AMERICAN UNIVERSITY OF BEIRUT

# ASSESSMENT OF THE LEBANESE DIETARY PATTERN AS A MEDITERRANEAN DIETARY PATTERN AND ITS ASSOCIATION WITH OBESITY AND THE METABOLIC SYNDROME

by
SHIRINE ANGELIQUE TOUFIC BAALBAKI

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# AN ABSTRACT OF THE THESIS OF

Shirine Angelique Toufic Baalbaki for Master in Nutrition
Major: Nutrition and Dietetics

Title: Assessment of the Lebanese dietary pattern as a Mediterranean dietary pattern and its association with obesity and the metabolic syndrome

Purpose: To compare the traditional Lebanese dietary pattern with selected Mediterranean patterns derived from the literature, to assess the effect of the Lebanese and the Mediterranean patterns on obesity as well as the Metabolic Syndrome and to examine socio-demographic and lifestyle correlates of adherence to both the Mediterranean and the Lebanese patterns among Lebanese adults.

Methods: A secondary data analysis was performed on a nationally representative cross-sectional survey of Lebanese adults. This survey consisted of a general questionnaire, a Food Frequency Questionnaire, anthropometric measurements and biochemical measurements. The Lebanese Dietary score was based on results of previous factor analyses conducted on the same dataset. The other Mediterranean scores were calculated based Mediterranean indexes described in the literature namely MSDPS, MS, MD, Med-DQI, rMED and MDS. Using Pearson's correlation, agreement by percentage and weighted Kappa, the Lebanese Dietary score was compared to the scores of the published Mediterranean indexes. Bivariate and multivariate logistic regression analyses were used to identify the association between all the indexes, obesity and the metabolic syndrome. Logistic regression analysis was used to determine the correlates of adherence to the Lebanese and Mediterranean pattern scores.

Results: There was a moderate agreement between the different Mediterranean patterns and the Lebanese pattern. Out of the six Mediterranean indexes chosen in the literature, the Mediterranean index most associated with the Lebanese pattern was the MD (r=0.539). The Lebanese dietary pattern was not found to be protective against obesity or the Metabolic Syndrome. Older age and higher educational levels were associated with increased adherence to all Mediterranean Diets studied. A healthier lifestyle characterized by high levels of physical activity, no smoking, higher frequency of breakfast consumption, and lower frequency of eating out was also associated with adherence to the Lebanese dietary pattern. However these results did not apply to all the other Mediterranean indexes.

Conclusion: Taking in consideration the quantity of food consumed and the food groups specific to the Lebanese Dietary pattern, the foods to be added to this new index comprise bulgur, dried fruits, dairy products in moderation and olive oil. Moreover, means of public awareness should be elaborated to encourage the Lebanese population to preserve their Lebanese diet and at the same time to decrease quantities consumed. The Lebanese Dietary index to be developed could be a useful tool in this process.

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# ABBREVIATIONS

| | |
|---|---|
| BMI | Body Mass Index |
| CHD | Coronary Heart Disease |
| CI | Confidence Interval |
| CIA | Central Intelligence Agency |
| CRP | C-Reactive Protein |
| CVD | Cardiovascular Diseases |
| DHA | Docosahexaenoic acid |
| DOI | Digital Object Identifier |
| EMR | Eastern Mediterranean Region |
| EPA | Eicosapentaenoic acid |
| EPIC | European Prospective Investigation into Cancer |
| EURATOM | European Atomic Energy Commission |
| FA | Fatty Acids |
| FAO | Food and Agriculture Organization |
| FFQ | Food Frequency Questionnaire |
| HbA1c | Glycated Hemoglobin |
| HDL | High-Density Lipoprotein |
| IDF | International Diabetes Federation |
| IL-6 | Interleukin 6 |
| LBP | Lebanese Pound |
| LDL | Low-density lipoprotein |
| MD | Mediterranean Diets |
| MDS | Mediterranean Diet Score |
| MED | Mediterranean score |
| Med-DQI | Mediterranean-Dietary Quality Index |
| MET | Metabolic Equivalent of Task |
| mMDS | modified Mediterranean Scale |
| MS | Mediterranean Score |
| MSDPS | Mediterranean Style-Dietary Pattern Score |
| MUFA | Monounsaturated fatty acids |
| NCDs | Non-communicable diseases |
| OR | Odds ratio |
| PUFA | Polyunsaturated fatty acids |
| rMED | Relative Mediterranean Diet |
| SD | Standard Deviation |
| SFA | Saturated Fatty Acids |
| STEPS | STEPwise approach to Surveillance |
| TAG | Triglycerides |
| TV | Television |
| U | Unit |
| UAE | United Arab Emirates |
| US | United States |
| USD | US Dollar |
| USDA | United States Department of Agriculture |
| UNDP | United Nations Development Programme |
| UNHCR | United Nations High Commissioner for Refugees |
| WC | Waist Circumference |
| WHO | World Health Organization |

# CHAPTER I

# BACKGROUND AND SIGNIFICANCE

## A. Non Communicable Diseases

### *1. Prevalence*

The world has recently observed a shift in disease spectrum: Non-Communicable Diseases (NCDs) have swapped infectious diseases like Hepatitis and tuberculosis. The data reported by the World Health Organization indicates that NCDs became the cause of sixty three percent of all deaths in the world. While cardiovascular diseases account for the death of 17.3 million people annually, other NCDs like cancers (7.6 million), respiratory diseases (4.2 million), and diabetes (1.3 million) are also a major threat worldwide. These four groups of diseases are considered together as the four main types of NCDs and the "leading killers". Out of the total deaths attributed to NCDs, more than 9 million occur before the age of 60 and the majority of these deaths (nearly 80%) occur in low- and middle-income countries putting a break on their development (WHO, 2010a).

The Eastern Mediterranean Region (EMR) does not escape from the outbreak. According to the WHO, the EMR refers to all Arab countries excluding Algeria, in addition to Afghanistan, Iran, and Pakistan. Out of the 2.2 million deaths from NCDs in this region, almost 2.1 million occur in low- and middle- income countries. For example, in the EMR, 1.2 million deaths are caused by cardiovascular diseases. However the regional distribution ranges from 13% in Somalia to 49% in Oman (WHO, 2010b).

If no action is taken, the WHO expects deaths from NCDs to increase as follows:

Table 1.1: Death expectations from NCDs in high-, middle- and low-income countries in 2015 and 2030 (WHO, 2010b)

| | High-, middle- and low-income countries | Middle-income and low-income countries only |
|---|---|---|
| **2015** | 23% increase in deaths from NCDs in the High-, middle- and low-income countries of the WHO Eastern Mediterranean Region compared to 24% increase in Africa, 23% in South-East Asia, 21% in the Western Pacific, 16% in the Americas and 6% in Europe | 23% increase in deaths from NCDs in the middle- and low-income countries of the WHO Eastern Mediterranean Region compared to 24% in low- and middle-income countries in Africa and the Americas, 23% in South-East Asia, 20% in the Western Pacific and 2% in Europe vs an 13% increase in high-income countries across the world |
| **2030** | 77% increase in deaths from NCDs in the high-, middle- and low-income countries of the WHO Eastern Mediterranean region compared to 76% increase in Africa, 63% in South-East Asia, 55% in the Western Pacific, 50% in the Americas, and 5% in Europe. | 43% increase in deaths from NCDs in the middle- and low-income countries of the WHO Eastern Mediterranean Region compared to 43% in Africa, 41% in the Americas, 39% in South-East Asia, 37% in the Western Pacific, and -3% in Europe vs a 21% increase in high-income countries across the world |

In addition to mortality, data on morbidity are also important for health care management. According to the report of the WHO (2010a), even if the current global rates remain as is, the estimated incidence of 12.7 million new cancer cases in 2008 will rise to 21.4 million by 2030 with nearly two third of them occurring in low- and middle-income countries. For Diabetes, in 2008, the highest prevalence observed was in the EMR and the Region of the Americas: 11% for both sexes. The lowest was for the WHO European and Western Pacific Regions (9% for both sexes).

## *2. Etiology*

The major challenge for public health research and advancement is that unlike infectious diseases, NCDs also called chronic diseases are characterized by being non contagious, and having a long latent period. Moreover, they cannot be treated spontaneously and complete cure is rarely achieved. For these reasons it is mostly important to address these diseases through prevention of risk factors rather than relying on treatment to attenuate the symptoms. However, risk factors are of multiple etiologies. They can be divided into non-modifiable and modifiable factors. Non-modifiable risk factors consist mainly of age, gender and genetics (WHO, 2015). The reasons behind aging of the population are the improvements in measures of survival along with the decrease in fertility. An increased proportion of the population is concentrated among older groups. Since susceptibility to NCDs increases with age, prevalence of NCDs is also increasing (United Nations, 2012). The other two non-modifiable risk factors are rarely purely responsible for NCDs. It is rather the effect of many genes, whether being a male or a female, with the interaction of the environment that affects the individual’s probability to develop any condition. For many of these conditions, the role of genetics is still blurred (WHO, 2010c). Given the improbability of altering these factors and their imprecise role, the risk factors that can be targeted for change are behavioral factors.

According to the WHO (2015) the behavioral factors that are mostly associated with NCDs are tobacco use, physical inactivity, harmful use of alcohol and unhealthy diet. The organization noted that insufficient physical activity contributes to about 3.2 million deaths annually whereas approximately 1.7 million deaths are attributable to low fruit and vegetable consumption. These behaviors lead to "intermediate risk factors" as raised blood pressure, increased blood glucose, elevated blood lipids, overweight and obesity. The WHO (2015) projects the explosion in rates of obesity whereby by 2015 approximately 2.3 billion adults will be overweight and 700 million will be obese. These "intermediate risk factors" are all precursors of the major diseases representing NCDs.

