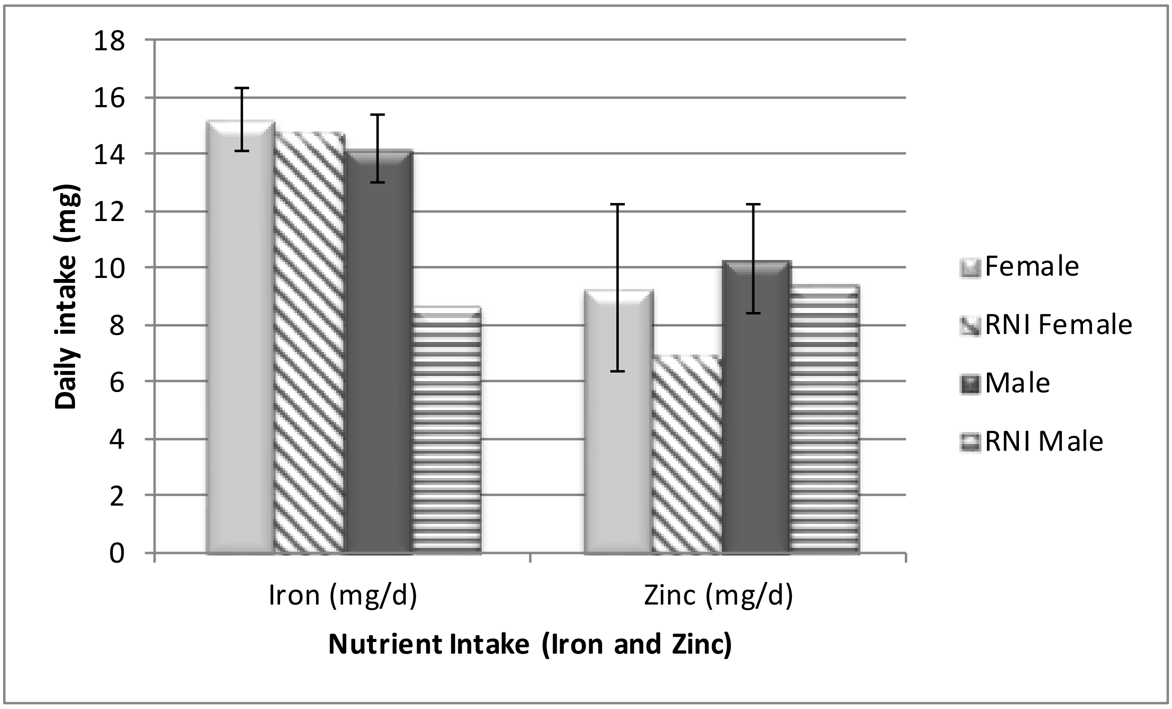
*Reference Nutrient Intake 19-50 y, (Department of Health, 1991).

Figure 5.4: Nutrient intake (cholesterol, calcium, magnesium, selenium, vitamin A and C) and RNI* of the study subjects by gender



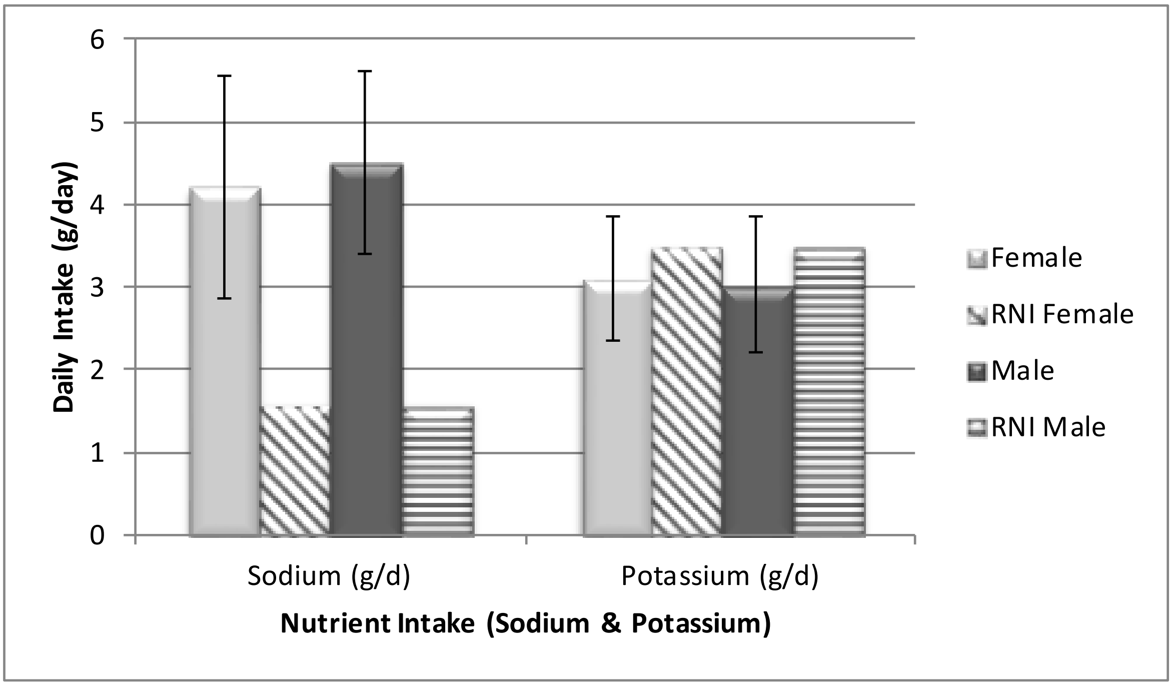
*Reference Nutrient Intake 19-50 y, (Department of Health, 1991).

Figure 5.5: Iron and Zinc and RNI* of the study subjects by gender



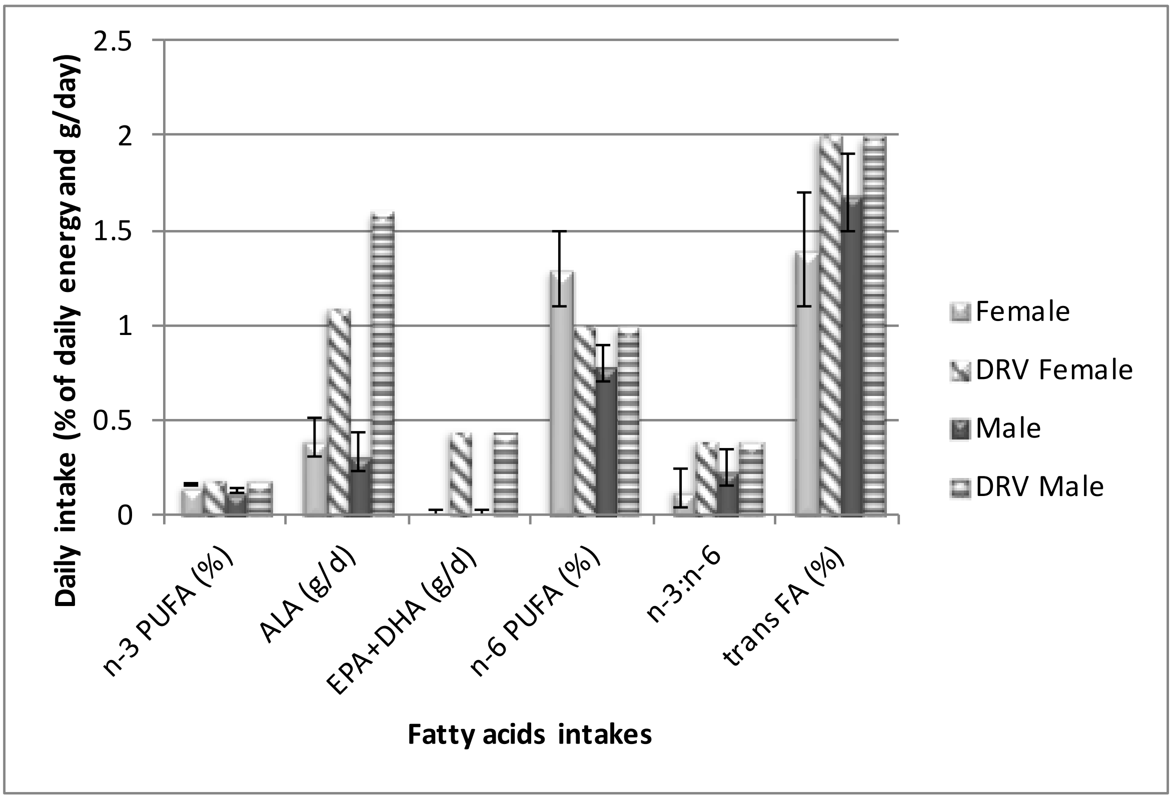
*Reference Nutrient Intake 19-50 y, (Department of Health, 1991).

Figure 5.6: Sodium and Potassium and RNI* of the study subjects by gender



*Reference Nutrient Intake 19-50 y, (Department of Health, 1991).

Figure 5.7: Fatty acids intakes and RNI*, adequate intake (AI) of the study subjects by gender**



*Reference Nutrient intake 19-50 y, (Department of Health, 1991).
** (Dietary Reference Intake, 2002), (UK Scientific Advisory Committee on Nutrition, 2004)

5.4.7 Relationship between nutrient intake and other factors

The correlation coefficients between indices of nutrients intakes with socioeconomic factors and CVD risk factors in the study subjects are provided in Table 5.13, 5.14 and 5.15.

5.4.7.1 Relationship between nutrient intake and socioeconomic status

Among study subjects, there were only two nutrients which were statistically significant associated with education and monthly income. Dietary fibre intakes were positively correlated with education and monthly income (r = 0.221, P = 0.022 and r = 0.201, P = 0.012, respectively). There was also a significant positive associations between vitamin E intakes with education (r = 0.199, P = 0.024).

5.4.7.2 Relationship between nutrient intake and CVD risk factors

There were weak positive associations between energy intake as MJ and kcal and history of hypercholesterolemia (P = 0.044, P = 0.040, respectively). Carbohydrates intakes showed no association with CVD risk factors. Dietary intakes of fibre were positively correlated with age ($P < 0.001$), and smoking status ($P < 0.001$), but negatively correlated with BMI (P = 0.022) and history of hypertension (P = 0.005). There was a statistically significant positive association between total fat intake and age (P = 0.019) and a negative association with smoking status (P = 0.010). Dietary SFA intakes and PUFA intakes were significantly affected with gender ($P < 0.001$). In addition, there were statistically significant associations between dietary calcium intakes with gender ($P < 0.001$). Potassium intake was positively correlated with smoking status (P = 0.019). In all participants, there was a negatively association between sodium intakes and age but a positive association with BMI (P = 0.016 and P = 0.013, respectively). Magnesium intakes and selenium intakes were positively associated with age (P = 0.013, P = 0.018, respectively). There were no apparent associations between iron and vitamin A intake and CVD risk factors. Vitamin C was positively associated with smoking status (P = 0.014). Subject age had a significant positive association with vitamin C intake ($P < 0.001$) and a weak positive correlation with BMI (P = 0.047). There were negative significant associations between vitamin E intake and history of hypertension (r = - 0.221, P = 0.012). Total omega 3 fatty acid intakes was negatively associated with BMI (r = - 0.181, P = 0.040). *Trans* fatty acid intake was associated with gender and age (P = 0.018 and P = 0.001, respectively); but positively associated with BMI (P = 0.002), hypertension (P = 0.021) and smoking (P = 0.018).

Table 5.13: Correlation coefficients between energy intakes and intakes of macronutrients with socioeconomic factors and CVD risk factors in the study subjects

Factors	Energy (MJ)		Energy (kcal)		Protein (g)		Carbohydrates (g)		Fibre (g)		Total fat (g)		SFA (g)		MUFA (g)		PUFA (g)		Cholesterol (mg)	
	r	*P*	*r*	*P*	*r*	*P*	*r*	*P*	*r*	*P*	*r*	*P*	*r*	*P*	*r*	*P*	*r*	*P*	*r*	*P*
Gender	0.082	0.357	0.084	0.345	0.065	0.462	0.171	0.053	0.000	0.993	-0.121	0.173	**-0.242**	**0.006**	-0.141	0.111	**0.419**	**0.000**	-0.071	0.421
Age	-0.110	0.213	-0.117	0.189	0.066	0.456	-0.040	0.653	**0.361**	**0.000**	**0.207**	**0.019**	-0.145	0.102	-0.106	0.231	-0.022	0.804	0.079	0.372
Education	-0.013	0.882	-0.011	0.903	-0.027	0.760	0.049	0.584	**0.201**	**0.022**	-0.071	0.424	-0.100	0.261	-0.003	0.801	0.099	0.264	-0.063	0.476
Monthly income	0.019	0.830	0.022	0.804	0.031	0.729	-0.030	0.732	**0.221**	**0.012**	0.042	0.635	0.098	0.268	-0.034	0.703	-0.080	0.370	0.029	0.747
BMI	-0.120	0.176	-0.127	0.153	-0.078	0.380	-0.042	0.637	**-0.201**	**0.022**	-0.146	0.099	-0.110	0.216	**-0.183**	**0.038**	0.057	0.522	0.003	0.973
History of diabetes	-0.028	0.754	-0.020	0.773	-0.098	0.270	-0.061	0.493	-0.126	0.156	0.097	0.276	0.069	0.439	**0.185**	**0.036**	-0.031	0.730	-0.070	0.432
History of hypertension	0.124	0.162	0.123	0.165	0.028	0.752	0.070	0.432	**-0.244**	**0.005**	0.136	0.123	0.108	0.223	0.076	0.389	0.114	0.196	-0.009	0.917
History of hypercholesterolemia	**0.178**	**0.044**	**0.181**	**0.040**	0.066	0.455	0.112	0.206	-0.087	0.329	0.142	0.108	0.028	0.749	**0.207**	**0.019**	0.022	0.802	-0.050	0.576
Family history	-0.093	0.295	-0.093	0.292	-0.011	0.402	-0.110	0.216	-0.086	0.330	0.048	0.587	0.046	0.605	0.054	0.546	-0.085	0.336	-0.103	0.243
Smoking status	0.024	0.791	0.024	0.784	0.075	0.401	0.172	0.051	**0.340**	**0.000**	**-0.225**	**0.010**	-0.133	0.132	-0.056	0.525	0.071	0.424	-0.131	0.140
Physical activity	-0.071	0.427	-0.068	0.447	-0.055	0.534	-0.082	0.357	0.114	0.197	0.008	0.926	0.058	0.515	0.121	0.173	-0.001	0.989	-0.002	0.981

SFA indicates saturated fatty acids; MUFA, monounsaturated fatty acids; PUFA, polyunsaturated fatty acids. Pearson's correlation coefficients were calculated for all study subjects. Statistical significant correlation coefficients are indicated in bold font.

Table 5.14: Correlation coefficients between intakes of micronutrients with socioeconomic factors and CVD risk factors in the study subjects

Factors	Calcium (mg)		Iron (mg)		Magnesium (mg)		Sodium (g)		Potassium (g)		Selenium (μg)		Zinc (mg)		Vitamin A (μg)		Vitamin C (mg)		Vitamin E (mg)	
	r	***P***	***r***	***P***	***r***	***P***	***r***	***P***	***r***	***P***	***r***	***P***	***r***	***P***	***r***	***P***	***r***	***P***	***r***	***P***
Gender	**0.312**	**0.000**	0.108	0.224	0.166	0.060	-0.119	0.178	0.075	0.401	-0.039	0.657	**-0.240**	**0.006**	0.158	0.073	0.074	0.404	0.054	0.544
Age	0.117	0.185	-0.019	0.830	**0.207**	**0.018**	**-0.212**	**0.016**	0.169	0.056	**0.219**	**0.013**	-0.044	0.621	0.119	0.181	**0.350**	**0.000**	0.021	0.815
Education	0.065	0.465	0.106	0.234	0.076	0.392	-0.121	0.171	0.058	0.515	0.113	0.202	-0.011	0.897	0.102	0.250	0.079	0.372	**0.199**	**0.024**
Monthly income	0.007	0.935	-0.008	0.928	0.089	0.315	-0.168	0.657	0.132	0.135	0.146	0.099	0.073	0.410	-0.012	0.895	0.143	0.105	0.144	0.104
BMI	0.024	0.789	-0.018	0.835	0.052	0.555	**0.219**	**0.013**	0.007	0.934	0.056	0.526	-0.098	0.269	0.017	0.852	**0.175**	**0.047**	0.056	0.532
History of diabetes	0.063	0.479	-0.152	0.085	-0.138	0.120	-0.009	0.918	-0.128	0.147	-0.141	0.110	-0.117	0.187	0.006	0.943	-0.130	0.143	0.143	0.106
History of hypertension	-0.005	0.956	0.055	0.538	-0.072	0.419	-0.041	0.647	-0.021	0.816	-0.016	0.861	0.124	0.166	-0.031	0.726	-0.040	0.651	**-0.221**	**0.012**
History of hypercholesterolemia	0.170	0.055	-0.044	0.583	-0.058	0.513	0.148	0.093	0.082	0.354	-0.146	0.099	0.014	0.879	0.017	0.852	-0.073	0.410	0.074	0.403
Family history	-0.008	0.441	-0.071	0.424	-0.144	0.103	-0.097	0.273	-0.099	0.263	0.013	0.885	-0.089	0.314	0.080	0.366	-0.092	0.299	-0.110	0.213
Smoking status	0.007	0.940	0.057	0.518	0.095	0.283	-0.062	0.487	**0.207**	**0.019**	0.135	0.127	-0.042	0.633	0.067	0.449	**0.216**	**0.014**	0.155	0.080
Physical activity	-0.018	0.839	-0.066	0.459	0.009	0.920	0.065	0.463	-0.012	0.890	-0.077	0.388	-0.038	0.667	0.139	0.115	0.033	0.709	0.002	0.986

Pearson's correlation coefficients were calculated for all study subjects. Statistical significant correlation coefficients are indicated in bold font.

Table 5.15: Correlation coefficients between intakes of fatty acids with socioeconomic factors and CVD risk factors in the study subjects

Factors	**Total n-3 PUFAs (g)**		**ALA (g)**		**EPA (g)**		**DHA (g)**		**Total n-6 PUFAs (g)**		**LA (g)**		**AA (g)**		***Trans* fatty acid (g)**	
	r	***P***	***r***	***P***	***r***	***P***	***r***	***P***	***r***	***P***	***r***	***P***	***r***	***P***	***r***	***P***
Gender	**0.189**	**0.032**	**0.220**	**0.012**	0.054	0.545	0.021	0.815	**0.387**	**0000**	**0.361**	**0.000**	**0.192**	**0.032**	**-0.207**	**0.018**
Age	0.076	0.391	0.065	0.401	-0.116	0.190	-0.091	0.305	-0.130	0.140	-0.046	0.607	-0.101	0.254	**-0.293**	**0.001**
Education	0.084	0.345	0.114	0.200	0.064	0.470	0.125	0.157	0.002	0.983	0.015	0.867	-0.078	0.378	-0.044	0.624
Monthly income	0.006	0.943	0.041	0.046	-0.009	0.921	0.013	0.883	**-0.181**	**0.040**	-0.117	0.188	-0.081	0.361	-0.047	0.595
BMI	**-0.181**	**0.040**	-0.150	0.091	-0.097	0.272	-0.077	0.386	0.001	0.989	0.059	0.507	-0.051	0.566	**0.273**	**0.002**
History of diabetes	-0.013	0.885	0.002	0.978	0.052	0.558	0.042	0.639	0.103	0.244	0.008	0.930	0.105	0.235	-0.041	0.647
History of hypertension	0.031	0.727	0.080	0.365	0.044	0.619	0.043	0.628	0.131	0.139	0.146	0.098	-0.024	0.784	**0.203**	**0.021**
History of hypercholesterolemia	-0.009	0.923	-0.046	0.605	0.011	0.905	0.019	0.833	0.132	0.136	0.017	0.898	0.049	0.585	0.021	0.813
Family history	-0.011	0.899	0.020	0.821	0.048	0.588	-0.096	0.281	-0.022	0.809	0.003	0.969	**0.210**	**0.017**	0.006	0.948
Smoking status	0.106	0.232	0.081	0.362	-0.070	0.433	-0.059	0.508	-0.039	0.658	-0.023	0.794	-0.038	0.667	**0.207**	**0.018**
Physical activity	-0.013	0.881	0.017	0.846	0.061	0.494	0.074	0.405	-0.043	0.929	-0.062	0.484	-0.059	0.510	-0.008	0.929

n-3, omega 3; ALA, alpha-linolenic acid (18:3n-3); EPA, eicosapentaenoic acid (20:5 n-3); DHA, docosahexaenoic acid (22:6 n-3); n-6, omega 6; LA, Linoleic acid (18:2 n-6); AA, arachidonic acid (20:4 n-6). Pearson's correlation coefficients were calculated for all study subjects. Statistical significant correlation coefficients are indicated in bold font.

5.4.8 Intake by food groups

Table 5.16 illustrates percentage, mean and 95% CI for food intake in different food groups of the study subjects by gender. The food group consumed by the highest percentage of study subjects was traditional Saudi foods (96%), followed by fast foods (95%), then fruit and vegetables with (88%) consuming these foods on at least one day from the three days of the assessment. On the other hand, food groups least consumed were nuts and seeds (2%) and fish groups (8%). The Mann-Whitney test did not show any significant differences between men and women ($P > 0.05$) in these data.

Table 5.16: Percentage, mean and 95% Confidence Intervals (CI) for intake by food group of the study subjects by gender

Dietary pattern	Overall			Females			Males			*P*
	n (%)	Mean (g/d)	95% CI	*n (%)*	Mean (g/d)	95% CI	*n (%)*	Mean (g/d)	95% CI	
Nuts and seeds	3 (2)	0.12	-0.02, 0.25	1 (2)	0.12	-0.11, 0.35	2 (3)	0.11	-0.04, 0.27	N.S
Fish and sea-food	10 (8)	3.2	0.85, 5.5	4 (7)	1.8	-0.1, 3.6	6 (8)	4.26	0.34, 8.1	N.S
Fruit & vegetables	114 (88)	152	131, 173	50 (89)	147	120, 174	64 (88)	156	124, 188	N.S
Fast food	122 (95)	597	536, 659	53 (95)	611	520, 702	69 (94)	586	501, 672	N.S
Traditional Saudi food	125 (96)	317	286, 348	55 (98)	338	294, 381	70 (95)	301	256, 346	N.S

N.S: not significant.

5.4.9 Relationship between intake by food group and other factors

Table 5.17 shows the association between intake by food groups with socioeconomic factors and CVD risk factors in the study subjects.

5.4.9.1 Relationship between food group intake and socioeconomic status

Among study subjects, the nuts and seeds consumption was negatively associated with education (ß = - 0.300, 95% CI -0.9, - 0.1, $P = 0.015$), whereas, it was positively associated with traditional Saudi food and education (ß = 0.266, 95% CI 13.1, 196.1, $P = 0.026$). With respect to monthly income there was a significant positively association with fruit and vegetables consumption ($P = 0.009$) but a negative association with fast food ($P = 0.005$).

5.4.9.2 Relationship between intake by food group and CVD risk factors

Multiple regression models were applied to examine the independent association of selected CVD risk factors with consumption of the five food groups identified in this study. In particular, the consumption of fish was positively associated with history of diabetes but it was negatively associated with history of hypercholesterolemia. Fruit and vegetables consumption was positively associated with age and smoking habits but negatively with BMI. Fast food consumption was also positively association with BMI ($P < 0.001$) and history of hypercholesterolemia ($P = 0.004$), but negatively associated with age ($P < 0.001$) and smoking habits ($P = 0.001$). Traditional Saudi food consumption was significantly positively associated with age (ß = 0.299, 95% CI 0.17, 12.8, $P = 0.044$), family history (ß = 0.213, 95% CI 7.8, 101.9, $P = 0.022$) and physical activity (ß = 0.194, 95% CI 1.4, 122.5, $P = 0.045$).

Table 5.17: Association between intake by food group with socioeconomic factors and CVD risk factors in the study subjects as assessed by multivariate linear regression**

Factors	Nuts and seeds		Fish and sea-food		Fruit & Vegetables		Fast food		Traditional Saudi food	
	ß	95% CI	ß	95% CI	ß	95% CI	ß	95% CI	ß	95% CI
Gender:										
Women	0.045	-0.2, 0.4	-0.113	-8.9,2.8	-0.070	-66, 32	0.037	-111,165	0.191	-6.9,144
Men	-0.033	-4.3, 3.1	-0.143	-22.7, 4	0.054	32, 55.5	-0.011	-74, 66	0.048	-37, 61
Age (years)	0.168	-0.1,0.1	0.134	-0.2,0.7	**0.537**	**3.7,11.9**	**-0.514**	**-33.6,10**	**0.299**	**0.17,12**
Education:										
High	**-0.300**	**-0.9,-0.1**	0.021	-6.4,7.6	0.117	-28.4,90	0.013	-152,176	**0.266**	**13, 196**
Low	-0.199	-9.3,1.2	0.164	-2,12.8	-0.041	-62.6,44	-0.129	-194,55	-0.037	-85.6,62
Monthly income:										
High	0.146	-0.1,0.2	0.030	-2.2,2.7	**0.218**	**3.1,38.7**	**-0.248**	**-100,-18**	0.137	-3.3,61
Low	0.107	-56,164	0.056	-0.2,0.3	-0.011	-74, 66	**0.232**	**87, 324**	0.066	-282,48
BMI (kg/m^2)	-0.092	-0.8,0.4	0.092	-0.62, 6	**-0.262**	**-16, 3.4**	**0.319**	**16.7,53**	-0.046	-15.6,10
History of diabetes*	0.087	-0.3,0.7	**0.259**	**0.7,19.7**	0.102	-43,116	-0.137	-366,83	-0.111	-234,11
History of hypertension*	0.097	-0.2,0.6	0.132	-2.3, 13	-0.008	-69, 63	0.032	-151,220	-0.043	-125,78
History of hypercholesterolemia*	0.061	-0.4,0.6	**-0.242**	**-17,-0.6**	0.029	61.8,81	**0.249**	**78, 414**	0.107	-56,164
Family history*	-0.145	-0.3,0.1	-0.013	-3.8,3.3	-0.069	-42,18.6	0.036	-67,104	**0.213**	**7.8,101**
Smoking status:										
Current smoker	0.056	-0.2,0.3	-0.093	-6.7,2.8	**0.174**	**0.27,64**	**-0.279**	**-244,-60**	0.117	-1.8,122
Non smoker	-0.083	-12, 5.7	0.015	-30, 34	0.009	100, 109	0.198	-1.1, 12	0.191	-6.9,144
Physical activity:										
Active	-0.066	-0.3,0.1	-0.087	-6.7,2.6	0.074	-23,54.9	-0.035	-132,88	**0.199**	**1.4, 122**
Inactive	0.024	-9.3, 11	0.159	-15, 58	0.035	-102,135	-0.013	-201,182	0.0107	-75, 193

ß and 95% CI are significant at $P < 0.05$, indicated in bold font. *Yes *vs.* No
**All the socioeconomic and CVD risk factors were run in one multivariate mode.

5.5 Discussion

The study sample was from Makkah which is the holy city in the Islamic world. In total, 129; 20-57 year olds of both genders (73 men and 56 women) were included in the study. In the present study the prevalence of overweight (55% for women and 56% for men) an obesity (13% for women and 8% for men) was very high and similar for men and women. These results, however, were close to data from a national survey in 2005 by Al Nozha *et al*. which encompassed 17,232 Saudi subjects aged 30-70 years old. The prevalence of obesity in this study for Saudi females at 44% was higher than men at 26.4%. Several studies have correlated this finding to the changes to sedentary lifestyle of Saudis, and to this eating behaviors, such as changing the quantity and quality of food to more refined carbohydrates and more high fat foods and also to increasing the frequency of meals (Bakhotmah, 2011; Midhet & Sharaf, 2011). Furthermore, girls' schools have no sports education and in public it is forbidden by social norms for women to practice physical activities. Lack of physical activity is a known cause of obesity and it was found in this study that 93% of women reported no physical activity in their daily life.

This study used a dietary food record to estimate food and nutrient intake because they can be considered more accurate and less expensive than other methods as discussed previously. However, few studies on measuring dietary intake of Saudi adults have used three day food records. The total energy intake of adults (men 2256 kcal/day and 2295 kcal/day for women) was lower for men and higher for women than the UK EAR for 19-59 year-olds (men = 2550 kcal/day, and women = 1940 kcal/day) (Department of Health, 1991). The total daily energy intake reported in this study was low compared with previously published estimates of average daily intake of energy (3068 kcal) per capita for the Saudi population between 2005-2009 (FAOSTAT, 2009). Abdel-Megeid *et al*. (2011) found that in a sample of 312 students attending King Saud University, Riyadh the mean energy intake was 2748 kcal /day for females and 3463 kcal /day for male students also much higher than reported here. In Al Madina city, Allam *et al*. (2012) used the 24-hour recall method and reported that the average daily consumption of energy for 194 male and female students was 2340 kcal /day and 2248 kcal /day, respectively. These results are marginally higher than the present study but it is important to highlight that different methodologies were used to collect dietary information in the two studies, with different age groups used which may have affected reporting levels. In the present study, the percentage of daily energy intake from total fat was 32% for women and 34% for men. When these results were compared with Abdel-Megeid *et al*., (2011) and Allam *et al*., (2012), it was found that they were higher than the daily energy intake of total fat for this study (46.8 % for females and 46% for males in the study by Abdel-Megeid *et al*. (2011); and 40% for female students and 40.4% for male students in the study by Allam *et al*. (2012)). The results also showed that the mean daily intake of SFA (14.4% of daily energy), MUFA (8.8% of daily energy) and PUFA (3.1% of daily energy) are below the UK recommendation of the Department of Health (1991) but not for SFA. Protein intake for men (85.3 (16.06) g/day) and for women (87.5 (17.77) g/day) was higher than UK RNI but was within the range of the daily intake of protein (85 g/day) per capita estimated from food availability data (FAOSTAT, 2009). The daily carbohydrate intake for men and women was higher than UK recommendation of the Department of Health (1991). The major sources of daily energy intake for participants in the current study were carbohydrates (55.4%), followed by fat (33%) and protein (15%). The mean daily intakes of fibre at 8.9 g /day for both men and women was much lower than those found in Abdel-Megeid *et al*. (2011) which reported intakes of 16 g/day for women and 18.9 for men.

According to the recommendation suggested by the Department of Health (1991), participants had a high sodium intake for sedentary people. The mean sodium intake was 4.4 (1.23) g/day, which was more than twice the current recommendation of 1.6 g/day. Likewise, Musaigar (2002) reported that people residing in the Arabia Gulf region consume more sodium than they actually need. High amounts of salt can be found in almost all the traditional Gulf dishes, fast foods and canned food. Recent studies indicated that there were correlation between an over intake of sodium with high blood pressure, strokes and contributes to heart attacks and heart failure (American Heart Association, 2006; Altun & Arici, 2006). Regarding to blood pressures classification in the study 11% for men and women have hypertension. The Ministry of Health reported that in 2003 the hypertension was the important common causes of death from CVD by 18% in the country, with 1151 deaths in total number of 6410 (Health Statistical Yearbook, 2003). Mean intake of iron was 14.2 mg/day for men and 15.2 mg/day for women in this study. This figure was lower than the figure reported for men in Abdel-Megeid *et al*. (2011) but similar to the value for women (16.2 mg/day for men and 15 mg/day for women). Both values are higher than reported by Allam *et al*. (2012) (12.7 mg/day for men and 9.1 mg/day for women). The mean daily intake of total selenium in the present study was approximately 43 (16.58) µg /day which was very similar to that reported in Alissa *et al*. study in (2006a) (47.4 µg /day) of 130 free control adult Saudis. A study by Al Othman *et al.* (2012) in Riyadh city how examined daily intake of selenium and concentrations in blood of residents of 260 adults. The study used 24-hour recall and FFQ and reported that the daily selenium intake was 90 µg /day which was twice as high as that in this study. In the Abdel-Megeid *et al*. (2011) study they found the zinc intake was 9.8 mg/day for female and for male it was 11.2 mg/day both of were which higher than this study. In the present study, the daily intakes of vitamin A, C and E were for men; 515 µg/day, 51.1 mg/day and 4.5 mg/day, respectively and for women were 596 µg/day, 57.9 mg/day and 4.6 mg/day, respectively. These results were all much lower compared with these reported by Abdel-Megeid *et al*. (2011) study, where comparable values for men students were 811 µg/day, 290 mg/day and 19 mg/day, respectively and for women students were 650 µg/day, 201 mg/day and 17 mg/day, respectively. The results from this survey in Makkah showed that participants might be at the risk of low intake of total omega 3 fatty acids and omega 6 fatty acids. The mean daily intake of total omega 3 fatty acids and omega 6 fatty acids for women were 0.41 g/day and 3.4 g/day, respectively and 0.33 g/day and 2.02 g/day, respectively for men. In contrast, the results of the study by Al Numair *et al*. (2011) showed that the average daily consumption of total omega 3 fatty acids (1.28 g/day) and omega 6 fatty acids (6.47 g/day) were much higher than this study. The dietary n-3: n-6 fatty acids ratio in Makkah participants was lower than the recommended level (0.4) by the UK Scientific Advisory Committee on Nutrition (2004).

The rapid economic growth of Saudi Arabia has led to significant lifestyle changes with effects on health, nutritional status and of disease patterns (Bani & Hashim, 1999). In the present data, it was observed that negative correlations were found between fibre intakes and BMI and hypertension. Similar findings were obtained by several research studies which indicated that there was a significant correlation between overweight and CVD risk associated with low dietary intake of fibre (Kabagambe *et al*., 2005; Kromhout *et al*., 2001; Mirmiran *et al*., 2009; Story *et al*., 2002). There was a positive correlation between *trans* fatty acid intake and BMI and hypertension, which supports the observation that a diet high in *trans* fatty acids might increase the risk of heart disease and hypertension (Beydoun *et al*., 2011; Heimburger, 2007). Saudi families have adapted to western food habits by replacing homemade meals with fast food or food ordered from restaurants. A study by Gillis and Bar-Or (2003) found that there was a positive relationship between obesity and numbers of meals eaten outside the home. The National Centre for Chronic Disease Prevention and Health Promotion Division of Nutrition and Physical Activity (NCCDP) (2006), also linked the frequency of eating fast food in restaurant to greater intake of both energy and fat, as well as increased BMI. The present results showed that all participants in both genders consumed fast food, and intake of these foods was positively associated with BMI and hypercholesterolemia. Younger subjects tended to follow the unhealthy fast food diet which was also associated with low monthly income (P = 0.005). On the other hand, higher fruit and vegetables consumption was associated with older subjects with higher income and low BMI. In the study by Gillis and Bar-Or (2003), it was reported that there were negative associations between servings of fruit and vegetables with body weight. These results suggest that participants with greater income provided a better food quality. In contrast, participants with low income level may depend more on quantities of lower quality cheap food such as fast food (Beydoun *et al*., 2008; Gillespie *et al*., 2011).

5.6 Summary and conclusions

The aims of this part of the study were achieved:

- Complete information was available for 129 participants 73 men (57%) and 56 women (43%). The mean (SD) ages of the women were 31.9 (8.56) years and men were 32.4 (7.4) years.
- The majority (73%) of women were of medium socioeconomic status, while more men (40%) were of high socioeconomic status.
- There were no significant differences between men and women in BMI classification, diabetes, high blood cholesterol ($P > 0.05$).
- Physical activity was low and men were more active than women ($P < 0.05$).
- Smoking was more prevalent in men (63%) than women (32%).
- The results show marked differences in diet composition between men and women which may affect CVD risk. Women had a significantly lower SFA intake but higher intakes of PUFA, vitamin A and total omega 3 fatty acids. Also, there were interactions observed between diet intake and risk of CVD and socioeconomic background.
- The mean daily intake of total omega 3 fatty acids was 0.41 g/day for females and 0.33 g/day for males. Differences were observed between gender in total omega 3 fatty acids and total omega 6 fatty acids.
- Higher education and higher total family monthly income were positive associated with daily intake of fibre ($P < 0.05$). *Trans* fatty acid intake was negatively associated with age ($P = 0.001$); but positively associated with BMI ($P = 0.002$), hypertension ($P = 0.021$) and smoking ($P = 0.018$).

- There were no differences in consumption of food in different food groups between women and men.
- There was a statistically significantly positive association between fast food intake and BMI and with history of hypercholesterolemia, whereas, there was a negative association with age and smoking habits.

Chapter 6

Study 3: Dietary Patterns and Risk of Heart Disease in Male and Female Saudi Arabians living in UK (Newcastle upon Tyne)

6.1 Introduction

In the UK, international students are distributed in all around the country for higher education and represent many different nationalities. International students represent different cultures and traditions around the world. Culture and religion may add more restrictions on the available foods for international students. For instance, for Arab student foods such as pork and typically all derivatives of pork are religiously restricted. According to the Ministry of Higher Education for Planning and Information (2011) report, the number of Saudi students enrolled in the UK institutions of higher education was 16,067; in academic year 2010/2011.

Moving to a new culture, the Saudis in the UK will experience a new, totally different, culture from their home culture that affects their overall lifestyle including their psychological, mental, nutritional health, and physical status. Saudi students are usually exposed to different dietary food habits and lifestyle changes when they first come to the UK. Consequently, they find it very difficult to maintain their usual conventional habits of eating because of their traditional foods are unavailable or they do have sufficient cooking and food preparation skills (Papadaki & Scott, 2002). However, their food and diet habits tend to be connected to the usual selections of traditional foods where they try to consume the foods which are available and those which they are familiar with (Gilbert & Khokhar, 2008). There has been insufficient or unavailable evaluation of Saudi students' diet to estimate the incorporation of nutrition guidelines into their current eating habits and behaviours effectively. Domestic students still have access to traditional cultural food and can maintain these preferences in their diet when they move away from home (Al Farhan. 2011). However, Saudi students do not have the same access to traditional cultural foods when they study abroad. For Saudi adults living in the UK, there is a gap in the evidence base on the nutritional status of Saudi population living outside their home country. Therefore, the nutrients intake and health of Saudi living in the UK was of particular interest in this work.

6.2 Study aims and objectives

6.2.1 Aims

- To measure and describe the dietary patterns of representative samples of the Saudi population living in Newcastle upon Tyne in UK.
- To investigate the relationships between dietary food intake and coronary risk factors in the Saudi population living in Newcastle upon Tyne within the UK in both men and women without overt CVD.
- To determine differences in total dietary intake as attested by age, gender and socioeconomic background.
- To explore the relationships between the dietary intake of total fat, omega 3 fatty acids and other fatty acids in Saudi population living in UK (Newcastle upon Tyne) as indicators of the risk of CVD.

6.2.2. Objectives

- To conduct a study to measure dietary intake in the Saudi population living in Newcastle upon Tyne, UK.
- To undertake a measure of dietary intake and anthropometric indices of Saudi adults and ask each of these adults to complete a three day estimated dietary food record in order to provide detailed dietary information.
- To interview each of these participants in order to clarify the information provided in their food diaries.
- To ask each of the participants to complete a survey questionnaire in order to collect their personal information, and data relating to medical, social and dietary habits.
- To determine the daily intake of: energy, protein, fat, SFA, MUFA, PUFA, carbohydrate, fibre, cholesterol, calcium, iron, magnesium, sodium, potassium, zinc, vitamin C, vitamin E, vitamin A and selenium.
- To estimate the daily intake of the following fatty acids: LA, ALA, total *trans* fatty acids, AA, EPA and DHA.
- To compare and report any significant differences between the intakes of males and females and with the UK RNI.
- To determine the subjects’ socioeconomic characteristics.
- To test the association between food intake and CVD risk factors and the socioeconomic characteristics of the population in this study.

- To compare consumption of food groups (nuts and seeds, fish, fruit and vegetable, fast food and traditional Saudi food) among men and women in this study.
- To test the association between intake by food group and CVD risk factors and the socioeconomic characteristics of the population sampled in this study.

6.3 Methods

6.3.1 Study subjects

The study consisted of Saudi population of Newcastle upon Tyne as representatives of those living in the UK and therefore outside of Saudi Arabia of both genders. Inclusion criteria included both postgraduate and undergraduate students who attend universities in Newcastle upon Tyne and /or their families, all aged within a range of 18-65 years. Participants who had been residing less than six months in the city were not collected in this study. This research was approved by the Ethical Committee of Newcastle University. Section 3.1 & 3.3 described

6.3.2 Demographic and anthropometric information

Demographic information was collected by questionnaire including age, family income per month, education level, marital status, residential status and period, present and family medical history, smoking history, physical activity and dietary habits. The final section of the questionnaire was a food record. Food intake was reported as average of the three consecutive days. The questionnaire was a self-administered, distributed to the study participants as hard copies by the researcher herself. The study participants filled and returned the questionnaire personally to the researcher. The questionnaire designs were described previously in the methods section 3.4. The following anthropometric information was measured: height (m) and weight (kg) from which BMI, (kg/m^2) was calculated, WC (cm), HC (cm), WHR (cm) and skin-fold thickness (mm) from which percent body fat (%) was calculated (Section 4.5). Blood pressure was measured twice for each participant using an automatic sphygmomanometer (Omron automatic blood pressure monitor, Germany). The procedure for blood pressure measurement was as described previously section 3.6.

6.3.3 Dietary assessment

The food consumed was recorded by volunteers on three consecutive days, two week days and one weekend day and nutrient intakes was compared with Recommended Dietary Intake levels. Food intake was converted to nutrient intake using the WinDiets program

(Robert Gordon's University, Aberdeen, UK). The percentage of energy from protein, carbohydrates, total fat and SFA, MUFA and PUFA was calculated for each day. An average across the three days of the assessment was calculated. Data collection in this study occurred from May 2012 to July 2012 (Section 3.7).

6.3.4 Statistical analysis

All the data were managed using SPSS Inc., version 19, Chicago, IL, USA for data entry and analysis completed as described in start with this section 3.9.

6.4 Results

6.4.1 Demographic and anthropometric data

79 subjects completed all aspects of the study. The mean and (SD) of the anthropometric variables are presented in Table 6.1. The mean (SD) ages of the women were 28.8 (4.96) years and men were 30.9 (6.27) years. Most of participants 62% were in the age range 18 - 30 years, about 34% of the sample in between 31- 40 years, 4% of participants were between 41 - 50 years, whereas no-one was aged between 50 - 65 years. The overall average BMI in males was higher than in females at 26.9 (5.26) kg/m^2 *vs.* 24.8 (3.42) kg/m^2. In-dependent samples *t* test showed that there were significant differences between men and women in height, weight, WHR, WC, BMR, body fat and TSF ($P < 0.001$).

Table 6.2 shows the mean (SD) blood pressure of the study subjects by age and gender. The average systolic pressure was 123 (8) mmHg and the average diastolic pressure was 81.1 (5.15) mmHg for female subjects. Whereas, in male subjects the average systolic pressure was 123 (6.02) mmHg and the average diastolic pressure was 82.6 (4.98) mmHg. There were only a few cases of hypertension in the participants (8%) and the majority of participants (92%) had normal blood pressure values.

6.4.2 Socioeconomic factor

Among the 79 Saudi people that participated in the study, 32 were males; 11 were single and 21 were married. Total female respondents were 47, 10 were single and 37 were married. Most of the respondents in the study were academically sponsored and had been residing in the UK for more than one year. Detailed demographics of the sample are presented according to gender in Table 6.3. Chi-square tests revealed there was significant ($P < 0.05$) difference between education and monthly income of female and male participants.

The majority of women (89%) were classified as of medium socioeconomic status, compared with 59% of men. Whereas 11% of the females were classified as of high socioeconomic status compared with 41% of the males. No-one was classified as of low socioeconomic status. Chi-square tests revealed there was a significant ($P < 0.05$) difference between males and females in socioeconomic factors.

Table 6.1: Anthropometric characteristics of the study subjects (mean (SD))

Variables	Females (*n* = 47)					Males (*n* = 32)				
	18-30	31-40	41-50	51-65	All	18-30	31-40	41-50	51-65	All
Age (years)	26.1 (2.91)	33.5 (2.06)	45	-	28.8 (4.96)	26.6 (3.54)	36.1 (4.42)	45	-	30.9 (6.27)
n (%)	31 (66)	15 (32)	1 (2)			18 (56)	12 (38)	2 (6)		
Height (cm)	157 (4.89)	160 (4.29)	156	-	158 (4.75)	172 (5.66)	174 (5.85)	175	-	173 (5.62)
Weight (kg)	57.8 (6.33)	70.6 (10.28)	72	-	62.2 (9.80)	80.2 (19.01)	81.46 (12.64)	80	-	80.5 (16.17)
BMI (kg/m^2)	23.3 (1.90)	27.6 (3.93)	29	-	24.8 (3.42)	27 (6.17)	27.02 (4.12)	26.3	-	26.9 (5.26)
Estimated BMR (kcal /d)	1355 (61.46)	1447 (96.4)	1400	-	1386 (84)	1593 (184.1)	1565 (127.55)	1508	-	1577 (159.4)
WC (cm)	79.6 (6.72)	87.3 (5.06)	95	-	82.4 (7.33)	92.5 (10.25)	93.6 (7.12)	95	-	93.2 (8.89)
HC (cm)	90.6 (6.63)	103 (6.64)	104	-	94.8 (8.80)	93.7 (3.22)	93 (2.04)	93	-	93.4 (2.74)
WHR (cm)	0.87 (0.05)	0.85 (0.01)	0.91	-	0.87 (0.05)	0.98 (0.10)	1.0 (0.07)	1.02	-	0.99 (0.09)
Body fat (%)*	28.4 (2.42)	31.1 (1.35)	30.6	-	29.3 (2.44)	22.5 (2.72)	22.8 (1.87)	23.3	-	22.7 (2.36)
TSF (mm)	16.1 (2.46)	18.9 (1.63)	18.4	-	17.1 (2.56)	12.3 (2.69)	12.4 (2.07)	13	-	12.4 (2.41)
AC (cm)	27.4 (1.71)	30.1 (1.43)	31	-	28.3 (2.03)	27.5 (2.93)	27.5 (2.02)	28.5	-	27.5 (2.52)
AMC (cm)	22.4 (1.12)	24.1 (1.26)	25.2	-	23.2 (1.43)	23.6 (2.30)	23.6 (1.69)	24.4	-	23.6 (2.01)

SD: Standard Deviation. BMI: Body Mass Index. BMR: Basal Metabolic Rate calculated using Schofield *et al*. equations (1985). WC: Waist circumference. HC: Hip Circumference. WHR: Waist: Hip Ratio. TSF: Triceps Skin-fold. AC: Arm Circumference. AMC: Arm Muscle Circumference. * Calculated from TSF (Durnin & Womersley, 1974).

Table 6.2: Mean and Standard deviation (SD) of blood pressure of the study subjects by gender

	Females (n = 47)					Males (n = 32)				
	18-30 (31)	31-40 (15)	41-50 (1)	50-65	All	18-30 (18)	31-40 (12)	41-50 (2)	50-65	All
SBP (mmHg)	121 (4.53)	125 (9.18)	154	-	123 (8)	121 (1.76)	126 (8.76)	122	-	123 (6.02)
DBP (mmHg)	79.8 (3.49)	82.8 (6.22)	96	-	81.1 (5.15)	81.3 (2.76)	84.7 (6.73)	80.5	-	82.6 (4.98)

SBP, Systolic Blood Pressure (mmHg).
DBP, Diastolic Blood Pressure (mmHg).
Normal SBP < 140 and DBP < 90.