Among the modifiable risk factors, adopting a healthy diet has consistently shown to reduce the risk of developing chronic diseases. However, processed foods and diets high in total energy, fats, salt and sugar are replacing healthy diets (FAO, 2004). To tackle this factor, traditional studies have shown the effect of single or groups of nutrients on health. An example of this association was reported in the study of Vitamin D, Calcium and type 2 Diabetes. The overall conclusion suggests that Vitamin D alone probably has no effect in healthy individuals, but once combined with calcium as supplements, they may have a role in the prevention of type 2 Diabetes especially in populations at risk or with glucose intolerance (Pittas et al., 2007). Other studies have failed to demonstrate the effect of single nutrients like Saturated Fatty Acids (SFA) on cardiovascular diseases (CVD). SFA have been known for their detrimental effects on health, however, a recent meta-analysis of 16 prospective cohort studies on 347,747 subjects showed that, during 5 to 23 years of follow-up, intake of saturated fat was not associated with increased risk of CVD (RR: 1.07, CI: 0.96-1.19, $p = 0.22$) (Siri-Tarino et al., 2010). Similarly, several cohort studies have shown protective associations between intake of n-3 fatty acids and heart disease suggesting that intake of 250 mg/day of eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) appears to be sufficient for primary prevention. However, these results were confronted with the findings of three control studies which states that dietary intake, plasma or adipose concentration of n-3 fatty acids have no protective effects on non-fatal myocardial infarction (Naja et al., 2014). These inconsistencies have inspired epidemiologists to consider the diet as a whole rather than its particular components. Hence, recently, nutrition researches have been focusing on dietary patterns rather than single nutrients consumption in order to study the effect of food on health.

## B. Dietary patterns

### *1. Definition*

A dietary pattern describes the quantities, proportions, variety, or combination of different foods, drinks, and nutrients (when available) in diets, and the frequency with which they are habitually consumed (USDA, 2014). The researchers have switched to this technique because studying the effect of single nutrients on health seems to be insufficient for several reasons. First it is difficult to attribute health effects to a single dietary component. Nutrients are consumed together and food components might have synergistic effects that do not appear when analyzed separately. Second, we cannot discard the interaction between dietary components at the level of absorption. Third, the substitution of one dietary component may affect another along with its nutrients. Fourth, the effect of a single nutrient may be too small to detect, but the cumulative effects of multiple nutrients included in a dietary pattern may be sufficiently large to be detectable. Finally, because nutrient intakes are commonly associated with certain dietary patterns, `single nutrient' analysis may potentially be confounded by the effect of dietary patterns (Hu et al., 2002).

## 2. *Methods of Assessment*

For all these reasons and in order to represent the real intake of the different combinations of food, dietary patterns can be assessed using several methods:

### a. The A Priori Method

The hypothesis-oriented dietary patterns are evaluated by calculation of a priori scores that measure the degree of adherence to specific dietary guidelines/recommendations or adherence to a healthy diet defined by scientific evidence on diet and disease. The evidence used can be retrieved from studies on single dietary components or general dietary habits for example, Mediterranean or Vegetarian diets. It can also be retrieved from dietary recommendations like the Food Guide Pyramid (Gu et al., 2011). A priori scores are multiple numeric scores assigned to different groups of foods, food components, and/or nutrients. These scores are either measured as dichotomous variables (with predefined cut-points), ordinal variables such as quintiles, or as continuous variables. The individual components are then summed to derive a total score so that all subjects can be ranked from maximum to minimum score (USDA, 2014). The disadvantage of this method is that it does not reflect the diet as a whole but rather the selected intake of several single nutrients and disregards the correlation between them (Hoffman et al. 2003). Moreover, this method is limited to current scientific knowledge concerning nutrition, health and disease and does not take into consideration the potential particularities of dietary choices of individuals (Kastorini et al., 2013).

b. The A Posteriori Method

This method is different from the a priori method whereby dietary patterns are empirical because they are data driven, therefore retrieved directly from the data at hand through a sample under study. In this method, nutrition epidemiology can apply two exploratory methods which are the factor analysis and the cluster analysis (Reedy et al. 2009).

i. Factor Analysis

Factor analysis is a multivariate statistical technique. It usually uses dietary intake from a food frequency questionnaire (FFQ). Once the details about dietary intake are collected, factor analysis puts foods that are correlated together and searches for underlying traits or factors. The purpose of factor analysis is to identify factors that are measurable estimates of the "true" latent structure of a set of variables and can be described as a correlation-based concept of the loadings of each indicator food usually standardized to a value between -1 and 1 (Togo et al., 2001). Thus, a large number of variables are reduced to a smaller set of variables which explains the variation in the data. Not all the factors that are generated are retained. The number of factors kept is usually determined by the extent of variance in a variable set that is explained by a factor or component using eigenvalues. The factors usually excluded in most published reports have eigenvalues ranging from <1 to 1.25. Another method to choose the factors is graphically, by examining scree plots

(Kant, 2004). In order to avoid correlation between factors, the factors obtained can be adjusted by using “orthogonal rotation”. Once the factors are determined, subjects of the sample are attributed a score based on the degree of adherence of their diet to each factor. This final score can be used in either correlation or regression analysis to examine the relationship between different eating patterns and the outcome of interest that can represent morbidities or mortality (Reedy et al., 2009).

ii. Cluster Analysis

Cluster analysis assembles subjects who share similar frequency pattern for consumption of food. In this method, each food represents an axis and individuals are placed in this multidimensional space created by these axes according to their various mean food intake. Then, cluster is defined by the different aggregations of individuals around common food consumed. Once the cluster is determined, the variations between individuals are no longer considered. Moreover, created clusters are mutually exclusive and individuals cannot overlap between them (Reedy et al., 2009).

There are many concerns that are involved in the a posteriori method. One of them is the subjectivity implicated during the process of factor analysis which can affect the type of patterns that are derived. The first step of the process that involves subjectivity is when the investigator selects the number of foods and food groups to be included in the FFQ. As an example, the investigators must decide whether to reduce the number of food items by grouping them according to similarities or not. This can be done for fruits and vegetables however this decision may affect the study results since types of vegetables or fruits may in fact belong to different eating patterns (Newby et al., 2004). Subjectivity also intervenes in the number of factors retained and their naming (Kant, 2004). Unless two variables are perfectly correlated, the method allows as many factors as there are variables. However, only a few of them can be interpreted. That is where the eigenvalue mentioned above plays its role. When this value is greater than 1, it represents a factor that explains more of the variance in the correlations than is explained by a single variable. However, this number can be arbitrary set and has no established objective criteria. The "Orthogonal Rotation" is usually used to apply a simple structure of the factor loading that is easier to interpret: the covariation is redistributed but in an additional subjective way (Martinez et al., 1998).

In addition to subjectivity, the disadvantage of factor analysis is that it does not capture all relevant dimensions of a healthy diet. For example, sodium which has a major role in CVD is rarely accurately measured in FFQs (Appel, 2008).

Another concern faced with factor and cluster analysis could be the fact that different study samples on different populations can lead to the extraction of components hard to compare. Indeed, the differences obtained in study results should represent true differences among populations and not the result of different tools and standards used. However, when Balder et al. (2003) compared similarities and differences in dietary patterns among four different European populations, the results showed that the small differences in the number of variables included in the FFQs and the inclusion of country-specific food in the latter did not inhibit the comparability of the results. Moreover, the subjective manipulation of the data like dichotomization and energy adjustments did not change the interpretation of factors.

Compared to a priori methods, a posteriori methods were advocated negligible differences for their predictive ability of diet and disease association (Kastorini et al., 2013).

iii. Reduced Rank Regression

It is an a posteriori method which combines both existing evidence and exploratory statistics. The method identifies linear functions of predictors (for example, food groups) that explain as much variation as possible in a set of intermediate response variables, for example, nutrients or biomarkers that have been shown to be associated with health outcomes under study (USDA, 2014).

c. Other Methods

By observation (USDA, 2014).

It is important to note that the use of dietary patterns does not replace the analysis of single nutrient effects but rather complements the various outcomes (Jacobs et al., 2003) and strengthen the effect of dietary interventions (Hu et al., 2000). If we take diabetes as an example, in their study Fung et al. (2004) talk about the emerging evidence that certain food and dietary factors may be associated with diabetes independently of obesity.

### *3. Common Patterns*

In the literature, as a result of the a posteriori analysis, the three dietary patterns that are most commonly extracted are the Prudent, the Western and the Mediterranean patterns.

a. The Prudent Dietary Pattern

The common components of the Prudent Dietary Pattern exposed in several studies are usually represented by a diet high in fruits, vegetables, legumes, fish, poultry and whole grains (Chen et al., 2015).

d. The Western Dietary Pattern

The Western Dietary Pattern, common in these studies, mainly consists of consumption of refined grains, red and processed meat, high fat dairy products, sweets and desserts (Kastorini & Panagiotakos, 2009).

e. The Prudent and Western Dietary Pattern and Diseases

When analyzing the association between dietary patterns and diseases, studies usually get similar conclusions. For example, subjects scoring high on the Western Dietary Pattern are usually more at risk of obesity (Esmaillzadeh et al., 2008) and subsequent diseases like CVD, strokes (Fung et al. 2004) and colon cancer (Fung et al., 2003). In his study, Fung et al. (2001) found out that the Western Dietary Pattern is significantly correlated with HDL cholesterol, homocysteine, leptin, fasting insulin, and C-reactive protein. On the contrary, the Prudent Pattern was inversely associated with fasting insulin and homocysteine. Since influence of diet on CVD and obesity may be mediated through these plasma biomarkers, the Western Dietary Pattern may be considered as a predictor of CVD and obesity. These results were obtained despite the fact that these patterns do not represent optimal patterns like the a priori patterns. Same results were found in the study of

Lopez-garcia et al. (2004): an inverse relation between a Prudent Dietary Pattern and plasma concentrations of CRP and E-selectin and a positive relation between a Western Dietary Pattern and concentration of CRP, IL-6, E-selectin and other markers of endothelial dysfunction reflecting potential pathway to CVD. These results were based on healthy subjects and the Body Mass Index (BMI) was controlled which reinforces the fact that the effect of diet on the development of atherosclerosis is not fully attributed to diabetes and obesity.

Another predictor of CVD is Metabolic Syndrome. The Metabolic Syndrome does not escape the predicted results whereby the results of the study conducted by Esmaillzadeh et al. (2007) show that participants in the highest quintile of the healthy dietary pattern which is very similar to the Prudent Pattern had lower odds for components of the Metabolic Syndrome; whereas, participants pertaining to the highest quintile of the Western Dietary Pattern score had higher odds for components of the Metabolic Syndrome.

Since compared to these morbidities, mortality has unequivocal consequences, Heidemann and his colleagues (2008) studied the relationship of the two dietary patterns (Prudent and Western) with total and cause-specific mortality. The setting was the Nurses' Health Study over an 18 years follow up. In multivariable analysis, those most adherent to the Prudent Diet had 17% lower risk of total mortality: 28% lower risk of CVD mortality and no significant relationship with cancer. Adherence to Western Diet was associated with increased total mortality by 21%: 22% for CVD mortality and 16% for cancer mortality.

## C. The Mediterranean Dietary Pattern

### *1. History*

The third common pattern is the Mediterranean Dietary Pattern shared in the Mediterranean region. The Mediterranean basin known as the region of lands around the Mediterranean Sea has been, for some time now, of great interest because of the observed lower prevalence of several diseases like Coronary Heart Disease (CHD), certain cancers and lower mortality rate in the area, as presented in the results of the Seven Countries Study in 1980 (Keys et al.). The mortality rates exposed by the WHO between 1960 and 1990 confirm this hypothesis whereby death rates were generally lower in this region knowing that the health care of many of these populations was inferior to North America for example and that prevalence of smoking was high (Trichopoulou et al., 1997). The probability of the diet playing a role in these observations inspired researchers to uncover the properties of the Mediterranean diet.

The basic structure of the Mediterranean diet was built upon the first systematic attempt to investigate dietary intake in the Mediterranean area after the end of World War II. This attempt took place in Greece, where the government asked from the Rockefeller Foundation to undertake a major epidemiological study on demographic, economic, social, health and dietary characteristics of the population of Crete. The conclusion published in the results of this investigation included the basic food components of Cretans described as: “olives, cereal grains, pulses, wild greens and herbs and fruits, together with limited quantities of goat meat and milk game, and fish…” However, this study lacked the association of dietary data with health of the population. These implications were explored later by Ancel

Keys starting 1952 who was intrigued by the low rates of heart diseases in the region. Keys and his colleagues started by observing the Italian eating habits that were characterized by mainly pasta served with tomato sauce and cheese. Meat and local sea food was occasionally added (approximately twice a week). Bread, fresh vegetables and wine completed the main elements of the diet. Keys found that the Italian diets were relatively low in fat (20% of energy). Upon these observations, Keys published a cookbook in 1959 summarizing the best advices for lifestyle practices to reduce risk of coronary heart diseases. An example of these advices was:

- “Restrict saturated fats; the fat in beef, pork, lamb, sausages, margarine, and solid shortenings; and the fat in dairy products.”
- “Favor fresh vegetables, fruits, and nonfat milk products.”

As compared to the US dietary guidelines of 1990, these advices have many similarities which show that the Mediterranean diet described by Keys constituted a “prototype” of these guidelines. Afterward, Keys and his colleagues developed a large-scale study of 16 cohorts distributed among seven countries. This study demonstrated the effect of fat on serum cholesterol concentrations and CHD risk. It also proposed the basic proportions of food in the Mediterranean diet (Nestle, 1995).

In the 1960s, another study conducted by the European Atomic Energy Commission (EURATOM) comparing the dietary intake patterns among the Italian regions pointed out the distinguishing diet characteristics of the Mediterranean area. This diet had a much greater intake of cereals, vegetables, fruit and fish and lower intake of potatoes, meat and dairy foods, eggs and sweets. The principal source of fat was olive oil (Nestle, 1995).

## *2. Definition*

However, since countries pertaining to the Mediterranean area are multiple and although they share common characteristics in their diets, they differ in their culture and ethnicity and might have some divergences in their dietary intake, therefore it was important to set a common definition of the Mediterranean diet (Nestle, 1995). To fulfill this task in 1993, international experts like Oldways Preservation & Exchange Trust and the WHO/Food and Agriculture Organization (FAO) Collaborating Center in Nutritional Epidemiology gathered at Harvard School of Public Health to describe and evaluate the implications of the Mediterranean diet. They created a pyramid (Figure 1) applicable on adults, similar to the USDA food guide pyramid of 1992, based on the traditional dietary pattern of Crete between 1950 and 1960. In addition, their source of information was based on diets of the Mediterranean regions producing olives and where olive oil is the main source of fat (Willet et al., 1995).

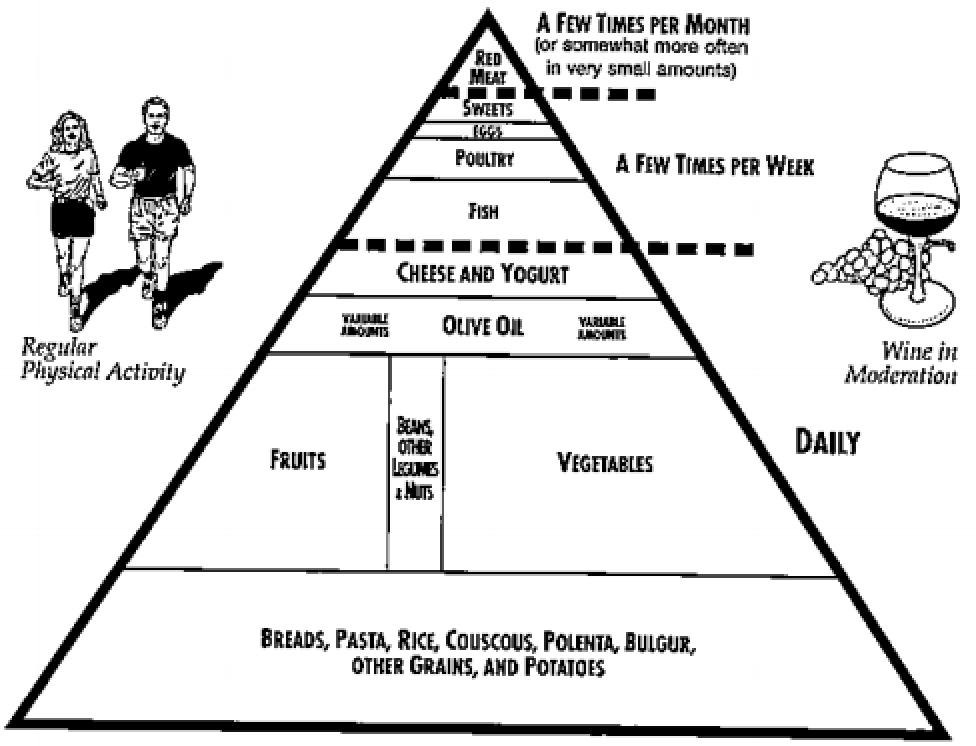


Figure 1: The Mediterranean diet Pyramid: a cultural model for healthy eating (Willet et al., 1995)

The researchers used Crete and Italy as a reference for 3 reasons: During the 1960s adult life expectancy in these regions was among the highest in the world and chronic diseases like CHD, certain cancer were among the lowest. The second reason is that the dietary patterns of the Mediterranean region have many similarities according to food availability and dietary intake and these similarities have been associated with low rates of chronic diseases and high adult life expectancy in numerous epidemiological studies. The diet similarities represented in the pyramid like abundant intake of plant foods are explained by the consumption of couscous, vegetables and legumes in North Africa; pasta, potatoes, vegetables and legumes in southern Europe; Bulgur, rice with vegetables, chickpeas and beans in Eastern

Mediterranean region. Bread is present at virtually all meals. Consumption of fruits, nuts, seeds and olives is frequent. Condiments used are garlic, herbs and onions. The pyramid also recommends a moderate consumption of ethanol, especially wine and a high consumption of fruits. Meat and meat products are consumed rarely and milk and dairy products moderately. The major source of fat is olive oil. As for quantities and proportions, total fat may be as high as 40% of total energy intake, and sometimes higher as consumed by the Greeks. In Italy, the consumption of fat is more moderate, around 28% of total energy intake. However, the ratio of Monounsaturated to saturated fats is high compared to other regions of the world (Willet et al., 1995).

### *3. Association with Non-Communicable Diseases*

The Mediterranean dietary pattern being described, it is possible to uncover the probable health benefits of this diet.

a. <u>CVD</u>

First, the Mediterranean diet seems to have an effect on cardiovascular diseases as mentioned above. Many studies have approached the topic like the Lyon Heart Study (1999) who found out that the persons following the Mediterranean diet had between 50 and 70% lower risk of recurrent heart disease.

Another study conducted by CARDIO2000 investigators in several regions of Greece claimed that the adoption of the Mediterranean diet by patients with previous myocardial infarction and unstable angina was associated with a 23% reduction in the risk of developing acute coronary syndrome. Nevertheless this effect was not homogenous among all the Greek regions. In patients with hypercholesterolemia, the combination of statin and the adoption of the Mediterranean diet had a synergistic effect whereby a 43% reduction in coronary risk was observed. These results were independent form cholesterol levels and other cardiovascular factors. In hypertensive patients, the Mediterranean diet also had its effect: a 17% reduction in coronary risk in controlled hypertensive subjects, 8% reduction in unaware subjects, 7% reduction in acknowledged but uncontrolled diet and 20% reduction in normotensive subjects. However, there was no significant influence of the Mediterranean diet on coronary risk in current smokers.