Table 6.3: Demographic characteristics of the study subjects by gender

Characteristics	Females (n = 47)		Males (n = 32)		χ^2	P
	No.	%	No.	%		
Education						
Illiterate	-	-	-	-		
Writing & Reading	-	-	-	-		
Primary	-	-	-	-	5.673	< 0.05
High School	13	28	2	6		
University or Above	34	72	30	94		
Monthly income (RS)*						
1 – 3000	1	2	-	-		
3001 - 6000	16	34	2	6		
6001 – 9000	23	49	17	53	6.755	< 0.05
9001 – 12000	7	15	7	22		
More than 12000	-	-	6	19		
Marital status						
Single	10	21	11	34		
Married	37	79	21	66	1.674	N.S
Widowed or Divorced	-	-	-	-		
Total residential periods						
More than a Year	47	100	32	100	1.442	N.S
Less than six months	-	-	-	-		
Socioeconomic status						
Low	-	-	-	-		
Medium	42	89	19	59	9.730	< 0.05
High	5	11	13	41		

N.S: not significant.
*Riyal Saudi (currency 5.83 RS = 1£).

Table 6.4: Prevalence of cardiovascular risk factors according to gender

Risk factors	Females (*n* = 47)		Males (*n* = 32)		χ^2	*P*
	No.	%	No.	%		
BMI Classification						
Underweight	-	-	-	-	2.455	N.S
Normal	29	61	15	47		
Overweight	14	30	11	35		
Obese	4	9	6	18		
Diabetes*						
Normal	46	98	30	94	0.886	N.S
Diabetic	1	2	2	6		
High blood cholesterol*						
Normal	46	98	30	94	0.886	N.S
Hypercholesterolemia	1	2	2	6		
High blood pressure*						
Normal	43	91	30	94	0.710	N.S
Hypertension	4	9	2	6		
Heart disease*						
Normal	46	98	32	100	0.690	N.S
Heart disease	1	2	-	-		
Family history						
Diabetes	17	36	14	43	0.152	N.S
Heart diseases	5	11	3	9		
Smoking status						
Non-smoker	43	92	9	28	35.945	< 0.001
Ex-smoker	1	2	5	16		
Current (<20 cigarette)	-	-	5	16		
Current (>20 cigarette)	-	-	6	18		
Shisha	3	6	9	28		
Physical activity						
Inactive	43	92	23	72	2.336	N.S
Moderately active	3	6	5	16		
Active	1	2	4	12		

N.S: not significant.
* Self-reported

6.4.3 Comparison of cardiovascular risk factors between genders

Prevalence of cardiovascular risk factors among males and female is shown in Table 6.4. There were no gender differences in BMI classification. However, the percentages of overweight and obese were higher in men at 35%, 18%, respectively, whereas in the female population 30% were overweight and 9% were obese. No differences were observed from the comparison between genders in self-reporting of diabetes, high blood cholesterol, high blood pressure and heart disease. Cigarettes were the most common type of tobacco smoked by subjects. Current smokers for cigarettes or shisha were reported at 34% and 28%, respectively for male subjects, and 6% of male subjects smoked both cigarettes and shisha. 6% of female subjects smoked shisha. There were highly significantly differences between genders in smoking habit ($\chi^2 = 35.945$, $P < 0.001$). The majority of participants were inactive with 92% of women and 72% of men falling into the inactive category.

6.4.4 Dietary data

Table 6.5 shows dietary eating habits in both genders. The majority of the female subjects ate three meals per day (55%), while in men subjects (56%) ate once or twice per day. The main meal of the day was dinner for 72% of females, and 72% of males. Most of the participants, 96% of females and 94% of males in this study were found to eat food outside their home at some time during the week. There were no significant differences between men and women in all dietary habits questions ($P > 0.05$).

Table 6.5: Prevalence of dietary habits according to gender

Eating patterns	Females (n = 47)		Males (n = 32)		χ^2	*P*
	No.	%	No.	%		
Meals (no./day):						
1 or 2	20	43	18	56		
3 or 4	26	55	13	41	1.576	N.S
More than 5	1	2	1	3		
Main meal:						
Breakfast	12	26	8	25		
Lunch	16	34	16	50	0.875	N.S
Dinner	34	72	23	72		
Eating breakfast:						
Daily	27	58	16	50		
Sometimes	9	19	13	41	5.461	N.S
Never	11	23	3	9		
Eating outside (per week):						
Never	2	4	2	6		
Once or twice	25	54	15	47		
Three or four times	11	23	9	28	0.469	N.S
More than four times	9	19	6	19		

N.S: not significant

Macronutrient and micronutrient intakes for the subjects are shown in Tables 6.6, 6.7. Data for these food components are presented as mean, (SD), and 95% CI. The mean and (SD) for energy intake in females subject was 2231 (271) kcal/day and for males subject was 2350 (290) kcal/day. On average, participants consumed 2279 kcal/day (9.6 MJ/day) with 55.3% of energy from carbohydrate, 15.02% of energy from protein and 32.9% of energy from fat. SFA contributed 13.8% of the total energy intake. Males had significantly higher dietary intakes than females with respect to total fat ($P < 0.05$) and protein ($P <$

0.001). The mean and (SD) for MUFA, PUFA intake levels were as follows: 24.5 (6.9) g/day, 10.2 (3.81) g/day and 25.6 (8.12) g/day, 11.9 (4.91) g/day for females and males respectively, with 10% of daily energy from MUFA and 4.3% of daily energy from PUFA for all study participants. Mean calcium intake was 815 (107) mg/day, which was above the dietary recommended intake level for both males and females of this age. In contrast, mean intakes of fibre and selenium (8.3 (3.13) g/day and 47.7 (19.99) µg/day, respectively) were found to be below recommended intake levels (Department of Health, 1991). The mean sodium intake was 3.1 (0.81) g/day, which is above the recommendation suggested by WHO (2003) of 1.7 g/day of sodium, which is equal to 5 g/day of salt. The mean and (SD) for zinc intakes for males and females were 10.4 (2.83) mg/day and 8.1 (2.41) mg/day, respectively. The mean intake of vitamin A intake for males was 481 (222) µg/day, and for females was 434 (207) µg/day, which for both males and females was below the dietary recommended intake of 700 µg/day, and 600 µg/day, respectively. The mean vitamin E intake for all study subjects was 5.4 (1.81) mg/day. In-dependent *t* tests revealed there were significantly differences between males and female in calcium intake ($P < 0.05$) and zinc intake ($P < 0.001$) (Table 6.7). Data for cholesterol and iron intake were not normally distributed. Data were therefore log transformed and geometric means were used in the analysis. The dietary cholesterol intake was within the recommendation guidelines of < 300 mg/day. Females had significantly lower cholesterol intake than males ($P < 0.001$). Daily intake of iron for females was 11.8 (95% CI 8.6, 16.1) mg/day and 10.3 (95% CI 7.4, 14.2) mg/day for men (see Tables 6.6 and 6.7).

Geometric mean, median and 95% CI for daily intake of total omega 3, ALA, EPA, DHA, total omega 6, LA, AA and *trans* fatty acids for subjects by gender are shown in Table 6.8. The mean daily intake of total omega 3 fatty acids for females was 0.72 g/day and it was 0.88 g/day for males, mainly in the form of ALA (0.54 g/day for females and 0.58 g/day for males), with 0.2 g/day for females and 0.2 g/day for males in the form of EPA and DHA. Total omega 3 fatty acids contributed 0.13% and 0.14% of daily energy intake for females and males, respectively. The geometric mean for daily intake of total omega 6 fatty acids for females was 3.9 g/day while for the males it was 3.4 g/day, mainly in the form of LA (3.4 g/day for females and 3.4 g/day for males), with 0.04 and 0.1 g/day for females and males, respectively in the form of AA. Omega 6 fatty acids contributed 0.95% for females and 0.98% for males to the daily energy intake. No significant differences were observed from the comparison between males and female in all omega 3 and omega 6 PUFA. The geometric mean for daily intake of *trans* fatty acid for females was 1.9 g/day and 3.7 g/day for males. *Trans* fatty acid contributed 1.01% for females and 1.3% for males to daily energy intake. There was a statistically significant difference between males and females in *trans* fatty acids intake ($P < 0.05$).

Table 6.6: Mean, standard deviation (SD), median and 95% Confidence Intervals (CI) for daily energy intake and daily intake of macronutrients for subjects by gender

Nutrient	Overall			Females			Males			*P*
	Mean (SD)	Median	95% CI	Mean (SD)	Median	95% CI	Mean (SD)	Median	95% CI	
Energy (MJ/d)	9.6 (1.21)	9.6	9.3, 9.8	9.4 (1.22)	9.3	9.1, 9.7	9.8 (1.19)	9.7	9.3, 10.2	N.S
Energy (kcal/d)	2279 (287)	2287	2215, 2343	2231 (271)	2230	2151, 2311	2350 (290)	2319	2242, 2458	N.S
Total fat (g/d)	83.2 (17.11)	82.5	79.4, 87.1	78.8 (16.44)	78.6	74.1, 83.7	89.6 (16.12)	89	83.8, 95.4	< 0.05
% of daily energy	32.9			31.9			34.5			< 0.05
SFA (g/d)	34.9 (8.50)	34.4	33.1, 36.8	33.8 (8.55)	33.6	31.3, 36.3	36.5 (8.28)	36.5	33.5, 39.5	N.S
% of daily energy	13.8			13.7			14.1			N.S
MUFA (g/d)	24.9 (7.71)	25.3	23.2, 26.7	24.5 (6.91)	23.3	22.5, 26.6	25.6 (8.12)	25.7	22.4, 28.7	N.S
% of daily energy	10			10			10			N.S
PUFA (g/d)	10.9 (4.38)	9.7	9.9, 11.8	10.2 (3.81)	9.5	9.1, 11.3	11.9 (4.91)	10.3	10.1, 13.7	N.S
% of daily energy	4.3			4.1			4.5			N.S
Cholesterol (mg/d)	231*	221	182, 294	187*	187	156, 225	318*	329	221, 477	< 0.001
Protein (g/d)	85.1 (19.11)	84.4	80.7, 89.3	77.4 (15.37)	76	72.9, 81.9	96.1 (18.41)	96	89.3, 102	< 0.001
% of daily energy	15.02			13.9			16.5			< 0.05
Carbohydrates (g/d)	316 (67.90)	303	301, 331	324 (65.87)	314	305, 343	305 (70.22)	281	280, 301	N.S
% of daily energy	55.3			57			51.5			< 0.05
Fibre (g/d)	8.3 (3.13)	8.1	7.4, 9.3	8.1 (4.04)	7.5	6.8, 9.3	8.8 (3.71)	8.7	7.4, 10.1	N.S

SFA indicates saturated fatty acids; MUFA, monounsaturated fatty acids; PUFA, polyunsaturated fatty acids.
*Geometric means.
$P < 0.05$, $P < 0.001$ variables were compared by *t* test.
N.S: not significant.

Table 6.7: Mean, standard deviation (SD), median and 95% Confidence Intervals (CI) for daily intake of micronutrients for subjects by gender

Nutrient	Overall			Females			Males			*P*
	Mean (SD)	Median	95% CI	Mean (SD)	Median	95% CI	Mean (SD)	Median	95% CI	
Calcium (mg/d)	815 (107)	838	791, 839	843 (88.69)	838	817, 869	774 (119)	764	731 817	< 0.05
Iron (mg/d)	11.2*	11.1	9.3, 13.4	11.8*	11.2	8.6, 16.1	10.3*	10.2	7.4, 14.2	N.S
Magnesium (mg/d)	273 (80.62)	259	255, 291	278 (79.71)	259	254, 301	267 (82.84)	259	237, 297	N.S
Sodium (g/d)	3.1 (0.81)	2.9	2.9, 3.2	2.9 (0.82)	2.9	2.7, 3.2	3.2 (0.80)	3.1	2.9, 3.5	N.S
Potassium (g/d)	3.1 (0.94)	3	2.9, 3.3	3.2 (0.91)	3.1	2.9, 3.5	3 (0.93)	2.8	2.6, 3.3	N.S
Selenium (µg/d)	47.7 (19.99)	43	43.3, 52.2	44.5 (17.21)	41	39.5, 49.6	52.4 (22.19)	46.5	44.1, 60.7	N.S
Zinc (mg/d)	9.1 (2.15)	8.4	8.4, 9.7	8.1 (2.41)	7.6	7.3, 8.8	10.4 (2.83)	9.8	9.4, 11.5	< 0.001
Vitamin A (µg/d)	462 (216)	453	413, 510	481 (222)	474	416, 546	434 (207)	415	359, 441	N.S
Vitamin C (mg/d)	62.9 (32.91)	53.1	51.5, 74.3	63.7 (24.30)	51	47.7, 79.6	61.7 (36.11)	55.1	45.01, 78.5	N.S
Vitamin E (mg/d)	5.4 (1.81)	4.7	4.8, 6.1	5.5 (2.41)	4.6	4.6, 6.4	5.4 (2.45)	4.9	4.5, 6.3	N.S

*Geometric means.
$P < 0.05$, $P < 0.001$ variables were compared by *t* test.
N.S: not significant.

Table 6.8: Geometric mean, median and 95% Confidence Intervals (CI) for daily intake of fatty acids for subjects by gender

Nutrient	Overall			Females			Males			*P*
	Mean	Median	95% CI	Mean	Median	95% CI	Mean	Median	95% CI	
Total n-3 PUFAs (g/d)	0.78	0.62	0.4, 1.4	0.72	0.55	0.2, 1.7	0.88	0.75	0.2, 4.2	N.S
% of daily energy	0.14			0.13			0.14			
ALA (g/d)	0.56	0.51	0.3, 0.9	0.54	0.44	0.24, 1.2	0.58	0.63	0.2, 1.6	N.S
EPA (g/d)	0.06	0.03	0.02, 0.2	0.1	0.02	0.01, 0.3	0.1	0.03	0.03, 1.3	N.S
DHA (g/d)	0.1	0.1	0.04, 0.2	0.1	0.1	0.04, 0.1	0.1	0.1	0.01, 1.3	N.S
Total n-6 PUFAs (g/d)	3.75	3.1	1.8, 8.01	3.9	3.1	1.5, 10.2	3.4	2.7	0.3, 32.6	N.S
% of daily energy	0.96			0.95			0.98			
LA (g/d)	3.7	3.04	1.7, 7.9	3.9	3.04	1.5, 10.1	3.4	2.7	0.4, 32.4	N.S
AA (g/d)	0.04	0.03	0.02, 0.1	0.04	0.03	0.01, 0.1	0.1	0.1	0.01, 0.2	N.S
Total n-6: total n-3 PUFAs	4.7	5.9	3.4, 6.7	5.4	5.4	3.8, 7.9	4.9	4.1	1.5, 10.2	N.S
Total n-3: total n-6 PUFAs	0.2	0.2	0.1, 0.2	0.18	0.15	0.1, 0.2	0.25	0.2	0.1, 0.6	N.S
trans fatty acid (g/d)	2.5	2.3	1.2, 5.1	1.9	1.7	0.5, 6.2	3.7	3.1	1.3, 10.8	< 0.05
% of daily energy	1.2			1.01			1.3			

n-3, omega 3; ALA, alpha-linolenic acid (18:3n-3); EPA, eicosapentaenoic acid (20:5 n-3); DHA, docosahexaenoic acid (22:6 n-3); n-6, omega 6; LA, Linoleic acid (18:2 n-6); AA, arachidonic acid (20:4 n-6).
$P < 0.05$ variables were compared by *t* tests.
N.S: not significant.

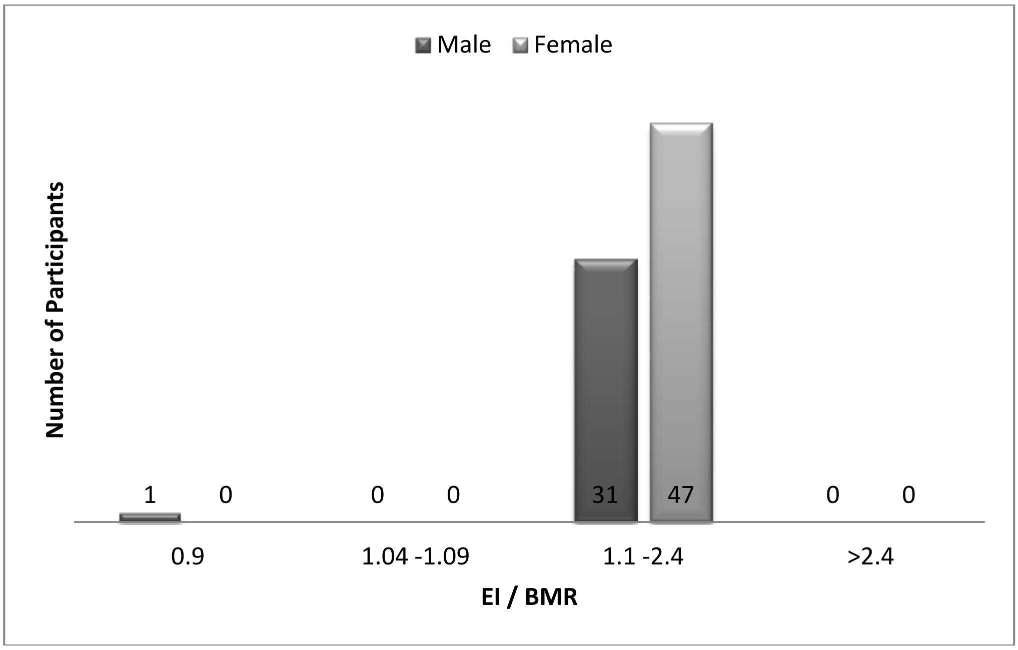
6.4.5 Validation of dietary data

Table 6.9 shows the mean reported EI of participants with the mean estimated BMR and calculated total EI: BMR of females and males together and separately. The mean BMR for the males was 1577 kcal/day and 1386 kcal/day for the females. Women were more likely than men to be high energy intake reporters at age 41-50 years old, while men reported higher energy intake at other age groups. The mean EI: BMR for males was 1.5 and it was 1.6 for females. There was one case in men participants of under-reporting. Figure 6.1 shows the distribution of participants for the Ratio of Energy Intake (EI) to Basal Metabolic Rate (BMR).

Table 6.9: Mean energy intake (EI), estimated Basal Metabolic Rate (BMR) and EI: BMR of study subjects

	overall	Female 18-30 (31)	Female 31-40 (15)	Female 41-50 (1)	Female 51-65	Female All (47)	Male 18-30 (18)	Male 31-40 (12)	Male 41-50 (2)	Male 51-65	Male All (32)
Energy intake (kcal/d)	2279	2235	2205	2493	-	2231	2321	2396	2324	-	2350
BMR (kcal/d)	1463	1355	1447	1340	-	1386	1593	1565	1508	-	1577
EI:BMR	1.5	1.6	1.5	1.7	-	1.6	1.5	1.5	1.5	-	1.5

Figure 6.1: Distribution of Participants for the Ratio of Energy Intake (EI) to Basal Metabolic Rate (BMR)



6.4.6 Comparison with UK Dietary Reference Values for food energy and nutrients (DRV)

Tables 6.10, 6.11 show the percentage of subjects with macronutrient and micronutrient intakes above and below DRV according to gender. The majority of male subjects had lower intakes than the UK EAR for energy intake in MJ and kcal. In contrast, 85% of female subjects had as energy intake higher than EAR. Figure 6.2 shows the energy intake and EAR of the study subjects by gender.

Nutrients that were consumed at levels above the RNI for the majority of both male and female subjects were SFA, protein, calcium and sodium. On the other hand, the nutrients which were consumed by the majority at levels which did not meet the UK RNI for both men and women were MUFA, PUFA, fibre, potassium and vitamin A. In the case of carbohydrate the majority of males and females (44% and 85%, respectively) had higher intakes than RNI, while for total fat and magnesium intakes for most males and females were lower than the RNI. Cholesterol intake was below the UK recommendation for 78% of females. The majority of males (88%) had an iron intake which was above the UK RNI, while only 49% of female subjects achieved the RNI and 42% were lower than the UK RNI. Zinc intake was below the UK RNI for 82% of females, whereas for 50% of male subjects zinc intake was above the UK recommendation. Mean vitamin C intakes were above the UK RNI for about half of male and female subjects. Figures 6.3, 6.4, 6.5 and 6.6 illustrate nutrient intake (fat, SFA, MUFA, and PUFA, protein, carbohydrates, fibre, cholesterol, calcium, magnesium, vitamin A, C selenium, iron, zinc, sodium and potassium) and RNI of the study subjects by gender.

Table 6.12 illustrates the percentage of subjects below, achieving or exceeding RNI and AI for fatty acids intakes according to gender. For all fatty acids examined intake was lower than the RNI and AI for fatty acids intake. On the other hand, the total omega 6 fatty acids intakes were similar to the recommendation in about half of both male and female subjects. Figures 6.7 shows the fatty acids intakes and RNI or AI of the study subjects by gender.

Table 6.10: Percentage of subjects below, achieving or exceeding EAR* for energy and RNI for macronutrient intake**

Nutrient	DRV		Male			Female		
	Males	Females	< DRV %	= DRV %	> DRV %	< DRV %	= DRV %	> DRV %
Energy (MJ/d)*	10.60	8.10 8.00***	72	6	22	13	2	85
Energy (kcal/d)*	2550	1940 1900***	72	6	22	13	2	85
% of daily energy from total fat**	35	35	43	19	38	70	2	28
% of daily energy from SFA**	11	11	9	16	75	19	21	60
% of daily energy from MUFA**	13	13	72	13	15	83	6	11
% of daily energy from PUFA**	6.5	6.5	78	19	3	89	5	6
Cholesterol (mg/d)**	< 300	< 300	37	25	38	78	9	13
Protein (g/d)**	55.5 53.3***	45 46.5***	-	-	100	-	-	100
% of daily energy from carbohydrates**	50	50	37	19	44	15	-	85
Fibre (g/d)**	12	12	63	22	15	78	11	11

SFA indicates saturated fatty acids; MUFA, monounsaturated fatty acids; PUFA, polyunsaturated fatty acids.
*Estimated Average Requirements for energy intake and % of subjects below, achieving or exceeding this value.
**Reference Nutrient intake 19-50 y, ***50+ y (Department of Health, 1991).

Table 6.11: Percentage of subjects below, achieving or exceeding RNI* for micronutrient intakes

Nutrient	RNI		Male			Female		
	Males	Females	< RNI %	= RNI %	> RNI %	< RNI %	= RNI %	> RNI %
Calcium (mg/d)*	700	700	9	31	60	6	13	81
Iron (mg/d)*	8.7	14.8 8.7**	3	9	88	42	9	49
Magnesium (mg/d)*	300	270	57	34	9	43	23	34
Sodium (g/d)*	1.60	1.60	-	3	97	2	9	89
Potassium (g/d)*	3.50	3.50	59	13	28	54	23	23
Selenium (µg/d)*	75	60	78	9	13	28	34	38
Zinc (mg/d)*	9.5	7.0	25	25	50	82	9	9
Vitamin A (µg/d)*	700	600	81	16	3	74	13	13
Vitamin C (mg/d)*	40	40	34	22	44	44	6	50

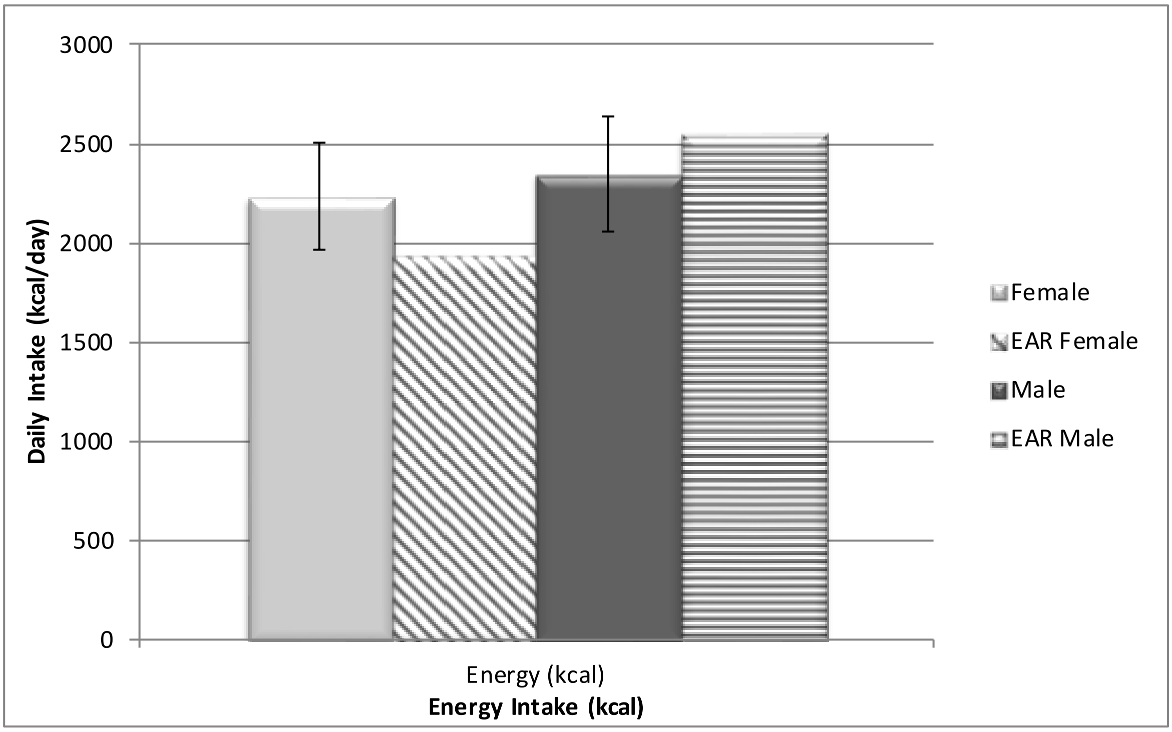
*Reference Nutrient intake 19-50 y, **50+ y (Department of Health, 1991).

Table 6.12: Percentage of subjects below, achieving or exceeding RNI*, adequate intake (AI) for fatty acids intakes

Nutrient	AI		Male			Female		
	Males	Females	< AI %	= AI %	> AI %	< AI %	= AI %	> AI %
% of daily energy from n-3 PUFAs*	0.2	0.2	41	22	37	43	36	21
ALA (g/d)**	1.6	1.1	97	3	-	96	4	-
EPA+DHA (g/d)*	0.45	0.45	97	-	3	100	-	-
% of daily energy from n-6 PUFAs*	1	1	13	53	34	23	45	32
LA (g/d)**	17	12	97	-	3	100	-	-
Total n-3: total n-6 PUFAs***	0.4	0.4	91	6	3	87	9	4
% of daily energy from *trans* – FA*	2	2	63	22	15	83	13	4

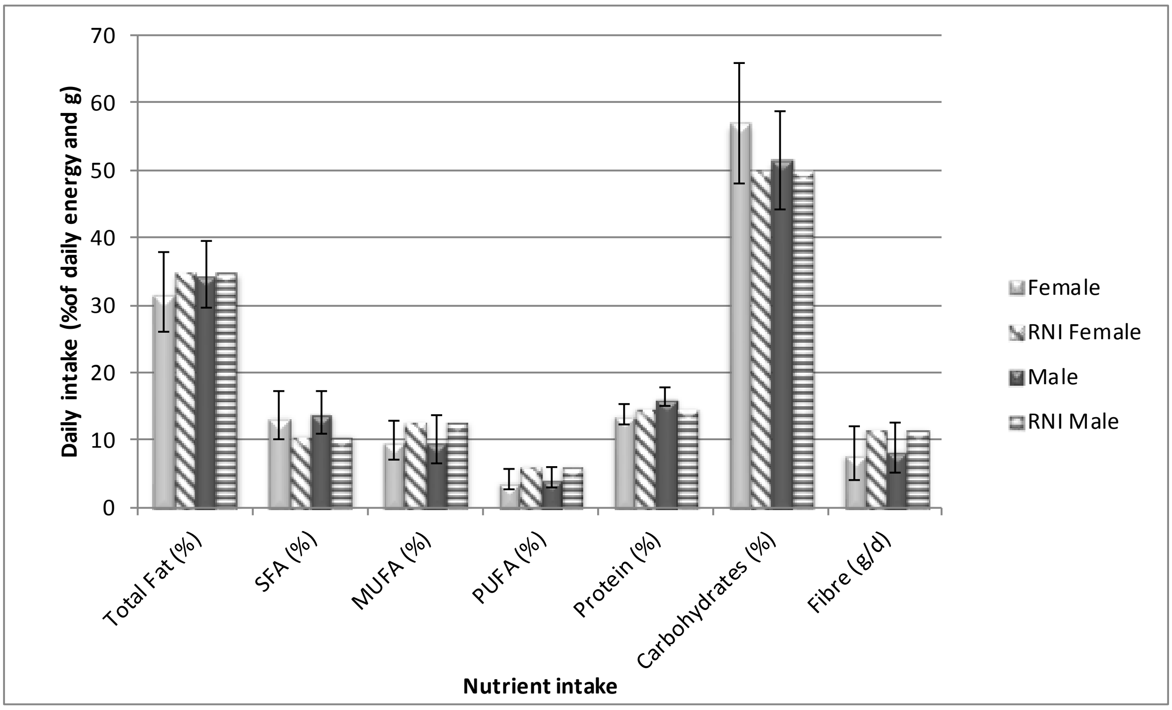
ALA, alpha-linolenic acid (18:3n-3); EPA, eicosapentaenoic acid (20:5 n-3); DHA, docosahexaenoic acid (22:6 n-3); LA, Linoleic acid (18:2 n-6); *trans*- FA, *trans* fatty acid.
*Reference Nutrient intake 19-50 y, (Department of Health, 1991).
** (Dietary Reference Intake, 2002)
*** (UK Scientific Advisory Committee on Nutrition, 2004).

Figure 6.2: Energy intake and EAR* of the study subjects by gender



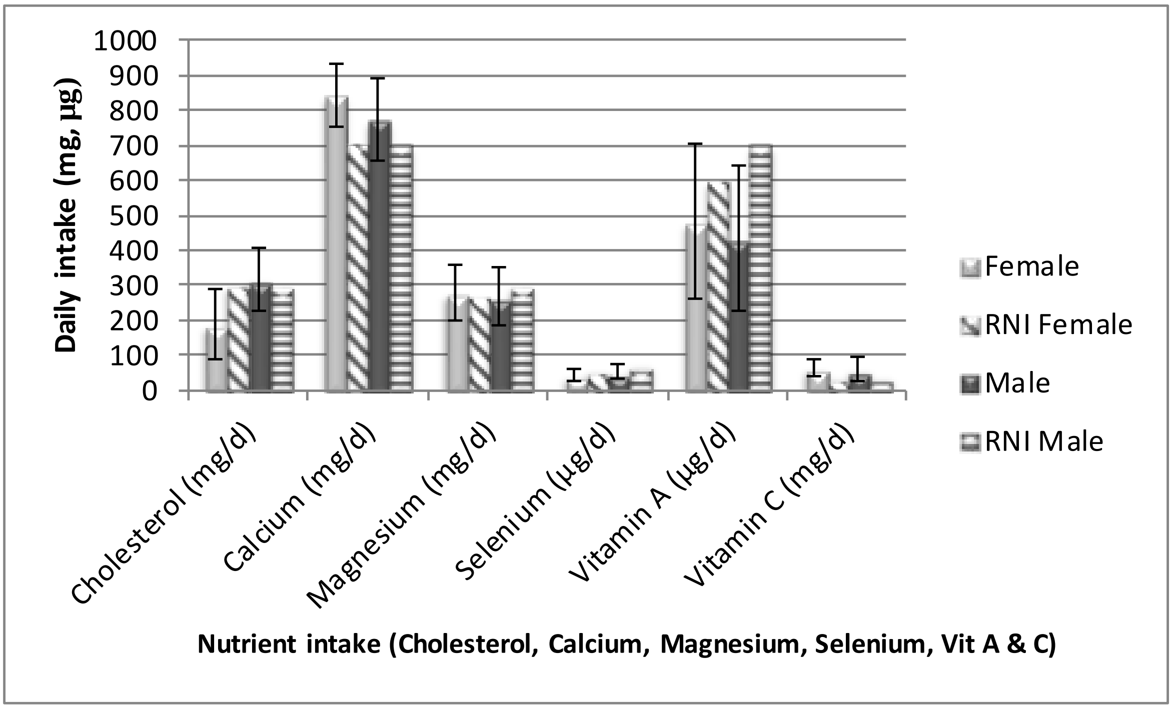
*Estimated Average Requirements for energy 19-50 y, (Department of Health, 1991).

Figure 6.3: Nutrient intake (fat, SFA, MUFA, PUFA, protein, carbohydrates and fibre) and RNI* of the study subjects by gender



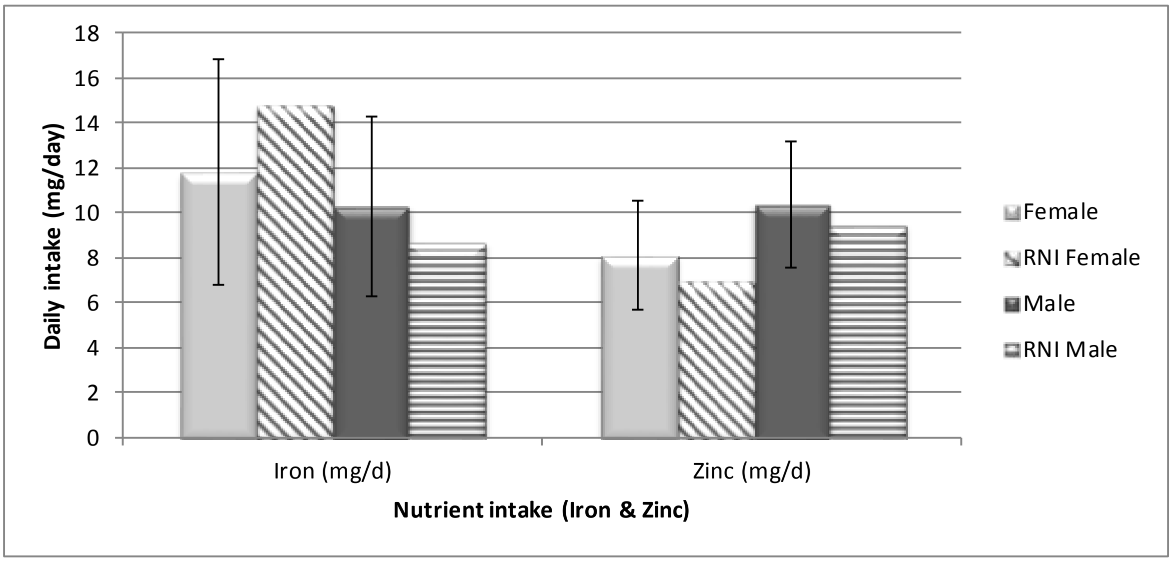
*Reference Nutrient Intake 19-50 y, (Department of Health, 1991).

Figure 6.4: Nutrient intake (cholesterol, calcium, magnesium, selenium, vitamin A and C) and RNI* of the study subjects by gender



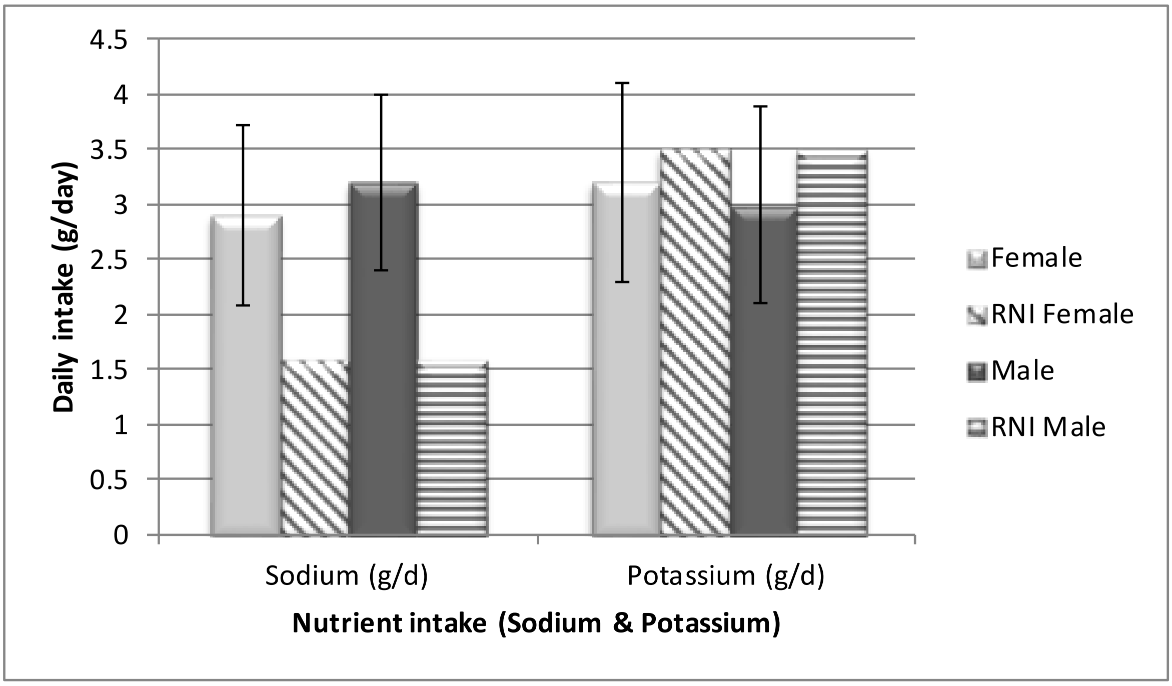
*Reference Nutrient Intake 19-50 y, (Department of Health, 1991).

Figure 6.5: Iron and Zinc and RNI* of the study subjects by gender



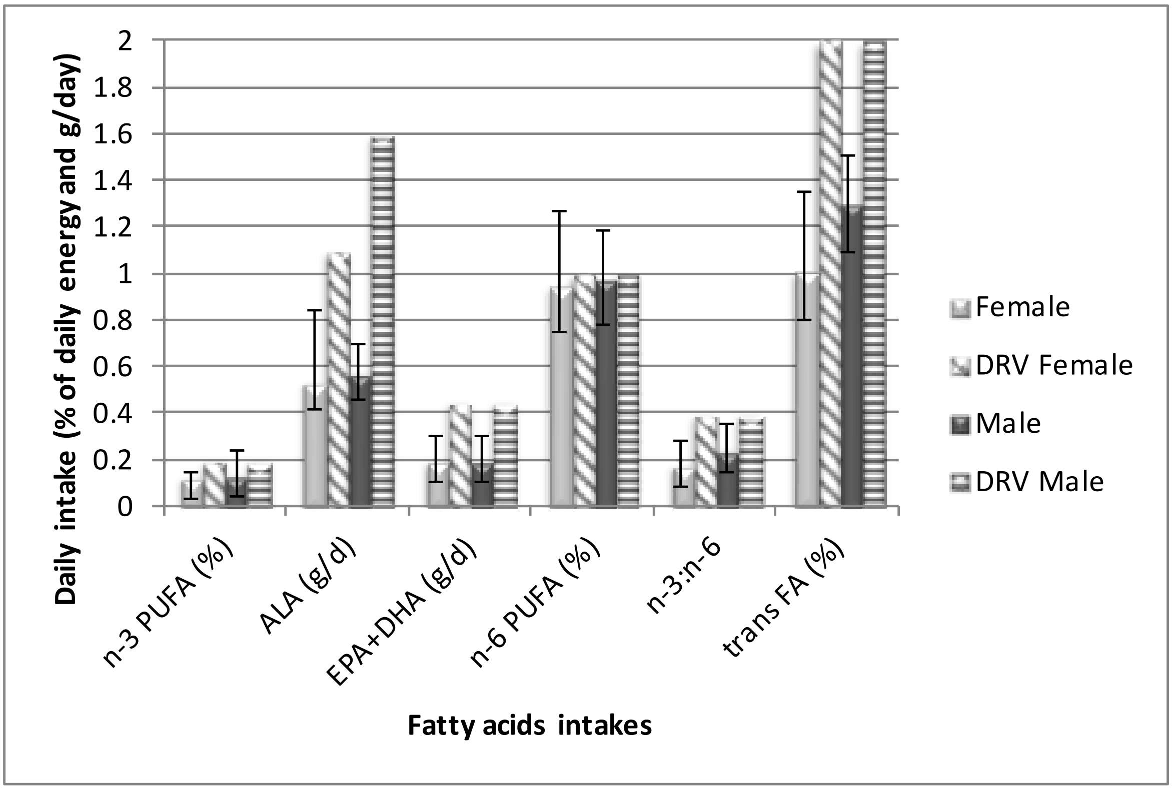
*Reference Nutrient Intake 19-50 y, (Department of Health, 1991).

Figure 6.6: Sodium and Potassium and RNI* of the study subjects by gender



*Reference Nutrient Intake 19-50 y, (Department of Health, 1991).

Figure 6.7: Fatty acids intakes and RNI*, adequate intake (AI) of the study subjects by gender**



*Reference Nutrient intake 19-50 y, (Department of Health, 1991).
** (Dietary Reference Intake, 2002), (UK Scientific Advisory Committee on Nutrition, 2004)

6.4.7 Relationship between nutrient intake and other factors

The correlation coefficients between indices of nutrients intakes with socioeconomic factors and CVD risk factors in the study subjects are provided in Table 6.13, 6.14 and 6.15.

6.4.7.1 Relationship between nutrient intake and socioeconomic status

Among study subjects, there were only three nutrients where there were statistically significant associations with monthly income. Dietary energy intakes (MJ) were positively correlated with monthly income (r = 0.227, P = 0.045). There were also significant positive associations between magnesium and potassium intakes and monthly income (r = 0.238, P = 0.034 and r = 0.280, P = 0.012, respectively).

6.4.7.2 Relationship between nutrient intake and CVD risk factors

There were no associations with CVD risk factors for energy intakes, carbohydrates intakes, SFA, MUFA and PUFA intakes. Dietary intake of fibre was positively correlated with age ($P < 0.001$). There were statistically significant associations between total fat intakes, cholesterol intakes and gender ($P < 0.001$). In addition, dietary calcium intakes was significantly affected with gender (P = 0.004) and with smoking status (P = 0.008). In all participants, there were positive associations between sodium intakes and hypertension (r = 0.242, P = 0.032). Iron intakes and magnesium intakes were positively associated with age (P = 0.033 P = 0.022, respectively). Vitamin A was positively associated with age and smoking status ($P < 0.001$, P = 0.002, respectively). For vitamin C and E intakes there were no associations with CVD risk factors. Both dietary total omega 3 intakes and ALA intakes were negatively correlated with age (r = - 0.243, P = 0.031 and r = - 0.261, P = 0.020, respectively) and with BMI (r = - 0.260, P = 0.021 and r = - 0.272, P = 0.015, respectively). In addition, there were statistically significant associations between dietary EPA intakes with gender (P = 0.032). Total omega 6 fatty acids intakes were negatively associated with BMI (r = - 0.295, P = 0.008). *Trans* fatty acid intake was significantly affected with gender (P = 0.030).

Table 6.13: Correlation coefficients between energy intakes and intakes of macronutrients with socioeconomic factors and CVD risk factors in the study subjects

Factors	Energy (MJ)		Energy (kcal)		Protein (g)		Carbohydrates (g)		Fibre (g)		Total fat (g)		SFA (g)		MUFA (g)		PUFA (g)		Cholesterol (mg)	
	r	***P***	***r***	***P***	***r***	***P***	***r***	***P***	***r***	***P***	***r***	***P***	***r***	***P***	***r***	***P***	***r***	***P***	***r***	***P***
Gender	-0.156	0.170	-0.205	0.070	**-0.482**	**0.000**	0.141	0.216	-0.085	0.455	**-0.312**	**0.005**	-0.158	0.165	-0.066	0.565	-0.196	0.083	**-0.556**	**0.000**
Age	-0.004	0.972	-0.009	0.939	**0.228**	**0.043**	0.021	0.852	**0.486**	**0.000**	-0.107	0.396	-0.100	0.379	-0.005	0.963	0.040	0.726	0.075	0.511
Education	0.214	0.058	0.203	0.072	-0.044	0.700	0.204	0.071	0.082	0.474	0.094	0.411	-0.021	0.853	0.185	0.104	0.156	0.170	0.016	0.892
Monthly income	**0.227**	**0.045**	0.210	0.063	0.072	0.526	0.176	0.120	0.161	0.157	0.159	0.162	0.052	0.648	0.163	0.150	0.209	0.065	0.193	0.088
BMI	-0.019	0.866	0.008	0.947	0.125	0.271	0.050	0.661	0.184	0.105	-0.138	0.227	-0.116	0.310	-0.048	0.675	-0.023	0.842	-0.010	0.934
History of diabetes	-0.040	0.727	-0.039	0.730	-0.045	0.693	-0.080	0.485	0.098	0.391	0.101	0.375	0.098	0.389	0.023	0.841	0.100	0.379	-0.141	0.216
History of hypertension	-0.029	0.803	-0.029	0.800	-0.033	0.772	-0.067	0.560	-0.196	0.083	0.096	0.399	0.116	0.310	-0.005	0.968	-0.026	0.817	0.025	0.826
History of hypercholesterolemia	-0.018	0.878	-0.039	0.734	0.025	0.824	-0.017	0.879	0.028	0.805	-0.039	0.731	0.037	0.744	-0.029	0.800	-0.149	0.189	-0.007	0.948
Family history	-0.002	0.989	0.059	0.605	-0.071	0.533	-0.018	0.875	-0.199	0.078	0.023	0.844	0.089	0.437	-0.127	0.265	-0.075	0.509	0.050	0.660
Smoking status	0.081	0.478	0.082	0.473	-0.147	0.196	0.121	0.290	0.155	0.311	0.035	0.760	0.116	0.308	0.163	0.150	-0.055	0.633	0.013	0.908
Physical activity	0.068	0.551	0.082	0.471	-0.022	0.845	0.062	0.584	-0.032	0.781	0.060	0.597	0.076	0.504	-0.070	0.538	-0.118	0.301	0.155	0.174

SFA indicates saturated fatty acids; MUFA, monounsaturated fatty acids; PUFA, polyunsaturated fatty acids. Pearson's correlation coefficients were calculated for all study subjects. Statistical significant correlation coefficients are indicated in bold font.