In 2003, Trichopoulou and his colleagues found that a 20% increase in the Mediterranean diet score for participants above 55 years old was associated with a 33% reduction in coronary heart disease mortality irrespective of age, BMI, gender, smoking status, level of education and physical activity (Dontas et al., 2007). Studies nowadays continue to show the protective effect of the Mediterranean diet on CVD.

An article published in the New England Journal of Medicine in 2013 on the PREDIMED trial conducted in Spain also concluded that the Mediterranean diet either supplemented with extra-virgin olive oil or nuts resulted in an absolute risk reduction of approximately three major cardiovascular events per 1000 person-years. The subjects under study were initially free of cardiovascular disease but at high risk. The relative risk reduction was of approximately 30%. The risk of stroke was also significantly reduced for both groups of the Mediterranean diet (Estruch et al., 2013).

In the review published in 2014, Dalen et al. likewise attest that dietary patterns consistent with the traditional Mediterranean-style diet are particularly cardio-protective. Even if these diets do not decrease total serum cholesterol or Low-density lipoprotein cholesterol, they can prevent CHD.

b. Cancer

In addition to studying the effect of the Mediterranean diet on heart diseases, the Lyon Heart randomized control trial investigated the effect of this diet on cancer. The Mediterranean group had significantly lower risk of cancer although the total number of cases was very small (n=24). Nonetheless, the association between the Mediterranean diet and cancer was mainly addressed during the last two decades and results were diverse according to the cancer type.

A review assessing this association collected articles published between 2003 and 2009 pertaining to several countries like the United States, Greece, Italy and Sweden. The diet was evaluated by attributing a score to individuals. For Breast Cancer risk, there appeared to be a 7% reduction for an increase in 10% in the Mediterranean diet score, in the receptor negative tumor group. In two other case-control studies on breast cancer, increasing adherence to the Mediterranean diet lowered incidence of breast cancer by 24% for American Hispanic and non-Hispanic women. Among Asian American women, it was a 35% lower risk. The higher consumption of the Mediterranean diet was also associated with 33% reduction in gastric adenocarcinoma in the European Prospective Investigation into Cancer (EPIC). In a cohort study applied in the United States, men had 28% lower risk of colorectal cancer when consuming a Mediterranean-like dietary pattern. The risk of colorectal cancer in men was also reduced by 21% with the Mediterranean diet in a case-control study.

When considering the overall cancer risk, two out of four cohort studies found a significant inverse association with the Mediterranean diet: in the Greek EPIC cohort, a 2-point increase in the Mediterranean diet score resulted in a significant reduction of 12% overall cancer incidence. On the other hand, it resulted in a 6% reduction in men in the National Institute of Health study of the US. In Italy, the three case-control studies conducted found a strong significant association between the Mediterranean diet and three upper aero-digestive tract cancers. However, one study on the association between the Mediterranean dietary pattern and endometrial cancer found no significant results in the American adult female population. Nevertheless, the positive results mentioned above suggest that the Mediterranean diet probably prevents some cancers (Verberne et al., 2010).

c. Obesity

As obesity is linked to several cancers and CVD, the increasing obesity epidemic will add to rising of these chronic diseases trends (Verberne et al., 2010). Nevertheless, the Mediterranean diet also seems to affect obesity. In the EPIC Spain study, Mendez et al. (2006) discovered that high adherence to the Mediterranean diet, translated by a score of 6 to 8, led to reduced incidence of obesity over three years (after adjustment for underreporting). But, in normal weight subjects, adherence to the Mediterranean diet was not associated with short-term overweight incidence.

Another cross-sectional study conducted in Spain found an independent inverse association between BMI and the Mediterranean diet in both men and women: an increase in 5 U in the dietary score, was associated with a BMI decrease of 0.43 U in men and 0.68 U in women; the score ranging between 9 and 27. In the age adjusted analysis, adherence to the Mediterranean diet tended to be associated with a lower prevalence of obesity but this association was only significant in women. However, after adjustment for energy consumption, educational level, smoking, physical activity and alcohol consumption, there was a 39% lower risk of being obese for those in the highest quartile of the Mediterranean diet (Schröder et al., 2004). The results of the Greek study of 2005 showed an inverse relation, after adjusting for age and sex, between Mediterranean diet score and BMI as well as waist circumference which, like BMI defines obesity. Higher adherence to the Mediterranean diet was associated with 51% lower odds of being obese and 59% lower odds of having central obesity after controlling for confounders like sex and physical activity (Panagiotakos et al., 2005). On the other hand, the EPIC prospective cohort study found that the Mediterranean diet score was not significantly associated with BMI among either men or women (Trichopoulou et al., 2005). The systematic review of 21 observational and intervention studies was done in 2008. Between them, 13 studies reported that adherence to the Mediterranean diet significantly reduced the probability of overweight/obesity, promoted weight loss, or resulted in more weight loss than a control diet (Buckland et al., 2008). The major limitation of certain of these studies that could affect the blurred results is the tendency of obese people to underreport (Schröder et al., 2004).

Because of the inconsistencies of these results, it is hard to assess the exact relationship between the Mediterranean diet and obesity; therefore, further research is needed to substantiate these findings (Buckland et al., 2008).

d. Diabetes Type 2

Obesity is closely related to Diabetes type 2: Lifestyle changes are effective measures to prevent diabetes type 2, and weight loss is the main predictor of success. Whether other lifestyle changes, like diet modifications, play a role in preventing diabetes is not very clear. For this purpose, a nested sub-study was conducted in Spain, based on the PREDIMED study mentioned above. A total of 418 non-diabetic volunteers were randomly assigned into three groups (Mediterranean diet supplemented with extra-virgin olive oil or nuts or a low fat control diet). After adjustment for various confounders, diabetes incidence was reduced by 51% in the Mediterranean diet with olive oil group and by 52% in the Mediterranean diet with nuts group compared to the control group. It is important to note that all groups were not calorie-restricted (Salsas-Salvado et al., 2011). In a prospective cohort study conducted in Spain and following 13,380 subjects during 4.4 years, participants with the highest compliance to the Mediterranean diet had a lower risk of developing diabetes of 83%. These participants were also more exposed to risk factors for diabetes like older age and higher BMI (Martinez-Gonzalez et al., 2008).

The European Prospective Investigation into Cancer and Nutrition study showed that among individuals with high adherence to the Mediterranean diet, there was a 12% decreased risk of type 2 diabetes. Whenever type 2 diabetes was already present, greater adherence to the Mediterranean diet was related to lower HbA1c levels and a lower 2 hours post meal glucose level independently of age, adiposity, energy intake, physical activity and other potential confounders. A systematic review with meta-analysis including 21 randomized controlled trials compared seven types of diets with control diets and their effect on type 2 diabetes. These diets were mainly low carbohydrate, vegetarian, vegan, low glycemic index, high fiber, Mediterranean and high protein diet. The Mediterranean, low carbohydrate, low glycemic index and high protein diets all resulted in a greater improvement in glycemic control compared to their respected control diets. However, the biggest effect was observed in the Mediterranean diet. Despite the results presented above, further larger cohorts and trials are needed to confirm the association between the Mediterranean diet and type 2 diabetes (Esposito et al., 2013).

e. The Metabolic Syndrome

The Metabolic Syndrome is a precursor to most of the diseases mentioned above since diagnosis is usually established when 3 of the 5 following risk factors are present: elevated waist circumference, elevated blood pressure, elevated triglycerides, elevated fasting glucose, reduced HDL Cholesterol or the equivalence of the last 4 components. Prevalence of this condition in the Mediterranean area is increasing where about one-fourth to one fifth of the population seems to be affected (Anagnostis, 2012). But the question is: is it associated with the Mediterranean diet. Researchers also tackled this topic and in the SUN prospective study, subjects with the highest adherence to the Mediterranean food pattern had lower cumulative incidence of the Metabolic Syndrome than those with the lowest adherence. In order to assess the adherence to the Mediterranean food pattern a score was assigned to each of the main components of the diet and then these scores were added to get a total score (Tortosa et al., 2007).

Moreover, a Meta-Analysis of 50 studies and 534,906 individuals was performed in 2011. However, only 8 of the studies included in this Meta-Analysis evaluated the role of the Mediterranean dietary pattern on Metabolic Syndrome as a whole. Five of these studies reported a beneficial effect on the Metabolic Syndrome when complying with the Mediterranean diet. The other studies integrated in the Meta-Analysis addressed the relationship of the Mediterranean diet with the different components of the Metabolic Syndrome and got various results (Kastorini et al., 2011). Thus another systemic review on the matter was conducted in 2013. Ten observational studies and 4 clinical trials were included in this review. One of the prospective studies incorporated was the Framingham Offspring Cohort where participants in the upper quintile of the Mediterranean Style-Dietary Pattern Score (MSDPS) had lower incidence of the syndrome (30.1%, 95%CI: 25.8%-34.4%) and better values for the majority of the syndrome's components.

Another large prospective study conducted among French adults showed that adherence to the Mediterranean diet assessed with the Mediterranean score (MED) was associated with 0.47 (0.32-0.69) lower risk of Metabolic Syndrome. A different score called modified Mediterranean Scale (mMDS) showed a 0.50 (0.32-0.77) lower risk, while the MSDPS revealed a 0.74 (0.52-1.06) lower risk comparing the highest to the lowest tertile (Esposito et al. 2013).

### *4. Association with Mortality*

Finally, Sofi et al. (2008) looked at the overall health status and adherence to the Mediterranean diet through a meta-analysis and concluded that greater adherence to a Mediterranean diet is associated with a significant improvement in health status, as seen by a significant reduction in overall mortality (9%), mortality from cardiovascular diseases (9%), and incidence of or mortality from cancer (6%).