Table 6.14: Correlation coefficients between intakes of micronutrients with socioeconomic factors and CVD risk factors in the study subjects

Factors	Calcium (mg)		Iron (mg)		Magnesium (mg)		Sodium (g)		Potassium (g)		Selenium (μg)		Zinc (mg)		Vitamin A (μg)		Vitamin C (mg)		Vitamin E (mg)	
	r	***P***	***r***	***P***	***r***	***P***	***r***	***P***	***r***	***P***	***r***	***P***	***r***	***P***	***r***	***P***	***r***	***P***	***r***	***P***
Gender	**0.318**	**0.004**	0.042	0.714	0.066	0.564	-0.147	0.197	0.106	0.354	-0.195	0.086	**-0.414**	**0.000**	0.108	0.346	0.019	0.868	0.024	0.832
Age	0.109	0.337	**0.240**	**0.033**	**0.257**	**0.022**	0.107	0.349	0.192	0.091	-0.056	0.624	-0.115	0.314	**0.409**	**0.000**	0.048	0.675	-0.065	0.509
Education	0.034	0.766	-0.202	0.074	-0.002	0.985	0.185	0.102	0.059	0.603	0.070	0.543	-0.092	0.419	-0.029	0.798	0.176	0.121	0.220	0.051
Monthly income	0.116	0.309	0.071	0.533	**0.238**	**0.034**	0.156	0.169	**0.280**	**0.012**	0.028	0.810	0.011	0.925	-0.055	0.633	0.219	0.053	0.210	0.063
BMI	-0.068	0.549	0.168	0.138	0.130	0.255	0.019	0.868	0.130	0.254	0.133	0.242	-0.078	0.494	0.096	0.402	0.009	0.934	-0.144	0.204
History of diabetes	0.091	0.427	0.060	0.597	0.166	0.144	-0.012	0.917	0.122	0.285	0.104	0.361	0.013	0.910	0.122	0.285	0.086	0.454	0.106	0.351
History of hypertension	0.074	0.514	-0.104	0.363	-0.063	0.584	**0.242**	**0.032**	-0.134	0.238	-0.054	0.639	0.118	0.302	-0.116	0.310	-0.025	0.825	0.030	0.793
History of hypercholesterolemia	-0.045	0.697	0.021	0.853	-0.011	0.923	-0.159	0.162	0.009	0.937	0.085	0.459	0.095	0.403	0.027	0.814	-0.031	0.789	-0.080	0.486
Family history	-0.087	0.445	-0.208	0.066	-0.160	0.158	0.058	0.613	-0.148	0.192	-0.080	0.482	0.080	0.484	-0.077	0.499	-0.089	0.435	0.009	0.936
Smoking status	**-0.297**	**0.008**	0.048	0.678	0.096	0.399	0.002	0.989	0.139	0.223	-0.178	0.117	-0.176	0.120	**0.337**	**0.002**	0.024	0.837	-0.071	0.535
Physical activity	0.030	0.793	0.022	0.844	0.010	0.929	0.029	0.797	0.096	0.398	0.018	0.872	0.090	0.430	-0.157	0.168	0.087	0.447	-0.051	0.652

Pearson's correlation coefficients were calculated for all study subjects. Statistical significant correlation coefficients are indicated in bold font.

Table 6.15: Correlation coefficients between intakes of fatty acids with socioeconomic factors and CVD risk factors in the study subjects

Factors	Total n-3 PUFAs (g)		ALA (g)		EPA (g)		DHA (g)		Total n-6 PUFAs (g)		LA (g)		AA (g)		*Trans* fatty acid (g)	
	r	***P***	***r***	***P***	***r***	***P***	***r***	***P***	***r***	***P***	***r***	***P***	***r***	***P***	***r***	***P***
Gender	-0.059	0.603	-0.049	0.670	**-0.241**	**0.032**	0.008	0.945	-0.031	0.789	0.030	0.793	-0.113	0.320	**-0.244**	**0.030**
Age	**-0.243**	**0.031**	**-0.261**	**0.020**	0.087	0.445	0.093	0.414	**-0.364**	**0.001**	**-0.365**	**0.000**	-0.213	0.059	-0.216	0.056
Education	-0.011	0.921	-0.016	0.892	0.071	0.537	0.122	0.285	0.056	0.616	0.060	0.598	0.045	0.695	-0.038	0.738
Monthly income	-0.004	0.972	-0.014	0.903	0.073	0.525	0.020	0.854	-0.058	0.614	-0.054	0.634	-0.154	0.174	0.011	0.926
BMI	**-0.260**	**0.021**	**-0.272**	**0.015**	0.038	0.738	-0.043	0.708	**-0.295**	**0.008**	**-0.293**	**0.009**	**-0.344**	**0.002**	-0.147	0.196
History of diabetes	0.145	0.201	0.147	0.197	0.044	0.699	0.029	0.798	0.139	0.220	0.139	0.220	0.066	0.564	-0.019	0.867
History of hypertension	0.030	0.790	0.022	0.847	0.068	0.554	-0.010	0.932	0.119	0.294	0.118	0.229	0.155	0.174	0.006	0.956
History of hypercholesterolemia	-0.180	0.112	-0.156	0.170	-0.125	0.272	-0.157	0.166	-0.183	0.106	-0.183	0.106	0.078	0.453	-0.016	0.886
Family history	0.011	0.922	0.033	0.773	0.164	0.119	-0.216	0.056	0.049	0.667	0.049	0.667	0.057	0.621	0.154	0.175
Smoking status	-0.104	0.360	-0.098	0.389	-0.005	0.633	-0.087	0.447	-0.004	0.971	-0.005	0.967	0.052	0.650	-0.098	0.393
Physical activity	0.026	0.819	0.018	0.877	-0.003	0.980	0.063	0.580	0.061	0.591	0.061	0.595	0.018	0.874	-0.002	0.989

n-3, omega 3; ALA, alpha-linolenic acid (18:3n-3); EPA, eicosapentaenoic acid (20:5 n-3); DHA, docosahexaenoic acid (22:6 n-3); n-6, omega 6; LA, Linoleic acid (18:2 n-6); AA, arachidonic acid (20:4 n-6).
Pearson's correlation coefficients were calculated for all study subjects. Statistical significant correlation coefficients are indicated in bold font.

6.4.8 Intake by food groups

Table 6.16 illustrates percentage, mean and 95% CI for food intake by different food groups for the study subjects by gender. 87% of subjects consumed fruit and vegetables on at least one day, 83% consumed fast foods and two thirds of the subjects consumed traditional Saudi foods. On other hand, the lowest percentage consumed nuts and seeds (15%) and fish (22%) at least on one day from the three days. Mann-Whitney test showed that there was a statistically significant difference between men and women for consumption of fast food ($P < 0.05$) and in traditional food ($P < 0.05$).

Table 6.16: Percentage, mean and 95% Confidence Intervals (CI) for intake by food group of the study subjects by gender

Dietary pattern	Overall			Females			Males			*P*
	n (%)	Mean (g/d)	95% CI	*n (%)*	Mean (g/d)	95% CI	*n (%)*	Mean (g/d)	95% CI	
Nuts and seeds	**12 (15)**	**4.02**	**1.4, 6.6**	**10 (21)**	**5.1**	**1.3, 8.7**	**2 (6)**	**2.5**	**-1.1, 6.1**	**N.S**
Fish and sea-food	**18 (22)**	**7.02**	**3.1, 10.9**	**10 (21)**	**6.9**	**1.2, 12.6**	**8 (25)**	**7.2**	**1.6, 12.6**	**N.S**
Fruit & Vegetables	**69 (87)**	**156**	**129, 184**	**42 (89)**	**155**	**120, 190**	**27 (84)**	**159**	**111, 206**	**N.S**
Fast food	**66 (83)**	**365**	**298, 432**	**37 (79)**	**300**	**226, 374**	**29 (91)**	**460**	**338, 582**	**< 0.05**
Traditional Saudi food	**51 (65)**	**143**	**103, 182**	**33 (70)**	**160**	**103, 217**	**18 (56)**	**117**	**63.9, 171**	**< 0.05**

$P < 0.05$ variables were compared by Mann-Whitney tests.
N.S: not significant.

6.4.9 Relationship between intake by food group and other factors

Table 6.17 shows the association between intake by different food groups with socioeconomic factors and CVD risk factors in the study subjects.

6.4.9.1 Relationship between intake by food group and socioeconomic status

There were no associations with the five food groups and socioeconomic status in Saudi population living in Newcastle using multiple regression models.

6.4.9.2 Relationship between intake by food group and CVD risk factors

Multiple regression models were applied to examine the independent association of selected CVD risk factors with dietary intake in the five food groups identified in this study. In particular, the consumption of fish was positively associated with history of diabetes (P = 0.041) but it was negatively associated with history of hypertension (P = 0.032). Consumption of fruit and vegetables was positively associated with smoking habits. Fast food consumption was negatively associated with age (*P* = 0.040) but positively associated with BMI (*P* = 0.038). Traditional Saudi food consumption was significantly positively associated with age (ß = 0.358, 95% CI 1.7, 20.9, *P* = 0.021), but it was negatively associated with history of hypertension (ß = - 0.234, 95% CI -301.8, -9.1, *P* = 0.038).

Table 6.17: Association between intake by food group with socioeconomic factors and CVD risk factors in the study subjects as assessed by multivariate linear regression**

Factors	Nuts and seeds		Fish and sea-food		Fruit & Vegetables		Fast food		Traditional Saudi food	
	ß	95% CI	ß	95% CI	ß	95% CI	ß	95% CI	ß	95% CI
Gender:										
Women	0.130	-3.6,9.7	-0.010	-10,9.3	-0.132	-103,34	**-0.434**	**-423,-102**	0.188	-27,162
Men	-0.083	-12, 5.7	0.015	-30, 34	0.009	100, 109	**0.198**	**-1.1, 12**	-0.111	-12,4.6
Age (years)	0.013	-0.64, 1	0.153	-0.5,1.4	0.182	-2.8,11	**-0.285**	**-31,0.91**	**0.358**	**1.7,20.9**
Education:										
High	0.036	-6.1,8.2	0.060	-7.7,13	-0.193	-14,135	-0.039	-144,204	-0.144	-167,38
Low	-0.145	-0.3,0.1	-0.013	-3.8,3.3	-0.069	-42,18.6	0.198	-1.1, 12	0.191	-6.9,144
Monthly income:										
High	0.222	-0.6,6.6	-0.229	-10,1.56	-0.180	-64,11.5	0.111	-127,49	0.132	-24.7,79
Low	0.002	-60.3,61	-0.040	-262,190	0.080	-47, 98	-0.107	-174, 60	0.194	28, 192
BMI (kg/m^2)	-0.263	-1.4,0.1	-0.060	-1.3,0.8	-0.172	-12,2.8	**0.213**	**-32.7,3**	0.057	-8.4,13
History of diabetes*	0.148	-7.7,25	**0.278**	**1.1,49.2**	0.054	-136,204	-0.062	-492,303	0.128	-199,350
History of hypertension*	-0.136	-14,7.3	**-0.318**	**-40,-1.8**	-0.002	-137,135	-0.070	-397,240	**-0.234**	**-301,-9**
History of hypercholesterolemia*	-0.183	-26.7,5	-0.230	-44,2.3	-0.194	-287,41	0.066	-282,48	-0.040	-262,190
Family history*	-0.147	-9.2,2.4	-0.111	-12,4.6	0.002	-60.3,61	-0.002	-143,140	0.123	-40,127
Smoking status:										
Current smoker	-0.102	-8.7,3.6	-0.105	-13,5.1	**0.309**	**18,147**	-0.036	-173,127	0.020	-81,96.4
Non smoker	-0.100	-0.9,-0.1	0.021	-6.4,7.6	-0.011	-74, 66	0.132	87, 324	0.066	-282,48
Physical activity*										
Active	-0.199	-9.3,1.2	0.164	-2,12.8	-0.041	-62.6,44	-0.129	-194,55	-0.037	-85.6,62
Inactive	0.097	-0.2,0.6	0.132	-2.3, 13	-0.008	-69, 63	0.032	-151,220	-0.043	-125,78

ß and 95% CI are significant at $P < 0.05$, indicated in bold font. *Yes *vs.* No
**All the socioeconomic and CVD risk factors were run in one multivariate model.

6.5 Discussion

This study investigated the dietary intake of Saudi adult students and their families residing in Newcastle, UK. Overall, there were noticeable variations of the sample participants; the number of total female participants was considerably higher than the total number of males. Moreover, the ratio of single females out of total females was smaller than that for males. Married couples constituted about one half of the total number of surveyed participants. The majority of participants from Saudi were students living for more than a year in Newcastle and attending Newcastle or Northumbria University or their families. Data information was collected from a sample of 79 subjects between 19-49 years of age. In this study, the average BMI of total participants indicated that overweight or obesity was more frequent among male participants (53%) compared with female samples (39%), making them more vulnerable to CVD risk factors such as type 2 diabetes, hypertension and hypercholesterolemia. These results are in agreement with several studies, which show that male students were more commonly at the risk of obesity than female students. In Saudi Arabia, Abdel-Megeid *et al*. (2011) reported that the prevalence rate of overweight and obese men students was 23% and 7% compared with women students at 19% and 6%, respectively. In the United Arab Emirates a study by Musaiger *et al*. (2003), reported that the prevalence of obesity was 35.7% in male students and it was higher than in women. In contrast, only 7.9% in Iranian male students were above the normal BMI (Nojomi & Najamabadi, 2006). However, among Chinese students overweight with only 2.9% with very low percentage of obesity at 0.4 % (Sakamaki *et al*., 2005b). Regarding blood pressure classification, 9% of women and 6% of men were classified as hypertensive (Table 6.4). A study by Irozusta *et al.* (2007) in University students in Spain, investigate a the relationship between the nutritional patterns of young students and health parameters related to CVD risk and reported that 30.6% of females and 38.9% of males were pre-hypertensive whereas 1.4% of females and 19.4% of males were hypertensive.

Related to their dietary habits, the results of this study showed that most women ate three meals per day while men ate once or twice daily. Breakfast remained the most skipped meal, dinner was the main meal (72%) in both genders and more than 90% reported that they ate regularly out of their home. Most participants were graduate students with a busy time schedule and little time to prepare food. Particularly, Saudi college students who move to live in a remote country away from their homes, adopt inappropriate eating habits reflecting an undesirable fast change in their traditional diet as well as their lifestyle towards a pattern of global behaviour (El Qudah, 2008; Nasreddine *et al*., 2005; Popkin *et al*., 2005). However, 73% of participants were married and lived with their family, which probably contributed to retaining at least some food practice of their home country. In this study, 65% of the participants ate at least on one day from the three days record traditional Saudi food but 83% also ate fast food and men were more likely to consumption fast food than women. These finding are consistent with the results of similar studies in Asia (Pan *et al*., 1999) and Thailand (Sukalakamala & Brittin, 2006) were University students had increased consumption of American foods and decreased consumption of their traditional foods. Recent studies showed that the trend of fast food consumption had increasing among students (Bodur *et al.*, 2010; Musaiger *et al*., 2011; Tayyem *et al*., 2008). There are several factors that contribute to increasing the consumption of fast food; being with friends, being away from home for many hours, cheap price, availability of fast foods and the limited choices of other foods in the Universities (Pei-Lin, 2004; Sakamaki, 2005a).

There are only few publications which assessed dietary intake of adult temporal migration international students in UK, and no research particularly in Saudi men and women. The current study revealed that the mean energy intake of 2231 kcal /day was somewhat higher than UK EAR of 1940 kcal/day for women age 19-50 years, while in men the intake was 2350 kcal /day which was lower than the UK EAR for 19-59 year 2550 kcal/day (Department of Health, 1991). A previous study by Anderson *et al*. (2005) reveled that in 175 South Asian and Italian women living in Glasgow, the mean energy intake was 1722 kcal/day which was lower than reported in the current study. However, it is important to highlight that Anderson *et al*. (2005) analyzed the dietary intake of subjects using a 7 day food record method which may have affected reporting levels. Energy intake from total fat (32.9%) in this study was lower than the 35% of daily energy recommended for health in the UK population (Department of Health, 1994). The percent of daily energy from fat intake estimated among migrant Saudi men (34.5%) was considerably lower than that reported by Miller *et al*. (1988) of Gujaratis and Muslim Bangladeshis males in London. Sevak *et al.* (1994) reported having a higher intake of energy from fat at 36% in Punjabi men, similar to the results of Anderson & Lean (1995), who reported among Sikh and Muslim men, which originating mostly from the Punjab and were resident in Glasgow, UK. Another study by Smith *et al.* (1993), reported that Muslim and Hindu men living in Bradford, UK consumed 38% and 42%, respectively of daily energy from fat. Anderson *et al*. (2005) observed higher percent of daily intakes of fat among women subjects at 39.2% compared with the 32% seen in the current study. However, it is difficult to compare between the results of different studies due to the use different methodologies in addition to the different sample numbers and age groups. The major source of daily energy intake for participants in the current study was the carbohydrates (55%), followed by fat (33%) and protein (15%). This contribution to energy intake from macronutrients is not in line with general guidelines for food consumption; it is at the low end of recommendations for carbohydrate (between 55% and 75%), above the upper level for fat (between 15% and 30%) and also at the upper level for protein (between 10% and 15%) (WHO, 2003). The diets of migrant Saudi men and women appeared to present high CVD risks, being higher in SFA and low in MUFA and PUFA, the latter for which were lower than the UK recommendation of the Department of Health (1991). In addition, the mean daily consumption of sodium intake was 3.1 g/day in the present study, which was twice the figure for the UK RNI for sodium. Several studies have been correlated high levels of sodium with hypertension and its contribution to increased CVD risk (du Cailar *et al*., 2002; Sacks *et al*., 2001; Scientific Advisory Committee on Nutrition, 2003). Furthermore, 8% for men and women were classified as having hypertension. A positive correlation was found between sodium intakes and blood pressure (r = 0.242, P = 0.032). Also, the results showed that participants' diet might be at the risk of low intake of omega 3 and omega 6 fatty acids. The mean daily intake of total omega 3 fatty acids and omega 6 fatty acids for women were 0.72 g/day and 3.9 g/day, respectively; 0.88 g/day and 3.4 g/day, respectively for men. To the researcher's knowledge, no published data are available on the dietary intake of omega 3 and omega 6 fatty acids in Saudi international immigrants. Results from the food group intake (Section 6.4.8) support the findings of the low dietary intake of omega 3 fatty acids, as only 22% of the Saudi subjects reported the intake of fish and sea-food with an average of only 7 g/day per person for this food group. For fruit and vegetables 87% reported consuming these foods at least on one day from the three days record, although the mean intake was 156 g/day per person which is below the current dietary recommendations of at least five portions of fruit and vegetables per day, equivalent to 400 g/day (WHO, 2003) for the prevention of chronic diseases such as heart disease, cancer, diabetes and obesity.

Changes in the lifestyles of Saudis who study abroad, particularly their dietary habits are normally attributed to their acculturation and integration into the community they have moved to, where all participants in the study were residing in the UK for more than one year. Change in the availability of certain food items is related to modifications in their food consumption and dietary intake. A number of studies have revealed that dietary habits are expected to alter to a more westernised diet or in favour of a mixed food diet at the expense of a traditional diet (Gilbert & Khokhar, 2008). Subsequently, in this study, fast food consumption was higher than expected for adults in Saudi Arabia and this was accompanied by a decrease in traditional food consumption especially in male subjects. Such findings reveal that the Saudi students who migrate adopt the consuming habits of the cuisines and the foods that are available to them in the new environment which they moved to. In spite of this change, the overall decrease in the consumption of the traditional food was less observed among married couples than among single students. This can be ascribed to the skills of cooking since some students may lack the necessary skills that can enable them to prepare their own foods (Brunt & Rhee, 2008) because they have left their family homes and took on the responsibility of purchasing and preparing their foods possibly for the first time in their lives (Papadaki & Scott, 2002). Another challenge that international students encounter is the unavailability of the traditional foods when they move to live in the UK. In addition, other factors such as the limited time of the students, and the lack of experience of shopping and preparing foods may come into play and make them unable to maintain their consumption of traditional foods (Greaney *et al*., 2009).

6.6 Summary and conclusions

The aims of this part of the study were achieved:

- Complete information was available for 79 participants 32 men (41%) and 47 women (59%). The mean (SD) ages of the women were 28.8 (4.96) years and men were 30.9 (6.27) years.
- The majority of men and women reported as medium socioeconomic status, with 89% of women and 59% of men.
- There were no significant differences between men and women in BMI classification, diabetes, high blood cholesterol, high blood pressure ($P > 0.05$).
- Physical activity was low in 72% of men and 92% of women.
- Smoking was more prevalent in men (56%) than women (6%).
- The results show marked differences in diet composition between men and women which may affect CVD risk. Men had significantly higher dietary intakes than women with respect to total fat, cholesterol and zinc ($P < 0.05$).
- The mean daily intake of total omega 3 fatty acids was 0.72 g/day for females and 0.88 g/day for males. No differences were observed between gender in total omega 3 fatty acids and total omega 6 fatty acids. However, there was a statistically significant difference in the mean total daily intake of *trans* fatty acids.

- There were no association with energy, carbohydrates, SFA, MUFA and PUFA intakes and CVD risk factors.
- There were relationship between both dietary total omega 3 intakes and ALA intakes with age ($P < 0.05$) and with BMI ($P < 0.05$).
- Based on food group consumption on data, men consumed a diet that was relatively high in fast food compared with women.
- There was a statistically significantly positively associated between fast food with BMI, but negatively associated with age.

Chapter 7

Comparison of the Dietary Patterns of Saudi Populations from different Geographical locations (Coastal and Internal Cities) in the Western Region of Saudi Arabia

7.1 Introduction

The significance of diseases that are related to diet has become greater than before over the last three decades (Moynihan, 2005; Watt & Sheiham, 1999). Musaiger (2002) argues that hypertension, diabetes mellitus, obesity, CVD and other chronic diseases that are related to diet have turned to be the major problem in the Arabian Gulf countries. Gender, age, media, socioeconomic status, and cultural aspects also have their effects on dietary patterns. In Saudi Arabia, there has been a significant change in disease trends due to the change in the lifestyle and dietary habits. For instance, in Saudi Arabia, adult and children eating behaviour have altered from a conventional diet that is characterized by low cholesterol and fat, and high fibre content to a diet which is similar to western diets that have high amounts of sodium, fat and cholesterol (Abahussain, 1999; Al Herbish, *et al*., 1996). Al Hazmi and Warsy (1999) mentioned that there has been a dramatic increase in daily individual consumption of fat in many countries in the Middle East. This ranges from 13.6% in the Sudan to 143.3% in Saudi Arabia (Shara, 2010). Research conducted by Magbool (1993) and Musaiger (2002) revealed that the data collected on food composition in this region reflects a high percentage of sodium content in the diets of Middle Eastern Arab countries. At present, the data is limited relating to the risk factors of CVD and diets of both Saudi men and women. Furthermore, much of the data is unknown as regards to individuals who come from various socioeconomic backgrounds and regions across the country, and with respect to their effects on diet. In view of the increase of CVD risk factors within this population group, there is a need for further investigation into health problems in the future.

The effects of diets containing sources rich in omega 3 fatty acids and their impact on CVD risk factors has been of interest over the last two decades (Lavie *et al*., 2009). As far as this researcher is aware, there is little published data available on the dietary intake of omega 3 fatty acids in both men and women in Saudi Arabia. Moreover, hardly any research has been carried out on the effects of geographic location on the consumption of omega 3 fatty acids in the other Arabian coastal countries. In addition, to ascertaining which food group contributes to a dietary pattern associated with CVD risk factors. It is important to collect detailed information about dietary patterns to assess the impact of dietary intake on the development of CVD. Therefore, this study was designed to investigate dietary intake, including omega 3 fatty acids, from two sample group of adults living in different geographic locations: one being Jeddah, a coastal city and the other, Makkah, which was considered representative of the interior area. According to the Ministry of Health for Saudi Arabia, the population in the coastal city of Jeddah consumes more fish in their diet and has a relatively lower death rate from CVD compared with the population of the inland city of Makkah (Health Statistical Year Book, 2009). Health statistics have revealed that 10% of the total deaths in Jeddah and 18% in Makkah were due to CVD (Health Statistical Yearbook, 2003).

7.2 Study aims and objectives

7.2.1 Aims

- To compare the dietary intake of the Saudi population living in the western coastal area of Saudi Arabia with those living in the internal area of the country.
- To compare the intake of omega 3 fatty acids of Saudi population living in the western coastal areas of Saudi Arabia with those living in internal area of the country.

7.2.2 Objectives

- To compare and report any significant differences between the intakes of men and women in these two cities in the daily energy intake and the daily intake of the following macronutrients: protein, fat, SFA, MUFA, PUFA and carbohydrate, fibre, cholesterol, calcium, iron, magnesium, sodium, potassium, zinc, vitamin C, vitamin E, vitamin A and selenium.
- To compare and report any significant differences between the intakes of men and women in these two cities in the daily intake of the following fatty acids: LA, ALA, total *trans* fatty acid, AA, EPA and DHA.
- To compare and report any significant differences between CVD risk factors and the socioeconomic characteristics in the study population.
- To compared and report any significant differences between food groups (nuts and seeds, fish, fruit and vegetable, fast food and traditional Saudi food) among the study subjects.

7.3 Methods

7.3.1 Study subjects

Participants in this study were recruited from King Abdul Aziz University, Jeddah and Umm Al Qura University, Makkah, in the western region of Saudi Arabia. All participants were working in all occupations in their respective universities and the study sampled both men and women without overt CVD within an age range of 18 to 65 years. After the research was approved by the committee, the researcher travelled twice to Saudi Arabia to collect the data. It took approximately three months to administer the surveys and collect the data from the participants from July to September 2010 and 2011. A potential participant was sent a letter of invitation from the general practice from the Employee Affairs Director within both universities. The total number of the employee who distributed the questionnaire was 400, 229 were completed and interviewed, 100 completed the survey from Jeddah and 129 participants completed the survey from Makkah (Chapter 3).

7.3.2 Demographic and anthropometric information

Each participant was asked to complete an interviewer administered questionnaire concerning demographic characteristics, including five sections, general information, medical information, social habits, dietary habits and food diary. The questionnaire designs and the anthropometric information were described previously in the methods chapter 3.

7.3.3 Dietary assessment

The subjects were asked to complete a three day estimated food diary on three consecutive days, two week days with one weekend day and were interviewed to clarify the information in the diary. The researcher met the subjects in any available place in the university and explained to the subjects how to complete the food diary and asked them to carry the food diary with them all the time during the three days. The researcher asked the subjects to record everything they ate or drank and to write down the amount of food or drink consumed using household measures (for example, plates, glasses, spoons). The importance of not changing their dietary pattern during the collection period was stressed. The interviews were undertaken on the first week day following completion of the food diaries in order not to compromise the subjects' ability to remember their dietary consumption. The interview was used to clarify the types and amounts of foods and drinks consumed over three days. The interview took place on an individual basis and where appointments were held at college or workplace a private room was made available. All information that was provided by the subjects was kept confidential. Participants were thanked for their co-operation and for participating in the study. Nutritional analysis was then carried out, as described in Chapter 3.6.

7.3.4 Statistical analysis

Following descriptive analysis, all questionnaire data were analysed using SPSS for Windows, version 19 (SPSS Inc., Chicago, IL, USA), with Chi square analysis, to determine if there were a statistically significant difference in the responses for different groups. The data were also analysed by same gender (Chi square analysis). The statistical significance level was set at 5% ($P < 0.05$). Comparisons between cities were carried out using in-dependent *t* tests. Comparisons between cities in nutrient intakes were adjusted by age, gender using regression analysis. Correlation coefficients and their probability levels were obtained from linear regression analyses. Stepwise multiple regression analysis was used to select significant covariates ($P < 0.05$) for each dietary intake between both cities. Several recent studies indicate that age, gender, BMI, WHR, diabetes, hypercholesterolemia, hypertension, socioeconomic status (educational status and/or monthly income), smoking and physical activity were shown to correlate with nutrient intake (Perk *et al*., 2012; Verschuren, 2012; Yen *et al*., 2010). Variables which were statistically significantly associated with dietary intake at the 5% level were selected. Therefore, it was decided that multivariate general linear model analysis was carried out using dietary intake as the dependant variables and age, gender, BMI, smoking and physical activity as the covariates.

7.4 Results

7.4.1 Demographic data

7.4.1.1 Age and gender

The characteristics of the study population appear in Table 7.1. Among the 229 adults who participated in the study, the total number of women was 106 (46%) and 123 (54%) were men. The mean (SD) age of women population was 32.1 (8.01) years old and for men it was 32.3 (8.71) years old with no significant differences between cities. The sample was divided into four categories. The majority 53% in Jeddah and 49% in Makkah samples were aged between 18 - 30 years old. About 32% in Jeddah and 35% in Makkah between 31- 40 years, 12% of participants Jeddah and 11% in Makkah were between 41 - 50 years, whereas those aged between 50 - 65 years constituted 3% and 5% of the sample.

Table 7.1: Distribution of respondents by site, gender and age

Site	Females (*n* = 106)				Males (*n* = 123)				Total of 229
	18-30 *n* (%)	31-40 *n* (%)	41-50 *n* (%)	51-65 *n* (%)	18-30 *n* (%)	31-40 *n* (%)	41-50 *n* (%)	51-65 *n* (%)	
Jeddah	23 (23)	19 (19)	8 (8)	-	30 (30)	13 (13)	4 (4)	3 (3)	100
Makkah	31 (24)	15 (12)	8 (6)	2 (2)	33 (25)	30 (23)	6 (5)	4 (3)	129

Table 7.2 summarizes the demographic characteristics of all study participants (both gender) in their respective cities.

7.4.1.2 Education status

With respect to the education level of men and women in both cities, the majority of subjects (98%) had completed a basic primary school level education or above, while 2% were illiterate. There were significant differences between cities in terms of education level (χ^2 = 10.546, P = 0.030) whereas, no significant differences in the same gender in both cities. Figure 7.1 shows the education level distribution of all study participants.

7.4.1.3 Monthly income

Current monthly incomes of 21%, 32% of the Jeddah and Makkah participants, respectively, were in the 1RS - 3000RS range, whereas 33%, 16% were in the 3001RS - 6000RS range, and 10%, 16% had a monthly income more than 12000RS. Statically significant differences occurred between Jeddah and Makkah in monthly income (χ^2 = 12.303, P = 0.010). Furthermore, there were no significant differences in monthly income between females of both cities, whereas in males monthly income was significantly higher in Makkah ($P < 0.05$). Figure 7.2 provides monthly incomes (RS) distribution of all study participants.

7.4.1.4 Marital status

Of the study population, 53% were married (coastal city 52% and internal city 53%). Approximately 45% were single (coastal city 46% and 45% internal city), and only 2% in both cities were widowed or divorced. There were no significant differences according to cities in marital status (P = 0.950). Figure 7.3 presents marital statuses distribution of all study participants.

7.4.2 Socioeconomic factor

The majority of participants had a medium socioeconomic status in both areas (63% for Jeddah samples and 50% for Makkah samples). 19% of participants had high socioeconomic status in Jeddah, with 31% for Makkah. The chi-square test did not show any significant differences between cities ($\chi^2 = 4.233$, $P = 0.120$).

Table 7.2: Comparison of demographic characteristics of subjects Jeddah and Makkah by gender

Characteristics	Females *n* (%)				Males *n* (%)			
	Jeddah	Makkah	χ^2	*P*	Jeddah	Makkah	χ^2	*P*
Education								
Illiterate	1 (1)	-			1 (1)	-		
Writing & Reading	2 (2)	-			-	-		
Primary	2 (2)	-	6.529	N.S	1 (1)	-	4.045	N.S
High School	11 (11)	10 (8)			23 (23)	28 (22)		
University or Above	34 (34)	46 (35)			25 (25)	45 (35)		
Monthly income (RS)*								
1 – 3000	8 (8)	20 (15)			13 (13)	22 (17)		
3001 - 6000	13 (13)	11 (8)			20 (20)	10 (8)		
6001 – 9000	18 (18)	13 (10)	8.403	N.S	5 (5)	10 (8)	13.158	< 0.05
9001 – 12000	9 (9)	6 (5)			4 (4)	17 (13)		
More than 12000	2 (2)	6 (5)			8 (8)	14 (11)		
Marital status								
Single	16 (16)	24 (19)			30 (30)	34 (26)		
Married	32 (32)	30 (23)	1.329	N.S	20 (20)	39 (30)	2.143	N.S
Widowed or Divorced	2 (2)	2 (2)			-	-		
Socioeconomic status								
Low	8 (8)	4 (3)			10 (10)	21 (16)		
Medium	31 (31)	41 (32)	2.390	N.S	32 (32)	23 (18)	11.361	< 0.05
High	11 (11)	11 (8)			8 (8)	29 (23)		

N.S: not significant.
*Riyal Saudi (currency 5.83 RS = 1£).

Figure 7.1: Education level distribution of all study participants (% illiterate, writing & reading, primary, high school, university or above)

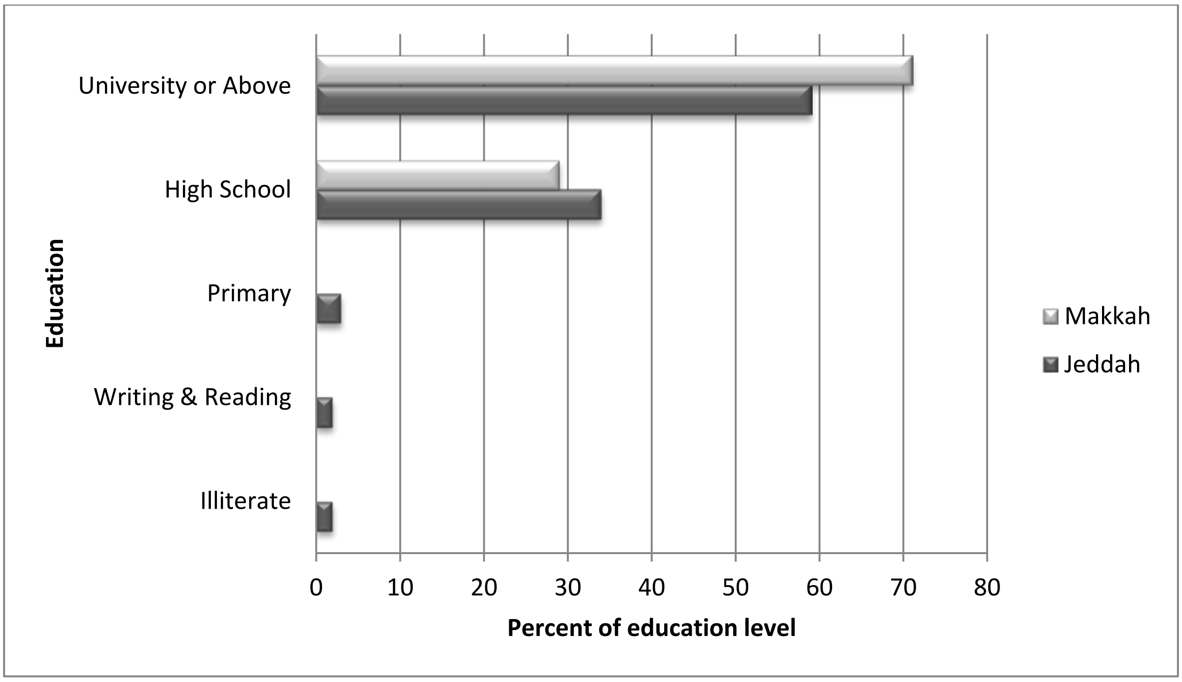


Figure 7.2: Monthly income (RS) distribution of all study participants (% 1-3000, 3001-6000, 6001-9000, 9001-12000, more than 12000)

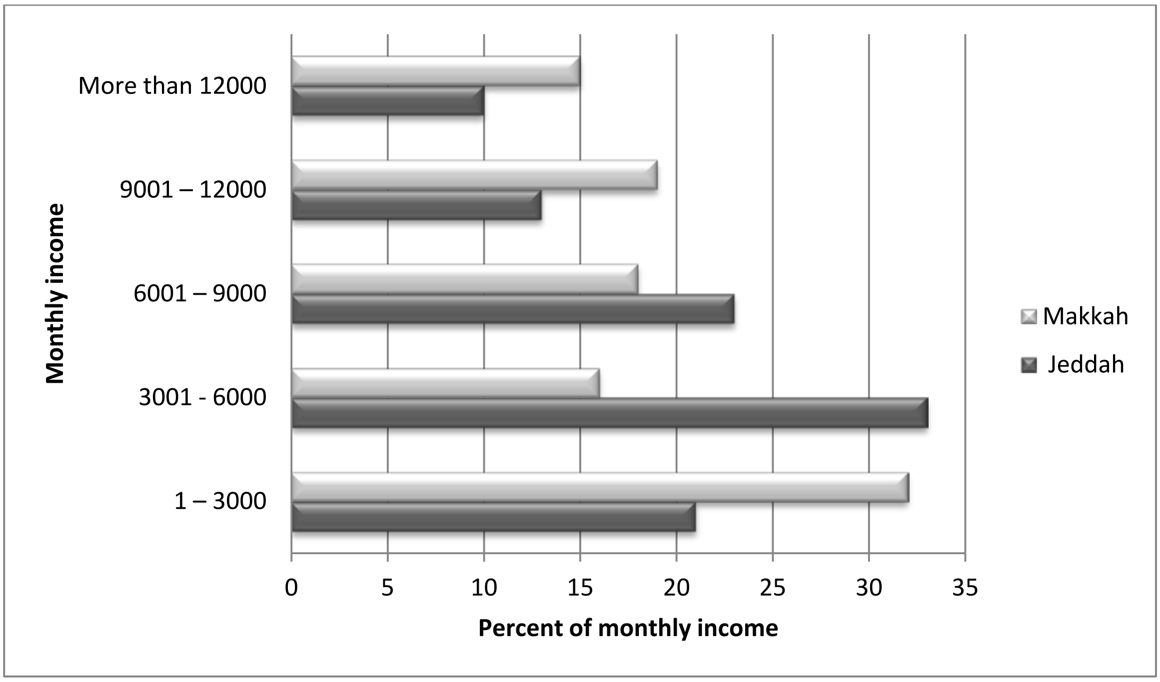
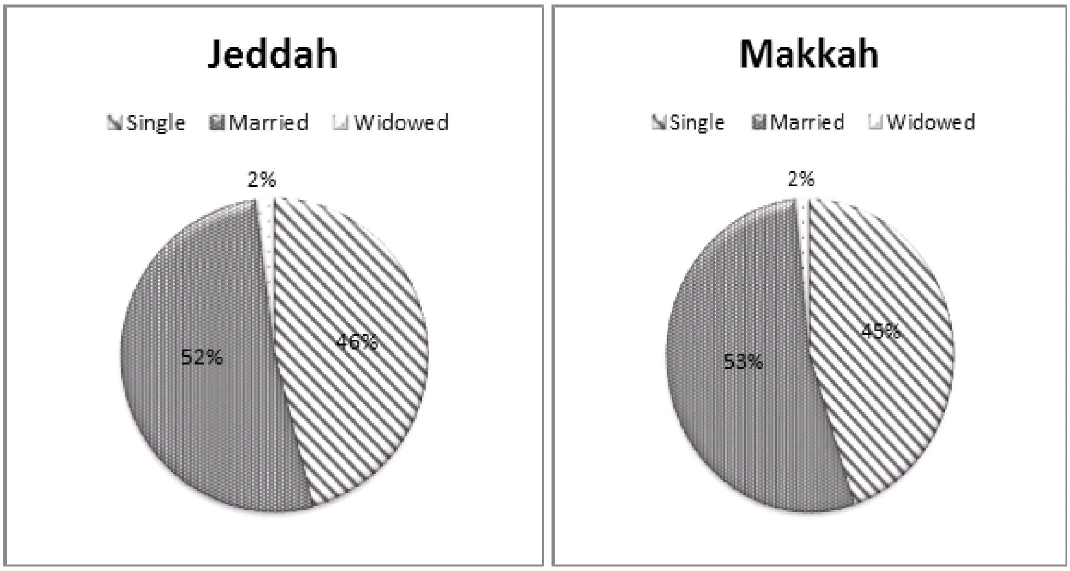


Figure 7.3: Marital status distribution of all study participants (% single, married, widowed)



7.4.3 Anthropometric data

On average, male participants were taller and heavier than female participants (Table 7.3). Of the 229 respondents, the mean (SD) BMI was 25.7 (3.08). In Jeddah and in Makkah the BMI was 25.1 (2.76) and 26.2 (3.21), respectively. In-dependent samples *t* test revealed there were significant differences between Jeddah and Makkah participants in BMI (P = 0.008). Differences in BMI were confirmed between females of both cities ($P < 0.05$). The mean (SD) for WC in females from Jeddah, females from Makkah, males from Jeddah and males from Makkah was 87.4 (7.2), 86 (10.03), 89.3 (11.7) and 91.5 (8.96) cm, respectively. There were significant differences between males from Jeddah and Makkah in WC ($P < 0.05$). With respect to WHR, differences were only found to be significant between males ($P < 0.05$), but not between female participants. The mean (SD) WHR for females from Jeddah, females from Makkah, males from Jeddah and males from Makkah was 0.86 (0.04), 0.86 (0.06), 0.97 (0.1) and 1 (0.07) cm, respectively. Females in Makkah had a greater mean percentage of body fat (34%) compared to females in Jeddah (32%). Table 7.3 summarizes the anthropometric measurements of all study participants (both gender) in their respective cities.

7.4.4 Comparison of cardiovascular risk factors between cities

The prevalence of cardiovascular risk factors among males and female in their respective cities is shown in Table 7.4.

Table 7.3: Comparison between anthropometric measurements of Jeddah and Makkah subjects by gender

Variables	Females mean (SD)			Males mean (SD)		
	Jeddah	Makkah	*P*	Jeddah	Makkah	*P*
Height (cm)	160 (5.80)	160 (6.20)	N.S	173 (5.47)	171 (4.35)	< 0.05
Weight (kg)	63.9 (7.28)	66.8 (11.40)	N.S	75.3 (9.87)	76.1 (7.86)	N.S
BMI (kg/m^2)	25 (2.41)	26.7 (3.94)	< 0.05	25.04 (3.01)	25.90 (2.49)	N.S
BMR (kcal /d)	1388 (76.5)	1414 (97.40)	N.S	1527 (100)	1521 (67.90)	N.S
WC (cm)	87.4 (7.22)	86 (10.03)	N.S	89.3 (11.71)	91.5 (8.96)	< 0.05
HC (cm)	101 (5.97)	99.8 (7.78)	N.S	91.9 (7.21)	91.4 (5.57)	N.S
WHR (cm)	0.86 (0.04)	0.86 (0.06)	N.S	0.97 (0.11)	1 (0.07)	< 0.05
Body fat (%)*	32.1 (4.01)	34.1 (6.26)	< 0.05	20.9 (4.81)	22.5 (4.39)	N.S
TSF (mm)	19.1 (2.41)	19.3 (2.26)	N.S	12.2 (3.54)	12.4 (2.57)	N.S
AC (cm)	30.4 (2.21)	30.2 (2.70)	N.S	28.7 (3.01)	27.7 (2.17)	N.S
AMC (cm)	24.4 (1.96)	24.1 (2.19)	N.S	24.8 (2.30)	23.8 (1.69)	< 0.05

BMI: Body Mass Index. BMR: Basal Metabolic Rate. WC: Waist Circumference. HC: Hip Circumference. WHR: Waist: Hip Ratio. TSF: Triceps Skin-fold. AC: Arm Circumference. AMC: Arm Muscle Circumference. $P < 0.05$, *t* test was used to compare cities, N.S: not significant. * Calculated from TSF (Durnin & Womersley, 1974).

7.4.4.1 Obesity

BMI values ranged from 17 to a maximum of 42.5 kg/m^2 in both areas. Overall, 55% of the participants were deemed overweight or obese (42% coastal area *vs.* 66% internal area). BMI classification was highly significantly different between two cities (χ^2 = 13.076, $P = 0.004$). Differences were also found between females and males ($P < 0.05$) (Table 7.4). In the study sample, about 25% of participants from Jeddah and 29% from Makkah could therefore be defined as high risk WC. High risk WC was defined as > 88 cm and > 102 cm for females and males, respectively (Molarius *et al.*, 1999). The optimal cuts off values of WHR were < 0.80 for women and < 0.95 for men (Lean *et al.*, 1995). With respect to WHR, 20% and 24% from both areas (Jeddah and Makkah, respectively) were defined as non-obese. There were no significant differences found when comparing between the two populations in terms of WC and WHR ($P > 0.05$; *t* test).

Table 7.4: Comparison of prevalence of cardiovascular risk factors of Jeddah and Makkah subjects by gender

Risk factors	Females n (%)				Males n (%)			
	Jeddah	Makkah	χ^2	*P*	Jeddah	Makkah	χ^2	*P*
BMI Classification								
Underweight	-	1 (1)			1 (1)	-		
Normal	29 (29)	17 (13)	8.57	< 0.05	28 (28)	26 (20)	5.913	< 0.05
Overweight	19 (19)	31 (24)			17 (17)	41 (32)		
Obese	2 (2)	7 (5)			4 (4)	6 (5)		
Diabetes*								
Normal	42 (42)	50 (39)	0.644	N.S	47 (47)	64 (49)	1.350	N.S
Diabetic	8 (8)	6 (5)			3 (3)	9 (7)		
High blood cholesterol*								
Normal	43 (43)	49 (38)	2.861	N.S	45 (45)	63 (49)	2.106	N.S
Hypercholesterolemia	7 (7)	7 (5)			5 (5)	10 (8)		
High blood pressure*								
Normal	36 (36)	50 (39)	5.156	< 0.05	46 (46)	65 (50)	3.226	N.S
Hypertension	14 (14)	6 (5)			4 (4)	8 (6)		
Heart disease*								
Normal	43 (43)	54 (42)	3.697	N.S	48 (48)	72 (56)	0.863	N.S
Heart disease	7 (7)	2 (1)			2 (2)	1 (1)		
Family history:								
Diabetes	27 (27)	36 (28)	0.264	N.S	25 (25)	37 (29)	3.870	< 0.05
Heart diseases	8 (8)	8 (6)			3 (3)	10 (8)		
Smoking status								
Non-smoker	46 (46)	38 (29)			15 (15)	13 (10)		
Ex-smoker	-	-			5 (5)	14 (11)		
Current (<20cigarette)	1 (1)	3 (2)	8.661	< 0.05	20 (20)	20 (15)	15.276	< 0.05
Current (>20cigarette)	-	1 (1)			5 (5)	25 (19)		
Shisha	3 (3)	14 (11)			5 (5)	19 (15)		
Physical activity								
Inactive	39 (39)	52 (40)			23 (23)	46 (36)		
Moderately active	10 (10)	3 (2)	9.186	< 0.05	17 (17)	21 (16)	12.970	< 0.05
Active	1 (1)	1 (1)			10 (10)	6 (5)		

N.S: not significant. * Self-reported.

7.4.4.2 Personal medical history

Among respondents, 11% compared with 12% having diabetes, 12% compared with 13% reported having hypercholesterolemia, 18% compared with 11% having hypertension and subjects having heart disease 9% compared with 2% from the total population in Jeddah and Makkah, respectively. No differences in self-reported diabetes (P = 0.490), hypercholesterolemia (P = 0.060) and heart disease (P = 0.07) were observed among adults between the two cities. However, significantly more women in the Jeddah self-reported high blood pressure compared with women in Makkah (χ^2 = 5.156, P < 0.05). Figure 7.4 presents personal medical conditions distribution of all study participants.

7.4.4.3 Family history

The prevalence of diabetes in any first degree relative (father, mother or both parents) was 52% in Jeddah samples and 57% in Makkah samples, while heart disease was reported at 11% in Jeddah and 14% in Makkah. Figure 7.5 shows family history distribution of all study participants.

7.4.4.4 Smoking habits

Smoking cigarettes presently or in the past was different in each region (Jeddah, 31% and Makkah, 48%), as was smoking shisha (8% in Jeddah and 26% in Makkah). Only participants from Makkah smoked both cigarettes and shisha (17% participants). 61% of respondents in Jeddah and 39% in Makkah stated that they had never smoked. There were highly significantly differences between cities in terms of smoking habits for all participants ($\chi^2 = 26.742$, $P < 0.001$), as well as for women ($\chi^2 = 8.661$, $P < 0.05$) and men ($\chi^2 = 15.276$, $P < 0.05$). Figure 7.6 shows the smoking status distribution of all study participants.

7.4.4.5 Physical activity

In total of the 229 participants, 71% reported a low level of physical activity with 62% in Jeddah and 76% in Makkah. In contrast, 29% had medium or high level of physical activity. Male participants reported engaging in more physical activity than females. Moreover, the level of physical activity was statistically different between the two cities ($\chi^2 = 12.739$, $P = 0.005$), and females from Jeddah had a greater percentage of activity (11%) than females from Makkah (3%) ($P < 0.05$), while males from Makkah had a greater percentage of inactivity than males from Jeddah (36% *vs.* 23%) ($P < 0.05$). Figure 7.7 illustrates the physical activity distribution of all study participants.

Figure 7.4: Personal medical conditions distribution of all study participants (% obesity, high blood pressure, high blood cholesterol, diabetes, heart disease)

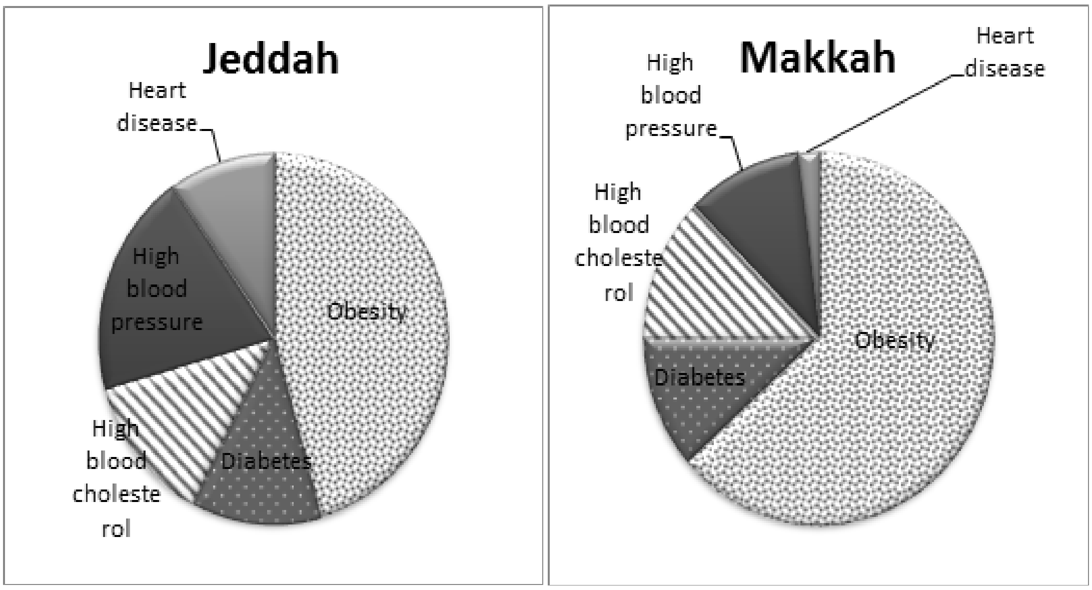


Figure 7.5: Family history distribution of all study participants (% heart disease, diabetes)

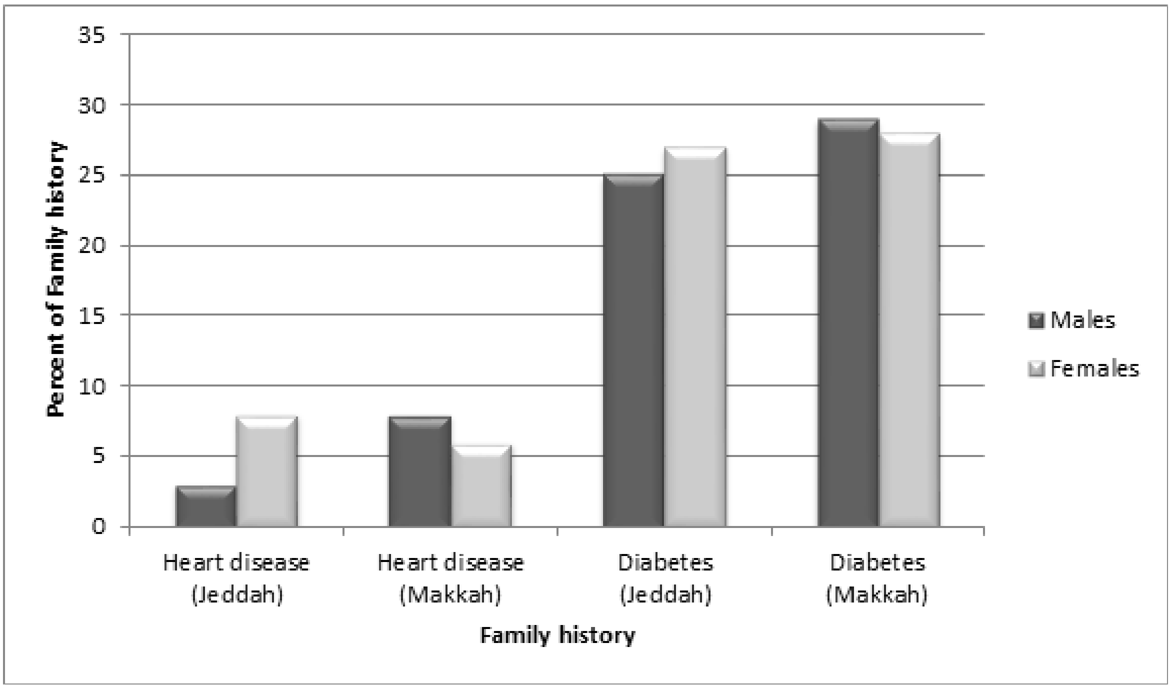


Figure 7.6: Smoking status distribution of all study participants (% non-smoker, ex-smoker, current < 20 cigarette, current > 20 cigarette, shisha)

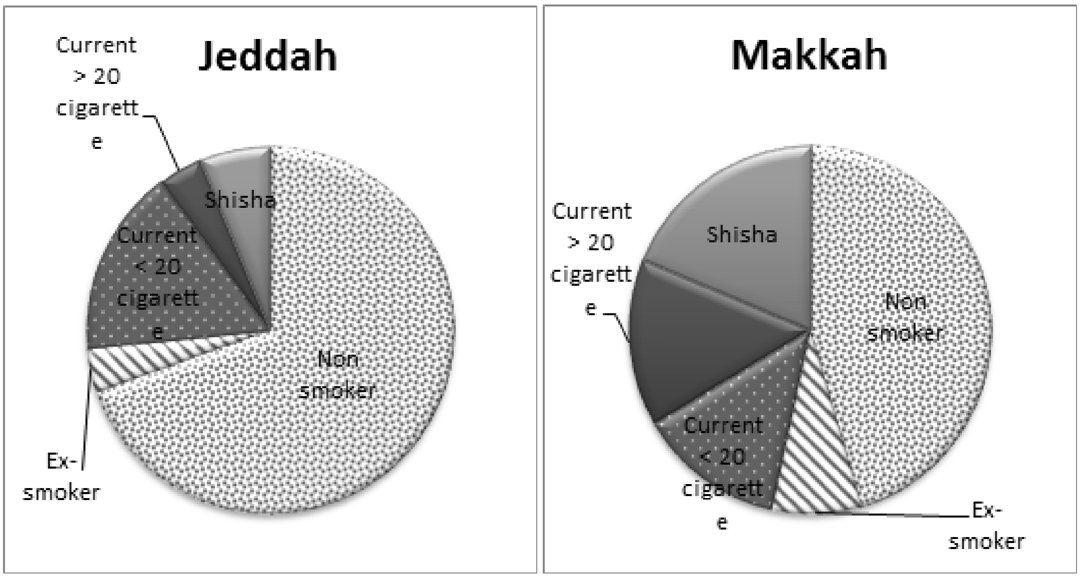
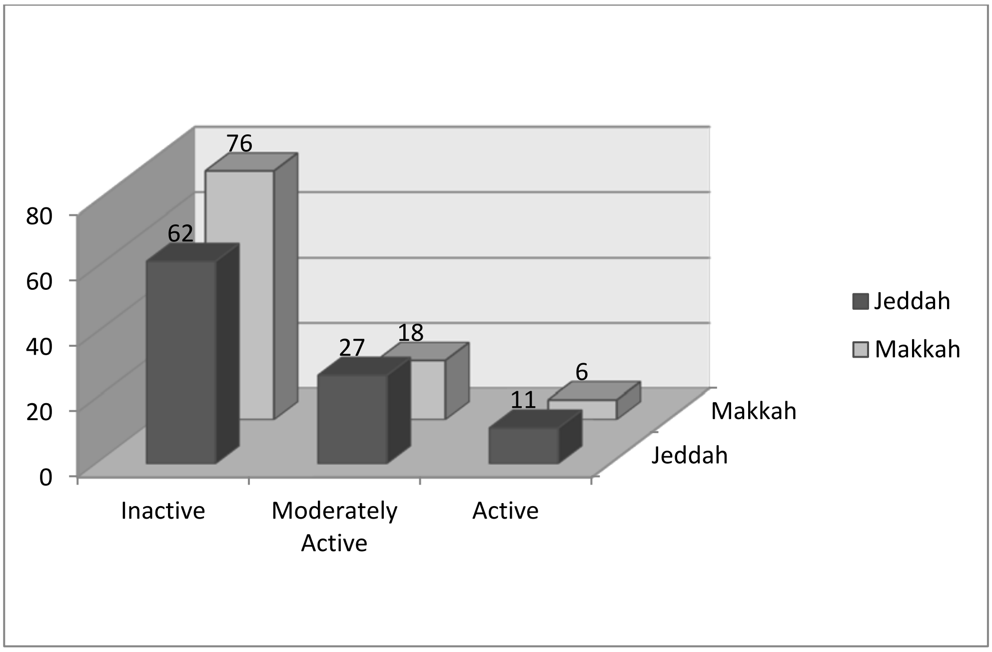


Figure 7.7: Physical activity distribution of all study participants (% active, moderately active, inactive)



7.4.5 Dietary data

7.4.5.1 Dietary habits

Table 7.5 shows dietary habits of both men and women in their respective cities. The majority of participants ate three meals per day (69% of the population in the coastal area and 75% in the internal area). The main meal was lunch for 86% of the population in

Jeddah, and 83% for those in Makkah. The frequency of daily breakfast consumption was 38% for Jeddah and 49% for Makkah. There were significant differences between females from Jeddah and females from Makkah in eating breakfast (*P* < 0.05). Most of the participants (89% in the coastal city and 93% the internal city) ate food outside their home at some time during the week with more females in Makkah reporting eating out (χ^2 = 10.413, *P* < 0.05).

Table 7.5: Comparison of prevalence of dietary habits between Jeddah and Makkah subjects by gender

Eating patterns	Females *n* (%)				Males *n* (%)			
	Jeddah	Makkah	χ^2	*P*	Jeddah	Makkah	χ^2	*P*
Meals (no./day):								
1 or 2	10 (10)	18 (14)			19 (19)	11 (8)		
3 or 4	39 (39)	37 (29)	1.999	N.S	30 (30)	60 (46)	8.382	< 0.05
More than 5	1 (1)	1 (1)			1 (1)	2 (2)		
Main meal:								
Breakfast	1 (1)	5 (4)			4 (4)	9 (7)		
Lunch	46 (46)	46 (35)	2.540	N.S	40 (40)	62 (48)	4.225	N.S
Dinner	13 (13)	13 (10)			18 (18)	25 (19)		
Eating breakfast:								
Daily	12 (12)	26 (20)			26 (26)	38 (29)		
Sometimes	27 (27)	24 (18)	6.486	< 0.05	22 (22)	33 (26)	0.885	N.S
Never	11 (11)	6 (5)			2 (2)	2 (2)		
Eating outside (per week):								
Never	5 (5)	5 (4)			6 (6)	3 (3)		
Once or twice	39 (39)	30 (23)	10.413	< 0.05	22 (22)	36 (28)	4.633	N.S
Three or four times	6 (6)	16 (12)			13 (13)	26 (20)		
More than four times	-	5 (4)			9 (9)	8 (6)		

N.S: not significant

7.4.5.2 Nutrient intake

7.4.5.2.1 Intake of energy, macronutrients, cholesterol and fibre

There were marked differences in the comparison of macronutrient between the coastal and internal areas, reflecting differences in overall dietary patterns. Energy intake for Makkah samples was higher than Jeddah samples (*P* < 0.001) (Table 7.6 and 7.7). The mean (SD) energy intake of females from Jeddah, females from Makkah, males from Jeddah and males from Makkah was as follows: 2051 (373), 2295 (251), 1959 (265), and 2256 (208) kcal/day, respectively. For individuals aged 19 to 59, the UK EAR is 1940 kcal/day for women and 2550 kcal/day for men. On average all men in the study were consuming below the recommended levels for energy. Total fat provided 36% and 33% of total energy for city inhabitants in Jeddah and Makkad, respectively ($P < 0.001$). Energy from SFA were significantly different between Jeddah and Makkah subjects with 12.4% and 14.4%, respectively ($P < 0.001$). Both MUFA intake and PUFA intake were higher in Jeddah participants compared to Makkah participants. The percentage energy from MUFA in Jeddah was 12.4% and 8.8% in Makkah ($P < 0.001$). The percentage energy from PUFA intake was 6.9% and 3.1% for inhabitants of Jeddah and Makkah, respectively ($P < 0.001$) (Tables 7.6 and 7.7). Dietary cholesterol intake was similar across the two cities. Intake of protein from total energy was lowest for Makkah (15.2%), compared with 16.4% in Jeddah ($P < 0.05$), as illustrated in Table 7.6 and 7.7. The percent energy from carbohydrates of Makkah subjects was higher than that of Jeddah subjects. Females in Makkah had the highest intake of total carbohydrate 56%, in contrast to 51% for females in Jeddah. Significant differences were observed within the same gender ($P < 0.001$) and also appeared between cities ($P < 0.001$). Table 7.6 demonstrates that the carbohydrate had the largest contribution (53%) to total daily energy intake for all 229 participants compared with fat (34%) and protein (16%).

It appears that the mean for fibre intake was below the recommended level. The mean (SD) of fibre intake among all 229 subjects was 9.4 (4.16) g/day. More specifically, the mean fibre intake for females from Jeddah, females from Makkah, males from Jeddah and males from Makkah was as follows: 11.3 (5.53), 8.9 (2.62), 8.8 (4.16) and 8.9 (3.69) g/day, respectively. After adjustment for age and gender, multiple linear regression analysis revealed there were significant differences between two cities ($P < 0.05$).

Table 7.6: Mean, standard deviation (SD), median and 95% Confidence Intervals (CI) for daily energy intake and daily intake of macronutrients of subjects by city

Nutrient	Overall			Coastal City Jeddah			Internal City Makkah			*P***
	Mean (SD)	Median	95% CI	Mean (SD)	Median	95% CI	Mean (SD)	Median	95% CI	
Energy (MJ/d)	9.1 (1.28)	9.07	8.8, 9.2	8.4 (1.36)	8.1	8.15, 8.69	9.5 (9.61)	9.4	9.38, 9.72	< 0.001
Energy (kcal/d)	2156 (304)	2153	2116, 2195	2005 (325)	1941	1941, 2070	2273 (228)	2233	2233, 2312	< 0.001
Total fat (g/d)	81.8 (17.8)	80	79.5, 84.2	80.2 (20.8)	77.3	76.09, 84.3	83.1 (14.94)	82.5	80.5, 85.7	N.S
% of daily energy	34.1			35.8			32.9			< 0.001
SFA (g/d)	32.6 (9.61)	32.6	31.3, 33.8	27.8 (9.2)	26.4	25.9, 29.6	36.3 (8.20)	36.5	34.8, 37.7	< 0.001
% of daily energy	13.5			12.4			14.3			< 0.001
MUFA (g/d)	23.7*	24.2	22.4, 24.7	26.5*	26.5	25.1, 28.1	22.1 (6.12)	22.7	21.1, 23.1	< 0.001
% of daily energy	10.3			12.4			8.8			< 0.001
PUFA (g/d)	11.2 (4.77)	10	10.4, 11.9	15.4 (6.12)	15.3	14.2, 16.65	7.9 (2.43)	8	7.5, 8.4	< 0.001
% of daily energy	4.78			6.9			3.1			< 0.001
Cholesterol (mg/d)	254 (88.16)	248	242, 265	256 (98)	251	237, 276	252 (80.03)	248	238, 266	N.S
Protein (g/d)	84.4 (17.48)	83.7	82.1, 86.7	82.09 (18.13)	79.4	78.4, 85.6	86.2 (16.79)	84.8	83.3, 89.1	N.S
% of daily energy	15.7			16.4			15.2			< 0.05
Carbohydrates (g/d)	288 (55.27)	286	280, 295	252 (49.7)	250	243, 262	315 (42.67)	315	307, 322	< 0.001
% of daily energy	53.2			50.4			55.3			< 0.001
Fibre (g/d)	9.4 (4.16)	8.9	8.9, 9.9	10.09 (5.04)	9.4	9.09, 11.09	8.9 (3.26)	8.3	8.3, 9.5	< 0.05

SFA indicates saturated fatty acids; MUFA, monounsaturated fatty acids; PUFA, polyunsaturated fatty acids.
*Geometric means. ** *P*-values were significant using general linear regression, which were adjusted for age and gender.
N.S: not significant.

Table 7.7: Comparison of daily energy intake and daily intake of macronutrients between Jeddah and Makkah subjects by gender

Nutrient	Females mean (SD)			Males mean (SD)		
	Jeddah	Makkah	*P*	Jeddah	Makkah	*P*
Energy (MJ/d)	8.6 (1.55)	9.6 (1.07)	< 0.001	8.2 (1.11)	9.4 (0.87)	< 0.001
Energy (kcal/d)	2051 (373)	2295 (251)	< 0.001	1959 (265)	2256 (208)	< 0.001
Total fat (g/d)	83.88 (22.96)	81.1 (15.10)	N.S	76.5 (18.08)	84.7 (14.72)	< 0.05
% of daily energy	36.5	31.7	< 0.001	35.1	33.7	< 0.05
SFA (g/d)	29.5 (10.48)	34.1 (7.68)	< 0.05	26.12 (7.46)	38.1 (8.22)	< 0.001
% of daily energy	12.8	13.3	< 0.05	12	15.1	< 0.001
MUFA (g/d)	28.18 (8.14)	21.1 (5.91)	< 0.001	26.1(23.9, 28.3)*	22.8 (6.11)	< 0.05
% of daily energy	12.3	8.3	< 0.001	12.4	9.2	< 0.001
PUFA (g/d)	16.6 (6.91)	9.1 (2.33)	< 0.001	14.25 (5.02)	7.1 (2.17)	< 0.001
% of daily energy	7.2	3.6	< 0.001	6.5	2.8	< 0.001
Cholesterol (mg/d)	243 (87.72)	245 (75.93)	N.S	269 (107)	257 (83.21)	N.S
Protein (g/d)	80.4 (19.93)	87.5 (17.77)	N.S	83.7 (16.17)	85.3 (16.06)	N.S
% of daily energy	15.7	15.3	N.S	17.2	15.1	< 0.05
Carbohydrates (g/d)	258 (48.54)	323 (42)	< 0.001	247 (50.72)	308 (42.37)	< 0.001
% of daily energy	50.7	56.3	< 0.001	50.3	54.6	< 0.05
Fibre (g/d)	11.3 (5.53)	8.9 (2.62)	< 0.05	8.8 (4.16)	8.9 (3.69)	N.S

SFA indicates saturated fatty acids; MUFA, monounsaturated fatty acids; PUFA, polyunsaturated fatty acids.
*Geometric means (95% CI). $P < 0.05$, $P < 0.001$ variables were compared by *t* test. N.S: not significant.

7.4.5.2.2 Intake of minerals

Mean daily intake of calcium was lower in Jeddah subjects than in Makkah subjects, and especially low for Jeddah males (644 mg/day). Mean intake of iron and magnesium for all participants in Jeddah was 13.6 mg/day and 240 mg/day, respectively compared with 14.6 mg/day and 264 mg/day, respectively in Makkah. Mean daily intake of sodium for all participants was higher in Makkah than Jeddah, and was highest for Makkah males (Tables 7.8 and 7.9). A similar result was found for potassium intake, but the highest amount was consumed by Makkah females. Both males and females in both cities had a mean intake above the UK RNI for sodium (1.6 g/day) and below the recommendation for potassium (3.5 g/day).

Makkah subjects had the lowest intake of selenium, at only 43.1 (16.58) µg/day compared with 53.7 (28.77) µg/day for those from the city of Jeddah. The mean zinc intake for females from Jeddah, females from Makkah, males from Jeddah and males from Makkah was as follows: 7.9 (2.17), 9.3 (2.91), 8.6 (2.41) and 10.3 (1.9) mg/day, respectively. Subjects in Makkah had significantly higher dietary intakes than in Jeddah after adjustment for age and gender with respect to calcium, magnesium, sodium, potassium and zinc ($P < 0.001$).

7.4.5.2.3 Intake of vitamins

The data showed the mean daily intake of vitamin A for females from Jeddah, females from Makkah, males from Jeddah and males from Makkah was as follows: 623, 596, 561 and 515 µg/day, respectively. Individuals below the UK RNI for vitamin A were more likely to be men. On the other hand, intake of total vitamin C was above the RNI recommendation for all study subjects. The mean daily intake of vitamin E was 4.8 mg/day and 4.5 mg/day for subjects from Jeddah and Makkah, respectively ($P < 0.05$).

Table 7.8: Mean, standard deviation (SD), median and 95% Confidence Intervals (CI) for daily intake of micronutrients of subjects by city

Nutrient	Overall			Coastal City Jeddah			Internal City Makkah			*P***
	Mean (SD)	Median	95% CI	Mean (SD)	Median	95% CI	Mean (SD)	Median	95%CI	
Calcium (mg/d)	742 (202)	722	715, 768	663 (200)	623	624, 702	803 (183)	792	771, 834	< 0.001
Iron (mg/d)	14.7*	13.4	13.9, 15.5	13.6*	13.1	12.5, 14.7	14.6 (4.61)	13.8	13.8, 15.4	N.S
Magnesium (mg/d)	253 (65.33)	247	245, 262	240 (77.14)	233	225, 255	264 (52.49)	254	255, 273	< 0.001
Sodium (g/d)	3.7 (0.13)	3.6	3.6, 3.9	2.9 (0.98)	2.8	2.7, 3.1	4.4 (1.23)	4.5	4.2, 4.6	< 0.001
Potassium (g/d)	2.8 (0.84)	2.7	2.7, 3.01	2.6 (0.85)	2.5	2.4, 2.8	3.1 (0.79)	3.01	2.9, 3.2	< 0.001
Selenium (µg/d)	47.7 (23.27)	44	44.7, 50.8	53.7 (28.77)	51	48.08, 59.4	43.1 (16.58)	41	40.2, 46.04	< 0.05
Zinc (mg/d)	9.2 (2.40)	8.9	8.8, 9.5	8.2 (2.3)	8.1	7.8, 8.7	9.9 (2.23)	9.8	9.5, 10.3	< 0.001
Vitamin A (µg/d)	661*	547	578, 743	591*	603	513, 682	550 (226)	527	511, 590	N.S
Vitamin C (mg/d)	68.4*	57.8	61.7, 75.1	51.4*	58.4	43.6, 60.6	54.1*	57	47.8, 60.9	N.S
Vitamin E (mg/d)	4.9*	4.4	4.6, 5.1	4.8*	4.6	4.4, 5.3	4.5 (1.37)	4.3	4.3, 4.8	< 0.05

*Geometric means (95% CI). ** *P*-values were significant using general linear regression, which were adjusted for age and gender.
N.S: not significant.

Table 7.9: Comparison of daily intake of micronutrients of Jeddah and Makkah subjects by gender

Nutrient	Females mean (SD)			Males mean (SD)		
	Jeddah	Makkah	*P*	Jeddah	Makkah	*P*
Calcium (mg/d)	682 (220)	867 (178)	< 0.001	644 (176)	753 (171)	< 0.05
Iron (mg/d)	14.2 (12.3,16.2)*	15.2 (4.96)	N.S	12.9 (11.8,14.2)*	14.2 (4.31)	N.S
Magnesium (mg/d)	243 (85.37)	272 (54.31)	< 0.05	237 (68.66)	257 (50.44)	< 0.05
Sodium (g/d)	3.01 (0.93)	4.2 (1.35)	< 0.001	2.8 (1.03)	4.5 (1.11)	< 0.001
Potassium (g/d)	2.7 (0.97)	3.1 (0.75)	< 0.05	2.5 (0.71)	3.03 (0.82)	< 0.05
Selenium (µg/d)	47.6 (24.57)	42.4 (14.4)	N.S	59.9 (31.47)	43.7 (18.13)	< 0.001
Zinc (mg/d)	7.9 (2.17)	9.3 (2.91)	< 0.05	8.6 (2.41)	10.3 (1.91)	< 0.001
Vitamin A (µg/d)	623 (520, 746)*	596 (241)	N.S	561 (447, 703)*	515 (208)	N.S
Vitamin C(mg/d)	54.5 (43, 68.5)*	57.9 (49, 68.5)*	N.S	48.5 (38, 61.9)*	51.1 (43, 60.8)*	N.S
Vitamin E(mg/d)	4.9 (4.3, 5.6)*	4.6 (1.37)	N.S	4.8 (4.2, 5.4)*	4.5 (1.37)	< 0.05

*Geometric means (95% CI). $P < 0.05$, $P < 0.001$ variables were compared by *t* test. N.S: not significant.

7.4.5.2.4 Intake of fatty acids

Table 7.10 and 7.11 shows a comparison of fatty acid intake among study samples in the two regions. Residents from Jeddah consumed more than twice the total omega 3 fatty acids daily intake when compared to Makkah ($P < 0.001$). The mean daily intake of total omega 3 fatty acids for Jeddah was 1.30 g/day and 0.37 g/day for Makkah, mainly in the form of ALA (1.01 g/day for Jeddah and 0.36 g/day for Makkah), with 0.17 g/day for Jeddah and 0.007 g/day for Makkah in the form of EPA /DHA for participants from Jeddah and Makkah, respectively. Total omega 3 fatty acids contributed 0.58% and 0.14% to the daily energy intake for Jeddah and Makkah residents, respectively. High statistical significance was observed among adults in ALA, EPA and DHA intake between the two cities ($P < 0.001$). On the other hand, the geometric mean for daily intake of total omega 6 fatty acids for Jeddah was 3.90 g/day while for Makkah area it was 2.62 g/day, mainly in the form of LA (3.7 g/day for Jeddah participants and 2.6 g/day for Makkah participants), with 0.16 and 0.019 g/day for Jeddah and Makkah, respectively in the form of AA. Omega

6 fatty acids were measured at 1.75% for Jeddah and 1.03% for Makkah in terms of the daily energy intake.

Table 7.10: Geometric mean, median and 95% Confidence Intervals (CI) for daily intake of fatty acids of subjects by city

Nutrient	Overall			Coastal City Jeddah			Internal City Makkah			*P**
	Mean	Median	95% CI	Mean	Median	95% CI	Mean	Median	95%CI	
Total n-3 PUFAs (g/d)	0.77	0.50	0.67, 0.88	1.3	1.1	1.1, 1.5	0.37	0.35	0.33, 0.41	< 0.001
% of daily energy	0.33			0.58			0.14			
ALA (g/d)	0.65	0.47	0.58, 0.71	1.01	1.1	0.89, 1.13	0.36	0.34	0.32, 0.4	< 0.001
EPA (g/d)	0.06	0.001	0.03, 0.09	0.13	0.01	0.06, 0.2	0.005	0.001	0.003, 0.007	< 0.001
DHA (g/d)	0.06	0.001	0.03, 0.10	0.14	0.001	0.07, 0.22	0.002	0.00	0.0004, 0.0034	< 0.001
Total n-6 PUFAs (g/d)	3.18	2.46	2.84, 3.52	3.9	2.7	3.25, 4.56	2.62	2.2	2.3, 2.9	< 0.05
% of daily energy	1.39			1.8			1.03			
LA (g/d)	3.1	2.3	2.7, 3.4	3.7	2.6	3.1, 4.3	2.6	2.1	2.2, 2.9	< 0.05
AA (g/d)	0.08	0.2	0.06, 0.10	0.2	0.10	0.11, 0.20	0.019	0.010	0.016, 0.023	< 0.001
Total n-6: total n-3 PUFAs	6.1	5.3	5.50, 6.71	4.2	2.8	3.4, 5.1	7.5	6.6	6.7, 8.3	< 0.001
Total n-3: total n-6 PUFAs	0.35	0.21	0.29, 0.42	0.55	0.35	0.42, 0.68	0.20	0.15	0.15, 0.25	< 0.001
Trans fatty acid (g/d)	3.3	3	3, 3.5	2.5	2.3	2.2, 2.8	3.9	3.4	3.5, 4.2	< 0.001
% of daily energy	1.4			1.1			1.5			

n-3, omega 3; ALA, alpha-linolenic acid (18:3n-3); EPA, eicosapentaenoic acid (20:5 n-3); DHA, docosahexaenoic acid (22:6 n-3); n-6, omega 6; LA, Linoleic acid (18:2 n-6); AA, arachidonic acid (20:4 n-6).

* *P*-values were significant using general linear regression, which were adjusted for age and gender.

Table 7.11: Comparison of daily intake of fatty acids of Jeddah and Makkah subjects by gender

Nutrient	Females Mean (95% CI)			Males Mean (95% CI)		
	Jeddah	Makkah	*P*	Jeddah	Makkah	*P*
Total n-3 PUFAs (g/d)	1.37 (1.03, 1.7)	0.41 (0.35, 0.47)	< 0.001	1.2 (0.99, 1.4)	0.33 (0.28, 0.38)	< 0.001
% of daily energy	0.60	0.16		0.55	0.13	
ALA (g/d)	0.97 (0.83, 1.11)	0.41 (0.35, 0.47)	< 0.001	1.1 (0.86, 1.26)	0.33 (0.28, 0.37)	< 0.001
EPA (g/d)	0.17 (0.05, 0.31)	0.005 (0.004, 0.01)	N.S	0.09 (0.03, 0.15)	0.004 (0.001, 0.007)	< 0.001
DHA (g/d)	0.21 (0.07, 0.36)	0.002 (0.001,0.003)	N.S	0.07 (0.03, 0.13)	0.001 (0.00, 0.004)	< 0.001
Total n-6 PUFAs (g/d)	2.99 (2.4, 3.5)	3.4 (2.9, 3.9)	N.S	4.8 (3.6, 5.9)	2.02 (1.6, 2.3)	< 0.001
% of daily energy	1.31	1.3		2.2	0.80	
LA (g/d)	2.8 (2.2, 3.4)	3.3 (2.9, 3.8)	N.S	4.6 (3.5, 5.7)	2 (1.6, 2.3)	< 0.001
AA (g/d)	0.14 (0.08, 0.19)	0.02 (0.01, 0.03)	< 0.001	0.17 (0.11, 0.24)	0.02 (0.01, 0.02)	< 0.001
Total n-6: total n-3 PUFAs	3.3 (2.4, 4.1)	8.6 (7.6, 9.6)	< 0.001	5.2 (3.8, 6.5)	6.6 (5.5, 7.8)	< 0.001
Total n-3: total n-6 PUFAs	0.70 (0.47, 0.94)	0.14 (0.12, 0.15)	< 0.001	0.40 (0.28, 0.52)	0.25 (0.17, 0.33)	< 0.001
trans fatty acid (g/d)	2.3 (1.8, 2.7)	3.5 (2.9, 4.1)	< 0.001	2.7 (2.3, 3.2)	4.2 (3.7, 4.7)	< 0.001
% of daily energy	1	1.4		1.2	1.7	

n-3, omega 3; ALA, alpha-linolenic acid (18:3n-3); EPA, eicosapentaenoic acid (20:5 n-3); DHA, docosahexaenoic acid (22:6 n-3); n-6, omega 6; LA, Linoleic acid (18:2 n-6); AA, arachidonic acid (20:4 n-6).
$P < 0.001$ variables were compared by *t* tests. N.S: not significant.

There was a higher statistically significant difference in the mean total daily intake of omega 6, LA fatty acid and AA fatty acid ($P \leq 0.001$) between the two cities. The geometric mean for the daily intake of *trans* fatty acid for Jeddah was 2.5 g/day and 3.9 g/day for Makkah. *Trans* fatty acids were deemed to be 1.1% for Jeddah samples and 1.5% for Makkah samples in terms of the daily energy intake. Differences were observed between the two cities for *trans* fatty acids ($P < 0.001$). Another comparison between the same genders was examined by using the *t* test. Higher statistically significant differences were observed in men between the two cities for all fatty acids ($P < 0.001$). Differences were also observed in female between both cities for total omega 3 fatty acids, ALA, AA and *trans* fatty acids ($P \leq 0.001$).

7.4.6 Intake by food groups

In comparison to that in Makkah, the diet in Jeddah was high in nuts, fish (10 times higher than in Makkah) and fruit and vegetable. Makkah men and women consumed twice as much fast food as men and women in Jeddah. Consumption of traditional Saudi food was higher in Makkah than Jeddah participants ($P < 0.05$). Table 7.12 and 7.13 shows a comparison of food group intakes among study samples in the two regions after adjustment for age and gender.

Table 7.12: Percentage, mean and 95% Confidence Intervals (CI) for intake by food group of study subjects by city

Food groups	Overall			Coastal city Jeddah			Internal city Makkah			*P**
	n (%)	Mean (g/d)	95%CI	*n (%)*	Mean (g/d)	95% CI	*n (%)*	Mean (g/d)	95% CI	
Nuts and seeds	25 (11)	2.3	1.2, 3.4	22 (22)	5.2	2.7, 7.7	3 (2)	0.12	-0.02, 0.25	< 0.001
Fish and sea-food	52 (23)	16.1	11.4, 20.7	42 (42)	32.6	23.3, 42.1	10 (8)	3.2	0.85, 5.5	< 0.001
Fruit & vegetables	211 (92)	175	157, 194	97 (97)	205	173, 237	114 (88)	152	131, 173	< 0.05
Fast food	201 (88)	479	434, 524	79 (79)	327	274, 381	122 (95)	597	536, 659	< 0.001
Traditional Saudi food	216 (94)	297	273, 321	91 (91)	271	233, 308	125 (96)	317	286, 348	< 0.05

* *P*-values were significant using general linear regression, which were adjusted for age and gender.

Table 7.13: Comparison of intake by food group of Jeddah and Makkah subjects by gender

Food groups	Females Mean (g/d) 95% CI		P	Males Mean (g/d) 95% CI		P
	Jeddah	Makkah		Jeddah	Makkah	
Nuts and seeds	5.6 (2.5, 8.6)	0.12 (0.11, 0.35)	< 0.001	4.8 (0.6, 8.9)	0.11 (0.04, 0.27)	< 0.05
Fish and sea-food	31.2 (18.1, 44.4)	1.8 (0.1, 3.6)	< 0.001	34.2 (20.4, 47.9)	4.26 (0.34, 8.1)	< 0.001
Fruit & vegetables	226 (191, 260)	147 (120, 173)	< 0.05	185 (130, 239)	156 (124, 188)	N.S
Fast food	287 (219, 354)	611 (520, 702)	< 0.001	368 (285, 451)	586 (501, 672)	< 0.05
Traditional Saudi food	331 (270, 392)	338 (294, 381)	N.S	211 (172, 249)	301 (256, 346)	< 0.05

P < 0.05, *P* < 0.001 variables were compared by Mann-Whitney tests.
N.S: not significant.

7.4.7 Multivariate analysis of the association between nutrients intake and CVD risk factors in between cities

General linear model analysis was applied to examine the associations of dietary intake with CVD risk factors. Stepwise multiple regression analysis was performed to adjust the data for possible effects of confounding factors between dietary intakes and CVD risk factors in the subject study (*n* = 229). Table (7.14) presented the significance of the association between nutrients intake and CVD risk factors between cities, as assessed by multivariate linear regression for all study subjects. Several recent studies indicate that age, gender, BMI, WHR, diabetes, hypercholesterolemia, hypertension, socioeconomic status (educational status and/or monthly income), smoking and physical activity have been influenced on nutrient intake (Perk *et al*., 2012; Verschuren, 2012; Yen *et al*., 2010). Variables (age, gender, BMI, WHR, diabetes, smoking, physical activity and socioeconomic status) were statistically significantly associated with dietary intake at 5% level were selected. Multiple linear regression analysis showed between Jeddah and Makkah significantly differences with energy intake (β = -0.203; *P* < 0.001), SFA (β = -0.295; *P* < 0.001), MUFA (β = 0.250; *P* < 0.001), PUFA (β = 0.450; *P* < 0.001), carbohydrate (β = -0.342; *P* < 0.001), fibre (β = 0.191; *P* = 0.025), vitamin A (β = 0.193; *P* = 0.010), vitamin E (β = 0.148; *P* = 0.003), sodium (β = -0.327; *P* < 0.001), potassium (β = -0.240; *P* < 0.001), zinc (β = -0.251; *P* < 0.001) selenium (β = 0.155; *P* = 0.001), total omega 3 (β = 0.313; *P* < 0.001), ALA (β = 0.369; *P* < 0.001), EPA (β = 0.283; *P* < 0.001), DHA (β = 0.294; P < 0.001), total omega 6 (β = 0.180; P = 0.002), LA (β = 0.155; P = 0.008), AA (β = 0.220; P < 0.001) and *trans* fatty acid (β = -0.214; P < 0.001).

Table 7.14: Significance of the association between nutrients intake and CVD risk factors between cities (*n* = 229), as assessed by general linear model analysis **

Nutrient	β	SE	*P*	95% CI	
				Lower limit	Upper limit
Energy (MJ/d)	**-0.205**	**0.162**	**< 0.001**	**-1.47**	**-0.83**
Energy (kcal/d)	**-0.203**	**38.49**	**< 0.001**	**-349**	**-197**
Total fat (g/d)	0.031	2.45	N.S	-7.75	1.93
SFA (g/d)	**-0.295**	**1.18**	**< 0.001**	**-10.65**	**-5.99**
MUFA (g/d)	**0.250**	**0.998**	**< 0.001**	**3.13**	**7.07**
PUFA (g/d)	**0.450**	**0.608**	**< 0.001**	**6.04**	**8.44**
Cholesterol (mg/d)	0.022	12.31	N.S	-20.92	27.62
Protein (g/d)	0.032	2.41	N.S	-9.07	0.424
Carbohydrates (g/d)	**-0.342**	**6.38**	**< 0.001**	**-76.26**	**-51.09**
Fibre (g/d)	**0.191**	**0.518**	**< 0.05**	**0.205**	**2.246**
Calcium (mg/d)	**-0.290**	**25.31**	**< 0.001**	**-188**	**-89.15**
Iron (mg/d)	0.022	0.862	N.S	-1.53	1.86
Magnesium (mg/d)	**-0.192**	**8.82**	**< 0.05**	**-41.49**	**-6.69**
Sodium (g/d)	**-0.327**	**15.36**	**< 0.001**	**-1867**	**-1261**
Potassium (g/d)	**-0.240**	**11.12**	**< 0.001**	**-680**	**-241**
Selenium (µg/d)	**0.155**	**3.08**	**< 0.05**	**4.11**	**16.27**
Zinc (mg/d)	**-0.251**	**0.313**	**< 0.001**	**-2.16**	**-0.935**
Vitamin A (µg/d)	**0.193**	**83.23**	**< 0.05**	**58.59**	**386**
Vitamin C (mg/d)	0.107	6.88	N.S	-13.29	13.85
Vitamin E (mg/d)	**0.148**	**0.271**	**< 0.05**	**0.262**	**1.32**
Total n-3 PUFAs (g/d)	**0.313**	**0.098**	**< 0.001**	**0.715**	**1.10**
ALA (g/d)	**0.369**	**0.060**	**< 0.001**	**0.521**	**0.757**
EPA (g/d)	**0.283**	**0.033**	**< 0.001**	**0.060**	**0.190**
DHA (g/d)	**0.294**	**0.035**	**< 0.001**	**0.074**	**0.214**
Total n-6 PUFAs (g/d)	**0.180**	**0.329**	**< 0.05**	**0.400**	**1.69**
LA (g/d)	**0.155**	**0.323**	**< 0.05**	**0.266**	**1.53**
AA (g/d)	**0.220**	**0.019**	**< 0.001**	**0.109**	**0.185**
Total n-3: total n-6 PUFAs	**0.328**	**0.067**	**< 0.001**	**0.234**	**0.497**
***trans* fatty acid (g/d)**	**-0.214**	**0.251**	**< 0.001**	**-1.86**	**-0.878**

SE, stander error; 95% CI, confidence interval; ß and 95% CI are significant at P < 0.05, P < 0.001indicated in bold font.
**All the socioeconomic and CVD risk factors were run in one multivariate model and adjusted for age, gender.

7.5 Discussion

CVD is a major public health concern globally, including USA and UK where it has been established as the number one cause of death (WHO, 2003). In Saudi Arabia CVD ranks as the second most significant cause of death. Health statistics have revealed that 10% of the total deaths in Jeddah and 18% in Makkah were due to CVD (Health Statistical Yearbook, 2003). These differences in percentage may be related to the impact of geographic location, where the variation in the terrain and division into coastal and internal areas may determine food habits and hence in nutrient intakes. With changes in lifestyle, exposure to CVD risk factors has become more important, such as adoption of diets high in SFA and low in dietary fibre, obesity, hypertension, diabetes, hyperlipidemia, smoking and inactivity (Musaiger, 2002).

The present study focused on two populations that had significant differences in monthly income and BMI but not in age and other anthropometric measurements. For CVD risk factors, there were significant differences in hypertension, smoking status and physical activity ($P < 0.05$) between the populations. One of the main risk factors for CVD is smoking which was twice as prevalent in Makkah than in Jeddah. There were only 4 women current smokers in the group from Jeddah compared with 18 women from Makkah, and as expected the majority of the smoker were men. In a study by Al Nozha *et al*. (2009) a sample of 17,350 Saudi adults for all Saudi regions was investigated and it was reported that the smoking rates in the western regions (which including cities in this study) were the third region in Saudi Arabia after the northern and eastern regions (including both coastal and internal areas). This finding could be due to the effect of cultural exposures to expatriates (smokers) and direct contact with Saudis living in these regions (Al Nozha *et al*., 2009). Physical inactivity was common among Makkah subjects (76%) and was still present in more than half of Jeddah subjects. In a nation study by Al Nozha *et al*. (2007b) the prevalence of inactivity was higher among men and women in the central region at 97.3% compared to other regions. There are several factors that contribute to physically inactivity in Saudi Arabia (Al Hazzaa, 2006; Al Refaee & Al Hazzaa, 2001; Binhemd *et al*., 1991; Rasheed, 1998) for examples, dependence on using cars rather than walking, spending a long time watching television especially within young demographic, hot weather and also, in school physical education programmes are limited especially for girls (Al Hazzaa, 2006). Women, in the present study were found to be much less physically active than men, reflecting less opportunity for women in Saudi Arabia to engage in physical activity in the community for cultural reasons. This low level of physical has been observed generally for Arab females (Al Sabbah *et al*., 2007; Henry *et al*., 2004), and is lower than for many developed countries (Mabry *et al*., 2010b). A further lifestyle difference which would impact on diet quality was skipping breakfast. More than half of those surveyed (62% in Jeddah and 51% in Makkah) skipped breakfast. At interview, various reasons for not eating breakfast were given by participants, such as not feeling hungry in the morning, saving time and to lose weight. Skipping breakfast has been associated with lower nutritional status and increased CVD risk (Sakarata *et al.*, 2001) and contributes to risk of obesity (Huang *et al.*, 2010). Most of the participants in this study (89% for Jeddah and 93% for Makkah) said they ate food outside their home, another contributor to low diet quality (Bowman & Vinyard, 2004; Myhre *et al*., 2013).

Few studies have focused on measuring dietary intake of Saudi adults using three-day food record. The dietary intake data demonstrate that subjects from Jeddah had a significantly lower total energy intake and lower SFA intake but higher intakes of MUFA and PUFA, fibre, selenium and vitamin E ($P < 0.05$). In contrast they ate significantly less carbohydrates, calcium, magnesium, sodium, potassium and zinc ($P < 0.05$). The findings of the current study are consistent with a study by Torres *et al.* (2000) who explored the impact of geographic location in two populations of men in Madeira, Portugal (a fishing village *vs.* an inland village) aged between 25 to 65 years using an FFQ to measure dietary intakes. Whilst this study also showed significant differences in the mean intakes of total energy, protein, carbohydrate, fibre, total fat, SFA, MUFA and PUFA between the two groups, total energy intake and SFA were higher for men in the fishing village than in the inland village (10 (2.2) MJ/day, 23.4 (9.1) g/day *vs*. 7.7 (2.8) MJ/day, 16.7 (9.4) g/day, respectively. In the current study, the percentage of energy derived from carbohydrate for subjects from Makkah (55.3%) was higher than for subjects living in Jeddah (50.4%) similar to the Torres *et al*. study (52% in inland village *vs*. 42% in the fishing village) (Torres *et al.*, 2000) but the daily fibre intake measured in this study was lower than that seen in the Madeira fishing area and inland area (19.1 (7) g/day and16.2 (7.3) g/day, respectively). The average daily dietary MUFA and PUFA intakes for both Jeddah (coastal city) and Makkah (internal city) were very similar to those reported by Torres *et al.* (2000) with exception of PUFA intake for the coastal Saudi population (15.4 g/day) compared with the Portuguese fishing village (9.9 g/day).

An important finding of this study comes from the observation that the coastal residents consumed more than twice of daily intake of total omega 3 fatty acids than those in the internal area. Subjects from the internal city had significantly lower intakes of all PUFA than the coastal city. These findings were consistent with the results of similar studies. In

Saudi Arabia, Al Numair *et al.* (2005) also found that the intake of total omega 3 fatty acids, EPA, DHA and ALA were higher in 120 elderly Saudi men living in the eastern coastal region (2.18 (0.58) g/day) when compared with those in the eastern internal region (0.79 (0.13) g/day). However, the intake of ALA was approximately 10% lower in elderly men in the coastal region compared with the values reported in the current study. Evidence from Torres *et al.* (2000) indicated the impact of geographic location in two populations on total omega 3 fatty acids consumption. He found a higher intakes of LA 7.4 (3.2) *vs*. 5.5 (2.9) g/day, ALA 0.49 (0.29) *vs*. 0.36 (0.31) g/day, EPA 0.22 (0.38) *vs*. 0.026 (0.075) g/day, DHA 0.54 (0.78) *vs*. 0.055 (0.079) g/day and AA 0.17 (0.097) *vs*. 0.13 (0.137) g/day in the fishing village compared to rural village (Torres *et al.,* 2000). In the USA, Lewis *et al.* (1995) also demonstrated an effect of geographic location on omega 3 fatty acids consumption by low-income pregnant women in Midwestern, USA. The intake of ALA in this group was 0.98 (0.30) g/day and EPA and DHA intakes (0.02 (0.06) and 0.04 (0.08) g/day, respectively) contributed much less to total omega 3 fatty acids. This was similar to the internal sample in the current study where more than 95% of intake of total omega 3 fatty acids was as ALA. The dietary omega 3 to omega 6 fatty acids ratio in Jeddah residents was above the recommended level (0.4) by the UK Scientific Advisory Committee on Nutrition (UK Scientific Advisory Committee on Nutrition, 2004). The current study, and others (Bulliyya *et al*., 1990; Torres *et al.*, 2000; Al Numair *et al.,* 2005) shows that populations living far from coastal areas have lower intakes of total omega 3 fatty acids, EPA and DHA. The results of the current study show that 42% of residents in the coastal city consumed of the fish and sea-food intake group on at least one day of the three day food record, while in the internal city the figure was only 8% which suggests that especially in this population very few subjects would achieve the American Heart Association recommendation of consuming fish groups at least twice per week (Lichtenstein *et al*., 2006), presumable due to lower availability of fresh fish in this area. The intake of nuts and seeds for Jeddah (the coastal population) was 5.2 g/day, and for Makkah (the internal population) was 0.12 g/day. Some nut types such as almonds, walnuts, pistachios and peanuts are excellent sources of omega 3 fatty acids, and this may explain why ALA was the main contributor to the total omega 3 fatty acids intake in the coastal population. Men and women living in Makkah consumed approximately twice as much fast food as the men and women in Jeddah. Many types of fast food are high in fat and low in fibre and nutrients (McCrory *et al*., 1999). Fast food has been associated with CVD risks in many studies (Berg *et al*., 2008; Brindal *et al*., 2008; Hamer & Mishara, 2010). Educational programmes to promote healthy eating habits in Saudi Arabia are needed to correct these habits.