### *5. Erosion of the Mediterranean Dietary Pattern*

If it is true that the Mediterranean Dietary Pattern protects against these morbidities and mortality like these studies imply, it is imperative to preserve the traditional dietary habits of the Mediterranean area and encourage other areas to adapt to it. However, dietary intake surveys and food balance data indicate that dietary patterns throughout the region are changing rapidly and generally in an undesirable direction. For example, a dietary intake study was conducted in Crete and reported an increase in intake of meat, fish and cheese; and a decrease in intake of bread, fruit, potatoes and olive oil when compared to the data of the 1960s reported by Keys. These changes are also taking place in Italy where food balance data report a large increase in the availability of meat, dairy foods and animal fats. Increasing evidence indicates that there is a simultaneous increase in chronic diseases like Coronary heart disease, diabetes and several types of cancers in various Mediterranean countries (Nestle, 1995).

## D. Nutrition Transition

The problem is not only striking the Mediterranean countries: dietary changes appear to be shifting universally toward a diet dominated by higher intakes of animal and partially hydrogenated fats and lower intakes of fiber. Even in many poor countries, where underweight persists as a significant problem, levels of overweight people in rural areas are becoming fairly high. This shift is called a nutrition transition and is described as a large shift in diet and activity patterns which are accompanied by major changes in health status. This shift is toward the westernized trend in which we can observe apart from the quality of food, an increase in portion sizes, in away-from-home food intake and snacking. The health status of concern here is the nutrition related NCDs that have been growing rapidly in most low-, middle-, and higher-income countries and their corresponding risk factors as explained above (Popkin, 2006).

**E. Scarce Data about the Eastern Mediterranean region**

This dietary and health status is mostly described and analyzed in the European Mediterranean countries like Greece, Italy, France and Spain. However, little information is available for the rest of the Mediterranean basin. Across all the countries that represent the Mediterranean region, variations in geography, culture, religion, agriculture, economy and health systems exist. Countries belonging to the north of Africa or to the Middle East cannot be pooled with European Mediterranean countries blindly. The Mediterranean dietary pattern was mostly studied in these European countries and the lack of evidence in north of Africa or the Middle East prevents us from attributing this diet to other countries of the region. For example, the island of Malta does not have a typical Mediterranean diet because first it was successively conquered by several different nations: England being the last one, which resulted in a unique blend of diets; Second, Malta is not self-sufficient and depends on food imports. Interestingly, CHD mortality rate for this island differs from the rates found in other Mediterranean countries (Lorgeril et al., 2001). When it comes to the health status, the literature reports that over the last 50 years, the economic development in most of the EMR countries has resulted in greater adoption of a diet higher in fat, especially saturated fat, cholesterol, refined carbohydrates and low in polyunsaturated fatty acids and dietary fibers. This nutrition trend was accompanied with a sedentary lifestyle and an increased level of stress. Consequently, the level of obesity and other NCDs has risen in the region (Musaiger, 2011).

In a review of 39 surveys done in 28 developing countries, Egypt and Turkey had the highest proportion of obesity (Martorell et al., 2000). According to the data released by the International Diabetes Federation (IDF) in 2011, six of the top ten countries with the highest prevalence of diabetes are in the Middle East and North Africa region: Kuwait (21.1%), Lebanon (20.2%), Qatar (20.2%), Saudi Arabia (20.0), Bahrain (19.9%) and UAE (19.2%) (Boutayeb et al., 2013).

## F. Lebanon

### *1. History*

Lebanon, a small middle-income country bordering the Mediterranean Sea in the Middle Eastern part of the region, with a population of approximately four million, was created when the French mandate expanded the borders of the former autonomous Ottoman Mount Lebanon district, forming in September 1920 the Lebanese Republic. Lebanon subsequently became an independent country in 1943. The 1975 to 1990 civil war seriously damaged the country (United Nations Development Programme, n.d.), however Lebanon's growth is slowly taking place.

### *2. Non-Communicable Disease Status in Lebanon*

According to Nassreddine et al. (2012), obesity increased by two-fold between 1997 and 2009 in the Lebanese adult population. It is the Western dietary pattern extracted in the same study which was associated with obesity (represented by BMI). Moreover, the prevalence of the Metabolic Syndrome in this country appeared to be 31.2% (Sibai et al., 2007). The country profile generated by the WHO (2014) on the distribution of causes of mortality shows that NCDs are estimated to account for 85% of total deaths as shown in the chart below. Therefore, it seems that Lebanon is also following the trend of westernization, leaving behind its traditional diet.

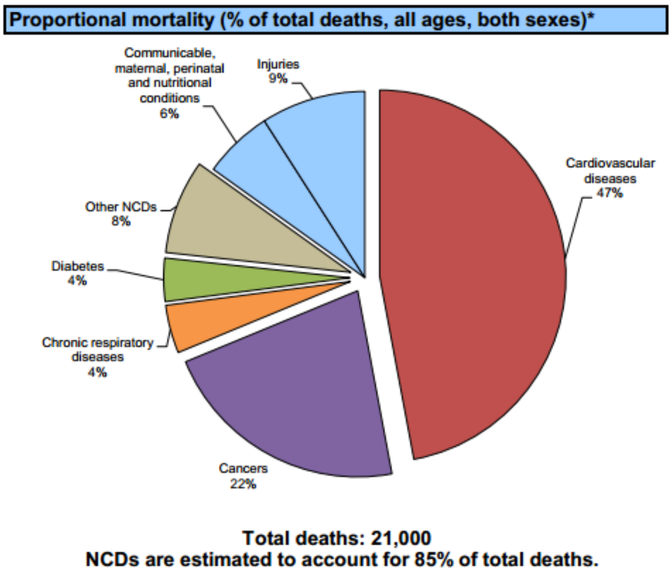


Figure 2: Proportional mortality in Lebanon for the year 2014 (WHO, 2014)

### *3. The Lebanese Dietary Habits*

On the other hand, It has been said that this country houses the world's oldest living olive trees which are over 6000 years old (Fares, 2013). Olive oil is also part of the country's history and culinary tradition. Apart from olive oil, the characteristics of the traditional Lebanese dietary pattern have not been extensively investigated. However, the Lebanese food pattern found in the study done by Naja et al. (2011) resembles the characteristics of the Mediterranean diet described above. The main food components of the "Traditional Lebanese" pattern extracted consisted of olives, dairy products, fruits, vegetables, bulgur, legumes, eggs, fats and oil, dried fruits and starchy vegetables. Nevertheless, being part of the Mediterranean area, Lebanon has not been previously and officially defined as following a Mediterranean dietary pattern.

### G. Objectives and Research Questions

The three objectives of this study were as follows: first to evaluate the association between the Lebanese dietary pattern and various Mediterranean indexes proposed in the literature; Second, to assess the effect of the Lebanese and the selected Mediterranean patterns on obesity as well as the Metabolic Syndrome; Third, to determine the correlates of adherence to both the Lebanese and the Mediterranean patterns among Lebanese adults.

# CHAPTER II

# METHODOLOGY

## A. Study population and design

This study is a secondary data analysis based on the National Nutrition and Non-Communicable Diseases Risk factors cross-sectional survey that was conducted in Lebanon between 2008 and 2009. The study population was selected randomly through multistage (by governorate) sampling and was based on the age-sex distribution of the Lebanese population (Living Conditions of households: The National Survey of Household Living Conditions 2004; Lebanese Republic Ministry of Social Affairs/Central Administration for Statistics/UNDP, pages 114–115). Lebanon was first divided into governorates. The selected governorates were further divided into districts as well as urban and rural areas. Housing units constituted the primary sampling units in the different districts of Lebanon. Then one adult from each household was chosen, excluding pregnant and lactating women and individuals with mental disabilities. The present paper focused only on participants who were between 20 and 55 years old with no history of chronic diseases. The total sample was 2048 participants. The remaining 565 participants were excluded from this study as they were older than 55 years old and there is a strong emerging evidence that BMI cut-offs may not be appropriate in increasing age (Queensland Government, 2014). Among these participants, 283 subjects agreed to provide a written consent and gave a blood sample. The protocol of the original survey was approved by the Institutional Review Board of the American University of Beirut, and all subjects gave informed consent for their participation (Naja et al., 2011).

## B. Data Collection

In the original study, various survey tools were used by trained field workers, phlebotomists, and dietitians to collect the data at the participants' residences. The WHO STEPwise approach to Surveillance (STEPS) was applied for data collection.

### *1. General Questionnaire*

First an extensive questionnaire was used to retrieve information about socio-demographic, lifestyle characteristics, and meal patterns. The data incorporated in the current study was age, monthly income, marital status, education, family history of obesity, smoking habits, physical activity, in addition to few details on meal patterns. The short version of the International Physical Activity Questionnaire was used to assess physical activity and three categories of physical activity were assigned based on METS-min per week: low, moderate and high.

### *2. FFQ*

A 61-item FFQ (Appendix 1) measured food intake of participants over the past year. A standard portion size was specified for each food item in the list with five frequency choices. In order to best estimate the real portion consumed by participants, common household measures like measuring cups, spoons and portion size photos were presented to them. This FFQ was created by nutritionists to be culture-specific. It was tested for clarity and cultural sensitivity. The Nutritionist IV software known as a food composition database generated daily gram intakes of food items, energy, and macronutrients intake of every participant.

### *3. Anthropometric measurements*

Anthropometric measurements were done by the trained team. The weight, height, and Waist Circumference (WC) of subjects were taken using standardized techniques and calibrated equipment. The weight was measured to the nearest 0.1 Kg while participants were wearing light indoor clothing, were barefooted or wearing stockings. The height was measured using a stadiometer. Participants were not wearing shoes and the height was recorded to the nearest 0.5 cm. WC was measured between the bottom of the rib cage and above the top of the iliac crest during minimal respiration. The tool used was a plastic measuring tape and it was measured to the nearest 0.5 cm. Blood pressure was measured using a standard mercury sphygmomanometer.