7.6 Summary and conclusions

The aims of this chapter were achieved. The findings have highlighted a number of important findings which were:

- The results showed that the subjects had a generally unhealthy lifestyle like smoking habit, physical inactivity and higher intake of SFA especially in Makkah (the internal area) which may affect CVD risk.
- On average, BMI was lower in men and women from Jeddah participants 25.1 (2.76) kg/m^2 than Makkah participants 26.3 (3.21) kg/m^2 ($P < 0.05$).
- The majority belonged to the medium socioeconomic status in both areas 63% for coastal area and 50% for internal area.
- No differences were observed from comparison sites in diabetes, hypercholesterolemia and heart disease between the two cities ($P > 0.05$).
- However, there were significant differences between coastal and internal areas between females in hypertension ($P < 0.05$), and differences were also found in family history between males Jeddah and Makkah ($P < 0.05$).
- Smoking was more prevalent in the Makkah (63%) than Jeddah (34%), ($P < 0.001$).
- Men were more physically active than women in both regions.
- The results also show marked differences in diet composition between coastal and internal areas. Subjects from Jeddah had a significantly lower energy intake but higher intakes of MUFA and PUFA, fibre, selenium and vitamin E ($P < 0.05$). In contrast they ate significantly less carbohydrates, sodium, potassium and zinc.
- The intakes of total omega 3 fatty acids for participants living in Jeddah were higher than those living in Makkah. The mean daily intake of total omega 3 fatty acids for Jeddah was 1.30 g/day and 0.37 g/day for Makkah.
- The coastal city consumed a diet that was relatively high in fish, nut and fruit and vegetables and low in fast food compared to internal city.

Chapter 8

Comparison of the Dietary Patterns of Saudi Populations from Different Geographical Locations in Saudi Arabia and the UK

8.1 Introduction

Like other highly developed countries, CVD and CHD are major health problems in Arab Gulf countries, including Saudi Arabia (WHO, 2009). Sawarya *et al*. (1999), claims that the reason for this is that CHD and CVD are connected to the accessibility of multiple and different foods and cuisines, including western foods that are exported to these countries from various countries around the world. The diet of the Arab Gulf countries has changed over the last twenty years. Their citizens have turned to consuming more wheat flour, sugar, fat, rice and meat, and at the same time they have become more sedentary. Dehghan *et al.* (2005) argues that this has led to CVD prevalence and a rise in hypertension, obesity and diabetes. Musaiger (1994) adds that the increase in socioeconomic statuses and the increase in incomes in the Arab Gulf countries could be considered other reasons. The last thirty years have witnessed fast changes in the food habits of Arabs and their diets. Most western and American restaurants have established branches in the region and their foods have spread all over the Gulf region. This number has added to the already existing traditional food stores and restaurants that are widespread. The number of people eating out has increased. This change has coincided with the public's trend for consuming more westernised foods that are rich in energy, sugar, fats and that have low complex carbohydrates. Al Khamees (2009) conducted a pilot study on female Kuwaiti college students. The results of the study revealed that as part of their diet they consumed low amounts of water, healthy fats and vegetables but consumed high amounts of fatty foods and sweets.

Although Ferlay *et al.* (2001) mention that the risk of chronic diseases varies to a great extent by ethnicity and country, the number of epidemiological studies that have investigated them among multiple populations is limited. Willett (1998) argues that nutritional intake varies a lot across geographic areas compared to small homogeneous populations; therefore, collecting evidence on other populations with varying eating habits could lead to a greater understanding of disease and diet risk. There is a major limitation when assessing CVD risks and how they are related to the intake and dietary sources found in Saudi Arabia, namely the shortage of data and published papers on different people living in different areas. The current research provided such data, as well as a comparison of geographical locations within Saudi Arabia and Saudi people living in the UK, where diet and lifestyle factors may be different.

8.2 Study aims and objectives

8.2.1 Aims

- To compare the dietary intake and heart disease risk in Saudi Arabian adults residing in Saudi Arabia (Jeddah and Makkah) and those living abroad (in this case, in Newcastle, UK).
- To compare the intake of omega 3 fatty acids in Saudi Arabian adults residing in Saudi Arabia (Jeddah and Makkah) and those living abroad (in Newcastle, UK).

8.2.2 Objectives

- To compare and report any significant differences between the intakes of men and women in these three cities in the daily energy intake and the daily intake of: protein, fat, SFA, MUFA, PUFA, carbohydrate, fibre, cholesterol, calcium, iron, magnesium, sodium, potassium, zinc, vitamin C, vitamin E, vitamin A and selenium.
- To compare and report any significant differences between the intakes of men and women in these three cities in the daily intake of the following fatty acids: LA, ALA, total *trans* fatty acid, AA, EPA and DHA.
- To compare and report any significant differences between CVD risk factors and the socioeconomic characteristics in the study population.
- To compared and report any significant differences between food groups (nuts and seeds, fish, fruit and vegetables, fast food and traditional Saudi food) among the study subjects.

8.3 Methods

8.3.1 Study subjects

Participants in study 1, study 2 and study 3 who were Saudi Arabian were recruited in three diverse geographical locations: Jeddah (Chapter 4) and Makkah (Chapter 5) inside Saudi Arabia, and Newcastle in the UK (Chapter 6).

8.3.2 Demographic and anthropometric information

The questionnaire was designed to be applicable to 18-65 year old Saudi men and women. The questionnaire was simple, easy to understand, and volunteers reported no difficulties in completing the questionnaire. The questionnaire consisted of 17 questions (Appendix E) and was piloted in the UK to test content and face validity. Questionnaires were prepared and distributed for completion and collection after one week. Instructions and examples were given to the subjects by the researcher to guide them in completing the questionnaire. The importances of a true record were also stressed by the researcher together with the confidentiality of any given information. The interview took approximately 30 minutes and anthropometric measurements were taken after completion of the questionnaire (Chapter 3).

8.3.3 Dietary assessment

Subjects were interviewed one-by-one in any available free place within the universities/ (as well as sometimes in the researcher's home or the participant's home). The use of domestic measures, such as different sizes of plates, cups and spoons, were encouraged to help the subjects to estimate their food portion sizes. The subjects were asked if they had made any changes to their dietary habits during the recording period. Nutritional analysis was carried out, as described in Chapter 3.6. It is important to highlight that many of the food and drink consumed by Saudi adults were the same as those available in the UK and the USA. The selection of best matches for the Saudi foods within the UK and the USA food tables was possible. The categorisation of meals and snacks adopted in the present study was similar to this in most aspects, but also considered the general lifestyle of Saudi Arabia.

8.3.4 Statistical analysis

In order to compare descriptive and dietary characteristics among the three groups, analysis using SPSS for Windows, version 19 (SPSS Inc., Chicago, IL, USA), were performed together with a Chi square analysis to determine if there were any statistically significant differences in the responses from the different groups. The data were also analysed according to gender (Chi square analysis). Comparisons between groups were carried out using a one-way analysis of variance (ANOVA). All differences were considered significant if P- values were < 0.05 (Section 3.9). Comparisons between cities in nutrient intakes or anthropometric measurement were adjusted by age, gender using regression analysis. Correlation coefficients and their probability levels were obtained from linear regression analyses. Stepwise multiple regression analysis was carried out to select significant covariates ($P < 0.05$) among dietary intake and CVD risk factors. Then, a multivariate general linear model analysis was carried out using dietary intake as the dependant variables and age, gender, BMI, smoking and physical activity as the covariates.

8.4 Results

8.4.1 Demographic data

8.4.1.1 Age and gender

The characteristics of the study population appear in Table 8.1. Among the 308 adults who participated in the study, the total number of women was 153 (50%) and 155 (50%) were men. The mean (SD) age of the female population was 31.1 (7.35) years old and for men it was 32.2 (8.27) years old. The age range for three cities was 18-63 years with statistically significant differences across cities (*P* < 0.05).

Table 8.1: Distribution of respondents by site, gender and age

Site	Females (*n* = 153)				Males (*n* = 155)				Total of 308
	18-30 *n* (%)	31-40 *n* (%)	41-50 *n* (%)	51-65 *n* (%)	18-30 *n* (%)	31-40 *n* (%)	41-50 *n* (%)	51-65 *n* (%)	
Jeddah	**23 (23)**	**19 (19)**	**8 (8)**	**-**	**30 (30)**	**13 (13)**	**4 (4)**	**3 (3)**	**100**
Makkah	**31 (24)**	**15 (12)**	**8 (6)**	**2 (2)**	**33 (25)**	**30 (23)**	**6 (5)**	**4 (3)**	**129**
Newcastle	**31 (39)**	**15 (19)**	**1 (1)**	**-**	**18 (23)**	**12 (15)**	**2 (3)**	**-**	**79**

Table 8.2 summarizes the demographic characteristics of all study participants (both genders) in their respective cities.

Table 8.2: Comparison of demographic characteristics of subjects Jeddah, Makkah and Newcastle by gender

Characteristics	Females n (%)					Males n (%)				
	Jeddah	Makkah	Newcastle	χ^2	*P*	Jeddah	Makkah	Newcastle	χ^2	*P*
Education										
Illiterate	1 (1)	-	-			1 (1)	-	-		
Writing & Reading	2 (2)	-	-			-	-	-		
Primary	2 (2)	-	-	12.159	N.S	1 (1)	-	-	19.881	< 0.05
High School	11 (11)	10 (8)	13 (16)			23 (23)	28 (22)	2 (3)		
University or Above	34 (34)	46 (35)	34 (43)			25 (25)	45 (35)	30 (38)		
Monthly income (RS)*										
1 – 3000	8 (8)	20 (15)	1 (1)			13 (13)	22 (17)	-		
3001 - 6000	13 (13)	11 (8)	16 (20)			20 (20)	10 (8)	2 (3)		
6001 – 9000	18 (18)	13 (10)	23 (29)	32.260	< 0.001	5 (5)	10 (8)	17 (22)	48.463	< 0.001
9001 – 12000	9 (9)	6 (5)	7 (9)			4 (4)	17 (13)	7 (9)		
More than 12000	2 (2)	6 (5)	-			8 (8)	14 (11)	6 (7)		
Marital status										
Single	16 (16)	24 (19)	10 (13)			30 (30)	34 (26)	11 (14)		
Married	32 (32)	30 (23)	37 (47)	7.948	N.S	20 (20)	39 (30)	21 (26)	5.312	N.S
Widowed or Divorced	2 (2)	2 (2)	-			-	-	-		
Socioeconomic status										
Low	8 (8)	4 (3)	-			10 (10)	21 (16)	-		
Medium	31 (31)	41 (32)	42 (54)	13.770	< 0.05	32 (32)	23 (18)	19 (24)	21.343	< 0.001
High	11 (11)	11 (8)	5 (6)			8 (8)	29 (23)	13 (16)		

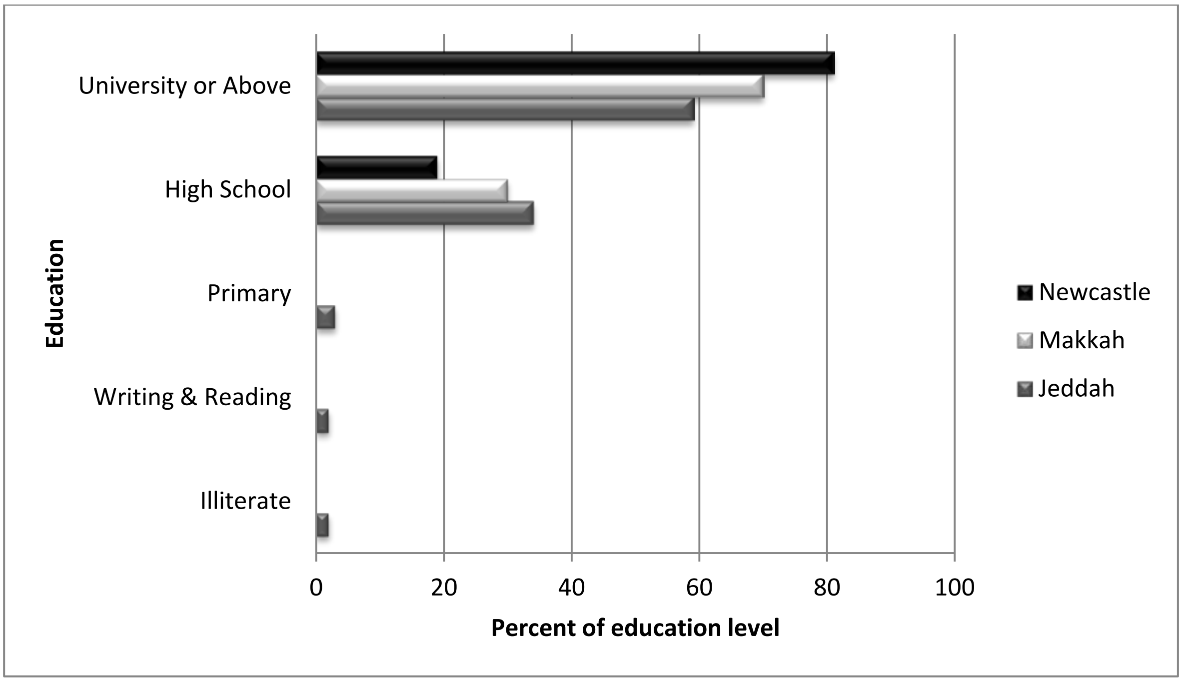
N.S: not significant.

*Riyal Saudi (currency 5.83 RS = 1£).

8.4.1.2 Education status

With respect to the education level of men and women in the three cities, the majority of subjects (99%) had completed a basic primary school level or above, while 1% were illiterate. There were significant differences between cities in terms of education level ($\chi^2 = 21.311$, $P < 0.05$) but no significant differences found among female subjects, only between male subjects ($P < 0.05$). Figure 8.1 shows the education level distribution of all study participants.

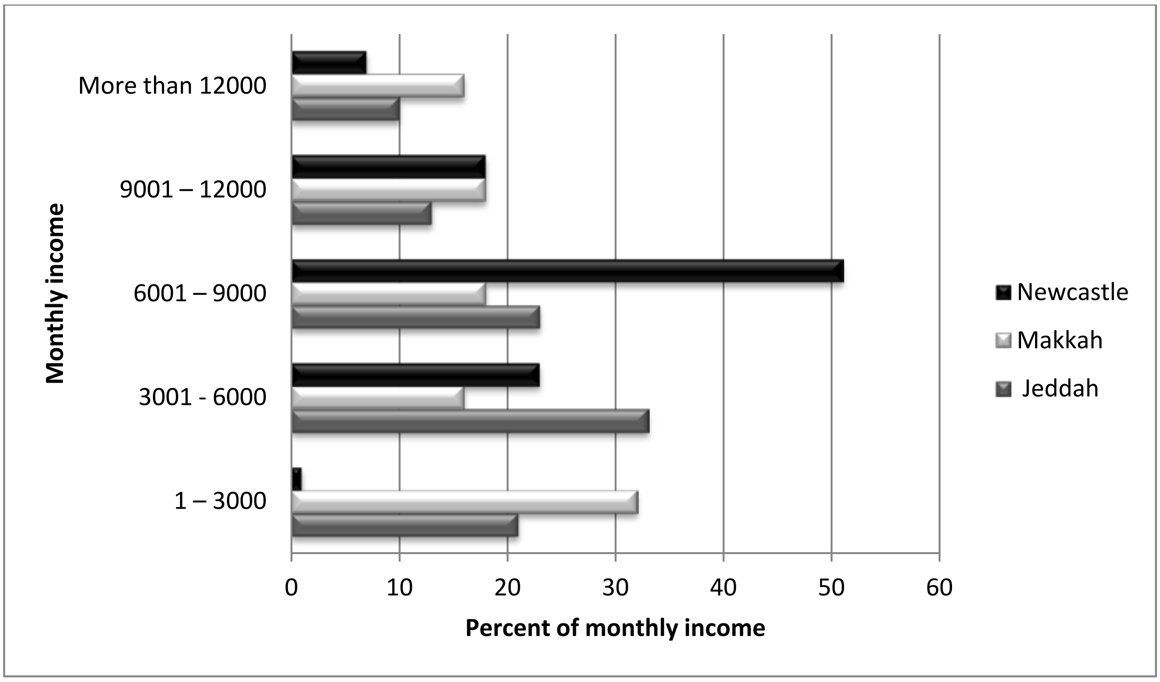
Figure 8.1: Education level distribution of all study participants (% illiterate, writing & reading, primary, high school, university or above)



8.4.1.3 Monthly income

Current monthly incomes of 21%, 32% and 1% of the Jeddah, Makkah and Newcastle participants, respectively, were in the 1RS - 3000RS range, whereas 33%, 16% and 23% were in the 3001RS - 6000RS range, and 10%, 16% and 7% had a monthly income more than 12000RS. Statically significant differences were found between the three cities in terms of monthly income ($\chi^2 = 56.167$, $P < 0.001$). Figure 8.2 provides the monthly incomes (RS) distribution of all study participants.

Figure 8.2: Monthly income (RS) distribution of all study participants (% 1-3000, 3001-6000, 6001-9000, 9001-12000, more than 12000)



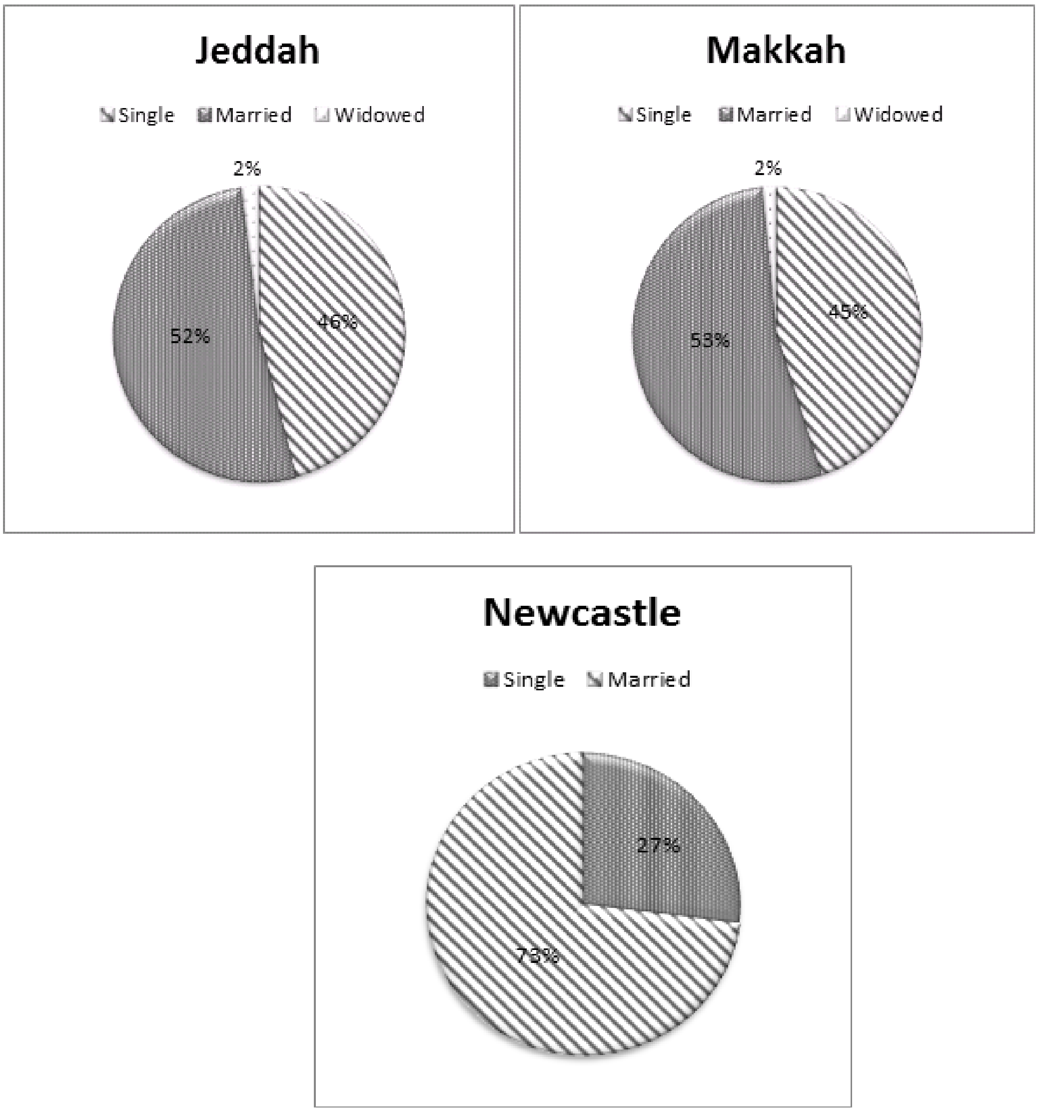
8.4.1.4 Marital status

Of the study population, 59% reported that they were married (52% in Jeddah, 53%in Makkah, and 73% in Saudi participants living in Newcastle). About 40% reported being single (Jeddah 46%, Makkah 45%, and Newcastle 27%). Only 1% in the three cities reported being widowed or divorced. There were no significant differences based on city of residence and marital status ($P > 0.05$). Figure 8.3 presents the marital statuses distribution of all study participants.

8.4.2 Socioeconomic factor

The majority of participants had a medium socioeconomic status in the three areas 63% for Jeddah, 50% for Makkah, and for Saudi people in Newcastle city 78%. Of the total 308 participants, 18% had a low socioeconomic status in Jeddah, while 19% in Makkah. No one in Newcastle fell into this category. However, comparing using a chi-square test showed highly significantly differences between the three cities ($\chi^2 = 24.868$, $P < 0.001$). Differences were also found between genders ($P < 0.05$) (Table 8.2).

Figure 8.3: Marital status distribution of all study participants (% single, married, widowed)



8.4.3 Anthropometric data

Table 8.3 summarizes the anthropometric measurements of all study participants (both genders) in their respective cities. On average, male participants were taller and heavier than female participants. Of the 308 respondents the mean (SD) BMI was 25.7 (3.44) kg/m^2. After adjustment for age, gender and height multiple linear regression analysis revealed there were significant differences between the three cities in BMI (P < 0.05). Differences in BMI were confirmed between females (P < 0.05), but not in male participants. A Tukey *post-hoc* test revealed that Jeddah was statistically lower than Makkah (25.1 (2.76) kg/m^2 *vs*. 26.3 (3.21) kg/m^2, P < 0.05) compared to Newcastle 25.6 (4.36) kg/m^2. Makkah men reported the lowest BMR, with 1521 (67.90) kcal/day, compared to other cities (P < 0.05). There were significant differences between women in Jeddah, Makkah and Newcastle in WC and HC after adjustment for age using multiple linear regression analysis (*P* < 0.05). With respect to WHR, the means (SD) for Jeddah, Makkah and Newcastle was 0.91 cm (0.086), 0.93 cm (0.097), and 0.92 cm (0.094), respectively. The Saudi women living in Newcastle reported the lowest percentage of body fat (29%) compared to women in Jeddah (32%), and women in Makkah (34%) (*P* < 0.05). A Tukey *post-hoc* test revealed that there were statistical differences between Jeddah and Newcastle samples in terms of AC and AMC (*P* < 0.001), and also between Jeddah and Makkah samples (*P* < 0.05) and Makkah and Newcastle samples in terms of AMC (*P* < 0.05).

Table 8.3: Comparison between anthropometric measurements of Jeddah, Makkah and Newcastle subjects by gender

Variables	Females mean (SD)				Males mean (SD)			
	Jeddah	Makkah	Newcastle	P**	Jeddah	Makkah	Newcastle	P**
Height (cm)	160[a] (5.80)	158[a] (6.20)	158[a] (4.75)	N.S	173[a] (5.47)	171[a] (4.35)	173[a] (5.62)	N.S
Weight (kg)	63.9[ab] (7.28)	66.8[a] (11.40)	62.2[b] (9.80)	N.S	75.3[a] (9.87)	76.1[a] (7.86)	80.5[a] (16.17)	N.S
BMI (kg/m^2)	25[a] (2.41)	26.7[b] (3.94)	24.8[ac] (3.42)	< 0.05	25.04[a] (3.01)	25.90[ab] (2.49)	26.9[b] (5.26)	N.S
BMR (kcal /d)	1388[a] (76.5)	1414[a] (97.40)	1386[a] (84)	N.S	1527[ab] (100)	1521[a] (67.90)	1577[b] (159.4)	< 0.05
WC (cm)	87.4[a] (7.22)	86[ab] (10.03)	82.4[b] (7.33)	< 0.05	89.3[a] (11.71)	91.5[a] (8.96)	93.2[a] (8.89)	N.S
HC (cm)	101[a] (5.97)	99.8[ab] (7.78)	94.8[c] (8.80)	< 0.05	91.9[a] (7.21)	91.4[a] (5.57)	93.4[a] (2.74)	N.S
WHR (cm)	0.86[a] (0.04)	0.86[a] (0.06)	0.87[a] (0.05)	N.S	0.97[a] (0.11)	1[a] (0.07)	0.99[a] (0.09)	N.S
Body fat (%)*	32.1[ab] (4.01)	34.1[a] (6.26)	29.3[b] (2.44)	< 0.05	20.9[a] (4.81)	22.5[a] (4.39)	22.7[a] (2.36)	N.S
TSF (mm)	19.1[a] (2.41)	19.3[ab] (2.26)	17.1[c] (2.56)	< 0.05	12.2[a] (3.54)	12.4[a] (2.57)	12.4[a] (2.41)	N.S
AC (cm)	30.4[a] (2.21)	30.2[ab] (2.70)	28.3[c] (2.03)	< 0.05	28.7[a] (3.01)	27.7[a] (2.17)	27.5[a] (2.52)	N.S
AMC (cm)	24.4[a] (1.96)	24.1[ab] (2.19)	23.2[c] (1.43)	< 0.05	24.8[a] (2.30)	23.8[b] (1.69)	23.6[b] (2.01)	< 0.05

BMI: Body Mass Index. BMR: Basal Metabolic Rate. WC: Waist Circumference. HC: Hip Circumference. WHR: Waist: Hip Ratio. TSF: Triceps Skin-fold. AC: Arm Circumference. AMC: Arm Muscle Circumference. * Calculated from TSF (Durnin & Womersley, 1974). ** *P*-values were significant using general linear regression, which were adjusted for age to compare cities, N.S: not significant a, b and c: Values with different superscripts within the column are significantly different at P < 0.05, values with similar or partially similar superscripts are not significant, using Tukey *post-hoc* test.

8.4.4 Comparison of cardiovascular risk factors between cities

The prevalence of cardiovascular risk factors among men and women in their respective cities is shown in Table 8.4.

8.4.4.1 Obesity

BMI values ranged from 17 to a maximum of 42.5 kg/m^2 in the three areas. Overall, 53% of the participants were overweight or obese (Jeddah 42%, Makkah 66%, and Newcastle 44%). Comparing between the three populations using a chi-square test revealed highly significant differences (χ^2 = 17.898, P = 0.006). Differences were also found between females (χ^2 =14.350, P < 0.05). According to Molarius *et al.* (1999), high risk WC can be defined as >102 cm and >88 cm for men and women, respectively. In the study sample, about 25% of men and women from Jeddah, 29% from Makkah, and 24% from Newcastle could therefore be defined as high risk WC. WHR was dichotomized as non-obese with cut off values of < 0.80 for females and < 0.95 for males (Lean *et al*., 1995). With respect to WHR, 20% in Jeddah, 24% in Makkah, and 19% in Newcastle were define as non-obese. There were no significant differences found when comparing between the three populations in terms of WC and WHR (P > 0.05; one way ANOVA tests) (Table 8.3).

Table 8.4: Comparison of prevalence of cardiovascular risk factors of Jeddah, Makkah and Newcastle subjects by gender

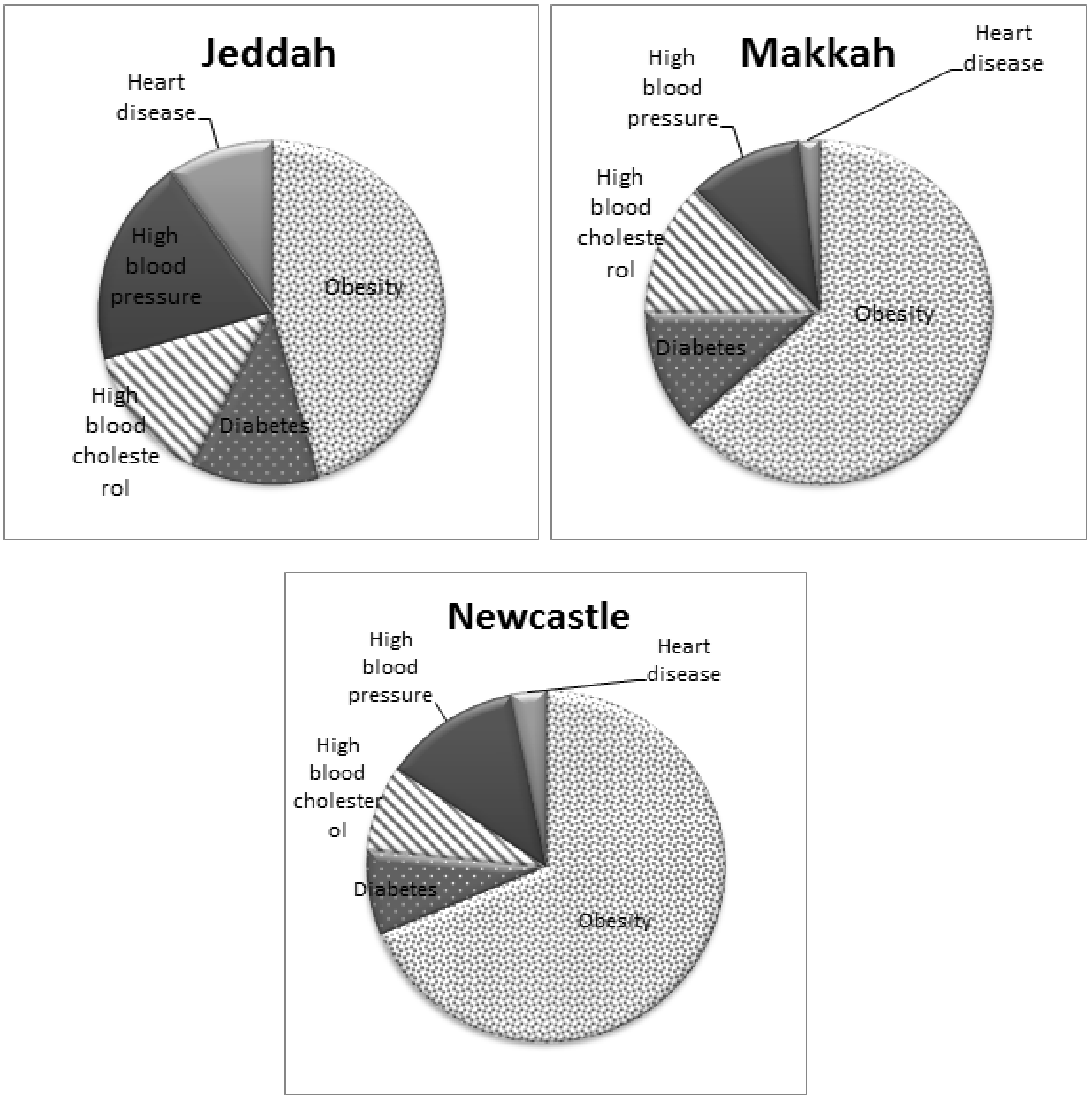
Risk factors	Females *n* (%)					Males *n* (%)				
	Jeddah	Makkah	Newcastle	χ^2	*P*	Jeddah	Makkah	Newcastle	χ^2	*P*
BMI Classification										
Underweight	-	1 (1)	-			1 (1)	-	-		
Normal	29 (29)	17 (13)	29 (37)	14.35	< 0.05	28 (28)	26 (20)	15 (19)	10.14	N.S
Overweight	19 (19)	31 (24)	14 (18)			17 (17)	41 (32)	11 (14)		
Obese	2 (2)	7 (5)	4 (5)			4 (4)	6 (5)	6 (7)		
Diabetes*										
Normal	42 (42)	50 (39)	46 (58)			47(47)	64 (49)	30 (37)		
Diabetic	8 (8)	6 (5)	1 (2)	6.197	N.S	3 (3)	9 (7)	2 (3)	2.403	N.S
High blood cholesterol*										
Normal	43 (43)	49 (38)	46 (58)			45(45)	63 (49)	30 (37)		
Hypercholesterolemia	7 (7)	7 (5)	1 (2)	8.760	N.S	5 (5)	10 (8)	2 (3)	3.737	N.S
High blood pressure*										
Normal	36 (36)	50 (39)	43 (55)			46(46)	65 (50)	30 (37)		
Hypertension	14 (14)	6 (5)	4 (5)	14.13	< 0.05	4 (4)	8 (6)	2 (3)	4.908	N.S
Heart disease*										
Normal	43 (43)	54 (42)	46 (58)			48(48)	72 (56)	32 (40)		
Heart disease	7 (7)	2 (1)	1 (2)	8.742	N.S	2 (2)	1 (1)	-	1.877	N.S
Family history:										
Diabetes	27 (27)	36 (28)	17 (22)			25(25)	37 (29)	14 (18)		
Heart diseases	8 (8)	8 (6)	5 (6)	27.53	< 0.001	3 (3)	10 (8)	3 (4)	6.057	N.S
Smoking status										
Non-smoker	46 (46)	38 (29)	43 (55)			15(15)	13 (10)	9 (11)		
Ex-smoker	-	-	1 (2)			5 (5)	14 (11)	5 (6)		
Current (<20cigarette)	1 (1)	3 (2)	-	6.706	N.S	20 (20)	20 (15)	5 (6)	12.77	< 0.05
Current (>20cigarette)	-	1 (1)	-			5 (5)	25 (19)	6 (7)		
Shisha	3 (3)	14 (11)	3 (4)			5 (5)	19 (15)	9 (11)		
Physical activity										
Inactive	39 (39)	52 (40)	43 (55)			23(23)	46 (36)	23 (28)		
Moderately active	10 (10)	3 (2)	3 (4)	7.293	N.S	17 (17)	21 (16)	5 (6)	8.136	N.S
Active	1 (1)	1 (1)	1 (2)			10 (10)	6 (5)	4 (5)		

N.S: not significant.
* Self-reported.

8.4.4.2 Personal medical history

Of the Jeddah respondents, 11% had diabetes, compared with 12% of Makkah respondents, and 5% of Newcastle respondents. Regarding hypertension, this was present in 18%, 11%, and 8% from the total respondents in Jeddah, Makkah and Newcastle, respectively. No differences in self-reported diabetes, hypercholesterolemia and heart disease were observed among adults in the three cities ($P > 0.05$). However, there were significant differences between the three cities in terms of hypertension ($\chi^2 = 16.915$, $P < 0.05$). Differences were also found between females ($\chi^2 = 14.130$, $P < 0.05$). Figure 8.4 presents personal medical conditions distribution of all study participants.

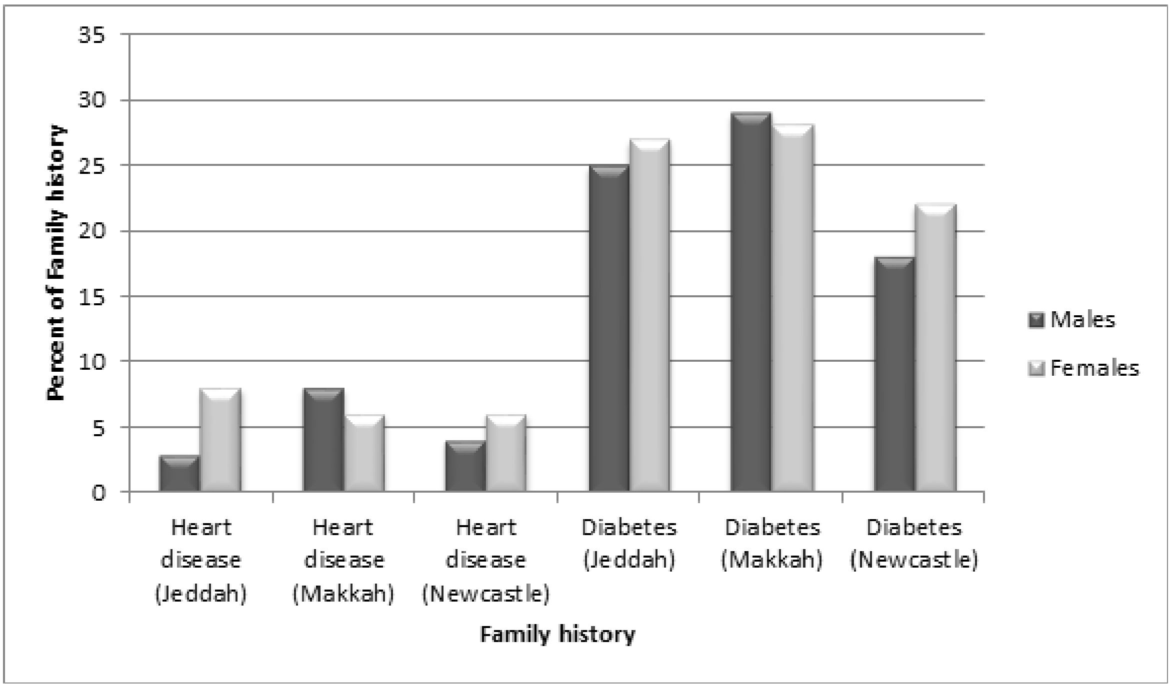
Figure 8.4: Personal medical conditions distribution of all study participants (% obesity, high blood pressure, high blood cholesterol, diabetes, heart disease)



8.4.4.3 Family history

The prevalence of diabetes in any first degree relative (father, mother or both parents) was 52% in Jeddah, 57% in Makkah, and 40% in Saudi subjects in Newcastle, while heart disease was reported at 11% in Jeddah, 14% in Makkah and 10% in Newcastle. A highly significant difference was found between different locations ($\chi^2 = 27.820$, $P < 0.001$; chi-square test). Figure 8.5 shows the family history distribution of all study participants.

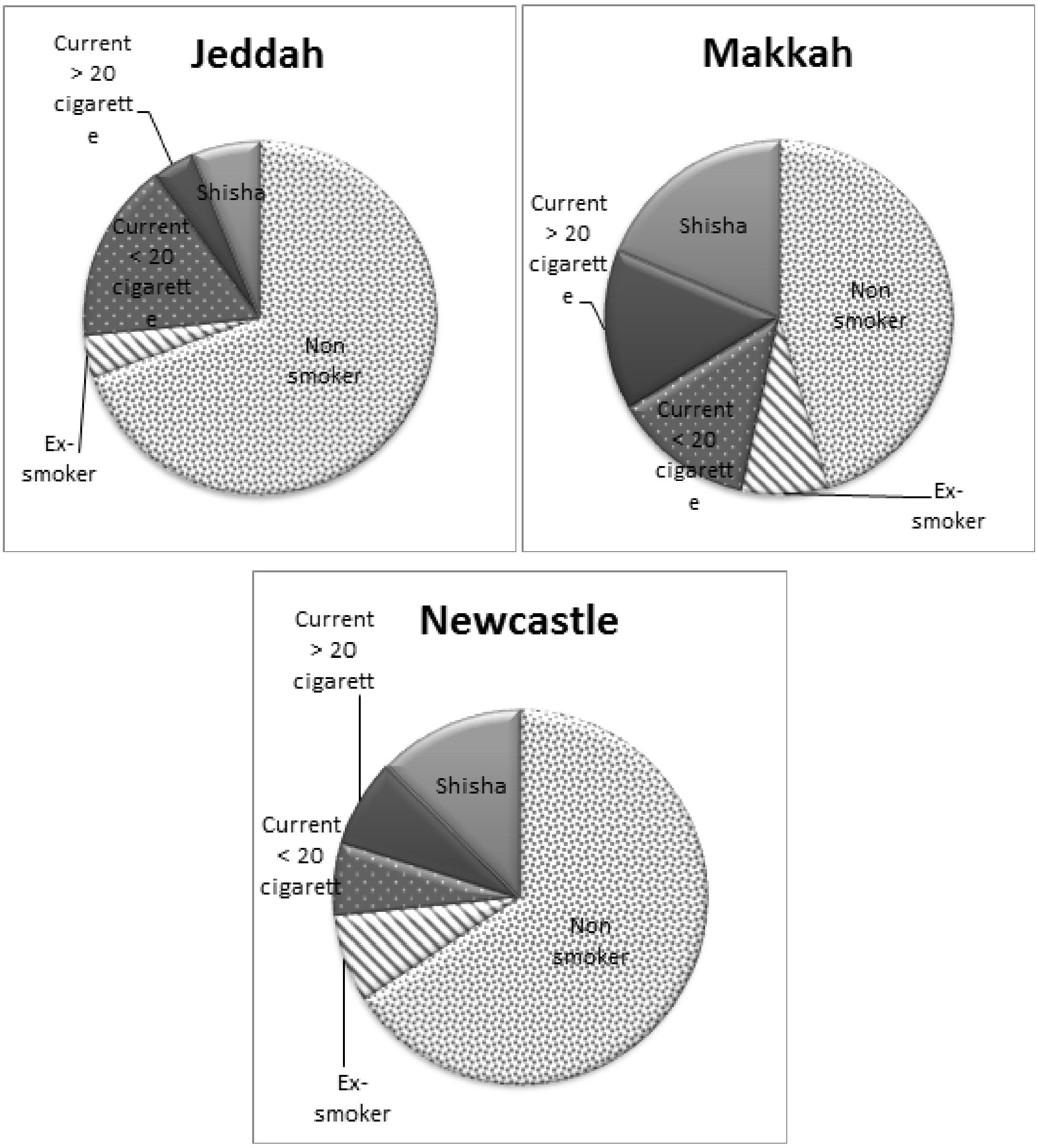
Figure 8.5: Family history distribution of all study participants (% heart disease, diabetes)



8.4.4.4 Smoking habits

Smoking cigarettes presently or in the past was different in each city (Jeddah 31%, Makkah 48%, and Newcastle 21%), as was smoking shisha (Jeddah 8%, Makkah 26%, and Newcastle 13%). Only 17% participants from Makkah smoked both cigarettes and shisha. Of the all the participants, 61% in Jeddah, 39% in Makkah and 66% of Saudi subjects in Newcastle stated that they had never smoked either cigarettes or shisha. There were highly significantly differences between cities in terms of smoking habits (χ^2 = 19.071, $P < 0.001$). Differences were also found between men (χ^2 = 12.776, $P < 0.05$). Figure 8.6 shows the smoking status distribution of all study participants.

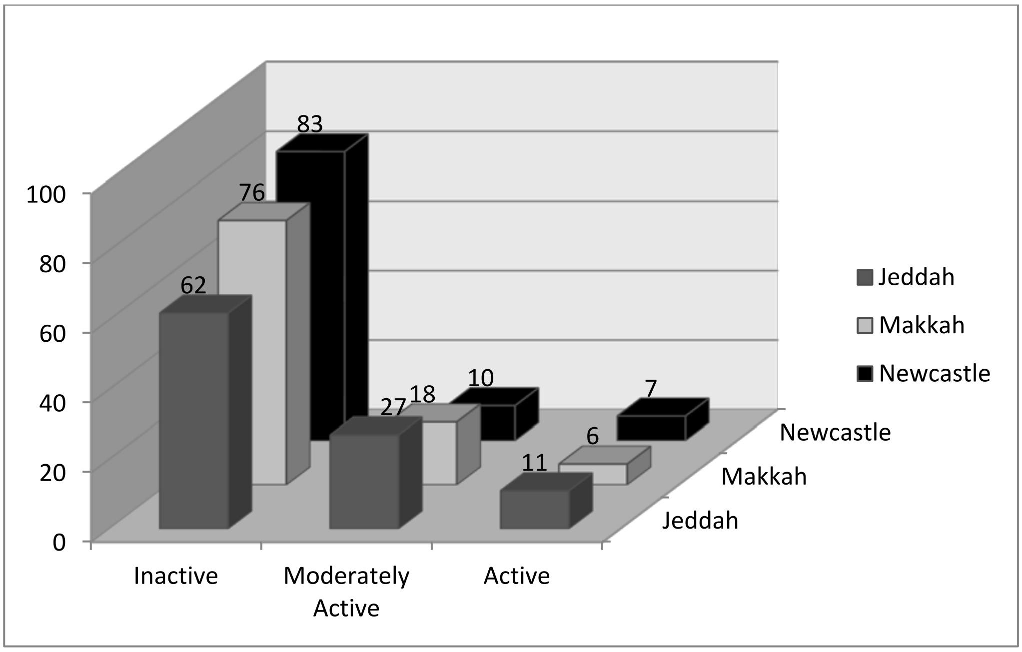
Figure 8.6: Smoking status distribution of all study participants (% non-smoker, ex-smoker, current < 20 cigarette, current > 20 cigarette, shisha)



8.4.4.5 Physical activity

Out of the total 308 participants, 73% engage in low level of physical activity (62% in Jeddah, 76% in Makkah, and 83% in Saudi subjects in Newcastle). In contrast, 27% of the participants engaged in medium or high level physical activity. Men reported engaging in more physical activity than women. Moreover, there were statistical differences between the three cities (χ^2 = 12.118, P < 0.05). Figure 8.7 illustrates the physical activity distribution of all study participants.

Figure 8.7: Physical activity distribution of all study participants (% active, moderately active, inactive)



8.4.5 Dietary data

8.4.5.1 Dietary habits

Table 8.5 shows dietary habits of both men and women in their respective cities. The majority of participants ate three meals per day (Jeddah 69%, Makkah 75%, and Newcastle 49%). The main meal was lunch for 86% of participants in Jeddah and 83% of participants in Makkah. However, the main meal of Saudi participants in Newcastle was dinner, at 72%. The frequency of daily breakfast consumption was 38% in Jeddah, 49% in Makkah, and 55% in Newcastle. There were significant differences between the three cities in meals per day ($P < 0.05$), main meal ($P < 0.001$), and eating breakfast ($P < 0.05$). Most of the participants (Jeddah 89%, Makkah 93%, and Newcastle 94%) ate food outside of their home with more women in Makkah reporting eating out ($\chi^2 = 17.651$, $P < 0.05$).

Table 8.5: Comparison of prevalence of dietary habits between Jeddah, Makkah and Newcastle subjects by gender

Eating patterns	Females *n* (%)					Males *n* (%)				
	Jeddah	Makkah	Newcastle	χ^2	*P*	Jeddah	Makkah	Newcastle	χ^2	*P*
Meals (no./day):										
1 or 2	10 (10)	18 (14)	20 (25)			19 (19)	11 (8)	18 (22)		
3 or 4	39 (39)	37 (29)	26 (33)	5.835	N.S	30 (30)	60 (46)	13 (16)	19.718	< 0.05
More than 5	1 (1)	1 (1)	1 (2)			1 (1)	2 (2)	1 (2)		
Main meal:										
Breakfast	1 (1)	5 (4)	12 (15)			4 (4)	9 (7)	8 (10)		
Lunch	46 (46)	46 (35)	16 (20)	43.233	< 0.001	40 (40)	62 (48)	16 (20)	19.283	N.S
Dinner	13 (13)	13 (10)	34 (43)			18 (18)	25 (19)	23 (29)		
Eating breakfast:										
Daily	12 (12)	26 (20)	27 (35)			26 (26)	38 (29)	16 (20)		
Sometimes	27 (27)	24 (18)	9 (11)	17.309	< 0.05	22 (22)	33 (26)	13 (16)	3.888	N.S
Never	11 (11)	6 (5)	11 (14)			2 (2)	2 (2)	3 (4)		
Eating outside (per week):										
Never	5 (5)	5 (4)	2 (3)			6 (6)	3 (3)	2 (3)		
Once or twice	39 (39)	30 (23)	25 (32)	17.651	< 0.05	22 (22)	36 (28)	15 (19)	5.221	N.S
Three or four times	6 (6)	16 (12)	11 (14)			13 (13)	26 (20)	9 (11)		
More than four times	-	5 (4)	9 (11)			9 (9)	8 (6)	6 (7)		

N.S: not significant

8.4.5.2 Nutrient intake

8.4.5.2.1 Intake of energy, macronutrients, cholesterol and fibre

There were marked differences in macronutrient composition between the three areas, reflecting differences in overall dietary patterns. Saudi men in Newcastle reported the highest average total energy intake. Jeddah subjects were lower than Makkah and Newcastle subjects (Tables 8.6 and 8.7). The mean (SD) energy intake of Jeddah, Makkah and Newcastle participants was as follows: 2005 (325), 2273 (228), and 2279 (287) kcal/day, respectively. Differences were found between genders and between cities in terms of energy intake (MJ/day and kcal/day) ($P < 0.001$). For individuals aged 19 to 59, the UK EAR is 1940 kcal/day for women and 2550 kcal/day for men. On average all men were consuming below the recommended level of energy intake. The percentage energy from total fat in Jeddah was 36% and 33% in Makkah and also for Saudi people living in Newcastle. Energy provided by SFA in Jeddah was 12%, 14% in Makkah and in Newcastle. The percentage of MUFA and PUFA in Jeddah was 12.4% and 6.9%, respectively, compared with 8.8% and 3.1% in Makkah, and 10% and 4.3% in Newcastle, respectively. There were statistically significant differences between cities, as determined by a one way ANOVA, in terms of SFA, MUFA and PUFA (P < 0.001). Jeddah participants had higher intakes of MUFA and PUFA (but not SFA) than the other two cities. A Tukey *post-hoc* test revealed that there were statistically significant differences in MUFA and PUFA (P < 0.001) between the three cities. Dietary cholesterol intake was similar across the three cities. However, Tukey *post-hoc* test revealed that there were statistically significant differences between Saudi men (P < 0.05) in different locations (Table 8.6).

Intake of total protein tended to be lower for Saudi women living in Newcastle at 14%, compared to about 16% and 15% for females in Jeddah and Makkah, respectively. There were significant differences between the means of the three cities in protein (P < 0.05), as illustrated in Table 8.6. The percentage of energy obtained from carbohydrate by Makkah subjects (55%) was similar to Newcastle subjects (55%) and higher than Jeddah subjects (50%). Saudi women in Newcastle reported the highest intake of total carbohydrate (57%), followed by Makkah women (56%) and Jeddah women (51%). There were significant differences observed within the same gender (P < 0.001) and also appeared between cities (P < 0.001). Table 8.6 demonstrates that carbohydrate was the largest contributor (54%) to total daily energy intake among total 308 participants, compared with fat (34%) and protein (16%). The Jeddah sample reported the highest percentage of energy from fat and the lowest percentage of energy from carbohydrate. The percentages of the Makkah and Newcastle samples were in contrast the exact reverse (lowest from fat and highest from carbohydrate). It appears that the mean intake of fibre was below the recommended intake level, with mean (SD) intake of fibre among all 308 participants at 9.1 (4.14) g/day. After adjustment for age and gender, multiple linear regression analysis revealed there were significantly differences between the three cities and differences were also found between females (P < 0.05).

Table 8.6: Mean, standard deviation (SD), median and 95% Confidence Intervals (CI) for daily energy intake and daily intake of macronutrients of subjects by city

Nutrient	Overall			Coastal City Jeddah	Internal City Makkah	Abroad City Newcastle	*P***
	Mean(SD)	Median	95% CI	Mean (SD)	Mean (SD)	Mean (SD)	
Energy (MJ/d)	9.1 (1.28)	9.1	9.1, 9.3	8.4^{a} (1.36)	9.5^{b} (9.61)	9.6^{b} (1.21)	< 0.001
Energy (kcal/d)	2188 (304)	2187	2154, 2221	2005^{a} (325)	2273^{b} (228)	2279^{b} (287)	< 0.001
Total fat (g/d)	82.2 (17.59)	81.4	80.2, 84.2	80.2^{a} (20.8)	83.1^{a} (14.94)	83.2^{a} (17.11)	N.S
% of daily energy	34			35.8^{a}	32.9^{b}	32.9^{b}	< 0.001
SFA (g/d)	33.2 (9.38)	33.4	32.1, 34.2	27.8^{a} (9.2)	36.3^{b} (8.20)	34.9^{b} (8.50)	< 0.001
% of daily energy	13.6			12.4^{a}	14.3^{b}	13.8^{b}	< 0.001
MUFA (g/d)	24.6 (7.71)	24.3	23.7, 25.5	26.5^{a} (25.1, 28.1)*	22.1^{b} (6.12)	24.9^{c} (7.71)	< 0.001
% of daily energy	10.2			12.4^{a}	8.8^{b}	10^{c}	< 0.001
PUFA (g/d)	11.1 (3.44)	9.8	10.5, 11.7	15.4^{a} (6.12)	7.9^{b} (3.1)	10.9^{c} (4.38)	< 0.001
% of daily energy	4.6			6.9^{a}	3.1^{b}	4.3^{c}	< 0.001
Cholesterol (mg/d)	256 (97.24)	247	245, 267	256^{a} (98)	252^{a} (80.03)	231^{a} (182, 294)*	N.S
Protein (g/d)	84.5 (17.89)	83.2	82.5, 86.5	82.09^{a} (18.13)	86.2^{a} (16.79)	85.1^{a} (19.11)	N.S
% of daily energy	16			16.5^{a}	15.2^{b}	15.02^{b}	< 0.05
Carbohydrates (g/d)	295 (59.97)	291	288, 302	252^{a} (49.7)	315^{b} (42.67)	316^{b} (67.90)	< 0.001
% of daily energy	54			50.5^{a}	55.4^{b}	55.3^{b}	< 0.001
Fibre (g/d)	9.1 (4.17)	8.6	8.7, 9.6	10.1^{a} (5.04)	8.9^{ab} (3.26)	8.3^{b} (3.13)	< 0.05

SFA indicates saturated fatty acids; MUFA, monounsaturated fatty acids; PUFA, polyunsaturated fatty acids. *Geometric means (95% CI).
** *P*-values were significant using general linear regression, which were adjusted for age and gender. N.S: not significant.
a, b and c: Values with different superscripts within the column are significantly different at $P < 0.05$, values with similar or partially similar superscripts are not significant, using Tukey *post-hoc* test.

Table 8.7: Comparison of daily energy intake and daily intake of macronutrients between Jeddah, Makkah and Newcastle subjects by gender

Nutrient	Females mean (SD)				Males mean (SD)			
	Jeddah	Makkah	Newcastle	*P*	Jeddah	Makkah	Newcastle	*P*
Energy (MJ/d)	8.6^{a} (1.55)	9.6^{b} (1.07)	9.4^{b} (1.22)	< 0.001	8.2^{a} (1.11)	9.4^{b} (0.87)	9.8^{b} (1.19)	< 0.001
Energy (kcal/d)	2051^{a} (373)	2295^{b} (251)	2231^{b} (271)	< 0.001	1959^{a} (265)	2256^{b} (208)	2350^{b} (290)	< 0.001
Total fat (g/d)	83.88^{a} (22.96)	81.1^{a} (15.10)	78.8^{a} (16.44)	N.S	76.5^{a} (18.08)	84.7^{b} (14.72)	89.6^{b} (16.12)	< 0.05
% of daily energy	36.5^{a}	31.7^{b}	31.9^{b}	< 0.001	35.1^{a}	33.7^{a}	34.5^{a}	N.S
SFA (g/d)	29.5^{a} (10.48)	34.1^{b} (7.68)	33.8^{b} (8.55)	< 0.05	26.12^{a} (7.46)	38.1^{b} (8.22)	36.5^{b} (8.28)	< 0.001
% of daily energy	12.8^{a}	13.3^{a}	13.7^{a}	N.S	12^{a}	15.1^{b}	14.1^{b}	< 0.001
MUFA (g/d)	28.18^{a} (8.14)	21.1^{b} (5.91)	24.5^{c} (6.91)	< 0.001	26.1^{a} (23.9,28.3)*	22.8^{b} (6.11)	25.6^{ab} (8.12)	< 0.05
% of daily energy	12.3^{a}	8.3^{b}	10^{c}	< 0.001	12.4^{a}	9.2^{b}	10^{b}	< 0.001
PUFA (g/d)	16.6^{a} (6.91)	9.1^{b} (2.33)	10.2^{b} (3.81)	< 0.001	14.25^{a} (5.02)	7.1^{b} (2.17)	11.9^{c} (4.91)	< 0.001
% of daily energy	7.2^{a}	3.6^{b}	4.1^{b}	< 0.001	6.5^{a}	2.8^{b}	4.5^{c}	< 0.001
Cholesterol (mg/d)	243^{a} (87.72)	245^{a} (75.93)	187^{a} (156,225)*	N.S	269^{b} (107)	257^{b} (83.21)	318^{a} (221,477)*	< 0.05
Protein (g/d)	80.4^{ab} (19.93)	87.5^{a} (17.77)	77.4^{b} (15.37)	< 0.05	83.7^{b} (16.17)	85.3^{b} (16.06)	96.1^{a} (18.41)	< 0.05
% of daily energy	15.7^{b}	15.3^{b}	13.9^{a}	< 0.05	17.2^{a}	15.1^{b}	16.5^{ab}	< 0.05
Carbohydrates (g/d)	258^{a} (48.54)	323^{b} (42)	324^{b} (65.87)	< 0.001	247^{a} (50.72)	308^{b} (42.37)	305^{b} (70.22)	< 0.001
% of daily energy	50.7^{a}	56.3^{b}	57^{b}	< 0.001	50.3^{a}	54.6^{b}	51.5^{ab}	< 0.05
Fibre (g/d)	11.3^{a} (5.53)	8.9^{b} (2.62)	8.1^{b} (4.04)	< 0.05	8.8^{a} (4.16)	8.9^{a} (3.69)	8.8^{a} (3.71)	N.S

SFA indicates saturated fatty acids; MUFA, monounsaturated fatty acids; PUFA, polyunsaturated fatty acids. *Geometric means (95% CI).
$P < 0.05$, $P < 0.001$ variables were compared by one way ANOVA. N.S: not significant.
a, b and c: Values with different superscripts within the column are significantly different at $P < 0.05$, values with similar or partially similar superscripts are not significant, using Tukey *post-hoc* test.

8.4.5.2.2 Intake of minerals

Mineral intakes differed significantly by location. Mean daily intake of calcium was lower in Jeddah participants compared to the other cities; it was especially low among Jeddah males (644 (176) mg/day). A Tukey *post-hoc* test revealed that there were statistically significant differences between Jeddah and the other two cities in terms of calcium intake ($P < 0.001$). Mean intake of magnesium for Jeddah was 240 (77.14) mg/day, compared with 264 (52.49) mg/day for Makkah, and 273 (80.62) mg/day for Newcastle. Mean daily intake of sodium was highest in Makkah, followed by Newcastle, then Jeddah. A similar result was found for potassium intake, with the highest intake found in Makkah and Newcastle followed by Jeddah (Table 8.8). Both men and women in all cities had mean intakes above the UK RNI recommendations for sodium (1.6 g/day) but below the recommendations for potassium (3.5 g/day). The Makkah sample had the lowest intake of selenium, (at 42.4 µg/day for women and 43.7 µg/day for men), compared to (44.5 µg/day for women and 52.4 µg/day for men) in Newcastle. In contrast, the highest intakes of selenium were found in Jeddah, (at 47.6 µg/day for women and 59.9 µg/day for men). The mean zinc intakes for Jeddah, Makkah and Newcastle were as follows: 8.2 (2.31), 9.9 (2.23), and 9.1 (2.15) mg/day, respectively. There were statistically significant differences as determined by a one way ANOVA between different locations for calcium, sodium, potassium and zinc ($P < 0.001$) (Tables 8.8 and 8.9).

8.4.5.2.3 Intake of vitamins

The data in Table 8.8 shows that the mean daily intake of vitamin A in Jeddah, Makkah and Newcastle was as follows: 591, 550 and 462 µg/day, respectively. Individuals below the UK RNI for vitamin A were more likely to be in male participants. Intake of total vitamin C was above the RNI recommendation for all study subjects. The mean daily intake of vitamin E was 4.8 mg/day for Jeddah, for Makkah it was 4.5 mg/day, and for Saudi men and women living in Newcastle it was 5.4 mg/day. There were significant differences between the three cities and differences were also found between male subjects ($P < 0.05$).

Table 8.8: Mean, standard deviation (SD), median and 95% Confidence Intervals (CI) for daily intake of micronutrients of subjects by city

Nutrient	Overall			Coastal City Jeddah	Internal City Makkah	Abroad City Newcastle	*P***
	Mean(SD)	Median	95%CI	Mean (SD)	Mean (SD)	Mean (SD)	
Calcium (mg/d)	760 (185)	770	740, 781	663^{a} (199)	803^{b} (183)	815^{b} (107)	< 0.001
Iron (mg/d)	13.8*	13.3	12.4, 15.3	13.6^{a} (12.5, 14.7)*	14.6^{a} (4.61)	11.2^{a} (9.3, 13.4)*	N.S
Magnesium (mg/d)	259 (69.98)	249	251, 266	240^{a} (77.14)	264^{b} (52.49)	273^{b} (80.62)	< 0.05
Sodium (g/d)	3.6 (1.26)	3.4	3.4, 3.7	2.9^{b} (0.98)	4.4^{a} (1.23)	3.1^{b} (0.81)	< 0.001
Potassium (g/d)	2.9 (0.87)	2.8	2.8, 3.1	2.6^{a} (0.85)	3.1^{b} (0.79)	3.1^{b} (0.94)	< 0.001
Selenium (µg/d)	47.7 (22.44)	44	45.2, 50.3	53.7^{a} (28.77)	43.1^{b} (16.58)	47.7^{ab} (19.99)	< 0.05
Zinc (mg/d)	9.1 (2.52)	8.8	8.8, 9.4	8.2^{b} (2.31)	9.9^{a} (2.23)	9.1^{b} (2.15)	< 0.001
Vitamin A (µg/d)	525*	582	418, 657	591^{a} (513, 682)*	550^{b} (226)	462^{b} (216)	< 0.001
Vitamin C (mg/d)	49.6*	54.2	39.2, 62.8	51.4^{a} (43.6, 60.6)*	54.1^{a} (47.8,60.9)*	62.9^{a} (32.91)	N.S
Vitamin E (mg/d)	5.1 (2.21)	4.5	4.8, 5.3	4.8^{b} (4.4, 5.3)*	4.5^{a} (1.37)	5.4^{b} (1.81)	< 0.05

*Geometric means (95% CI). ** *P*-values were significant using general linear regression, which were adjusted for age and gender.
N.S: not significant. a, b and c: Values with different superscripts within the column are significantly different at $P < 0.05$, values with similar or partially similar superscripts are not significant, using Tukey *post-hoc* test.

Table 8.9: Comparison of daily intake of micronutrients of Jeddah, Makkah and Newcastle subjects by gender

Nutrient	Females mean (SD)				Males mean (SD)			
	Jeddah	Makkah	Newcastle	*P*	Jeddah	Makkah	Newcastle	*P*
Calcium (mg/d)	682^a (220)	867^b (178)	843^b (88.69)	< 0.001	644^a (176)	753^b (171)	774^b (120)	< 0.001
Iron (mg/d)	14.2^a (12.3,16.2)*	15.2^a (4.96)	11.8^a (8.6,16.1)*	N.S	12.9^a (11.8,14.2)*	14.2^a (4.31)	10.3^a (7.4,14.2)*	N.S
Magnesium (mg/d)	243^a (85.37)	272^b (54.31)	278^b (79.71)	< 0.05	237^a (68.66)	257^a (50.44)	267^a (82.84)	N.S
Sodium (g/d)	3.01^b (0.93)	4.2^a (1.35)	2.9^b (0.82)	< 0.001	2.8^b (1.03)	4.5^a (1.11)	3.2^b (0.80)	< 0.001
Potassium (g/d)	2.7^a (0.97)	3.1^b (0.75)	3.2^b (0.91)	< 0.05	2.5^a (0.71)	3.03^b (0.82)	3^b (0.93)	< 0.05
Selenium (µg/d)	47.6^a (24.57)	42.4^a (14.4)	44.5^a (17.21)	N.S	59.9^a (31.47)	43.7^b (18.13)	52.4^{ab} (22.19)	< 0.05
Zinc (mg/d)	7.9^b (2.17)	9.3^a (2.91)	8.1^b (2.41)	< 0.05	8.6^a (2.41)	10.3^b (1.91)	10.4^b (2.83)	< 0.001
Vitamin A (µg/d)	623^a (520, 746)*	596^b (241)	481^b (222)	< 0.05	561^a (447, 703)*	515^{ab} (208)	434^b (207)	< 0.05
Vitamin C (mg/d)	54.5^a (43.3,68.5)*	57.9^a (49.1,68.5)*	63.7^a (24.30)	N.S	48.5^a (38.01, 61.9)*	51.1^a (43.1, 60.8)*	61.7^a (36.11)	N.S
Vitamin E (mg/d)	4.9^a (4.3, 5.6)*	4.6^a (1.37)	5.5^a (2.41)	N.S	4.8^a (4.2, 5.4)*	4.5^a (1.37)	5.4^a (2.45)	< 0.05

*Geometric means (95% CI). $P < 0.05$, $P < 0.001$ variables were compared by one way ANOVA. N.S: not significant.
a, b and c: Values with different superscripts within the column are significantly different at $P < 0.05$, values with similar or partially similar superscripts are not significant, using Tukey *post-hoc* test.

8.4.5.2.4 Intake of fatty acids

Table 8.10 and 8.11 shows a comparison of fatty acid intake among study subjects in the three cities. Fatty acid intake varied significantly according to geographical location. Residents from Jeddah reported the highest daily intake of total omega 3 fatty acids, followed by Saudi participants in Newcastle, then Makkah residents ($P < 0.001$). The mean daily intake of total omega 3 fatty acids in Jeddah, Makkah and Newcastle was 1.30 g/day, 0.37 g/day and 0.78 g/day, respectively. The main total omega 3 fatty acids were in the form of ALA (Jeddah 1.01 g/day, Makkah 0.36 g/day, and Newcastle 0.56 g/day), and EPA/DHA with 0.17 g/day in Jeddah, 0.007 g/day in Makkah, and 0.16 g/day in Newcastle. Total omega 3 fatty acids contributed 0.58%, 0.14%, and 0.14% to the daily energy intake in Jeddah, Makkah and Newcastle, respectively. On the other hand, the geometric mean for daily intake of total omega 6 fatty acids for Jeddah was 3.90 g/day, while it was 2.62 g/day in Makkah, and 3.75 g/day in Newcastle. The intake of omega 6 fatty acids was mainly in the form of LA (Jeddah 3.7 g/day, Makkah 2.6 g/day, and

Newcastle 3.7 g/day), and AA with (0.16, 0.019, and 0.04 g/day in Jeddah, Makkah and Newcastle, respectively). Omega 6 fatty acids contributed 1.75% of daily energy intake in Jeddah, 1.03% in Makkah, and 0.96% in Newcastle.

Table 8.10: Geometric mean, median and 95% Confidence Intervals (CI) for daily intake of fatty acids of subjects by city

Nutrient	Overall			Coastal City Jeddah	Internal City Makkah	Abroad City Newcastle	*P**
	Mean	Median	95% CI	Mean 95% CI	Mean 95% CI	Mean 95% CI	
Total n-3 PUFAs (g/d)	1.1	0.99	0.8, 1.3	1.3^{a} (1.1, 1.5)	0.37^{b} (0.33, 0.41)	0.78^{b} (0.4, 1.4)	< 0.001
% of daily energy	0.41			0.58^{a}	0.14^{b}	0.14^{b}	
ALA (g/d)	0.72	0.66	0.58, 0.89	1.01^{a} (0.89, 1.1)	0.36^{b} (0.32, 0.4)	0.56^{b} (0.3, 0.9)	< 0.001
EPA (g/d)	0.1	0.04	0.04, 0.10	0.13^{a} (0.06, 0.2)	0.005^{b} (0.003, 0.007)	0.06^{b} (0.02, 0.2)	< 0.001
DHA (g/d)	0.1	0.1	0.1, 0.13	0.14^{a} (0.07, 0.22)	0.002^{b} (0.0004,0.0034)	0.1^{b} (0.04, 0.2)	< 0.001
Total n-6 PUFAs (g/d)	3.4	3.2	2.2, 4.3	3.9^{a} (3.25, 4.56)	2.62^{b} (2.3, 2.9)	3.75^{b} (1.8, 8.01)	< 0.001
% of daily energy	1.4			1.8^{a}	1.03^{b}	0.96^{b}	
LA (g/d)	3.3	3.1	2.6, 4.1	3.7^{b} (3.1, 4.3)	2.6^{a} (2.2, 2.9)	3.7^{b} (1.7, 7.9)	< 0.05
AA (g/d)	0.1	0.1	0.04, 0.1	0.2^{a} (0.11, 0.20)	0.019^{b} (0.016, 0.023)	0.04^{b} (0.02, 0.1)	< 0.001
Total n-6: total n-3 PUFAs	3.3	4.4	2.5, 4.3	4.2^{a} (3.4, 5.1)	7.5^{b} (6.7, 8.3)	4.7^{c} (3.4, 6.7)	< 0.001
Total n-3: total n-6 PUFAs	0.3	0.2	0.2, 0.3	0.55^{a} (0.42, 0.68)	0.2^{b} (0.15, 0.25)	0.2^{b} (0.1, 0.2)	< 0.001
Trans fatty acid (g/d)	2.3	2.5	1.8, 2.8	2.5^{b} (2.2, 2.8)	3.9^{a} (3.5, 4.2)	2.5^{b} (1.2, 5.1)	< 0.001
% of daily energy	1.3			1.1^{b}	1.5^{a}	1.2^{b}	

n-3, omega 3; ALA, alpha-linolenic acid (18:3n-3); EPA, eicosapentaenoic acid (20:5 n-3); DHA, docosahexaenoic acid (22:6 n-3); n-6, omega 6; LA, Linoleic acid (18:2 n-6); AA, arachidonic acid (20:4 n-6).

* *P*-values were significant using general linear regression, which were adjusted for age and gender.

a, b and c: Values with different superscripts within the column are significantly different at $P < 0.05$, values with similar or partially similar superscripts are not significant, using Tukey *post-hoc* test.

Table 8.11: Comparison of daily intake of fatty acids of Jeddah, Makkah and Newcastle subjects by gender

Nutrient	Females Mean (95% CI)				Males Mean (95% CI)			
	Jeddah	Makkah	Newcastle	*P*	Jeddah	Makkah	Newcastle	*P*
Total n-3 PUFAs (g/d)	1.37^{a} (1.03, 1.7)	0.41^{b} (0.35, 0.47)	0.72^{b} (0.2,1.7)	< 0.001	1.2^{a} (0.99, 1.4)	0.33^{b} (0.28, 0.38)	0.88^{b} (0.2,4.2)	< 0.001
% of daily energy	0.60^{a}	0.16^{b}	0.13^{b}		0.55^{a}	0.13^{b}	0.14^{b}	
ALA (g/d)	0.97^{a} (0.83,1.11)	0.41^{b} (0.35,0.47)	0.54^{b} (0.24,1.2)	< 0.001	1.1^{a} (0.86, 1.26)	0.33^{b} (0.28,0.37)	0.59^{b} (0.2,1.6)	< 0.001
EPA (g/d)	0.17^{a} (0.05,0.31)	0.005^{b} (0.004,0.01)	0.1^{b} (0.01,0.3)	< 0.05	0.09^{a} (0.03, 0.15)	0.004^{b} (0.001,0.007)	0.1^{ab} (0.03,1.3)	< 0.05
DHA (g/d)	0.21^{a} (0.07,0.36)	0.002^{b} (0.001,0.003	0.1^{b} (0.04,0.1)	< 0.001	0.07^{a} (0.03, 0.13)	0.001^{b} (0.00, 0.004)	0.1^{ab} (0.01,1.3)	< 0.05
Total n-6 PUFAs (g/d)	2.99^{a} (2.4, 3.5)	3.4^{ab} (2.9, 3.9)	3.9^{b} (1.5,10.2)	N.S	4.8^{a} (3.6, 5.9)	2.02^{b} (1.6, 2.3)	3.4^{b} (0.3,32.6)	< 0.001
% of daily energy	1.31^{a}	1.3^{ab}	0.95^{b}		2.2^{a}	0.80^{b}	0.98^{b}	
LA (g/d)	2.8^{a} (2.2, 3.4)	3.3^{ab} (2.9, 3.8)	3.9^{b} (1.5,10.1)	N.S	4.6^{a} (3.5, 5.7)	2^{b} (1.6,2.3)	3.4^{b} (0.4,32.4)	< 0.001
AA (g/d)	0.14^{a} (0.08,0.19)	0.02^{b} (0.01, 0.03)	0.04^{b} (0.01,0.1)	< 0.001	0.17^{a} (0.11, 0.24)	0.02^{b} (0.01,0.02)	0.1^{b} (0.01,0.2)	< 0.001
Total n-6: total n-3 PUFAs	3.3^{a} (2.4, 4.1)	8.6^{b} (7.6, 9.6)	5.4^{b} (3.8,7.9)	< 0.001	5.2^{ab} (3.8, 6.5)	6.6^{a} (5.5, 7.8)	4.9^{b} (1.5,10.2)	< 0.05
Total n-3: total n-6 PUFAs	0.70^{a} (0.47,0.94)	0.14^{b} (0.12, 0.15)	0.18^{b} (0.1,0.2)	< 0.001	0.40^{a} (0.28,0.52)	0.25^{b} (0.17, 0.33)	0.25^{b} (0.1,0.6)	< 0.05
trans fatty acid (g/d)	2.3^{b} (1.8, 2.7)	3.5^{a} (2.9, 4.1)	1.9^{b} (0.5,6.2)	< 0.05	2.7^{a} (2.3, 3.2)	4.2^{b} (3.7, 4.7)	3.7^{ab} (1.3,10.8)	< 0.05
% of daily energy	1^{b}	1.4^{a}	1.01^{b}		1.2^{a}	1.7^{b}	1.3^{ab}	

n-3, omega 3; ALA, alpha-linolenic acid (18:3n-3); EPA, eicosapentaenoic acid (20:5 n-3); DHA, docosahexaenoic acid (22:6 n-3); n-6, omega 6; LA, Linoleic acid (18:2 n-6); AA, arachidonic acid (20:4 n-6). $P < 0.05$, $P < 0.001$ variables were compared by one way ANOVA. NS: not significant.

a, b and c: Values with different superscripts within the column are significantly different at $P < 0.05$, values with similar or partially similar superscripts are not significant, using Tukey *post-hoc* test.

There were statistically significant differences in the mean total daily intake of omega 6, LA and AA fatty acid ($P \leq 0.001$) between the three cities. The geometric mean for daily intake of *trans* fatty acid was 2.5 g/day in Jeddah, 3.9 g/day in Makkah and 2.5 g/day in Newcastle. *Trans* fatty acid contributed 1.1% to daily energy intake in Jeddah, 1.5% in Makkah and 1.2% in Newcastle. Observed differences among the three populations in terms of *trans* fatty acids were statistically significant ($P < 0.001$). Another comparison between subjects of the same gender found statistically significant differences among females in terms of total omega 3 fatty acids, ALA, EPA, DHA, AA and *trans* fatty acids ($P \leq 0.001$).

8.4.6 Intake by food groups

Jeddah subjects showed an interesting characteristic: the fish consumption was more than 75% higher than in the other two cities, and fruit and vegetable consumption was 25% higher than in the Makkah and Newcastle samples. On the other hand, Makkah participants reported high consumption of fast food and traditional Saudi foods ($P < 0.001$). Both genders in Newcastle reported a lower consumption of traditional Saudi food. Jeddah and Makkah women consumed approximately twice as much traditional Saudi food than women in Newcastle, but among male subjects, Jeddah men consumed twice as much as Newcastle men and Makkah men consumed three times as much as Newcastle men. Intake of nut and seed products was higher in Jeddah and Newcastle than Makkah ($P < 0.001$). Table 8.12 and 8.13 provides a comparison of intake by food group among study samples in the three cities after adjustment for age and gender.

Table 8.12: Percentage, mean and 95% Confidence Intervals (CI) for intake by food group of study subjects by city

Food groups	Overall			Coastal city Jeddah	Internal city Makkah	Abroad City Newcastle	*P**
	n (%)	Mean (g/d)	95% CI	Mean (g/d) *n (%)*	Mean (g/d) *n (%)*	Mean (g/d) *n (%)*	
Nuts and seeds	**37 (12)**	**2.7**	**1.7, 3.8**	**5.2[b]** **22 (22)**	**0.12[a]** **3 (2)**	**4.02[b]** **12 (15)**	**< 0.001**
Fish and sea-food	**70 (23)**	**13.7**	**10.1, 17.3**	**32.6[a]** **42 (42)**	**3.2[b]** **10 (8)**	**7.02[b]** **18 (22)**	**< 0.001**
Fruit & vegetables	**280 (91)**	**170**	**155, 186**	**205[a]** **97 (97)**	**152[b]** **114 (88)**	**156[b]** **69 (87)**	**< 0.05**
Fast food	**267 (87)**	**450**	**412, 488**	**327[b]** **79 (79)**	**597[a]** **122 (95)**	**365[b]** **66 (83)**	**< 0.001**
Traditional Saudi food	**267 (87)**	**257**	**236, 279**	**271[b]** **91 (91)**	**317[b]** **125 (96)**	**143[a]** **51 (65)**	**< 0.001**

* *P*-values were significant using general linear regression, which were adjusted for age and gender.

a, b and c: Values with different superscripts within the column are significantly different at $P < 0.05$, values with similar or partially similar superscripts are not significant, using Tukey *post-hoc* test.

Table 8.13: Comparison of intake by food group of Jeddah, Makkah and Newcastle subjects by gender

Food groups	Females Mean (g/d) (95% CI)			*P*	Males Mean (g/d) (95% CI)			*P*
	Jeddah	Makkah	Newcastle		Jeddah	Makkah	Newcastle	
Nuts and seeds	5.6[b] (2.5, 8.6)	0.12[a] (0.11, 0.35)	5.1[b] (1.3, 8.7)	< 0.05	4.8[a] (0.6, 8.9)	0.11[b] (0.04, 0.27)	2.5[b] (1.1, 6.1)	< 0.05
Fish and sea-food	31.2[a] (18.1, 44.4)	1.8[b] (0.1, 3.6)	6.9[c] (1.2, 12.6)	< 0.001	34.2[a] (20.4, 47.9)	4.26[b] (0.34, 8.1)	7.2[b] (1.6, 12.6)	< 0.001
Fruit & vegetables	226[a] (191, 260)	147[b] (120, 174)	155[b] (119, 190)	< 0.05	185[a] (130, 239)	156[a] (124, 188)	159[a] (111, 206)	N.S
Fast food	287[b] (219, 354)	611[a] (520, 702)	300[b] (225, 374)	< 0.001	368[b] (285, 451)	586[a] (501, 672)	460[b] (338, 582)	< 0.05
Traditional Saudi food	331[b] (270, 392)	338[b] (294, 381)	160[a] (103, 217)	< 0.001	211[a] (172, 249)	301[b] (256, 346)	117[c] (63.9, 171)	< 0.001

$P < 0.05$; $P < 0.001$ variables were compared by Kruskal Wallis tests. N.S: not significant.
a, b and c: Values with different superscripts within the column are significantly different at $P < 0.05$, values with similar or partially similar superscripts are not significant, using Tukey *post-hoc* test.

Table 8.14 describes the association between intake by food group and energy and nutrient intake. Intake of the nuts and seeds group had the strongest positive associations with total fat, MUFA, PUFA, magnesium and vitamin E ($P < 0.001$). As for the fish and sea-food group, this was higher in PUFA, selenium, total omega 3, ALA, EPA and DHA but lower in SFA, carbohydrates and sodium. The fruit and vegetables group was positively correlated with fibre, magnesium, potassium and vitamin C. Fast food had positive associations with energy ($r = 0.240$, $P < 0.001$), total fat, sodium, total omega 6 fatty acid, LA and *trans* fatty acid ($r = 0.463$, $P < 0.001$). However, there were negative associations with fibre ($r = -0.427$, $P < 0.001$), magnesium, potassium and vitamin C. Traditional Saudi food was characterized by a high intake of energy, protein, carbohydrates, fibre ($r = 0.498$, $P < 0.001$), iron ($r = 0.439$, $P < 0.001$), magnesium ($r = 0.351$, $P < 0.001$), sodium ($r = 0.391$, $P < 0.001$), potassium ($r = 0.445$, $P < 0.001$) and vitamin C.

Table 8.14: Pearson's correlation coefficients of intake by food groups with energy and other nutrient intakes

Nutrient	Food groups				
	Nuts & seeds	Fish	Fruit & vegetables	Fast food	Traditional Saudi food
Energy (kcal)	0.066	**-0.159***	-0.064	**0.240****	**0.171***
Total Fat (g)	**0.214****	-0.049	-0.031	**0.177***	-0.012
SFA (g)	-0.058	**-0.211****	-0.091	0.103	0.021
MUFA (g)	**0.321****	**0.123***	0.081	-0.064	-0.048
PUFA (g/d)	**0.450****	**0.246****	**0.186***	-0.149	0.055
Cholesterol (mg)	-0.030	0.030	0.002	0.021	0.099
Protein (g)	0.042	0.110	-0.011	-0.024	**0.119***
Carbohydrates (g)	-0.071	**-0.214****	-0.049	**0.196***	**0.217****
Fibre (g)	**0.188***	0.048	**0.361****	**-0.427****	**0.498****
Calcium (mg)	0.023	**-0.112***	0.067	**-0.114***	0.059
Iron (mg)	0.002	0.030	0.071	**-0.184***	**0.439****
Magnesium (mg)	**0.238****	0.041	**0.201****	**-0.226****	**0.351****
Sodium (g)	**-0.159***	**-0.243****	-0.053	**0.274****	**0.391****
Potassium (g)	0.031	-0.008	**0.232****	**-0.247****	**0.445****
Selenium (µg)	0.182	**0.434****	0.072	-0.017	-0.070
Zinc (mg)	-0.057	**0.146***	0.085	**-0.135***	-0.070
Vitamin A (µg)	0.067	0.093	**0.144***	-0.105	0.098
Vitamin C (mg)	0.061	0.045	**0.494****	**-0.285****	**0.128***
Vitamin E (mg)	**0.471****	-0.038	**0.140***	**-0.152***	0.033
Total n-3 PUFAs (g)	**0.161***	**0.314****	**0.161***	-0.040	0.045
ALA (g)	**0.162***	**0.231****	**0.151***	-0.035	0.059
EPA (g)	0.160	**0.553****	**0.234***	-0.102	-0.106
DHA (g)	0.147	**0.429****	**0.362***	-0.156	-0.216
Total n-6 PUFAs (g)	**0.176***	**0.113***	-0.018	**0.215****	-0.059
LA (g)	**0.175***	0.097	-0.024	**0.224****	-0.064
AA (g)	**0.212***	0.366	0.019	0.000	-0.031
***Trans* fatty acid (g)**	-0.078	**-0.168***	-0.018	**0.463****	-0.096

Correlation is significant at * $P < 0.05$ and ** $P < 0.001$.

8.4.7 Multivariate analysis of the association between nutrients intake and CVD risk factors in between cities

General linear model analysis was applied to examine the associations of dietary intake with CVD risk factors. Stepwise multiple regression analysis was performed to adjust the data for possible effects of confounding factors between dietary intakes and CVD risk factors in the subject study (n = 308). Table 8.15 presented the significance of the association between nutrients intake and CVD risk factors between cities, as assessed by multivariate linear regression for all study subjects. Variables (age, gender, BMI, WHR, diabetes, smoking, physical activity and socioeconomic status) were statistically significantly associated with dietary intake at 5% level were selected. Multiple linear regression analysis showed significantly differences between (Jeddah, Makkah and Newcastle) for energy intake (β = -0.206; P < 0.001), SFA (β = -0.233; P < 0.001), MUFA (β = 0.149; P = 0.010), PUFA (β = 0.394; P < 0.001), carbohydrate (β = -0.277; P < 0.001), vitamin A (β = 0.180; P = 0.019), vitamin E (β = 0.156; P = 0.043), selenium (β = 0.159; P = 0.005), sodium (β = -0.360; P < 0.001), potassium (β = -0.461; P < 0.001), zinc (β = -0.190; P = 0.031), total omega 3 fatty acids (β = 0.333; P < 0.001), ALA (β = 0.415; P < 0.001), EPA (β = 0.288; P < 0.001), DHA (β = 0.181; P < 0.001), total omega 6 fatty acids (β = 0.190; P = 0.024), LA (β = 0.186; P = 0.017), AA (β = 0.267; P < 0.001) and *trans* fatty acid (β = -0.203; P < 0.001).

Table 8.15: Significance of the association between nutrients intake and CVD risk factors between cities (*n* = 308), as assessed by general linear model analysis

Nutrient	β	SE	*P*	95% CI	
				Lower limit	Upper limit
Energy (MJ/d)	**-0.202**	**0.073**	**< 0.001**	**9.05**	**9.33**
Energy (kcal/d)	**-0.206**	**17.31**	**< 0.001**	**2153**	**2221**
Total fat (g/d)	0.091	1.002	N.S	80.26	84.21
SFA (g/d)	**-0.233**	**0.534**	**< 0.001**	**32.15**	**34.25**
MUFA (g/d)	**0.149**	**0.439**	**< 0.05**	**23.78**	**25.51**
PUFA (g/d)	**0.394**	**0.310**	**< 0.001**	**10.54**	**11.76**
Cholesterol (mg/d)	0.142	5.54	N.S	245	267
Protein (g/d)	0.129	1.01	N.S	82.58	86.59
Carbohydrates (g/d)	**-0.277**	**3.41**	**< 0.001**	**288**	**301**
Fibre (g/d)	0.110	0.238	N.S	8.71	9.64
Calcium (mg/d)	**-0.246**	**10.53**	**< 0.001**	**739**	**781**
Iron (mg/d)	0.085	0.389	N.S	14.36	15.89
Magnesium (mg/d)	**0.152**	**3.981**	**< 0.05**	**250**	**266**
Sodium (g/d)	**-0.360**	**0.721**	**< 0.001**	**3.46**	**3.74**
Potassium (g/d)	**-0.461**	**0.499**	**< 0.001**	**2.86**	**3.05**
Selenium (μg/d)	**0.159**	**1.27**	**< 0.05**	**45.27**	**50.31**
Zinc (mg/d)	**-0.190**	**0.141**	**< 0.05**	**8.88**	**9.44**
Vitamin A (μg/d)	**0.180**	**32.18**	**< 0.05**	**546**	**672**
Vitamin C (mg/d)	0.094	2.92	N.S	61.31	72.81
Vitamin E (mg/d)	**0.156**	**0.126**	**< 0.05**	**4.82**	**5.32**
Total n-3 PUFAs (g/d)	**0.333**	**0.044**	**< 0.001**	**0.58**	**0.757**
ALA (g/d)	**0.415**	**0.029**	**< 0.001**	**0.50**	**0.615**
EPA (g/d)	**0.288**	**0.012**	**< 0.001**	**0.03**	**0.081**
DHA (g/d)	**0.181**	**0.013**	**< 0.001**	**0.02**	**0.082**
Total n-6 PUFAs (g/d)	**0.190**	**0.158**	**< 0.05**	**2.68**	**3.31**
LA (g/d)	**0.186**	**0.155**	**< 0.05**	**2.62**	**3.24**
AA (g/d)	**0.267**	**0.011**	**< 0.001**	**0.05**	**0.08**
Total n-3: total n-6 PUFAs	**0.175**	**0.027**	**< 0.001**	**0.26**	**0.37**
trans fatty acid (g/d)	**-0.203**	**0.115**	**< 0.001**	**2.95**	**3.41**

SE, stander error; 95% CI, confidence interval; ß and 95% CI are significant at $P < 0.05$, $P < 0.001$indicated in bold font.
**All the socioeconomic and CVD risk factors were run in one multivariate model and adjusted for age, gender.

8.5 Discussion

The conducted research aimed to measure and compares the dietary intake of Saudi men and women and risk factors of CVD, covering different geographical locations in both Saudi Arabia and the UK. Dietary information was collected from a sample of 308 18-63 year old Saudi men and women. The sample was sufficiently enough to determine differences in total omega 3 fatty acids intake between coastal and internal areas with power of 95% (Chapter 3). Men represented 50% (155) and women 50% (153) of the study population. The mean age of the females was 31.1 (7.35) years and of the males it was 32.2 (8.27) years.

In the present study, the proportion of men and women with self-reporting heart medical conditions was very low (4%). However, regarding the risk factors that relate to CVD, the most common risk factor reported was being physical inactive, with 73% of the total population reporting this (44% of women and 30% of men, of which 62% were in Jeddah, 76% in Makkah, and 83% in Newcastle). There was a statistically significant association between physical activity and gender and the cities. It is suggested that the reason might be that when participants spend more time away from home it might influence their participation in sport. Al Rafaee and Al Hazzaa (2001) reported that about 53.5% of Saudi men aged 19 years and older are generally physically inactive, and 27.5% are irregularly active and only 19% were found to be active. Physical activity has also been found to be lower among married individuals, those who work in the private sector or have two shifts of work, individuals with lower education, and those who work six days a week with only one day off. Al Rafaee and Al Hazzaa (2001) concluded that time seemed to be the major limiting factor that contributed towards physical inactivity and most Saudi men primarily resort to physical activity to lose weight and to maintain health. More recently, Al Nakeeb *et al.* (2012) have reported similar findings, that youth in the city of Al Ahsa in eastern Saudi Arabia have lower rates of physical activity and a higher percentage of obesity and sedentary time when compared with those living in Birmingham and Coventry. In Al Ahsa, Saudi Arabia, the unavailability of parks, sports grounds and facilities that can encourage the youth to practice sport and physical activities are the major reason behind their low levels of physical activity. In addition, the Saudi Arabian desert climate does not encourage individuals to engage in physical activity throughout the various seasons of the year. Similar to Al Nakeeb *et al*. (2012), females in the three cities of the current study, engaged in less physical activity than males. Of these subjects, 44% smoked cigarettes and/or shisha, of which 34% were located in Jeddah, 63% in Makkah, and 26% in

Newcastle. There was a statistically significant association between smoking status with gender, age and socioeconomic status (*P* < 0.05). The incidence of smoking was greater among those who were men, young and less educated.

The mean BMIs of adult Saudi subjects in the various age groups included in this study were 25.8 (3.45) kg/m^2 for men and 25.6 (3.44) kg/m^2 for women. This study found that a substantial proportion of the population were overweight or obese. A total of 53% of the subjects in the present study were either overweight or obese, of whom 42% were from Jeddah, 66% from Makkah, and 44% from Newcastle. Comparing between the three population highly significant differences were found (*P* < 0.05). However, the results indicated that there were no significant differences between men and women with regard to the prevalence of being overweight /obese in each of the three cities when analyzed separately. On the other hand, with respect to WHR, 79% from the three areas were categorised as obese. The mean WHR for all women was 0.86 (0.05) cm and for all men it was 0.99 (0.08) cm. WHR was classed as non-obese with cut off values of < 0.80 for females and < 0.95 for males (Lean *et al*., 1995). Overall, more than one-third of subjects had WC ≥ 102 cm (men) and 88 cm (women). This was greatest among Saudis living in internal city, which is putting these men and women at risk of CVD related to obesity. Recent research shows that WC or WHR may be useful indicators of the risk of obesity (Lee *et al*., 2008). This is consistent with a previous study by Al Saif *et al*. (2002) involving 3261 Saudi men and women aged between 30-70 years. The study found that 49.15% of women and 29.94% of men were overweight or obese, and many Saudis were in the highest category of WHR 63%. It seemed that this was due to a mixture of over consumption, the influences that culture exerts on individuals’ eating behaviours, and a lack of physical activity. Obese and overweight men and women were significantly more likely to be between 40-59 years of age, to have high incomes, and to be non-smokers. It has been reported that participants’ attitudes are influenced by economic status and/or educational level. There were significant differences between men and women and between cities as regards socioeconomic status; the majority had a medium economic status. These results are in accordance with Al Qauhiz (2010), who found during the last three decades that economic development in Saudi Arabia has changed the population nutritional and lifestyle habits. The results of the present study indicate that participants with a high socioeconomic status (high education and high total monthly income) are more likely to be older and non-smokers (*P* < 0.05). Studies have shown that in developed and developing countries there are a significant relationship between socioeconomic status and many CVD risk factors (Marmot, 2001; Yu *et al*., 2000). Additionally, studies in Canada and the USA have revealed an inverse association between educations and regular smoking, high blood pressure and being overweight (Dhalla *et al*., 2003; Nair *et al*., 1989). In the WHO Countrywide Integrated Non-communicable Diseases Intervention (CINDI) program in Austria, people with a low education were found to have a worse CVD risk profile (Ulmer *et al*., 2001).

One of the purposes of this study was to evaluate current dietary practices of Saudi adults in different locations. The study found that there were several differences in their dietary habits; most participants (67%) had irregular meals and a total of three meals per day. The main meal was lunch for 86% of coastal city and 83% of internal city. However, the main meal of Saudi participants in Newcastle was dinner (72%). There were significant changes in the main meals taken by study samples ($P < 0.001$) in terms of Saudis in their home town and those in the UK. The frequency of having breakfast and lunch dropped while the frequency of having dinner remained the same as it did in their home town. The present study indicates that around half of the participants do not consume breakfast daily. Various reasons for not eating breakfast were given by participants, such as not feeling hungry in the morning, saving time and wanting to lose weight. A study by Sakarata *et al.* (2001) claimed that skipping breakfast was associated with lower nutritional status and increased CVD risk. Furthermore, a lack of eating breakfast may contribute towards the prevention of obesity (Huang *et al.*, 2010). Most of the participants in this study (89% in Jeddah, 93% in Makkah, and 94% in Newcastle) said they ate food outside of their home. The study also found that Saudi students in Newcastle had more difficulty maintaining their native diet compared to other subjects (in Jeddah and Makkah). This can be attributed to a number of factors, among which are: the limited number of stores that sell ethnic foods; the high prices of various ethnic foods because of a monopoly of surrounding businesses in the area; the quality of food is below the consumer's expectations; food choices are influenced by convenience, as a limited time available for cooking may force students to depend on frozen foods. It was also found that students who had arrived recently tended to skip meals and increase their consumption of snack foods because of a financial burden and their school schedules (Papadaki & Scott, 2002; Perez-Cueto *et al*., 2009; Reeves & Henry, 2000).