### *4. Biochemical Measurements*

Biochemical measurements were collected from blood samples which were retrieved after an overnight fast. Serum was centrifuged on site and was then sent to the American University of Beirut Laboratory using dry ice. TAG, HDL-Cholesterol, and glucose levels were measured by an enzymatic spectrophotometric technique using Vitros 350 analyzer (Ortho-Clinical Diagnostics, Johnson & Johnson, 50–100 Holmers Farm Way, High Wycombe, Buckinghamshire, HP12 4DP, United Kingdom). The inter-assay variation of measurements did not exceed 4%. Quality control was performed within each run using standard performance verifier solutions provided by Ortho-Clinical Diagnostics. Samples were all analyzed in duplicates in order to use the average value in statistical analysis (Naja et al., 2013).

## C. Determination of the dietary patterns in Lebanon

Another previous study conducted by the same research group using this data set characterized the main dietary patterns in Lebanon. For this purpose, food items from the FFQ were grouped into 30 groups (Appendix 2). The researchers created these groups based on similarities in ingredients, nutrient profile, and/or culinary usage of food items. Some food items having a unique composition could not be included in a group (e.g. eggs, olives, and mayonnaise) and were classified individually. In order to calculate the total consumption for each group the daily gram intake of each item within the group was summed for individuals.

Exploratory factor analysis was implemented on these food groups. In order to justify undertaking factor analysis, the correlation matrix among the thirty food groups was visually and statistically examined. The correlation among the variables was sufficiently strong for a factor analysis according to both tests: Bartlett test of sphericity had a significant $\chi 2$ at $p < 0.05$, and the Kaiser-Meyer-Olkin test showed a score of >0.6. The number of factors retained was based on three criteria. The first one was the Kaiser criterion with eigenvalues > 1. The second one was the inflection of the scree plot. The third one was interpretability of factors. The factors were rotated using a Varimax rotation (orthogonal transformation). The strength and direction of the association between the patterns and food groups was indicated by factor loadings. The derived dietary patterns were labeled according to food groups having a rotated factor loading > 0.4.

Four main dietary patterns emerged and were named according to the food groups loading highest on the respective dietary patterns. The classification of these patterns was as follows: the “Western” pattern, the “Prudent” pattern, the “Fish and alcohol" pattern and the "Traditional Lebanese" pattern. The food groups representing the "Western" pattern were mainly fast food like pies and pizzas, fast food sandwiches, fried potatoes, regular soda, bottled juices, meat and poultry, cured meat, nuts and seeds, refined grains, mayonnaise, ice cream and sweets. The "Prudent" pattern was positively associated with healthy food like whole bread, low-fat dairy and light soda and negatively associated with refined grains, fats and oils, and regular soda. The "Fish and alcohol" pattern represented fish and alcohol consumption. The main ten food groups represented by the "Traditional Lebanese" Pattern were fruits, vegetables, legumes, olives, bulgur (crushed whole wheat), whole-fat milk and dairy products, starchy vegetables, fats and oils, dried fruits and eggs (Naja et al., 2011).

### D. The Lebanese dietary score

Factor scores were calculated using the multiple regression approach and each individual received a factor score for each dietary pattern extracted above. These scores indicated the degree to which each participant's diet corresponded to the identified pattern. Only the scores of the Lebanese dietary pattern were used in this study (Naja et al., 2011).

### E. Calculation of the Mediterranean dietary scores

In order to evaluate the association between the "Traditional Lebanese" dietary pattern and the various Mediterranean patterns described in the literature, six Mediterranean indexes applied to different countries were retrieved and were calculated for our sample following the method described in the article related to each index.

***1. The Mediterranean Diet Score (Europe)***

The Mediterranean Diet Score (MDS) originally created to examine the adherence to the Mediterranean diet in nine European countries (Denmark, France, Germany, Greece, Italy, the Netherlands, Spain, Sweden, and United Kingdom) was computed by assigning a value of zero or one to each participant according to their position toward the sex specific median of the food groups. Participants consuming the beneficial food groups within quantities above the median were assigned a value of 1 and vice versa (vegetables, legumes, fruits, cereals and fish). As for the food groups that were considered having negative effects for the health a 0 was assigned for each participant when consumed above the median (meat and dairy products). Alcohol score was calculated differently where men received a value of 1 if they consumed between 10g and less than 50g of alcohol per day and women between 5g and 25g per day. For lipid intake, the ratio of monounsaturates and polyunsaturates to saturates was calculated. This modified Mediterranean diet score could take a value from zero (minimal adherence) to nine (maximal adherence) (Trichopoulou et al., 2005).

***2. The Mediterranean score (Canada)***

The Mediterranean score (MS) was originally used to examine the adherence of French Canadian woman to the Mediterranean food pattern and analyze the effect of promoting this pattern. The MS was based on a food pyramid made of 11 components. These components are grains, fruits, vegetables, legumes, nuts and seeds, legumes being part of the nuts and seeds component, olive oil, dairy products, fish, poultry, eggs, sweets and red meat/processed meat. Each component was divided into 5 ranges of consumption of portions per day or per week with a score of 0 to 4. A high score was attributed to a high consumption for food groups at the bottom of the pyramid. Inversely, a high score was attributed for a lower frequency of intake for food groups at the top of the pyramid like red meat/processed meat, sweets and eggs. The maximum possible score was therefore 44 (Goulet et al., 2002).

### *3. The Mediterranean-Dietary Quality Index (France)*

The researcher Mariette Gerbert developed the Mediterranean-Dietary Quality Index (Med-DQI) in order to create a qualitative method to evaluate the Mediterranean diet in adults living in a French Mediterranean area. The Med-DQI consisted of 7 components. Each component received a grade between 0 and 2 according to recommended guidelines when present (Cholesterol, SFA) or by dividing the population's consumption of the other components (Meats, Olive oil, Fish, Cereals, Vegetables and fruit) into tertiles. Scores were added and ranged from 0 to 14, 0 having the healthiest diet and 14 the poorest (Gerbert, 2006). For the purpose of comparison with other diets considered in the study, the MED-DQI scores were transformed using the following formula: [14-(MED-DQI)].

### *4. The Mediterranean Style Dietary Pattern Score (Boston)*

Mediterranean Style Dietary Pattern Score (MSDPS) has an advantage compared to other scores where it considers the negative implications of overconsumption of food items pertaining to the Mediterranean diet. The score is represented by 13 food groups of the Mediterranean diet pyramid which are whole-grain cereals, fruits, vegetables, dairy, wine, fish, poultry, olives-legumes-nuts, potatoes, eggs, sweets, meat and olive oil. The food guide pyramid recommends for each food group a daily or weekly consumption. Each individual was assigned a score from 0 to 10 according to the percentage correspondence with recommendations except for olive oil. For example, consuming 70% of the recommended servings would result in a score of 7. Overconsumption was taken into consideration by subtracting a point proportionally to the number of servings consumed in excess of recommendations. For example, exceeding the recommendation by 60% would result in a score of 4. Negative scores were defaulted to zero. The score of olive oil was categorical: 0, 5 or 10 according to its exclusive use or not. These scores were summed and standardized into a scale between 0 and 100 by dividing the calculated sum by the theoretical maximum sum of 130 then multiplying in by 100. In order to take into consideration food that are not part of the Mediterranean pyramid (hot dogs…), the final score was weighted by the proportion of energy intake consumed from food that are part of the Mediterranean dietary pattern (Rumawas et al., 2009).

### 5. *The relative Mediterranean diet (Spain)*

The data from the Spanish cohort EPIC was used to study the relationship between adherence to relative Mediterranean diet (rMED) and incidence of coronary heart disease. Adherence to the Mediterranean diet was measured by a score based on 9 components: fruits, vegetables, legumes, cereals, fresh fish, olive oil, meat, dairy products and alcohol. Consumption of these food groups (apart from alcohol) was measured as grams per 1000 kcal/day and was divided into tertiles. For the first, second and third tertile, a value of 0, 1 or 2 was assigned respectively. Both meat and dairy products considered not to fit the Mediterranean diet had reversed score. In order to boost moderate consumption of alcohol, it was assigned a dichotomous score as 2 for moderate consumers (5-25 g/day for women and 10-50 g/day for men) and zero for above and below the recommended sex specific range. The final score was then calculated by adding the points of each component. The scores ranged from 0 to 18 units which represented minimal to maximal adherence respectively (Buckland et al., 2009).

### *6. The Cardioprotective Mediterranean diet index (Spain)*

For the Cardioprotective Mediterranean diet or the MD index (Cardio) previous analysis was used to set a cutoff point for each of the 9 food categories (Olive oil, fruit, vegetables or salad, fruit and vegetables, legumes, fish, wine, meat, white bread and rice or whole grain bread) that best represented observed dose-response relationships against myocardial infarction. One point was added when this cutoff point was met. For example one point was added when the participant consumed 1 serving of fruit per day or more. Therefore the range of each individual's score reached 9 as a maximum (Martinez-Gonzalez et al., 2004).

In this study, the dietary intake data collected by means of the FFQ were used to calculate the scores of the various indexes considered. Different groupings of foods and nutrients were run in accordance with the proposed method of score calculation for each index.

## F. Definition of obesity and the Metabolic Syndrome

The degree of obesity was defined by the calculation of the BMI and its classification but also by the measurement of the WC and its thresholds for abdominal obesity. As described by the WHO, BMI is an index of weight for height that categorizes adults as underweight, overweight or obese. To calculate it, the weight in kilograms was divided by the square of the height in meters (kg/m2). The thresholds for WC established by the International Diabetes Federation (IDF) are population specific. Since Lebanon is part of the Middle East and the Mediterranean area, the corresponding threshold were set as ≥ 94cm for men and ≥ 80cm for women (Alberti et al., 2009).

The definition for the Metabolic Syndrome released by the IDF Task force was used as a reference in this study. Diagnosis of the Metabolic Syndrome was established when 3 of the 5 following risk factors were present: elevated waist circumference, elevated blood pressure, elevated triglycerides, elevated fasting glucose, reduced HDL-C or the equivalence of the last 4 components. The cut points for each component are described in the table below (Alberti et al., 2009).