The main dietary intake data gathered across the three locations demonstrate that subjects from the coastal city had significantly low energy and SFA intakes but higher intakes of MUFA and PUFA, fibre, selenium and vitamin A ($P < 0.05$). In contrast, they ate significantly less carbohydrates, calcium, magnesium, sodium, potassium and zinc ($P <$

0.05). Overall, the diet of internal city residents resembled that of the subjects based in Newcastle more than the diet of Jeddah residents because the levels of key nutrient and food intakes, such as energy, SFA, carbohydrates, calcium, magnesium, potassium and vitamin A, were similar. On the other hand, MUFA and PUFA intakes differed between the three cities ($P < 0.001$). The Makkah population was characterised by a high intake of sodium 4.4 (1.23) g/day, which was above the recommendation suggested by the Department of Health of 1.6 g/day. However, Jeddah and Newcastle Saudi subjects also had a fairly high intake of sodium, at 2.9 (0.98) g/day and 3.1 (0.81) g/day, respectively. Several studies have found a correlation between high levels of sodium and hypertension and increased CVD risk (du Cailar *et al.*, 2002; Sacks *et al.*, 2001; Scientific Advisory Committee on Nutrition, 2003). A number of studies have reported that a high intake of potassium acts as protection against CVD (D'Elia *et al.*, 2011; Tunstall-Pedoe *et al.*, 1999). Potassium intakes were notably low amongst Saudi subjects. Potassium intakes among Jeddah subjects were considerably lower than that of subjects based in Makkah and Newcastle. Vitamin E are considered cardio-protective due to their antioxidant properties (Greig & Maxwell, 2001; Marchioli *et al.*, 2001). It was found that there was a higher intake of vitamin E and a lower intake of vitamin A among Saudis living in Newcastle than Saudis living in Jeddah and Makkah ($P < 0.05$).

One of the aims of this study was to compare the intake of omega 3 fatty acids among the Saudi population living within Saudi Arabia (Jeddah and Makkah) and those living abroad (in Newcastle, UK). To the best of the researcher's knowledge, this is the first study to investigate and compare the intakes of omega 3 and omega 6 fatty acids by Saudis living in different locations, both within Saudi Arabia and elsewhere. Jeddah residents were characterised by high intakes of total omega 3 fatty acids (1.3 g/day), ALA (1.01 g/day), EPA (0.13 g/day), DHA (0.14 g/day), total omega 6 fatty acids (3.9 g/day), LA (3.7 g/day) and AA (0.2 g/day). Intake of the same fatty acids among Saudis living in Makkah and Newcastle were similar. When these results were compared with the recommendations of Simopoulos *et al*. (1999), it was found that intakes were lower than those considered adequate for total omega 3 fatty acids (3 g/day), ALA (2.22 g/day), EPA (0.22 g/day), DHA (0.22 g/day) and LA (6.67 g/day) in all three cities. Tom *et al*. (2004) recommended that the minimum intake of EPA + DHA should be 500 mg/day to ensure good cardiovascular health. In addition, EPA + DHA in the present study were lower than figures should be, as reported by FAO/WHO (2003), namely that EPA + DHA intake should be 200-500 mg/day. The UK Scientific Advisory Committee on Nutrition (2004) has recommended that the dietary omega 3 to omega 6 fatty acids ratio should be 0.4. It appeared that among Jeddah residents this was above the recommended level, but it was lower in the other two cities. The percentage of daily *trans* fatty acids intake as a proportion of daily energy intake was deemed to be 1.1% among the Jeddah sample, 1.5% among the Makkah sample, and 1.2% among Saudis living in Newcastle. Differences were observed among the three populations in terms of intake of *trans* fatty acids ($P < 0.001$). It has been recommended by the American Heart Association that no more than 1% of an individual's total energy intake (approximately 1-3 g/day) should derive from *trans* fatty acids (Lichtenstein *et al*., 2006).

A study by Shara (2010) divided the countries of the Middle East into two parts. Saudi Arabia is one of the oil rich countries of the region and population's diet comprises a high intake of red meat, carbohydrates and sugar. Another important finding of this study is related to food group consumption; there were five food groups examined in this study. The Jeddah population showed an interesting characteristic, namely that their fish intake was more than 75% higher than the other two cities' populations. This may be explained by the fact that Jeddah is a coastal city. Al Khateeb and Al Gelban (2008) mention that fish is not commonly served among Saudis living in the interior of the country. Fruit and vegetable intake was 25% higher in Jeddah than among Saudis in Makkah and Newcastle. On the other hand, Makkah participants reported higher consumption of fast food and traditional Saudi foods ($P < 0.001$). Both genders in Newcastle reported lower intake of traditional Saudi food. The variety of fast food in Saudi Arabia is vast. Most of the popular American and other western restaurants are present in the Arabian Gulf region. People have become increasingly used to eating outside of their home (Al Fawaz, 2012). This has given rise to the trend of consuming a westernised diet that is rich in energy, fat and sugars, and low in dietary fibre, calcium and iron (Guthrie *et al*., 2002). A previous study focusing on 141 female college students aged 22 years in Riyadh, Saudi Arabia, indicated that the frequency of consumption of fast food was in the range of 1-2 times per week among 75% of the participants. About half of the women ate chips, fried food and French fries and drinking soft beverages (Al Fawaz, 2012). In Kuwait, another study by Al Khamees (2009) reported that the consumption of vegetables and healthy fat among female students was low, while sweets and fast food consumption was high in their diet. A study conducted in the United Arab Emirates reported that there was a high level of skipping meals in the morning and afternoon among female students. It was also reported that fruit and vegetable intakes were low and that in general they consumed much westernised food (Musaiger, 1994). One common finding of the current study that is in agreement with several other studies (Himmelgreen *et al*., 2004; Himmelgreen *et al*., 2005; Sharma *et al*., 1999) is the high level of fast food consumption and low level of traditional food consumption. It is possible that families try to maintain a traditional diet but factors associated with limited income, limited time to prepare foods, and reliance on convenience and easy to prepare foods mean that they cannot. Results of the present study have revealed a relationship between BMI and age, smoking, total fat present and fast food. The younger population is more likely to be overweight, smoking, and consuming food with high total fat and fast food compared to the older population. Men were found to consume more fast food than women, while the latter consumed more traditional Saudi food ($P < 0.05$). Based on the research conducted, in various at risk populations a larger public program should be designed to specifically help these individuals.

8.6 Summary and conclusions

The research has highlighted a number of important findings, as follows:

- The results showed that the subjects had a generally unhealthy lifestyle, such as a smoking habit, physical inactivity and a high intake of SFA (especially in internal area), which may affect their CVD risk.
- On average, BMI was lower among men and women from Jeddah (25.1 (2.76) kg/m^2), followed by Saudis living in Newcastle (25.6 (4.36) kg/m^2), then those living in Makkah (26.3 (3.21) kg/m^2) ($P < 0.05$).
- The majority belonged to the medium socioeconomic status, specifically 63% in Jeddah, 50% in Makkah, and 78% in Newcastle.
- No differences were observed among adults in terms of self-reported diabetes, hypercholesterolemia and heart disease ($P > 0.05$).
- Men were more physically active than women in the three different locations.
- Nutritional intake differed significantly between the three areas in energy intake, total fat percentage, and intakes of carbohydrate, fibre, sodium, potassium, selenium, zinc, vitamins A and E and all fatty acids.
- Subjects from Jeddah had a significantly lower energy intake and SFA intake, but higher intakes of MUFA and PUFA, fibre, selenium and vitamin A ($P < 0.05$). In contrast, they consumed significantly less carbohydrates, calcium, magnesium, sodium, potassium and zinc ($P < 0.05$).
- Overall, the diet of internal city residents resembled that of the subjects based in Newcastle more than the diet of Jeddah residents because the levels of key nutrient

and food intakes, such as energy, SFA, carbohydrates, calcium, magnesium, potassium and vitamin A, were similar.

- The intake of total omega 3 fatty acids for participants living Jeddah was higher than those living in Makkah and in Newcastle.
- A significant decrease in the consumption of traditional Saudi food and an increased intake of fast foods were the major dietary changes reported by Saudis living away from their home country.
- Table 8.16 shows the comparison summary of prevalence of cardiovascular risk factors of Jeddah, Makkah and Newcastle subjects by age and gender.

Table 8.16: Comparison summary of prevalence of cardiovascular risk factors of Jeddah, Makkah and Newcastle subjects by age and gender

Variables	CVD risk factors					
	Obesity (>25- >30) (%)	Diabetes (%)	High blood cholesterol (%)	High blood pressure (%)	Smoking (%)	Physical inactive (%)
Jeddah (100)						
Men						
(18-30)	7	-	-	-	20	10
(31-40)	9	-	-	-	7	7
(41-50)	3	1	2	2	3	3
(51-65)	2	2	3	2	1	3
Women						
(18-30)	7	1	1	1	2	17
(31-40)	8	1	1	5	-	14
(41-50)	6	6	5	8	1	8
(51-65)	-	-	-	-	-	-
All (Men+ Women)	42	11	12	18	34	62
Makkah (129)						
Men						
(18-30)	9	1	1	2	35	13
(31-40)	19	-	2	2	12	19
(41-50)	5	2	2	2	2	3
(51-65)	4	3	3	1	-	1
Women						
(18-30)	11	2	1	1	8	20
(31-40)	9	1	1	1	4	11
(41-50)	7	2	1	2	2	8
(51-65)	2	1	2	-	-	1
All (Men+ Women)	66	12	13	11	63	76
Newcastle (79)						
Men						
(18-30)	8	-	-	-	14	14
(31-40)	13	1	1	2	10	11
(41-50)	1	1	1	-	5	3
(51-65)	-		-	-	-	-
Women						
(18-30)	8	1	1	-	5	35
(31-40)	12	-	-	4	-	18
(41-50)	2	2	2	2	-	2
(51-65)	-	-	-	-	-	-
All (Men+ Women)	44	5	5	8	34	83
All three cities (308)	53	10	10	12	44	73

Chapter 9

General Discussion, Conclusions, Hypotheses Testing, Recommendations and Further Work

This thesis has considered aspects related to dietary food intake and CVD risk factors in Saudi adults, as attested by age, gender and socioeconomic background, and dietary intake of total fat, omega 3 fatty acids and long chain polyunsaturated fatty acids, as well as a comparison within geographical locations. A detailed discussion of the results has previously been presented in chapters 4 to 8. The aims of this chapter are:

- To discuss and contextualize the results across a broader spectrum.
- To draw conclusions and make recommendations.
- To identify relevant aspects related to the development of dietary food intake that merit further research.

This study has a number of strengths, including the use of appropriate tools for data collection and recruiting sub-samples from the three geographical locations which allowed for assessing differences due to gender and age. Few studies have focused on measuring dietary intake of Saudi adults using three day food records. Not many studies have investigated the dietary intake of omega 3 fatty acids in Saudi Arabia. To the best of the researcher knowledge, two studies have investigated omega 3 fatty acids intake; one among elderly men in the eastern regions of Saudi Arabia by Al Numair *et al.* (2005), and the second among men in Riyadh by Al Numair *et al*. (2011). Neither of these studies was carried out in the western region of the country. Also, the present study’s dietary assessment of Saudi immigrants living in Newcastle, UK, is the first known assessment of dietary intakes conducted in the UK that has incorporated nutrient analysis and a selection of Saudi participants. This study has helped to document the intake of omega 3 fatty acids in Saudi Arabia and also to document the effect of geographic location.

9.1 General discussion

Over the last four decades, the rapid economic growth of Saudi Arabia has led to significant changes in the lifestyle of the people, with negative effects on health, nutritional status and disease patterns (Kumosani *et al*., 2011). CVD are the most significant causes of death on a global level. There are several lifestyle risk factors that cause CVD, including smoking, a lack of physical activity, an unhealthy diet, diabetes mellitus, hypercholesterolemia, hypertension and obesity (Smith *et al*., 2004; Wilson *et al*., 1998; Yusuf *et al*., 2004). The current study found that there was a striking prevalence of CVD risk factors in the populations investigated, as 40% of the subjects had ≥ 3 CVD risk factors. This study computed the proportion of the subjects as having from 0 to 7 of the risk behaviours (obesity, diabetes, hypercholesterolemia, hypertension, family history, smoking, physical inactivity and unhealthy diet), giving CVD risk factors scores of 0-2 for low risk, 3-5 for medium risk and 6-7 for high risk. Table 9.1 shows the proportion of gender (men and women), locations (Jeddah, Makkah and Newcastle), with CVD risk factors scores for all the study subjects.

Table 9.1: Prevalence of cardiovascular risk factors categories according to gender and locations

	CVD Risk Factors		
	Low RF (0-2) ***n* (%)**	**Medium RF (3-5)** ***n* (%)**	**High RF (6-7)** ***n* (%)**
Gender			
Men (155)	**87 (56)**	**64 (41)**	**4 (3)**
Women (153)	**97 (63)**	**50 (33)**	**6 (4)**
Location			
Jeddah (100)	**60 (60)**	**33 (33)**	**7 (7)**
Makkah (129)	**58 (45)**	**68 (53)**	**3 (2)**
Newcastle (79)	**66 (84)**	**13 (16)**	**-**
All (308)	**184 (60)**	**114 (37)**	**10 (3)**

9.1.1 Age and gender

Reaching the age of 45 years is considered a risk factor for CVD in men (National Cholesterol Education Program [NCEP], 2002). An increased risk occurs for women during their late 50s which is, for many women, after the menopause has stopped. Men tend to have higher mortality rates and CVD prevalence than women. Research has consistently confirmed this finding (Lawlor *et al*., 2001) across countries and regions (Allen & Szanton, 2005; Pilote *et al*., 2007). Risk factors that positively correlate with

CVD risk in both men and women are obesity, smoking, hypertension, diabetes, and total cholesterol (Anand *et al*., 2008; Jee *et al*., 2008; Yen *et al*., 2010). These factors are different in terms of their effect on males and females (Pilote *et al*., 2007). Factors such as triglycerides, diabetes, cholesterol and HDL have been claimed to have a greater effect on women than men (Shaw *et al*., 2006; Yen *et al*., 2010). The current study revealed that age was a significant predictor of the prevalence of obesity and diabetes ($P < 0.001$). Compared with those below 40 years of age, diabetes was more common among subjects in the 40- 65 year old age group. This finding is in agreement with a study by Alarouj *et al*. (2013) which found that among the Kuwaiti population, the prevalence of diabetes was 10 times more common among subjects in the age range of 50-65 years. In addition, the results of the current study also found that there were significant differences between the smoking status and physical activity of men and women ($P < 0.001$). Women were less active and less likely to smoke than men. Additionally, it has been noted that a decrease in the incidence of CVD and mortality rates among women is likely to be due to the lower prevalence of smoking among females. The lower prevalence of smoking amongst women in the current study is also observed around the world (Pilote *et al*., 2007).

9.1.2 Obesity

Obesity was found to be more prominent in men (28%) than women (25%) and over 50% of the participants were overweight or obese, reflecting the sedentary lifestyle of the Saudi population. When compared with other Arab Gulf countries (Al Mahroos & Al Roomi, 1999; Al Nuaim, 1997a), the results illustrate that Saudi Arabia has the highest prevalence of obesity. Several previous studies have been carried out among the general population of Saudi Arabia and the prevalence of obesity has been reported to be high among both Saudi men and women (Kumosani *et al*., 2011). A survey conducted in 2007 by the Ministry of Health highlighted that the prevalence of obesity among Saudi women was 51% and among Saudi men it was 45% (Mousa, 2009). A national survey by Al Othaimeen *et al*. (2007), who investigated the prevalence of obesity among 19,598 Saudis of both genders in rural and urban areas, the overall prevalence of obesity, was 25.6%, 14.2% among men and 23.6% among women. It has also been noted that the rate of being overweight was higher among men, at 30.7%, than among women, at 28.4% (Al Othaimeen *et al*., 2007). In the Arabian Gulf, particularly in Saudi Arabia, rates of obesity are generally higher than the rates reported for countries in Europe (Bellisle *et al*., 1995). The WHO recommends that attention is paid to preventing diabetes and obesity (WHO, 2003). Protective lifestyle interventions have to focus on risk factors that can be modified, particularly those that reduce the weight of the body. Moreover, the absence of nutritional education, as well as a reduction in physical activity worsens the problem, whereas encouraging a more active and rewarding lifestyle and diet awareness are solutions (Al Rukban, 2003). Al Rukban (2003) recommends developing a national program aimed at an early age to prevent and control obesity, such as physical activity and nutritional educational programs that can be held in schools.

9.1.3 Diabetes mellitus

Out of the total 308 study subjects, about 10% were diabetic. Approximately 73% of diabetic subjects were in the 40- 65 year old age range. There is a high prevalence of family history of diabetes in the current population as a whole (50%). The estimated prevalence of diabetes in Saudi in this study is high when compared with people in other Arabian Gulf countries. The overall prevalence of diabetes was found to be higher than that reported for Yemen (4.6%) by Al Habori *et al*. (2004) and for Iraq (4.8%) by Al Kasab *et al*. (1979). However, the finding was in agreement with some other research; Oman, 10% (Asfour *et al*., 1995); Qatar, 10.7% (Bener *et al*., 2009), and United Arab Emirates, 10.2% (Saadi *et al*., 2007). In Saudi Arabia, studies have estimated that diabetes prevalence is going to reach about 50% of the whole population by 2020. Al Zaid (1997) speculated that in view of the fact that 60% of the population in Saudi Arabia was aged 20 or younger, it would be expected that diabetes prevalence would increase rapidly in the future and could possibly reach one the highest levels in the world. In order to confront such a disease, health education concerning the impact of diet on diabetes risk should be used. Newspapers, television, public media, and radio should participate in this campaign of education. The lifestyle and diet of the individual plays an essential role in the existence and prevalence of diabetes in the Saudi community. It is worth considering that the prevention and the management of the disease will not be successful without proper education that targets the lifestyles and diets of individuals.

9.1.4 Hypertension

The prevalence hypertension in the current study was 12%, two-thirds of which were females. There were significant differences between the three cities in terms of hypertension ($P < 0.05$). A major national research project on Coronary Artery Disease in Saudis (CADISS) by Al Nozha *et al.* (2007a) analysed the prevalence of hypertension among Saudis of both genders aged between 30 and 70 years in both rural and urban communities. The result of the study concluded that, in general, hypertension is increasing in prevalence in Saudi Arabia, affecting more than one fourth of the adult Saudi population. Studies from Arab Gulf countries and China have shown that hypertension is affecting 27% - 29% of adults in Kuwait and 32% in Qatar (Bener *et al*., 2004; Zubaid *et al*., 2004). In China, a study by Dongteng *et al*. (2004) found that there was 27% hypertension prevalence among the Chinese adult population. The overall prevalence of hypertension was 26.4% among the world's adult population in 2000 (27% for men and 26% for women), and approximately 1 in 3 adult aged over 20 years (it is expected that by year 2025) will have hypertension (Kearney *et al*., 2005).

9.1.5 Smoking status

Smoking was of particular concern due to its established association with CVD risk (Kimokoti & Newby, 2013). One of the main risk factors of CVD found in the current study is smoking, which was prevalent in 36% of men (cigarettes and/or shisha). Most of the smokers (80%) were young to middle aged (20-50 years old). Only 8% of women out of the total 153 subjects were currently smokers. This is in agreement with Pilote *et al*. (2007) who reported that around the world, the prevalence of female smoking is lower than that of men. Shisha (water pipe) is a common type of smoking in Saudi Arabia, and shisha smokers in this study amounted to 17%, of which two-thirds were from Makkah. Al Nozha *et al*. (2009) emphasised in their study the connection between smoking prevalence and coronary artery disease among Saudi Arabians with a more widespread smoking habit among Saudi citizens who live in the north, west and east than the other regions of the Kingdom. The large amount of smoking that has been found among the participants of the current study highlights the fact that there is not only a dire need for a public health program that addresses the problem, but also for firm governmental policies that can efficiently encourage Saudis to cut down on smoking.

9.1.6 Physical activity

Lack of physical activity in this population was very high at about 73% of the population. Mabry *et al.* (2010b) mention that individuals residing in the Arabian Gulf are, by and large, not physically active and normally pass their free time in sedentary activities. In spite of the fact that physical exercise has well known health benefits, exercise habits have not gained popularity among individuals in the Saudi community, which reflects a lack of awareness of the significance of exercising for health. Sedentary behaviours and physical inactivity, combined with low levels of physical fitness, have become progressively more prevalent in the Saudi community. Al Hazim and Warsy (2002) maintain that the available research evidence testifies to the fact that adult Saudis do not engage in the minimum requirement of physical activity needed to protect the cardio-respiratory system.

9.1.7 Socioeconomic status

According to Al Harbi (2004), the Saudi community has recently experienced rapid changes due to the booming economy. The revitalization that has happened in almost every field of Saudi life and the changes in dietary practices and overall lifestyle habits have, in turn, led to some health and food problems among members of the Saudi society. In the current study, the majority had a medium socioeconomic status (61%), of which 37% were women. In Saudi Arabia, there is no governmental classification of areas based on socioeconomic information. For this reason, education level and monthly income were used to assess the socioeconomic status of subjects. Of the total sample, 69% reported having a higher (university or postgraduate) education level, and 28% were educated up to high school level. Only 1% was illiterate. Illiteracy is considered one of the factors that obstructs the progress and development of habits and patterns of food consumption. It also encourages the spread of unreliable information about food and prevents healthy practices from reaching individuals in the community when reasons for introducing shelter and food are addressed (Al Zahrani, 2008). Research has also revealed that dietary acculturation is influenced by the individual's level of education (Jonnalagadda & Diwan, 2002; Satia *et al*., 2000). Al Zahrani (2008) mentions that the higher the level of the mother's education, the more significant the impact of her education is on her dietary consciousness. Such consciousness and awareness, in turn, becomes a major factor affecting change in the dietary habits and food consumption of the whole family. A significant association was found between socioeconomic status and increased age ($P < 0.001$) and BMI ($P < 0.05$), but decreased with smoker subjects ($P < 0.001$). Further research is needed to test education level and monthly income as a proxy measure of socioeconomic status, as well as CVD risk factors in different regions in Saudi Arabia.

9.1.8 Diet and dietary habits

Detailed dietary information was collected from a sample of 308 Saudi subjects. One of the purposes of this study was to evaluate current dietary practices of Saudi adults in different locations. Data were collected in the form of a three day food record, which showed nutrient intake deficit as well as surplus. Considering the health perspective of the population, this can be considered most useful since inadequate and excessive nutrient intake may have considerable effects on the health of both the individual and the group, specifically among certain population sectors (Kerver *et al*., 2003). Dietary assessment has no perfect method. Like other methods that are used to gather dietary information, a three day dietary diary has its limitations. The accuracy of dietary data that are collected using household measures is considered lower than that collected through the use of a weighed food diary. The co-operation of the subject is necessary so as to record the dietary information in detail. Moreover, the subject has to keep their dietary habits throughout the recording period (Anderson, 1995; Biró *et al.*, 2002; Walker *et al.*, 2000). On the other hand, a three day food diary with estimates of portion size offers a good quality estimate of the mean group intake (Hackett *et al.*, 1983). The method is also relatively low in cost and is less disturbing to the daily activities of the subjects than other methods such as a weighed food diary. On the other hand, a number of studies (Hinds & Gregory, 1995; Walker *et al.*, 2000) have recorded the frequency of daily food and drink consumption using the FFQ method. Although the FFQ method provides an estimation of the frequency of food and drink consumed, it lacks sufficient sensitivity required to provide information regarding the time of consumption and whether intakes were connected with snacks or meals. Furthermore, a three day dietary diary does not depend on the participant’s memory (Anderson, 1995). In the present study nutrient intakes were compared with UK RNI, since there are no specific nutrient recommendations for Saudis or other countries that have similarities to Saudi Arabia in terms of food consumption. The comparisons mainly serve to highlight the nutrient intake status of adults in Saudi Arabia (sections 4.4.6, 5.4.6, and 6.4.6).

Torun *et al.* (1996) mention that validation of methods for dietary assessment has extensively mentioned that misreporting occurs when recording dietary intake. Nelson (2000) stated that epidemiological studies commonly suffer from a particular source of error, specifically under-reporting. In this study, validation has been achieved by comparing the estimated BMR with dietary intake to calculate EI: BMR (Schofield *et al.* 1985). Livingstone *et al.* (1992) claimed that under-reporting can be ascribed to the forgetfulness of the individual or the inability to comply with unplanned eating events, such as eating outside of the home. On the other hand, it is vital not to overlook that over- or under-reporting may possibly occur during the process of collecting dietary information. In a survey that used a diary of weighed food intake that was conducted in the UK, it was found that over-reporting was not very widespread. One of the techniques used for the estimation of under-reporting stems from the principle that energy intake has a minimum level that is compatible with survival and is based on the individual's body weight, sex and age (Gregory *et al.*, 2000). In the present study, about 4% of the total sample was found to have under-reported. Overall, the mean EI: BMR for all subjects was 1.4, on average, suggesting good or normal reporters. Under-reporting can occur due to a number of reasons. Since the method depends on the subjects being asked to identify and describe units and quantities, it is not easy to correctly assess the size of the food portions consumed. Moreover, the subjects' co-operation and interest are indispensable when they are asked to record all of the small dietary items they have consumed.

Subjects, during the dietary interviews, were asked whether their diet had undergone any changes during the period they were completing their food diary. The subjects reported that parties were the major reason for changes in their dietary intake. Interestingly, the participants were asked whether they had their food diaries with them throughout the three day period. Some of the subjects mentioned that they had not taken their food diaries with them to their work location; however, they had taken notes on the food items they had consumed and they copied these notes into their food diaries when they returned home. On the other hand, other subjects maintained that they had not taken their food diary with them but that as soon as they had returned home they completed the diary and recorded all the food and drink they had consumed while they were out. It is worth noting that some subjects mentioned that they would take pictures of or record all the food and drink they consumed while they were out on their cell phones so that when they returned home they could recall what they had eaten and copy the information into their diary. Future research on dietary habits needs to consider implementing such technologies as they have become widespread among the public around the world.

In this study there were several differences found in the dietary habits of subjects. Most participants (67%) had irregular meals and three meals per day. The main meal was lunch for 86% of volunteers in Jeddah and 83% in Makkah. However, evening dinner was the main meal of 72% of Saudi participants in Newcastle. There were significant difference in the changes in main meals between study samples ($P < 0.001$), especially between Saudis in their home towns and those in the UK. The frequency of having breakfast and lunch dropped while the frequency of having dinner remained the same as it did in their home country. The present study found that around half of the participants did not consume or had irregular breakfasts. Various reasons for not eating breakfast were given by participants, such as not feeling hungry in the morning, saving time and wanting to lose weight. A study by Sakarata *et al.* (2001) claimed that skipping breakfast was associated with lower nutritional status and increased CVD risk. Furthermore, a lack of eating breakfast may contribute towards the prevention of obesity (Huang *et al.*, 2010). Most of the participants in this study (89% in Jeddah, 93% in Makkah and 94% in Newcastle) said they ate food outside of their home. The study found that Saudi students in Newcastle faced difficulties in maintaining their native diet compared with the other study subjects (in Jeddah and Makkah). This can be attributed to a number of factors, among which are:

the limited number of stores that sell ethnic foods; the high prices of various ethnic foods because of the monopoly of surrounding businesses in the area; the quality of food being below the consumer's expectations; and food choices being influenced by convenience, as if there is limited time for cooking it may force students to depend on frozen or prepared foods. It has also been found that students who have arrived recently tend to skip meals and increase their consumption of snack foods because of financial burden and their busy school schedules (Papadaki & Scott, 2002; Perez-Cueto *et al*., 2009; Reeves & Henry, 2000).

Geographical location has led to significant changes in dietary patterns and food consumption. For example, cities bordering coastal areas often eat sea-food products, while other cities depend on farm and animal products (Al Zahrani, 2008). In this study, the main finding of dietary intake data taken from across the three locations was that subjects from the coastal city of Jeddah had a significantly lower energy intake and SFA intake but higher intakes of MUFA and PUFA, fibre, selenium and vitamin A ($P < 0.05$). In contrast, they ate significantly less carbohydrates, calcium, magnesium, sodium, potassium and zinc ($P < 0.05$). Overall, the diet of internal city residents in Makkah resembled the diet of the sample in Newcastle more than the sample in Jeddah because the levels of key nutrient and food intakes, such as energy, SFA, carbohydrates, calcium, magnesium, potassium and vitamin A, were similar. The proportions of energy derived from carbohydrate, total fat, and protein were 54%, 34%, and 16%, respectively. The mean dietary fibre intake of subjects was inadequate, at 9.1 g/day, compared with the WHO recommendation of 27 to 40 g/day. MUFA and PUFA were different between the three cities ($P < 0.001$). The Makkah population was characterised by a high intake of sodium 4.4 (1.23) g/day, which was above the recommendation suggested by the Department of Health of 1.6 g/day. However, Jeddah and Newcastle populations also had a high intake of sodium, at 2.9 (0.98) g/day and 3.1 (0.81) g/day, respectively. A number of dietary intakes have been reported to influence blood pressure, in particular a high intake of sodium and low intakes of potassium, magnesium and calcium (Scientific Advisory Committee on Nutrition, 2003). Potassium intakes were notably low amongst Saudi subjects, at 2.9 (0.87) g/day. Potassium intakes among coastal residents were considerably lower than those of in internal and immigration Saudis in Newcastle. Vitamin E is considered cardio-protective due to the antioxidant properties of this vitamin (Greig & Maxwell, 2001; Marchioli *et al.*, 2001). A higher intake of vitamin E and lower intake of vitamin A was found among Saudis living in Newcastle compared to Saudis living in their home cities ($P < 0.05$).

Data on omega 3 fatty acids intake and status of Saudis are very limited. The preset study has provided useful information about the intake of total omega 3 fatty acids and long chain PUFA in Saudi Arabian adults residing in different geographical locations in Saudi Arabia and in the UK. Fatty acid intake varied significantly according to geographical location. Jeddah residents reported the highest daily intake of total omega 3 fatty acids, followed by Saudi participants in Newcastle, then Makkah residents ($P < 0.001$), although the intake of these fatty acids among Saudis living in Makkah and Newcastle were similar. When these results were compared with the recommendations of Simopoulos *et al*. (1999) and Tom *et al*. (2004), it was found that they were lower than adequate for intakes of total omega 3 fatty acids in all three cities. The omega 3 to omega 6 fatty acids ratio among Jeddah residents was above the recommended level, but it was lower in Makkah and Newcastle residents. *Trans* fatty acids contributed 1.1% to dietary energy intake in Jeddah, 1.5% in Makkah and 1.2% in Newcastle. Observed differences among the three populations in terms of *trans* fatty acids were statistically significant ($P < 0.001$). It has been recommended by the American Heart Association that no more than 1% of an individual's total energy intake (approximately 1-3 g/day) should derive from *trans* fatty acids (Lichtenstein *et al*., 2006). Another important finding was related to intake by food groups between the three cities. Residents of Jeddah had a diet that was relatively high in fish consumption with more than 75% consuming fruit and vegetables with 25% in Makkah and Newcastle residents. On the other hand, Makkah participants reported high consumption of fast food and traditional Saudi foods ($P < 0.000$). Both genders in Newcastle reported lower intakes of traditional Saudi food.

In terms of determining the association between dietary intake and CVD risk factors, the results indicated that older subjects differed significantly in total fat and protein intake from young subjects included in this study ($P < 0.05$). Older subjects consumed less fat and more fibre and protein. Older subjects consumed less fast food and more traditional Saudi food, as well as more fruit and vegetables. In relation to gender, men consumed more fast food than women, while the latter consumed more Saudi food ($P < 0.05$). However, the dietary food records showed that men consumed higher levels of protein, zinc, sodium and cholesterol than women ($P < 0.05$). In contrast, they ate less PUFA, carbohydrates and iron ($P < 0.05$). In terms of the association between smoking and vitamin C ($P < 0.05$), several studies have indicated that there is a relationship between low vitamin C and smoking cigarettes (Halliwell & Gutteridge, 1990; Hughes *et al*., 1998; Mezzetti *et al*., 1995). Statistically significant relationships between socioeconomic differences and various CVD risk factors were observed in the present study. Highly educated Saudi people with high incomes had diets rich in PUFA (P < 0.05). High education was also associated with low intake of the Saudi traditional food group. Income was significant negatively associated with BMI (P < 0.05). Fast food consumption was also found to be negatively affected by income (P < 0.05).

9.2 Representative of the study

The research conducted aimed to measure and evaluate the dietary intake of Saudi men and women, and the risk factors of CVD, by covering different geographical locations in both Saudi Arabia and the UK. This study focused mainly on the western region of Saudi Arabia, principally Jeddah and Makkah. The populations in these two cities are close to five million people, and are the most heavily populated cities in Saudi Arabia (Ministry of the economy & demarcation, 2004). This disallows generalization on the population as a whole and therefore, this study was not a representative sample of the total population of Saudi Arabia. However, the study group size was estimated by the least standardized difference using expected changes in the total of omega 3 fatty acids. The sample size of 308 was sufficiently enough to determine differences in the total intake of omega 3 fatty acids between coastal and internal areas with a power of 95% (Chapter 3).

Future studies will need to provide further evidence to corroborate the findings of this study, using a large representative sample of the general adult population of men and women, and the risk factors of CVD, in order to describe the issues of dietary intake for the kingdom as whole.

9.3 Limitation of the study

There are a number of limitations to this study. Recruitment of a compliant sample within Saudi Arabia and the UK was difficult. Recruitment was of a convenient sample and not a random one. The sample was limited to the groups accessible to the researcher, namely university employees in the cities chosen in Saudi Arabia, and in the UK students and their families based in Newcastle. This has limitations, such as that most of the participants were highly educated, and there were few participants who might have had a low education level. There was also likely to be selection bias based upon willingness to respond. Some of the issues encountered included the fact that some people were extremely reluctant to participate in the survey as it sought personal information. Some people said that they thought the questionnaire would take excessive time to fill in.

Limitations were also found when coding certain types of food; other options were chosen where the exact match was not available. Approximately 53 codes were added to the database for home-made recipes and new food items or products found in the dietary records. The nutritional content of participants' foods was based on the McCance and Widdowson food tables (6th edition) obtained from the WinDiets software (Robert Gordon University, 2010). The program has missing values for some foods, especially for the long chain of PUFA composition and omega 6 fatty acids (about 15% of the data is missing). However, the study discovered significant differences between the three cities, in terms of all PUFA fatty acids, which is the main aim of this thesis.

9.4 Summary and conclusions

The overall summary and conclusions of the current study were that:

- Of the total sample of 308 adults, 100 were from coastal city (Jeddah), 129 were from internal city (Makkah) and 79 were Saudis living in Newcastle, UK. Their average age was about 31 years for both men and women in each of the cities, with majority reported as medium socioeconomic status in the three locations. Dietary food intake was statistically significantly affected by socioeconomic status factors for the whole study population.
- The results also showed that the subjects generally had an unhealthy lifestyle, such as a smoking habit, physical inactivity and a high intake of SFA, especially in the internal city which may affect CVD risk.
- The high mean of BMI for the subjects of the survey indicated that approximately 53% were overweight or obese. Obesity represents a major public health issue in the study population in all three different locations. The prevalence of obesity is due to lifestyle, a lack of physical activity and an increased consumption of food rich in fat and calories.
- One of the main risk factors for CVD found in this study was smoking, which was prevalent in 36% of men. Most of the smokers (80%) were young to middle aged (20-50 years old). Only 8% of women subjects were current smokers. Smoking was more prevalent in Makkah (63%) than in Jeddah (34%) and Newcastle (26%) ($P < 0.001$).
- The most common risk factor was physical inactivity, affecting 73% of the total population. Men were more physically active than women in the three different locations.

- Geographic location has an impact on the nutritional intake in the current study. Observed differences among the three populations in terms of energy, total fat percentage, carbohydrate, fibre, sodium, potassium, selenium, zinc, vitamins A and E and all fatty acids intakes were statistically significant ($P < 0.001$).
- Subjects in Jeddah had higher intakes of MUFA and PUFA, fibre, selenium and vitamin A ($P < 0.05$). In contrast, they ate significantly less SFA, carbohydrates, calcium, magnesium, sodium, potassium and zinc ($P < 0.05$) compared with Makkah and Newcastle subjects.
- The subjects' intake of sodium was above the recommendation suggested by the Department of Health of 1.6 g/day.
- Participants living close to the coastal area in Jeddah (at 1.3 g/day) had higher intake of total omega 3 fatty acids compared with participants in Makkah (at 0.37 g/day) and in Newcastle (at 0.78 g/day).
- Comparing the intake by food group between the different locations, participants from Jeddah was relatively high in fish, nuts and fruit and vegetables consumptions and low in fast food compared with participants from Makkah.
- There was a significant decrease found in the consumption of traditional Saudi food, together with an increased intake of fast foods, with the main dietary changes being reported by Saudis living away from their country home.

9.5 Hypotheses testing

The following null hypotheses were tested in the present study:

- There are relationships between dietary food intakes and CVD risk factors.
- There are differences in total dietary intake with regards to age, gender and socioeconomic background.
- An increased intake of omega 3 fatty acids and long chain polyunsaturated fatty acids has a beneficial effect on a range of CVD risk factors. There are relationships between dietary intakes of total fat and omega 3 fatty acids in different regions of Saudi Arabia, which are indicators of the risk of CVD. Moreover, Jeddah, being a coastal city, is characterized as having a population with higher fish consumption and a relatively lower death rate from CVD compared with Makkah, an inland city with a population characterized as having a lower fish intake and relatively higher death rate from CVD.
- There are differences in the dietary intake and food habits of Saudis living away from their home country and those living in Saudi Arabia.

The present results indicate that the prevalence of CVD risk factors in Saudi adults seems to be high. Food intake was statistically significantly correlated with CVD risk factors for the whole study population. There were differences between each location: people living close to the coastal area consumed more fish and therefore more total omega 3 fatty acids relative to individuals living in the internal areas of Saudi Arabia, in Makkah. This higher intake of total omega 3 fatty acids by individuals living in the coastal city of Jeddah may be one of the reasons for the city's lower rates of CVD.

Another effect of location was on Saudis who live overseas, for example, in the UK. International students often encounter an unavailability of their traditional foods when they move abroad to study. Therefore, fast food consumption was higher than expected for adults in Saudi Arabia and this was accompanied by a decrease in traditional food consumption, especially in male subjects.

9.6 Recommendations

Considering the aspects presented in this study, the following recommendations can be made:

- Since different food consumption patterns in the different regions of Saudi Arabia were reported, evaluation of dietary intake and omega 3 fatty acids intake in other parts of the country is recommended.
- There is a need for changes in Saudi dietary habits to reduce the high intake of SFA and *trans* fatty acids, as well as to increase intake of dietary omega 3 fatty acids.
- Nutrition education intervention among internal residents is needed to increase the consumption of omega 3 fatty acids by increasing the consumption of fish.
- People need to be educated to moderate their sodium intake. To achieve a lower intake of sodium, people should consume fresh foods such as fruit and vegetables.
- Saudi immigrants should be supported to make healthy food choices through educational programmes that encourage them to maintain their previous food practices.
- Adult awareness of CVD and potential risk factors of its development should be increased. Advice for its prevention should also be increased. Educational information about CVD risk factors should be distributed using easy and accessible messages that are understood by all people, supported by governmental and private organizations.

- It would be useful to adopt educational programmes on dietary consumption and physical activity promotion. Such a high prevalence of inactivity represents a major public health concern, therefore public policies are needed to encourage active living and discourage sedentary habits.
- Implementation of physical education courses for girls in Saudi schools should take place, since there is no sports education in girls' schools and families may not encourage females to take part in physical activity.
- There is also a need to implement prevention programmes directed towards both genders that aim to prevent not only tobacco smoking but also the use of other tobacco products like shisha.

9.7 Further work

There is a need for a national study of all regions of Saudi Arabia to address the issue of CVD risk factors. This should be done to collect diet, physical activity, BMI, WC and WHR data. The need for a national database would help define best practices and areas of concern in the country as a whole. The evaluation of people's CVD awareness and knowledge of potential risk factors is needed. Assessment of knowledge, behaviours and attitudes using focus groups comprising Saudi children, adults and public health planners covering CVD and its potential risk factors should be undertaken in order to facilitate decisions on future plans and programmes for education and awareness. There is an urgent need for intervention programmes that raise the health awareness and knowledge of children and adolescents about CVD risk factors and encourage them to adopt healthy dietary behaviour, promote physical exercise, and promote smoking cessation. Further research should be developed to determine the omega 3 fatty acids intakes of other age groups, as well as those of a low socioeconomic background in order to investigate the impact of these variables on CVD. More research is needed to examine the dietary habits and intakes of Saudi men and women living in the UK, as well as to discover the long term health effects in order to improve their dietary habits. Also, further exploration of changes in their dietary intakes when they go back home is needed.

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Appendix (A): Ethical committee letter

Newcastle University

Faculty of Science, Agriculture & Engineering

Newcastle University
Devonshire Building
Newcastle upon Tyne
NE1 7RU United Kingdom

1st August 2012

To whom it may concern:

DIETARY PATTERNS AND RISK OF HEART DISEASE IN SAUDI ARABIA - POSTGRADUATE RESEARCH STUDY BY NOHA ALMORAIE, SCHOOL OF AGRICULTURE, FOOD AND RURAL DEVELOPMENT

The Faculty Ethics Committee considered the above project and awarded ethical approval in July 2010.

An amendment to the research protocol (to carry out the same study in the UK) was approved by the Faculty Ethics Committee in July 2012.

Professor Tony Roskilly

Dean of Research and Chair of Faculty Ethics Committee

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Appendix (B): Participant information letter

□ المملكة العربية السعودية
□وزارة التعليم العالي
جامعة الملك عبد العزيز بجدة

School of Agriculture,
Food & Rural Development
Agriculture Building
Newcastle University
Newcastle upon Tyne NE1 7RU

Dietary patterns and risk of heart disease in Saudi Arabia

Information sheet for study Participants

Study contact: Noha al Moraie

Mobile Tel: 0552023821
n.m.d.almoraie@ncl.ac.uk

You are being invited to take part in a research study. Before you decide to take part it is important you understand why the research is being done, and what it will involve. Please take time to read the following information carefully. Please ask us if there is anything that is not clear or if you would like more information. Take your time to decide whether or not you wish to take part, and thank you for reading this information sheet.

What is the purpose of this study?

This study as part of my PhD research which investigates the role of dietary pattern in the risk of developing heart disease in Saudi Arabia.

Why have I been chosen?

You have been contacted because you have expressed an interest in our research. We need men or women between the ages of 18-65 years to take part in this study. We will be recruiting 100 volunteers in total at king Abdul-Aziz University in the city of Jeddah, in the western region of Saudi Arabia, 100 volunteers from Umm Al-qura University in the city of Makkah, in the western region of Saudi Arabia, 100 volunteers from Newcastle, UK.

Do I have to take part?

It is up to you to decide whether or not you want to take part. If you do decide to take part you will be asked to sign a consent form, and will be given a copy of the consent form for own record. You are free to withdraw from the study at any time and without giving a reason.

What will happen to me if I take part?

If you decide to take part you will be asked to complete a lifestyle and health questionnaire (with the help of the researcher if needed). You will then be asked to keep a dietary of all the food you eat and drink over a three day period, using a special dietary diary which we will give you. When you have completed the diary the researcher will come to speak with you and ask you about your dietary intake, which will take approximately 30 minutes.

Will my taking part in this study be kept confidential?

Any information which is collected about you during the study will be kept strictly confidential. Information collected will not be used for any other purpose than that explained in this sheet.

And finally...

Thank you for having taken the time to read this information sheet and your interest in the study. If you do decide to take part in the study, you will be given a copy of this information sheet and a signed consent form for you to keep.

Newcastle University

School of Agriculture,
Food & Rural Development
Agriculture Building
Newcastle University
Newcastle upon Tyne NE1 7RU

المملكة العربية السعودية
وزارة التعليم العالي
جامعة الملك عبد العزيز بجدة

الأسباب الغذائية و خطر الإصابة بأمراض القلب في المملكة العربية السعودية

إرشادات للمشاركين في الدراسة

الباحثة: نهى معلا المورعي

Mobile Tel: 0552023821

n.m.d.almoraie@ncl.ac.uk

من المهم معرفة إذا قررت أن تشترك في هذه الدراسة فلابد من معرفة ما هو هدف البحث وماذا سيتضمن هذا البحث الرجاء قراءة هذه الإرشادات بعناية وإذا كان هناك أي سؤال غير واضح الرجاء الاتصال بنا ونحن سوف نناقش هذا بعناية شكرا لقراءتك هذه الإرشادات....

ما هدف هذه الدراسة؟

هذه الدراسة كجزءٍ لإجْراء بحثٍ دكتوراهِ لتحرّي الأنماطِ الغذائية للسعوديين وخطر الإصابة بأمراض القلب في المملكة العربية السعودية.

لماذا إخترتُ؟

لأنك أبديتَ إهتماماً في بحثِنا. نَحتاجُ الرجالَ أو النِساءَ بين أعمار 18-65 سَنَوات للإشتِراك في هذه الدراسة. سوف يشترك في هذه الدراسة حوالي 300 متطوّعَ أو أكثر في جامعة الملك عبد العزيز في مدينة جدة، في المنطقة الغربية للملكة العربية السعودية. ومن جامعة ام القرى بمكة المكرمة وكذلك من مدينة نيوكاسل بالمملكة المتحدة.

هَلْ يتطلب على أنْ أشتركَ؟

يعود القرار لك إذا قررت الإشراك سَوف يتطلَّبُ منك التَوْقيع على شكل الموافقة، وإذا أردت عدم الاشتراك فيمكنك الانسحاب أي وقت تشاء.

ماذا سَيَحْدثُ لي إذا أشتركُ؟

يَعتمدُ بحثِي كلياً على هذا الاستفتاء، لذا سأكون شاكراً لكم لو تفضلتم بقضاء الوقتِ لإكْماله لي. سوف يكون هناك مجموعة من الأسئلة سوف تطرح عليكم (وإذا كنت بحاجة إلى مساعدة فيمكن لك أن تسال الباحث) وسوف يكون هناك أيضا تسجيل لنوع الغذاء والشراب الذي سوف تقوم بتسجيله ولمدة ثلاثة أيام. وللسَماح لي للمَجيءِ ضمن الأسبوع التالي. المقابلة سَتأْخذُ تقريباً 30 دقيقة.

هَلْ هذه المعلومات ستبقى سرية؟

أيَ معلومات سوف تجمَع عنك أثناء الدراسة سَتبْقى سرَية تماماً. نحن قدْ نَتّصلُ بك أيضاً في الفحوص الإضافية إذا احتاج البحث لذلك.

وأخيراً ...

شكراً لقِراءة صفحة الإرشادات .وإذا تُقرّرُ إشراك في هذه الدراسة، سوف تقوم بالتوقيع على هذه الموافقة.

Appendix (C): Participant consent form

المملكة العربية السعودية ☐
☐وزارة التعليم العالي
جامعة الملك عبد العزيز بجدة

School of Agriculture,
Food & Rural Development
Agriculture Building
Newcastle University
Newcastle upon Tyne NE1 7RU

《 Consent form 》

Dietary patterns and risk of heart disease in Saudi Arabia

Please sign box

1 - **I confirm that I have read and understood the Information Sheet for the above study and have had the opportunity to ask questions.** ☐

2 - **I understand that participation is voluntary and that I am free to withdraw at any time.** ☐

3 - **I agree to have the body measurements taken which are needed for the study.** ☐

4 - **I understand that the data provided by me will be kept strictly confidential and will not be identifiable.** ☐

....	....	....
Name of Volunteer	**Date**	**Signature**
....	....	....
Name of Researcher	**Date**	**Signature**

School of Agriculture,
Food & Rural Development
Agriculture Building
Newcastle University
Newcastle upon Tyne NE1 7RU

المملكة العربية السعودية
وزارة التعليم العالي
جامعة الملك عبد العزيز بجدة

﴿ إذن بالموافقة ﴾

الأسباب الغذائية و خطر الإصابة بأمراض القلب

في المملكة العربية السعودية

وقع على المربع المناسب

1 - أُؤكِّدُ بأنّني قَرأتُ وفَهمت المعلوماتَ عن هذه الدراسةِ ☐

2 - أنا استوعبت بأنّ الإشراك طوعيُ وبإمكاني الانسحاب في أي وقت. ☐

3 - أنا موافق بان بالدراسة سوف تؤخذ مقاييس جسمية ☐

4 - أنا استوعبت بان جميع المعلومات التي سوف أزود الدراسة بها ستكون سرية ولن تستخدم إلا في أغراض الدراسة. ☐

....	....	....
اسم المتطوع	التاريخ	التوقيع
....	....	....
اسم الباحثة	التاريخ	التوقيع

Appendix (D): The time table during the Educational journey (2010, 2011)

Period:	Task:
1 July – 11 July	• Travel from the city of Newcastle in the United Kingdom to the city of (Jeddah – Makkah) in Saudi Arabia. • Processing, printing and photocopy the required number of: Questionnaire, food dairy forms and consent forms.
12 July – 14 July	• Meeting with the supervisor of the Educational journey.
15 July – 10 September	• Go to the University of King Abdul-Aziz or Umm Al Qura University and visiting departments (such as the Central Library, King Fahd Centre for Research, University Hospital ... etc.) and distribution of forms on participants, male and female. • Write the names of participants and methods of communication available to them. • After one week of the distribution of questionnaires to participants is an interview with each person for half hour. • During the interview is a quick review of all the questions that have been packaged and verified data. • Review of food three days to make sure that all food may be accurately recorded. • Take the necessary measurements in the study of participants (such as height, weight, body mass index, waist, waist circumference, arm circumference, thickness of the layer of skin, muscle arm circumference).
11 September – 28 September	• Review all the questionnaires. • Take some food sample for Saudi foods that are not in the available food tables to analysis in Newcastle University. • Travel from (Jeddah – Makkah) in Saudi Arabia to Newcastle in the UK.

Appendix (E): Questionnaire survey (English version)

□ المملكة العربية السعودية

□وزارة التعليم العالي

جامعة الملك عبد العزيز بجدة

School of Agriculture,
Food & Rural Development
Agriculture Building
Newcastle University
Newcastle upon Tyne NE1 7RU

Dear Sir/Madam,

Dietary patterns and risk of heart disease in Saudi Arabia

I am a doctoral student in the School of Agriculture, Food and Rural Development at Newcastle University, UK. I am conducting a study for my PhD research to investigate dietary patterns in the Saudi population and risk of heart disease in Saudi Arabia.

I am hoping that you will be able to assist me in my study. My research depends totally on this questionnaire, so I would be grateful if you would spend time to complete it for me and to allow me to come to speak to you within the next week. The interview will take approximately 30 minutes. All responses will be kept strictly confidential, and will be used for research purposes only.

Your co-operation in this research effort is deeply appreciated.

Yours faithfully,

Noha al Moraie

Prof. C. J. Seal, Dr. G. Lietz
Project supervisors.

Diet and risk of heart disease in Saudi Arabia

Code No:		Questionnaire Date:	

GENERAL Questionnaire:

Please answer every question by writing the answer in the space provide or by ticking the appropriate box:

Name:		Age:	
Home Tel:		Mobile Tel:	
Preferred contact number: ❐ Home ❐ Mobile			
If you would like to receive a summary of the results, please provide an e-mail address e-mail:			

1- Are you:

Male. ❐

Female. ❐

2- What is your level of education?

Illiterate, ❐

Writing and Reading, ❐

Primary school only, ❐

Elementary and Secondary schools, ❐

University or Above. ❐

3- What is approximately your monthly income (SR)?

1-3000, ❐

3001- 6000, ❐

6001- 9000, ❐

9001- 12000, ❐

More than12000. ❐

4- Are you?

Married with one wife, ❐

Married with two wives, ❐

Single, never married ❐

Single, widowed or divorced / separated. ❐

5- ***How many persons are in your family?***

1- 3, ❐

4- 6, ❐

More than 6, ❐

How many of the household are children (under 18 years) ....

Medical History:

6- Have you ever been told by a doctor that you have one of the following?

- ***Diabetes:***

Yes, ❐

No, ❐

Don't know. ❐

If Yes, when was this diagnosed? ....

- **High blood cholesterol:**

Yes, ❐

No, ❐

Don't know. ❐

If Yes, when was this last measured? ....

If Yes, can you remember what the value was? ....

- **High Blood Pressure:**

  Yes, ❒

  No, ❒

  Don't know. ❒

  If Yes, when was this last measured? ....

  If Yes, can you remember what the value was? ....

- **Heart disease:**

  Yes, ❒

  No, ❒

  Don't know. ❒

  If Yes, when was this diagnosed? ....

  If Yes, which type of heart disease do you have?

  Coronary heart disease, ❒

  Stroke, ❒

  Angina, ❒

  Don't know. ❒

  Other..

7- Is there a history of heart disease or diabetes in your family?

Yes, ❒

No, ❒

Don't know. ❒

If Yes, Please give details: ....

....

....

Habits:

8- Are you a current smoker?

Yes, ❒

No. ❒

If Yes, Please go to question 9.

If No, Please go to question 10.

9- How much do you smoke?

Occasionally less than 1 per day, ❒

2-10 per day, ❒

11-20 per day, ❒

More than 20 per day. ❒

10- Have you ever smoked?

Yes, ❒

No. ❒

If Yes, when did you quit? ....

11- Do you smoke shisha now or did you ever smoke shisha before?

Yes, ❒

No. ❒

If Yes, when did you quit? ....

12- For each of the following physical activities please indicate how long you spend doing that activity?

Walking:

Never, ❒

Less than 30 minute a day, ❒

Between 30 and 60 minutes a day, ❒

More than 60 minutes a day. ❒

❂ **Running:**

Never, ❒

1- 3 times per week, ❒

4-7 times per week, ❒

More than 7 times per week. ❒

Have long do you run for in an average session? ....

❂ **Swimming:**

Never, ❒

1- 3 times per week, ❒

4-7 times per week, ❒

More than 7 times per week. ❒

Have long do you swim for in an average session? ....

Please specify any other types of sport as exercise:..

Dietary Habits:

13- How many meals do you normally eat per day?

- 1 or 2, ❒
- 3 or 4, ❒
- More than 5 meals. ❒

14- What is usually your main meal?

- Breakfast, ❒
- Lunch, ❒
- Dinner. ❒

15- Do you usually eat breakfast?

- Daily, ❒
- Sometimes, ❒
- Never. ❒

If NO, why?

- Do not feel hungry in the morning, ❒
- To lose weight, ❒
- To save time in the morning, ❒
- Not available at my place of work, ❒
- Other, ...

16- How frequently do you eat outside home?

- Never, ❒
- Ones or twice per week, ❒
- Three or four times per week, ❒
- More than four times per week. ❒

Food Records:

Details of how to fill in the diary:

- The food diary will be completed for three consecutive days.
- It is very important that you do not change what you normally eat and drink just because you are keeping this record. Please keep to your usual food habits.
- Each day is divided into sections from the first thing in the morning to late evening and through the night.
- When recording your food include the brand name (if you known), portion size (using household measures, weights from labels, any additions to the food (fats, oils, sugar, salt, pepper etc), cooking methods (fried, grilled, baked, roasted etc),
- Please record everything at the time of eating, not from memory at the end of the day. The diary covers a 24-hr period, so please include any food or drinks that you may have had during the night. You might have some foods and drinks between meals (snacks).
- You can see an example of how we would like you to record your food and drink intake.
- If you have any difficulties in estimating or describing any food or drink during filling this diary please call me, Noha Almoraie on *0552023821* any time to help you.

Amounts and Conversions:

1/4 cup = 50 ml or 4 Tablespoons

1/3 cup = 75 ml or 5 1/2 Tablespoons

1/2 cup = 125 ml or 8 Tablespoons

2/3 cup = 150 ml or 10 1/2 Tablespoons

3/4 cup = 175 ml or 12 Tablespoons

1 cup = 250 ml or 16 Tablespoons

1 oz = 1 slice of processed cheese or lunchmeat

How to Estimate Your Portion Size:

Meat Three (3) ounces of meat are about the size and thickness of a deck of playing cards or an audiotape cassette.	
Fruit A medium apple or peach is about the size of a tennis ball.	
Grains One cup of rice or pasta is about the size of your fist.	
Cheese One ounce of cheese is about the size of four dice.	

Three-Day Food Record Checklist:

Beverages	What kind of milk? Homo, 2%, 1%, skim, other. Was it fruit juice or fruit beverage or drink?
Breads	Did you spread on butter or margarine?
Cereal	Did you add milk? Did you add sugar or fruit?
Dairy	What brand or kind of yogurt? What brand or kind of cheese?
Vegetables	Was it raw or cooked? Was it fresh, frozen or canned? Did you add any butter, margarine or sauce?
Fruit	Was it a small, medium or large fruit? Was it fresh, frozen or canned?
Grains	Did you add any butter, margarine, peanut butter, jam or honey? Was it a half or whole sandwich? Was it a small or large muffin or bagel?
Fish	Was your canned fish packed in water or oil How did you cook your fish?
Meats	How did you cook your meat? What kind of cut was it e.g. chicken leg or chicken breast?
Soups	Was your soup prepared with milk, water or cream?
Restaurants	What restaurant was it?
Packaged food	What brand was it?

Day (1): Monday			Date: 1-2-2010
When	**Where**	**Food / Drink description and preparation**	**Portion size**
6.35	Home	Whole milk with sugar Toast with butter Jam Cream cheese	Mug – 1 teaspoon 1 slice-1 teaspoon 1 tablespoon 1 tablespoon
10.15	Office	Tea with sugar Fatayer with spinach	Mug -2 teaspoon 2 slice
2.00	Home	Lamb, grilled with butter Ruz mandi Konafah with cream Apple	200 g 10 tablespoon 5 tablespoon 1
5.10	Home	Cola drink Sambousak with meat	200ml 3
7.30	Home	Arabic coffee Dates	3 small cups 5
9.20	Home	Arabic bread Honey Labneh	1 slice 2 tablespoon 4 tablespoon
11.00	Home	Whole milk	Mug

Day (1):		Date: - - 2010	
When	**Where**	**Food / Drink description and preparation**	**Portion size**

Day (2):		Date: - - 2010	
When	Where	Food / Drink description and preparation	Portion size

Day (3):		Date: - - 2010	
When	**Where**	**Food / Drink description and preparation**	**Portion size**

(12)

School of Agriculture,
Food & Rural Development
Agriculture Building
Newcastle University
Newcastle upon Tyne NE1 7RU

المملكة العربية السعودية
وزارة التعليم العالي
جامعة الملك عبد العزيز بجدة

الأخت الكريمة الأخ الكريم:

السلام عليكم ورحمة الله وبركاته .... وبعد

أفيدكم بأنني مبتعثة من قبل جامعة الملك عبد العزيز, كلية التربية للاقتصاد المنزلي والتربية الفنية بجدة لدراسة الدكتوراه في بريطانيا وأنا الآن في مرحلة جمع المعلومات حيث يتعلق البحث بالأسباب الغذائية وخطر الإصابة بأمراض القلب والجهاز الدوري في المملكة العربية السعودية .

البحث معتمد كليا على المعلومات التي سوف يتم جمعها من خلال قائمة الاستبيان التي بين يديك, لذلك فان مساهمتك في تعبئة هذه القائمة مهمة جدا لتكملة هذا البحث, فرجاءً أن تمنحنا حوالي عشر دقائق من وقتك لتعبئة هذا الاستبيان ولكم مني جزيل الشكر.

أحب أن أذكركم أن جميع المعلومات التي سوف اجمعها ستكون سرية ولن تستخدم إلا في مجال البحث الأكاديمي فقط. مساهمتكم في تعبئة هذا الاستبيان مهمة لتكملة بحثي الأكاديمي ولكم مني جزيل الشكر ومن الله الأجر والثواب.

نهى بنت معلا المورعي

المشرفون :

ا.د. كريس، د. جورج

الأسباب الغذائية وخطر الإصابة بأمراض القلب والجهاز الدوري

في المملكة العربية السعودية

رقم الاستمارة:		التـــــاريخ:	

❁ فضلاً أجب على كل سؤال بوضع علامة (√) في الخانة المناسبة لحالتكم:

البيانات العامة (اختياري):

الاســــــم :		الســـــــن:	
رقـــم المنـــزل:		رقـم الجـوال:	
وأيهما تفضل في حالة الاتصال بك:	❒ رقم منزل	❒ رقم جوال	
البريد الالكتروني إن وجد:			

١ - الجنس:

ذكر. ❒

انثى. ❒

٢ - المستوى التعليمي:

لا يقرا ولا يكتب. ❒

يقرا ويكتب. ❒

ابتدائي. ❒

تعليم ثانوي. ❒

تعليم جامعي أو دراسات عليا. ❒

٣ - الدخل الشهري:

من ١ ريال - ٣٠٠٠ ريال ❒

من ٣٠٠١ ريال- ٦٠٠٠ ريال ❒

من ٦٠٠١ ريال- ٩٠٠٠ ريال ❒

من ٩٠٠١ ريال- ١٢٠٠٠ ريال ❒

أكثر من ١٢٠٠٠ ريال ❒

٤ - الحالة الاجتماعية:

متزوج من امرأة واحدة. ❒

متزوج من أكثر من امرأة. ❒

أعزب / آنسة. ❒

أرمل أو مطلق. ❒

٥ - عدد أفراد الأسرة:

١ - ٣ ❒

٤- ٦ ❒

أكثر من ٦ أفراد. ❒

كم عدد الأطفال في العائلة (تحت س **18** سنة) ....

التاريخ الطبي:

٦ - هل تعانى من احد هذه الأمراض؟

السكرى

نعم. ❒

لا. ❒

لا اعرف. ❒

إذا كانت الإجابة بنعم. متى تم تشخيص الحالة؟ ....

ارتفاع في الكولسترول

نعم. ❒

لا. ❒

لا اعرف. ❒

إذا كانت الإجابة بنعم. متى كان أخر قياس؟ ....

إذا كانت الإجابة بنعم. هل تتذكر أخر نتيجة له؟ ....

❁ **ضغط الدم :**

نعم, ❐

لا, ❐

لا اعرف. ❐

إذا كانت الإجابة بنعم, متى كان أخر قياس؟ ....

إذا كانت الإجابة بنعم, هل تتذكر أخر نتيجة له؟ ....

❁ **إمراض القلب :**

نعم, ❐

لا, ❐

لا اعرف. ❐

إذا كانت الإجابة بنعم, متى تم تشخيص الحالة؟ ....

إذا كانت الإجابة بنعم، أي نوع من أمراض القلب:

أمراض القلب التاجي, ❐

السكتة القلبية, ❐

الذبحة القلبية, ❐

لا اعرف. ❐

أخرى...

٧ - هل يوجد في العائلة شخص مصاب بأمراض القلب أو السكري ؟

نعم, ❐

لا, ❐

لا اعرف. ❐

إذا كانت الإجابة بنعم, الرجاء إعطاء تفاصيل أكثر: ....

....

العادات:

٨ - هل أنت مدخن؟

- نعم. ❐
- لا. ❐

إذا كانت الإجابة بنعم الرجاء الانتقال إلى سؤال رقم ٩

إذا كانت الإجابة بلا الرجاء الانتقال إلى سؤال رقم ١٠

٩ - كم سيجارة تدخن يوميا تقريبا؟

- سيجارة واحدة يوميا. ❐
- من ٢ إلى ١٠ سيجارة يوميا. ❐
- من ١١ إلى ٢٠ سيجارة يوميا. ❐
- أكثر من ٢٠ سيجارة يوميا. ❐

١٠ - هل كنت مدخن في السابق؟

- نعم. ❐
- لا. ❐

إذا كانت الإجابة بنعم، متى أقلعت عن التدخين؟......................................

١١ - هل تدخن الشيشة؟

- نعم. ❐
- لا. ❐

لا، لكن كنت مدخن في السابق وقد أقلعت......................................

١٢ - كم مرة في اليوم أو الأسبوع تقوم بهذه النشاطات الرياضية؟

المشي:

- أبدا. ❐
- اقل من ٣٠ دقيقة في اليوم. ❐
- من ٣٠ إلى ٦٠ دقيقة في اليوم. ❐
- أكثر من ٦٠ دقيقة في اليوم. ❐

❂ **الجري:**

أبدا. ❐

من ١- ٣ مرات في الأسبوع. ❐

من ٤ إلى٧ مرات في الأسبوع. ❐

أكثر من ٧ مرات في الأسبوع. ❐

كم متوسط مدة ما تجري في الدورة الواحدة...

❂ **السباحة:**

أبدا. ❐

من ١- ٣ مرات في الأسبوع. ❐

من ٤ إلى ٧ مرات في الأسبوع. ❐

أكثر من ٧ مرات في الأسبوع. ❐

كم متوسط مدة ما تسبح في الدورة الواحدة...

إذا كنت تقوم بأي رياضات أخرى الرجاء إعطاء تفاصيل أكثر.........................

....

العادات الغذائية:

١٣ - كم وجبة تتناول خلال اليوم؟

- من مرة واحدة إلى مرتين. ❐
- من ٣ إلى ٤ مرات. ❐
- أكثر من ٥ مرات. ❐

١٤ - ما الوجبة الرئيسية التي يجتمع عليها جميع أفراد الأسرة؟

- الإفطار. ❐
- الغذاء. ❐
- العشاء. ❐

١٥ - هل تحرص على تناول وجبة الإفطار؟

- يوميا. ❐
- أحيانا. ❐
- لا أتناول. ❐

إذا كانت الإجابة بلا، فما السبب؟

- فقدان الشهية. ❐
- لإنقاص الوزن. ❐
- ضيق الوقت. ❐
- عدم توافر ما أفضله. ❐
- أخرى تذكر ....

١٧ - كم عدد المرات التي يتم تناول الطعام خارج المنزل؟

- أبدا. ❐
- مرة أو مرتين في الأسبوع. ❐
- من ٣ إلى ٤ مرات في الأسبوع. ❐
- أكثر من مرة في الأسبوع. ❐

استرجاع غذاء ٢٤ ساعة:

❁ إرشادات عن كيفية ملء استبيان استرجاع غذاء 24 ساعة:

- من المهم جدا إبقاء عاداتك الغذائية من تناول الطعام والشراب كما هي بدون أي تغيرات.
- كل يوم ينقسم إلى عدة أقسام من الصباح إلى المساء و حتى خلال فترات الليل.
- يرجى تسجيل كل شيء في وقت تناول الطعام، وكذلك أي طعام أو شراب حتى ولو كان أثناء الليل. أو حتى الوجبات الخفيفة.
- عند تسجيل طعامك يجب أن يتضمن اسم الصنف، كمية الطعام المأخوذ، أي إضافات على الغذاء (الدهون والزيوت والسكر والملح والفلفل، الخ)، وطرق طهي الطعام (القلي، الشيء، السلق، بالفرن الخ).
- يمكنك أن ترى مثال على كيفية تسجيل المواد الغذائية وتناول الشراب خلال يوم واحد.

كيفية تقدير وقياس حجم الوجبة الغذائية:

اللحوم عبارة عن ثلاث اوقية هى حوالى حجم وسمك ورق اللعب	
الفواكهه تفاحة متوسطة الحجم او خوخ عبارة عن حجم كرة التنس	
الحبوب كوب واحد من الارز او المكرونة عبارة عن حجم قبضة اليد	
الاجبان اونصة واحدة من الجبن عبارة عن حجم اربعة من النرد	

قائمة مراجعة الثلاث ايام الغذائية:

المشروبات:	ماهو نوع العصائر او المشروبات وماهى العلامة التجارية؟ ما نوع الحليب (كامل الدسم- خالى الدسم)؟
الخبز:	هل تم اضافة زبدة؟
الحبوب:	هل تم اضافة حليب؟ هل تم اضافة سكر او فواكهة؟
الالبان:	ماهو نوع اللبن وماهي العلامة التجارية؟ ماهو نوع الجبن وماهي العلامة التجارية؟
الخضراوات:	هل الخضروات (نية ام مطبوخة)؟ هل كانت (طازجة- مجمدة- معلبة)؟ هل تم اضافة اى دهن عليها؟
الفواكهه:	ما حجم الثمار (كبيرة- متوسطة- صغيرة)؟ هل كانت (طازجة- مجمدة- معلبة)؟
الحبوب:	هل تم اضافة (عسل - زبدة – مربى)؟ هل الحبوب كاملة الحبة؟ ماهو حجم الفطائر (كبيرة- متوسطة- صغيرة)؟
الاسماك:	كيفية طبخ السمك؟ هل السمك (طازج- معلب- مجمد)؟
اللحوم:	كيفية طبخ اللحم؟ ماهو الجزء المستخدم مثلا الدجاج (صدر- ساق – جناح)؟
الشورية:	هل هو معد مع الماء او الحليب او الكريمة؟
المطاعم:	ماهو نوع المطعم؟

اليوم (1): الاثنين		**التاريخ : 1431/2/18هـ**	
الوقت	**المكان**	**الطعام**	**الوزن**
٦,٢٥	المنزل	حليب كامل الدسم مع السكر خبز توست محمص مع زبده مربى - جبنه كاملة الدسم	كوب- ملعقة شاي شريحة- ملعقة شاي كلا بمقدار ملعقة طعام
١٠,١٥	المكتب	شاي مع السكر فطائر بالسبانخ	كوب- ملعقتين شاي ٢
٢,٠٠	المنزل	شريحة لحم مشوية مع قليل من الزبد رز مندي كنافة بالقشطة تفاحة	٢٠٠ جم- ملعقة شاي ١٠ ملاعق طعام ٥ ملاعق طعام ١
٥,١٠	المنزل	بيبسي سمبوسك باللحم	كوب ٢ حبات
٧,٢٠	المنزل	قهوة عربية تمر	ثلاث فناجين خمس حبات
٩,٢٠	المنزل	خبز عربي عسل لبنة	شريحة واحدة ٢ ملعقة طعام ٤ ملاعق طعام
١١,٠٠	المنزل	حليب كامل الدسم	كوب

اليوم (١):		التاريخ : / /١٤٣....هـ	
الوقت	**المكان**	**الطعام**	**الوزن**

اليوم (٢):		التاريخ : / /....١٤٣هـ	
الوقت	المكان	الطعام	الوزن

اليوم (٣):

التاريخ : / /....١٤٣هـ

الوقت	المكان	الطعام	الوزن

Appendix (G): Anthropometric Measurements

Anthropometric Measurements:

- Height: ....
- Weight: ....
- Body Mass Index (BMI): ....
- Waist Circumference: ....
- Hip Circumference: ....
- Thickness Skin Fold (TSF): ....
- Arm circumference (AC): ....
- Arm Muscle Circumference (AMC): ....

AMC = AC- 3.14 x TSF (cm)

استمارة المقايس الجسمية:

الطول:..

الوزن:..

مؤشر كتلة الجسم:...

محيط الوسط:..

محيط الورك:...

سمك طبقة الجلد:...

محيط الذارع:..

محيط عضلة الذراع:..

Appendix (H): Food test laboratories analyses

foodtestlaboratories

SAFETY - QUALITY - LEGALITY

Fatty Acid Profile

Sample Number : N020 1
Sample Description : Saudi Dried Milk Based Food
Received : 02/03/2011 Fat Content : 8.1%

Fatty Acid ID	Result (%)	Fatty Acid ID	Result (%)
C8:0	0.2	C18:3n3	0.1
C10:0	0.8	C20:0	<0.1
C12:0	0.3	C20:1	<0.1
C13:0	<0.1	C20:2	<0.1
C14:0	1.0	C20:3n6	<0.1
C14:1	0.0	C20:3n3	<0.1
C15:0	0.1	C20:4n6	<0.1
C15:1	<0.1	C20:5n3	<0.1
C16:0	3.0	C21:0	<0.1
C16:1	0.1	C22:0	<0.1
C17:0	0.1	C22:1n9	<0.1
C17:1	0.0	C22:2	<0.1
C18:0	0.6	C22.6n3	<0.1
C18:1n9c	1.7	C23:0	<0.1
C18:2n6t	0.0	C24:0	<0.1
C18:2n6c	0.1	C24:1	<0.1
C18:3n6	<0.1		

Approved by: Christopher Murgatroy, Chemistry Manager — Approved and electonically signed by the stated signatory

Tests marked" #" in this report are not included in the UKAS accreditation schedule of the laboratory. Tests marked "*" were subcontracted to a UKAS accredited laboratory. Tests marked "**" were subcontracted to a Non-UKAS accredited laboratory. Opinions and interpretations contained herein are outside the scope of UKAS accreditation. Calculations of energy values are preformed according to the Food Labelling Regulations 1996. Unless reported, alcohol, polyols and organic acids have not been considered in the energy calculation. Calculations of meat content are corrected for cereal fillers where known to be added, but are not corrected for other sources of protein including; soya; caseinate; milk powder and non meat sources of fat. Where the analysis for connective tissue has not been requested meat content analysis (for labelling purposes) may be an overestimate. "< " means less than." >" means greater than." ND" means not detected. "e" means a microbiological count is estimated. "Pres"' means presumptive.

foodtestlaboratories
SAFETY - QUALITY - LEGALITY

Fatty Acid Profile

Sample Number : N020 2
Sample Description : Saudi Fermented Product (Jar)
Received : 02/03/2011 Fat Content : 99.0%

Fatty Acid ID	Result (%)	Fatty Acid ID	Result (%)
C8:0	2.5	C18:3n3	0.6
C10:0	7.7	C20:0	0.2
C12:0	4.5	C20:1	<0.1
C13:0	<0.1	C20:2	<0.1
C14:0	12.5	C20:3n6	<0.1
C14:1	<0.1	C20:3n3	<0.1
C15:0	1.0	C20:4n6	<0.1
C15:1	<0.1	C20:5n3	<0.1
C16:0	34.0	C21:0	<0.1
C16:1	1.0	C22:0	<0.1
C17:0	0.5	C22:1n9	<0.1
C17:1	0.4	C22:2	<0.1
C18:0	9.9	C22.6n3	<0.1
C18:1n9c	22.1	C23:0	<0.1
C18:2n6t	0.6	C24:0	<0.1
C18:2n6c	1.7	C24:1	<0.1
C18:3n6	<0.1		

Approved by: C Murgatroy Christopher Murgatroy
Chemistry Manager
Approved and electonically signed by the stated signatory

LABORATORY REPORT

Report No: N020 / 460473

Unit 10a, Langthwaite Business Park, WF9 3AP
Tel: 01977 608319 Fax: 01977 608319
e-mail: info@foodtest.co.uk

c

UKAS TESTING 1819

G1

Customer Details: **Newcastle University (Agriculture)** Agriculture Building,Newcastle University,Newcastle upon Tyne,NE1 7RU

Report Contact: Dr Chris Seal

Sample No: 1 Description of Sample: Saudi Dried Milk Based Food,

Date Received: 02/03/2011 Date Tested: 02/03/2011 Date of Report: 31/03/2011

Test, Units, Reference	Results	Test, Units, Reference	Results
Energy Values, kCal/kJ per 100g,A20	379/1602	Ash, g/100g,A3	7.4
Protein (Nx6.25), g/100g,A4	39.1		
Fat, g/100g,A14	8.1		
of which saturates% (A19)	6.1		
of which mono-unsaturated%(A19)	1.7		
of which poly-unsaturated%(A19)	0.2		
of which trans% (A19)	<0.1		
Av Carbohydrate % (by diff') (A20)	37.5		
Total Sugars, g/100g,A15	14.5		
Dietary Fibre AOAC,g/100g,A17	1.3		
sodium mg /100g (A16)	438		
Moisture % (A2)	6.6		

Comments

Approved by: [signature] Christopher Murgatroy
Chemistry Manager

Approved and electonically signed by the stated signatory

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LABORATORY REPORT

Report No: N020 / 460474

Unit 10a, Langthwaite Business Park, WF9 3AP
Tel: 01977 608319 Fax: 01977 608319
e-mail: info@foodtest.co.uk

c

UKAS TESTING 1819

G1

Customer Details: **Newcastle University (Agriculture)** Agriculture Building,Newcastle University,Newcastle upon Tyne,NE1 7RU

Report Contact: Dr Chris Seal

Sample No: 2 Description of Sample: Saudi Fermented Product (Jar),

Date Received: 02/03/2011 Date Tested: 02/03/2011 Date of Report: 31/03/2011

Test, Units, Reference	Results	Test, Units, Reference	Results
Energy Values, kCal/kJ per 100g,A20	894/3675	Ash, g/100g,A3	<0.1
Protein (Nx6.25), g/100g,A4	0.1		
Fat, g/100g,A14	99.0		
of which saturates% (A19)	73.5		
of which mono-unsaturated%(A19)	23.3		
of which poly-unsaturated%(A19)	2.3		
of which trans% (A19)	<0.1		
Av Carbohydrate % (by diff') (A20)	0.6		
Total Sugars, g/100g,A15	<0.1		
Dietary Fibre AOAC,g/100g,A17	<0.1		
sodium mg /100g (A16)	1		
Moisture % (A2)	0.3		

Comments

Approved by: C Murgatroy Christopher Murgatroy
Chemistry Manager

Approved and electonically signed by the stated signatory

Tests marked" #" in this report are not included in the UKAS accreditation schedule of the laboratory. Tests marked "*" were subcontracted to a UKAS accredited laboratory. Tests marked "**" were subcontracted to a Non-UKAS accredited laboratory. Opinions and interpretations contained herein are outside the scope of UKAS accreditation. Calculations of energy values are preformed according to the Food Labelling Regulations 1996. Unless reported, alcohol, polyols and organic acids have not been considered in the energy calculation. Calculations of meat content are corrected for cereal fillers where known to be added, but are not corrected for other sources of protein including; soya; caseinate; milk powder and non meat sources of fat. Where the analysis for connective tissue has not been requested meat content analysis (for labelling purposes) may be an overestimate. "< " means less than." >" means greater than." ND" means not detected. "e" means a microbiological count is estimated. "Pres'" means presumptive.

Appendix (I): Summary of an association between nutrients \ food groups with CVD risk

Nutrients	Reasons	References
Energy intake	Essential Macronutrient.	(Verschuren, 2012)
Total fat intake	↑Risk of diabetes, metabolic syndrome components. ↑Body weight/adiposity.	
SFA intake	↑Blood cholesterol, ↑LDL cholesterol levels. ↑Risk of diabetes, ↑Risk of hypertension. ↑Body weight/adiposity. ↑Heart disease, stroke.	
MUFA intake	↓Blood cholesterol, ↓LDL cholesterol levels. ↓Risk of heart disease.	
PUFA intake	Essential (LA, ALA). ↓Risk of CHD, diabetes, metabolic syndrome components. ↓ Blood cholesterol, ↓LDL cholesterol levels.	
Cholesterol intake	↑Heart disease, stroke. ↑LDL cholesterol levels.	
Protein intake	Essential Macronutrient.	
Carbohydrates intake	Essential Macronutrient.	
Fibre intake	Fosters weight management. ↓Blood cholesterol, ↓LDL cholesterol levels. ↓Risk of heart disease, diabetes.	
Calcium intake	Essential Micronutrient. Mineralization of bones and teeth, also involved in muscle contraction and relaxation, blood clotting, blood pressure.	(Verschuren, 2012)
Iron intake	Essential Micronutrient. ↑Transportation of oxygen in the blood.	
Magnesium intake	Critical to heart function and to protect against hypertension.	
Sodium intake	↑Blood pressure, ↑heart disease.	
Potassium intake	↓ Blood pressure, ↓heart disease.	
Selenium intake	Antioxidant, Important for skin, immunity system. ↑HDL cholesterol levels, ↓Risk of heart disease.	
Zinc intake	Important for skin, bone and tooth growth. Immunity system.	
Vitamin A intake	Important for skin, bone and tooth growth. Immunity, protecting the heart and CVD system.	(Verschuren, 2012)
Vitamin C intake	Antioxidant, help heart and blood vessels.	
Vitamin E intake	Antioxidant, prevent heart disease and blood vessels.	

SFA indicates saturated fatty acids; MUFA, monounsaturated fatty acids; PUFA, polyunsaturated fatty acids.

Nutrients/food group	Reasons	References
Total n-3 PUFA intake	Essential (ALA). ↓Risk of total CHD, stroke. ↓Triglyceride levels. Helps to prevent blood clots, protect against irregular heartbeats and lower blood pressure.	(Lavie *et al*., 2009; Lee *et al*., 2008; Verschuren, 2012)
Total n-6 PUFA intake	Essential (LA). ↓ Risk of diabetes, metabolic syndrome components. ↑Body weight/adiposity.	
Total n-3: total n-6 PUFAs	↓Risk of CVD.	(UK Scientific Advisory Committee on Nutrition 2004)
***Trans* fatty acid intake**	↓HDL cholesterol levels, ↑LDL cholesterol levels. ↑Risk of CHD and sudden cardiac death. ↑Risk of diabetes, metabolic syndrome components. ↑Body weight/adiposity.	(Verschuren, 2012)
Nuts and seeds group	↑PUFA, Magnesium and potassium ↑n-3, ALA ↓Risk of CVD, stroke.	(Azadbakht & Rouhani 2013; Craig, 2010)
Fish and sea-food group	↑n-3, EPA, DHA ↓Risk of total CHD, stroke.	(Verschuren, 2012)
Fruit & vegetables group	↓Calories, ↑Fibre ↓ Blood pressure, ↓Risk of CVD, stroke.	(Verschuren, 2012)
Fast food group	↑SFA, sodium and sugar. ↓Fibre, iron and calcium. ↑Body weight/adiposity.	(Duffey *et al*., 2007; Guthrie *et al*., 2002)
Traditional Saudi food group	There is little information available regarding the type of nutrients consumed in Saudi Arabia and CVD	(Bani & Hashim, 1999)

SFA indicates saturated fatty acids; MUFA, monounsaturated fatty acids; PUFA, polyunsaturated fatty acids. n-3, omega 3; ALA, alpha-linolenic acid (18:3n-3); EPA, eicosapentaenoic acid (20:5 n-3); DHA, docosahexaenoic acid (22:6 n-3); n-6, omega 6; LA, Linoleic acid (18:2 n-6).

Appendix (J): Work published and presented to date

- October 2011: poster presented on Human Nutrition Research day, Newcastle University, Newcastle upon Tyne, UK.
- July 2012: presentation and abstract published on Nutrition Society Summer Meeting, Queen’s University Belfast, UK.
- September 2012: presentation on Nutrition Society Postgraduate Conference, Newcastle University, Newcastle upon Tyne, UK.
- October 2012: presentation on Human Nutrition Research day, Newcastle University, Newcastle upon Tyne, UK.

Dietary patterns and risk of heart disease in Saudi Arabia

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1. Introduction:

Cardiovascular diseases (CVD) are the most important causes of death at a global level. The statistics conducted in the Kingdom of Saudi Arabia over the past forty years show an increase in deaths caused by CVD (1).

The reason for the increasing incidence of diseases of the heart and vascular system is due to a range of factors such as lack of physical activity, obesity, diabetes and smoking, including a change in the pattern and quantity of food consumed, for example energy dense high fat foods (2).

However, knowing the family history, age and also gender (male or female) can help to predict the occurrence and the spread of CVD (3). Buttriss (1999) claimed that by maintaining normal weight, exercising and avoiding increased consumption of fats could help reduce CVD.

2. Aims:

* To investigate the relationships between dietary food intakes and coronary risk factors in the city of Jeddah, in the western region of Saudi Arabia in both men and women without overt CVD.

* To determine differences in total dietary intake as attested by age, gender and socio-economic background.

* To explore the relationships between dietary intake of total fat, omega-3 fatty acids and long chain polyunsaturated fatty acids in different regions of Saudi Arabia as indicators of risk of CVD.

3.Methodology:

4. Results:

One hundred Saudi men (*n* =50) and women (*n* =50) aged between 18 - 65 years were recruited in the King Abdul-Aziz University in the city of Jeddah, in the western region of Saudi Arabia.

Mean (SD) for the age of female and male subjects were 32.4 (7.4) years and 30.9 (9.6) years, respectively. Statically significant differences occurred between males and females in monthly income ($P < 0.05$) and marital status ($P < 0.05$). On the other hand, there were no significant differences according to gender in education ($P > 0.05$). Male participants reported having physical activity more than females ($P < 0.05$). The prevalence of current smokers amongst males was 50% which was significantly more than amongst females at 2%.

Mean macronutrient and micronutrient intake were reported in Table (1 & 2).

Table 1: • Macronutrient Intake of the study subjects by sex:

Nutrient	Overall	Males	Females	*P*
	Mean ±SD	Mean ±SD	Mean ±SD	
Energy (Kcal)	2005.35 ± 325.215	1959.14 ± 265.335	2051.56 ± 372.730	< 0.05
Total Fat (g)	80.23 ± 20.887	76.59 ± 18.086	83.88 ± 22.962	NS
(%)	36	35.18	36.79	
SFA (g)	27.81 ± 9.214	26.12 ± 7.463	29.51 ± 10.486	< 0.05
(%)	12.48	11.99	12.94	
MUFA (g)	27.70 ± 8.460	27.22 ± 8.820	28.18 ± 8.145	NS
(%)	12.43	12.50	12.36	
PUFA (g)	15.43 ± 6.125	14.25 ± 5.020	16.61 ± 6.911	< 0.05
(%)	6.92	6.54	7.28	
Cholesterol (mg)	256.380 ± 98.013	269.30 ± 106.645	243.46 ± 87.723	N.S
Protein (g)	82.091 ± 18.137	83.74 ± 16.177	80.43 ± 19.933	< 0.05
%	16.37	17.09	15.68	
Carbohydrates (g)	252.46 ± 49.751	246.53 ± 50.723	258.38 ± 48.541	N.S
%	50.35	50.33	50.37	
Fiber (g)	10.09 ± 5.045	8.81 ± 4.169	11.38 ± 5.538	< 0.05

Table 2: • Micronutrient Intake of the study subjects by sex:

Nutrient	Overall	Males	Females	*P*
	Mean ±SD	Mean ±SD	Mean ±SD	
Calcium (mg)	663.03 ± 198.869	643.76 ± 175.82	682.3 ± 219.62	NS
Iron (mg)	14.93 ± 7.692	13.77 ± 5.719	16.09 ± 9.170	NS
Magnesium (mg)	240.110 ± 77.145	236.96 ± 68.667	243.26 ± 85.375	NS
Sodium (mg)	2947.23 ± 984.724	2890 ± 1030.52	3004.4 ± 934.65	NS
Potassium (mg)	2647.490 ± 851.839	2562.08 ± 707.950	2732.9 ± 974.67	NS
Selenium (µg)	53.79 ± 28.776	59.98 ± 31.478	47.60 ± 24.576	< 0.05
Zinc (mg)	8.27 ± 2.309	8.57 ± 2.417	7.96 ± 2.177	NS
Vitamin A (µg)	802.99 ± 909.371	844.74 ± 115.90	761.2 ± 575.43	NS
Vitamin C (mg)	69.71 ± 55.772	67.98 ± 58.428	71.44 ± 53.520	NS
Vitamin E (mg)	5.38 ± 2.442	5.28 ± 2.318	5.49 ± 2.580	NS

5. Conclusions:

* The results of this study showed that the intake of SFA, MUFA and PUFA meets the UK recommendation for both males and females.

* The results of this preliminary study are currently used to design a follow on study in a more arid region of Saudi Arabia.

References:

(1): Kumosani, T. Al-Madany, K. (2000): Anti-oxidation between health and disease - Dar Al-Madany - Jeddah, Saudi Arabia.
(2): Houston, M. C., Fazio, S., Chilton, F. H., Wise, D. E., Jones, K. B., Barringer, T. A. and Bramlet, D. A. (2009): Nonpharmacologic Treatment of Dyslipidemia. Progress in Cardiovascular Diseases, 52, (2): 61-94.
(3): Buttriss, J. (1999): n-3 fatty Acids and Health. British Nutrition Foundation. P: (4-10) (36-37).

HNRC Research Day & Annual Lecture

Wednesday 10th October 2012

10:00 – 18:00

Lindisfarne Room and Herschel Building

10:00 – 10:30	**Arrival and Coffee**	
10:30 - 10:45	**Welcome and Introduction by Professor John Mathers**	
Oral Presentations – Molecular Nutrition (Chairs: Jill McKay and Fiona Malcomson)		
10:45 – 11:00	Luisa Wakeling	*"Nutritional influences on honeybee DNA methylation and their potential impact on development and lifespan"*
11:00 – 11:15	Eva Morales	*"Epigenetic marks in newborns associated with maternal gestational weight gain"*
11:15 – 11:30	Agbor Ogo	*"Metal micronutrient homeostasis through a novel gene transcriptional regulatory mechanism"*
Oral Presentations – Reviews		
11:30 – 11:45	Dr Jose Lara	*LIVEWELL diet systematic review*
11:45 – 12:00	Dr Mario Siervo	*"Sarcopenic obesity and cardio-metabolic risk: a critical appraisal of the current evidence"*
12:00 – 13:00	**Lunch (view posters)**	
Oral Presentations – Public Health (Chairs: Anna Sherrington and Laura Basterfield)		
13:00 – 13:15	Dr Sokrates Stergiadis	*"Effects of dairy production systems on milk fatty acid composition and nutritional value"*
13:15 – 13:30	Helen Kendall	*"Food Provisioning and the Domestic Food Handling Practices of the Over 60s In the North east of England"*
13:30 – 13:45	Jennifer Delve	*"The impact of using calibrated utensils to assess portion sizes in infants aged 4-18 months"*
13:45 – 14:00	Noha Almoraie	*'Dietary patterns and risk of heart disease in populations from different geographical locations in Saudi Arabia'*
14:00 – 14:45	**Poster Competition - PowerPoint presentations from the 3 finalists**	
14:45 – 15:00	**Coffee Break**	
Oral Presentations – Applied Nutrition (Chairs: Tom Hill and Caroline Shaw)		
15:00 – 15:15	Dr Naomi Willis	*"Impact of non-digestible carbohydrates on biomarkers of colorectal health"*
15:15 – 15:30	Dr Matthew Wilcox	*"The potential of alginates to inhibit pancreatic lipases: from bench to acute studies" (a longer-term project that has developed basic science into Biotech IP and potential diet-based anti-obesity strategy).*
15:30 – 15:45	Gemma Crossfield	*"Dietary intake in cystic fibrosis patients and its association with gastric reflux and disease progression". (Gastric reflux appears to be a driver for progression of upper airways damage or dysfunction and is strongly linked to dietary and lifestyle factors)*
15:45 – 16:15	**Break then move to Herschel Lecture Theatre**	
16:15 – 16:45	**Poster Prize Presentation and Roundup**	
Annual lecture given by Professor Tim Lang (Professor of Food Policy, Centre for Food Policy, City University, London)		
17:00 – 18:00	*"Food democracy and societal renewal: is this top down or bottom up?"*	

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Proceedings of the Nutrition Society (2012), **71** (**OCE2**), E50 doi:10.1017/S0029665112001073

Summer Meeting hosted by the Irish Section, 16–19 July 2012, Translational nutrition: integrating research, practice and policy

Dietary patterns and risk of heart disease in populations from different geographical locations in Saudi Arabia

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The food situation in Saudi Arabia has markedly changed during the last two decades. A nutrition transition is taking place in the country in which traditional foods are being replaced by fast foods high in fat, sugar, and salt. Since one important modifiable risk factor of cardiovascular disease (CVD) is dietary intake. It is important to monitor these changes in order to estimate the potential effects of this dietary transition as CVD risk. Saudi Arabia has a wide geographical variation with its two major cities located in contrasting regions where local food availability is very different. Therefore, this study was designed to investigate dietary intake in two samples of adults living in different geographic locations (coastal and internal areas) of Saudi Arabia. 229 Saudi men and women aged 18–65 years were recruited from King Abdul-Aziz University, in the coastal city of Jeddah (50 men, 50 women) and Umm Al Qura University, in the inland city of Makkah (73 men, 56 women). All participants completed detailed three consecutive day food records and an assessment questionnaire that included question on lifestyle practices and socioeconomic status. Height and weight, waist and hip circumference were measured in order to calculate body mass index (kg/m^2), and waist/hip ratio, respectively. The mean (SD) ages of women and men were 32.1 (8.01) and 32.3 (8.71), respectively. BMI was lower in men and women from the coastal region 25.1 (2.76) than the inland region 26.3 (3.21), respectively ($P<0.05$). Smoking was more prevalent in the inland area (36%) than coastal area (17%), ($P<0.001$). Men were more physically active than women. Daily energy and nutrient intake averaged for men and women for the coastal and inland regions are shown in the Table:

Nutrient	Coastal City Mean (SD) n = 100	Inland City Mean (SD) n = 129	P
Energy (kcal/d)	2005.3 (325.21)	2272.9 (227.51)	<0.05
Total Fat (% energy)	35.8 (6.16)	32.9 (4.53)	NS
SFA (% energy)	12.4 (3.41)	14.4 (2.82)	<0.05
MUFA (% energy)	12.4 (2.98)	8.8 (8.4, 9.2)*	<0.05
PUFA (% energy)	6.8 (2.29)	3.2 (3.01, 3.3)*	<0.05
Protein (% energy)	16.4 (3.19)	15.2 (2.86)	NS
Carbohydrates (% energy)	50.5 (6.78)	55.3 (5.08)	<0.05
Fibre (g/d)	10.1 (5.04)	8.9 (3.26)	<0.05
Sodium (g/d)	2.9 (0.98)	4.4 (0.12)	<0.05
Potassium (g/d)	2.6 (0.85)	3.1 (0.79)	<0.05
Selenium (µg/d)	53.7 (28.77)	43.1 (16.58)	<0.05
Zinc (mg/d)	8.2 (2.31)	9.9 (2.23)	<0.05
Vitamin A (µg/d)	591.3 (512.9, 681.5)*	550.2 (225.86)	NS
Vitamin C (mg/d)	51.4 (43.6, 60.6)*	54.1 (47.8, 60.9)*	NS
Vitamin E (mg/d)	4.8 (4.4, 5.3)*	4.5 (1.37)	<0.05

SFA indicates saturated fatty acids; MUFA, monounsaturated fatty acids; PUFA, polyunsaturated fatty acids.
*Geometric means (95% CI), variables compared by Mann-Whitney tests. NS: not significant.

Subjects from the coastal city had a significantly lower energy intake but higher intakes of MUFA and PUFA, fibre, selenium and vitamin E ($P<0.05$). In contrast they ate significantly less carbohydrates, sodium, potassium and zinc. The results show marked differences in diet composition between coastal and internal areas which may affect CVD risk. The reasons for these differences require further investigation.

NAM is in receipt of a scholarship from the Saudi government.

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