Table 2.1. Criteria for Clinical Diagnosis of the Metabolic Syndrome

| **Measure** | **Categorical cut points** |
|---|---|
| Elevated waist circumference (Middle East, Mediterranean area specific) | ≥ 94cm for men and ≥ 80cm for women |
| Elevated triglycerides (drug treatment for elevated triglycerides is an alternate indicator)* | ≥ 150 mg/dL (1.7 mmol/L) |
| Reduced HDL-C (drug treatment for reduced HDL-C is an alternate indicator | < 40 mg/dL (1.0 mmol/L) in males<br>< 50 mg/dL (1.3 mmol/L) in females |
| Elevated blood pressure (antihypertensive drug treatment in a patient with a history of hypertension is an alternate indicator) | Systolic ≥ 130 and/or diastolic ≥ 85 mm Hg |
| Elevated fasting glucose** (drug treatment of elevated glucose is an alternate indicator) | ≥ 100 mg/dL |

HDL-C indicates high-density lipoprotein cholesterol.
*The most commonly used drugs for elevated triglycerides and reduced HDL-C are fibrates and nicotinic acid. A patient taking 1 of these drugs can be presumed to have high triglycerides and low HDL-C. High-dose ω-3 fatty acids presumes high triglycerides.
**Most patients with type 2 diabetes mellitus will have the metabolic syndrome by the proposed criteria.

## G. Statistical analyses

Analyses were carried out using the Statistical Package for the Social Sciences statistical software package version 14.1. A P value of $<0.05$ was considered significant. Frequencies and means ± standard deviations (SDs) were used to describe various sociodemographic, lifestyle, anthropometric and clinical characteristics of participants, according to their classification as continuous or categorical variables.

Two statistical methods were used to describe the association between the Lebanese dietary scores and the six Mediterranean indexes: Pearson's correlation coefficient and agreement by percentage and weighted Kappa. Pearson's correlation coefficient is a statistical measure of the strength of a linear relationship between paired data (Kent State University, n.d.). On the other hand, Kappa was designed to estimate the degree of consensus after correcting the percent agreement figure for the amount of agreement that could be expected by chance alone. In the latter method, study participants were grouped into tertiles according to their score in each index (Viera et al., 2005). The Mediterranean index that matched the most with the Lebanese index was chosen upon results.

Furthermore, the association between all the indexes, obesity and the Metabolic Syndrome was evaluated using bivariate and multivariate logistic regression analyses where the tertiles of the scores were considered as independent variables predicting the risk of obesity defined by BMI and WC and the risk of Metabolic Syndrome.

Finally, logistic regression analysis was used to determine the correlates of adherence to the Lebanese and Mediterranean pattern scores. In this model, pattern scores were used as dependent variables while socio-demographic and lifestyle variables were used as independent variables.

# CHAPTER III

# RESULTS

## A. Socio-demographic and lifestyle characteristics

The socio-demographic and lifestyle characteristics of study participants are presented in Table 3.1 (n = 2,048). The sample was composed of 923 men (45%) with a mean age of 34.5 ± 10.0 years old and 1125 females (55%) with a mean age of 34.8±9.9 years old. The BMI for males had a mean of 27.29 ± 4.86 $Kg/m^2$ and for females 25.99 ± 5.64 $Kg/m^2$ with females having a significantly lower BMI than males.

Seventy percent of study participants had a monthly income lower than 1,000,000 LBP (equivalent to $667 USD), with males having significantly higher income than females. 34% of participants had a high educational level with a university degree. Moreover, 44.5% of participants had a family history of obesity. Compared to males, a lower percentage of females smoked cigarettes ($p<0.05$). Overall, almost half of the study population had a low level of physical activity (48.1 %). Average weekly breakfast consumption was about five times per week and was comparable between males and females. Compared to males, females reported lower frequencies of eating out and eating while watching TV.

The mean waist circumference for woman exceeds the cut point of 80 cm and the percentage of women having a high waist circumference is of 55.7%. When it comes to the Metabolic Syndrome, 31.4% of the study population appeared to have it with a higher proportion for men compared to women (40% compared to 24.2%) and these results were significant.

Table 3.1. Socio-demographic, lifestyle characteristics and body mass index of males and females aged 20-55 years (n=2048)*

| | Total (n=2048) | Males (n=923) | Females (n=1125) | Significance** |
|---|---|---|---|---|
| Age (years) | 34.7±9.9 | 34.5 ± 10.0 | 34.8 ± 9.9 | p>0.05 |
| BMI | 26.58±5.34 | 27.29±4.86[a] | 25.99±5.64[b] | p<0.05 |
| Income per month†† | | | | |
| < 1 million LBP | 1447(70.8) | 603(65.5) | 844(75.2) | |
| 1 million LBP < Income < 3 million LBP | 501 (24.5) | 264(28.7) | 237(21.1) | |
| > 3 million LBP | 96 (4.7) | 54(5.9) | 42(3.7) | $X^2$=23.36 p<0.001 |
| Marital status | | | | |
| Single | 861(42.1) | 462(50.1) | 399(35.5) | |
| Married | 1185(57.9) | 460(49.9) | 725(64.5) | $X^2$ =44.4 p<0.001 |
| Education | | | | |
| Illiterate, primary education | 269(13.1) | 130(14.1) | 139(12.4) | |
| Elementary | 514(25.1) | 243(26.3) | 271(24.1) | |
| Secondary | 346(16.9) | 143(15.5) | 203(18.0) | |
| Technical | 221(10.8) | 107(11.6) | 114(10.1) | |
| University & Higher education | 698(34.1) | 300(32.5) | 398(35.4) | $X^2$=6.35 p>0.05 |
| Family history of obesity | | | | |
| No | 1131(55.5) | 556(60.6) | 575(51.3) | |
| Yes | 907(44.5) | 362(39.4) | 545(48.7) | $X^2$=17.39 p<0.001 |
| Smoking†† | | | | |
| No | 1267(61.9) | 467(50.6) | 800(71.1) | |
| Yes | 781(38.1) | 456(49.4) | 325(28.9) | $X^2$=90.45 p<0.001 |
| Physical activity level | | | | |
| Low | 841(48.1) | 434(53.3) | 407(43.6) | |
| Moderate | 485(27.7) | 211(25.9) | 274(29.4) | |
| High | 422(24.1) | 170(20.9) | 252(27) | $X^2$=17.1 p<0.001 |
| Breakfast per week | 4.7±2.9 | 4.8±2.9 | 4.6±2.9 | p>0.05 |
| Snack per day | 1.5±1.3 | 1.5±1.4 | 1.5±1.1 | p>0.05 |
| Eating at TV per week | 3.1±3.2 | 3.5±3.2[a] | 2.8±3.1[b] | p<0.001 |
| Eating out per week | 1.6±2.2 | 2.4±2.5[a] | 1.0±1.5[b] | p<0.001 |
| Waist Circumference | 87.88±14.04 | 93.50±13.01[a] | 83.29±13.15[b] | p<0.001 |
| Waist Circumference | | | | |
| Normal | 976(47.9) | 480(52.4) | 496(44.3) | |
| High | 1060(52.1) | 436(47.6) | 624(55.7) | $X^2$=13.30 p<0.001 |
| Metabolic Syndrome | | | | |
| No | 194(68.6) | 78(60) | 116(75.8) | |
| Yes | 89(31.4) | 52(40) | 37(24.2) | $X^2$=8.16 p<0.05 |

* Categorical variables are expressed as n (%), continuous variables are expressed as Mean±SD
**Significance is derived from independent t-test for continuous variables and Chi square test for categorical variables
†† Income is expressed in terms of Lebanese pound LBP (1500LBP is almost equivalent to 1 USD)
††Smokers were defined as current smokers while nonsmokers included nonsmokers and past smokers
[ab]Values with different superscripts are significantly different at p<0.05

## B. Factor Analysis

As mentioned before, the derivation of a score to measure adherence to the Lebanese Dietary Pattern was based on the results of earlier investigations led by Naja et al. (2011) aiming to characterize the main dietary patterns in Lebanon. In these investigations, using factor analysis to derive dietary patterns, a Lebanese traditional pattern has consistently emerged as a common pattern. Out of 30 food groups/food items entered in the factor analysis, ten repeatedly loaded high on this pattern, including fruits, vegetables, legumes, olives, fats and oils, bulgur (crushed whole wheat), whole milk and dairy products, starchy vegetables (including potato, corn and peas), dried fruits and eggs. Table 3.2 represents the Factor loading matrix showing the patterns retrieved in the Lebanese population and the corresponding food groups.

Table 3.2. Factor loading matrix of the patterns among the Lebanese adults (Naja et al. 2011)

| | Patterns | | | |
|---|---|---|---|---|
| **Food Group** | **Western** | **Traditional Lebanese** | **Prudent** | **Fish& Alcohol** |
| Fried potato | **0.64** | | | |
| Pizza and pies | **0.61** | | | |
| Regular soda | **0.58** | | -0.20 | |
| Fast food sandwiches | **0.50** | | | |
| Mayonnaise | **0.50** | | | |
| Sweets | **0.48** | 0.24 | | -0.39 |
| Cured meat | **0.48** | | | |
| Nuts and seeds | 0.36 | | | 0.23 |
| Meat and poultry | 0.33 | | | 0.22 |
| Bottled fruit juices | 0.31 | 0.21 | | |
| Ice cream | 0.31 | | | |
| Fruits | | **0.60** | | |
| Vegetables | | **0.58** | | 0.21 |
| Legumes | | **0.49** | | |
| Olives | | **0.40** | -0.3 | |
| Bulgur (crushed wheat) | | 0.39 | | |
| Whole dairy products | 0.22 | 0.37 | | |
| Starchy vegetables | | 0.35 | 0.22 | |
| Eggs | | 0.27 | | |
| Dried fruits | | 0.24 | | |
| Refined grains | **0.40** | | **-0.58** | |
| Whole bread | | | **0.43** | |
| Low fat dairy products | | | **0.42** | |
| Turkish coffee | | | **-0.40** | 0.40 |
| Breakfast cereals | | | 0.39 | |
| Fats and oils | 0.21 | 0.31 | -0.34 | |
| Light soda | | | 0.33 | 0.28 |
| Alcoholic beverages | | | | **0.58** |
| Hot drinks | | 0.25 | 0.27 | **-0.47** |
| Fish | | 0.32 | | **0.45** |
| **Percent variance explained by each pattern** | **9.92** | **7.24** | **5.63** | **4.84** |

## C. Food Groups, Foods and Nutrients Used in Mediterranean Indexes and the Lebanese Pattern

Table 3.3 shows the food groups, foods and nutrients used in the calculations of the scores of various Mediterranean diets indexes considered in this study. Fruits and vegetables were the two common denominators for the Mediterranean and Lebanese patterns. Food groups and foods specific to the Lebanese pattern score included bulgur, fats and oils, and dried fruits. Fish was an integral component of all the Mediterranean diets indexes except the Lebanese index. Alcohol was not part of the Lebanese, MS and Med-DQI scores. The ratio of the sum of MUFA and PUFA over SFA were used in that of the EPIC/Europe MDS.

Table 3.3. Food, food groups and nutrients used in the calculation of the Lebanese and the various Mediterranean pattern scores considered in this study.

| | **Lebanese pattern score[1]** | **MSDPS score[2] (Boston)** | **MS score[3] (Canada)** | **MD score[4] (Spain)** | **Med-DQI score[5] (France)** | **rMED Score[6] (Spain)** | **MDS score[7] (Europe)** |
|---|---|---|---|---|---|---|---|
| Alcohol | - | √ | - | √ | - | √ | √ |
| Bulgur | √ | - | - | - | - | - | |
| Cereals | - | - | - | - | √ | √ | √ |
| Cholesterol | - | - | - | - | √ | - | - |
| Dairy products | √ | √ | √ | - | - | - | √ |
| Dried fruits | √ | - | - | - | - | - | - |
| Eggs | √ | √ | √ | - | - | - | - |
| Fish | - | √ | √ | √ | √ | √ | √ |
| Fruits | √ | √ | √ | √ | √ | √ | √ |
| Legumes | √ | √ | √ | √ | - | √ | √ |
| Nuts and seeds | - | √ | √ | - | - | √ | - |
| Olive oil | - | √ | √ | √ | √ | √ | - |
| Olives | √ | √ | √ | - | - | - | - |
| Pasta and refined grains | - | - | - | - | - | √ | - |
| Poultry | - | √ | √ | - | √ | - | - |
| Red meat | - | √ | √ | √ | √ | - | √ |
| Rice | - | - | - | √ | - | √ | - |
| Saturated fat | - | - | - | - | √ | - | - |
| Starchy vegetables | √ | √ | - | - | - | - | |
| Sweets | - | √ | √ | - | - | - | - |
| Vegetables | √ | √ | √ | √ | √ | √ | √ |
| White bread | - | - | - | √ | - | √ | - |
| Whole grains | - | √ | √ | √ | - | √ | - |
| (MUFA+PUFA)/SFA | - | - | - | - | - | - | √ |
| Fats and oils | √ | - | - | - | - | - | - |

[1] Naja F et al. Public Health Nutr. 2011 Sep;14(9):1570-8.
[2] Rumawas ME et al. J Nutr. 2009 Jun;139(6):1150-6.
[3] Goulet J et al. Atherosclerosis. 2003 Sep;170(1):115-24
[4] Martínez-González MA et al. Eur J Clin Nutr. 2004 Nov;58(11):1550-2.
[5] Gerber M. Public Health Nutr. 2006 Feb;9(1A):147-51.
[6] Buckland G et al. Am J Epidemiol. 2009 Dec 15;170(12):1518-29.
[7] Trichopoulou A et al. BMJ. 2005 Apr 30;330(7498):991.

## D. Pearson Correlation between Mediterranean Scores and the Lebanese Score

The associations between the various Mediterranean scores were evaluated using Pearson's correlation (Table 3.4). Overall, 16 out of 21 correlation coefficients were in the acceptable range of strength or more (above 0.3) (University of Strathclyde, n.d.). The strongest correlation was between the MS and the MD (r = 0.610). The scores of the Lebanese dietary pattern had the highest correlation with scores of the MD (r = 0.539), followed by the MS (r = 0.453) and was least correlated with that of MSDPS (r = 0.196). The MSDPS and MDS were least correlated (r = 0.177).

Table 3.4. Pearson correlation coefficients between the different dietary pattern scores

| | Lebanese pattern | MSDPS (Boston) | MS (Canada) | MD (Spain) | Med-DQI (France) | rMED (Spain) | MDS (Europe) |
|---|---|---|---|---|---|---|---|
| Lebanese pattern | 1 | - | - | - | - | - | - |
| MSDPS (Boston) | 0.196** | 1 | - | - | - | - | - |
| MS (Canada) | 0.453** | 0.502** | 1 | - | - | - | - |
| MD (Spain) | 0.539** | 0.468** | 0.610** | 1 | - | - | - |
| MEDDQI (France) | 0.335** | 0.352** | 0.515** | 0.513** | 1 | - | - |
| rMED (Spain) | 0.276** | 0.461** | 0.319** | 0.387** | 0.374** | 1 | - |
| MDS (Europe) | 0.266** | 0.177** | 0.352** | 0.325** | 0.302** | 0.200** | 1 |

**Correlation is significant at the 0.01 level (2-tailed)

## E. Agreement between the Lebanese dietary pattern and the various Mediterranean indexes

In order to examine the agreement between the Lebanese dietary pattern and the various Mediterranean indexes, percent agreement between the scores' tertile distributions and Kappa statistics were calculated (Table 3.5). In conformity with the correlation analysis, the highest agreement was observed between the Lebanese dietary pattern and the MD with 50.29% and 89.84 % of subjects classified in the same and the same or adjacent tertiles respectively. The Kappa statistics reached 0.42 indicating a moderate agreement. On the other hand, the least agreement was noted with the MSDPS index whereby 40.19 % of subjects belonged to the same tertiles. The Kappa statistics for the association between the Lebanese dietary index and the MSDPS was 0.22, reflecting fair agreement (Sim & Wright, 2005).

Table 3.5. Agreement (same tertiles and same or adjacent tertiles) between Lebanese diet and 6 Mediterranean scores (% agreement + Kappa (weighted)).

| | % Agreement | | Kappa |
|---|---|---|---|
| Patterns scores | Same tertiles | Same or adjacent tertiles | Weighted Kappa |
| MSDPS (Boston) | 40.19 | 85.21 | 0.22 |
| MS (Canada) | 48.24 | 89.45 | 0.41 |
| MD (Spain) | 50.29 | 89.84 | 0.42 |
| Med-DQI (France) | 46.24 | 90.23 | 0.34 |
| rMED (Spain) | 44.19 | 86.82 | 0.27 |
| MDS (Europe) | 41.36 | 82.03 | 0.22 |

## F. The association between various Mediterranean diet score (including the Lebanese score) with obesity (BMI and WC) and the Mediterranean score using logistic regression

Table 3.6 shows the association between the tertiles of the Mediterranean dietary pattern scores and the Lebanese dietary scores with the BMI, the WC and the Metabolic Syndrome. Subjects belonging to the third tertile of the Lebanese dietary pattern had significantly higher odds of obesity whether represented by the BMI or the WC (OR: 1.39, 95% CI: 1.07-1.80 and OR: 1.42, 95% CI: 1.15-1.76 respectively). Same results are applied to the MD and Med_DQI. However, when this association was adjusted for age and sex (Table 3.7), only MDS appeared to be negatively associated with the BMI, OR: 0.75, 95% CI: 0.58-0.97 for the third tertile. This association was attenuated by the multivariate adjustment (Table 3.8) where the MDS was not associated with the BMI anymore. In the multivariate adjustment, the significant results were a positive association between the third tertile of MS and the Metabolic syndrome (OR: 2.00, 95% CI: 1.01-3.96); as well as a positive association between the second tertile of Med-DQI and the Metabolic syndrome (OR: 2.48, 95% CI: 1.24-4.99).

Table 3.6. Association of the various Mediterranean diet score (including the Lebanese score) with obesity (BMI and WC) and the Mediterranean score using logistic regression.

| | Obesity | | Metabolic Syndrome |
|---|---|---|---|
| | BMI | WC | |
| Lebanese dietary pattern | | | |
| $1^{st}$ tertile | 1 | 1 | 1 |
| $2^{nd}$ tertile | 1.25 (0.96-1.62) | **1.29 (1.04-1.59)** | 1.04 (0.54-1.97) |
| $3^{rd}$ tertile | **1.39 (1.07-1.80)** | **1.42 (1.15-1.76)** | 1.73 (0.95-3.18) |
| MSDPS (Boston) | | | |
| $1^{st}$ tertile | 1 | 1 | 1 |
| $2^{nd}$ tertile | 0.97 (0.75-1.26) | 1.16 (0.94-1.43) | 0.88 (0.47-1.65) |
| $3^{rd}$ tertile | 1.14 (0.88-1.47) | **1.47 (1.19-1.82)** | 1.00 (0.55-1.83) |
| MS (Canada) | | | |
| $1^{st}$ tertile | 1 | 1 | 1 |
| $2^{nd}$ tertile | 0.91 (0.71-1.17) | **0.77 (0.63-0.95)** | 0.64 (0.36-1.16) |
| $3^{rd}$ tertile | 1.16 (0.89-1.52) | 0.96 (0.76-1.21) | 0.64 (0.33-1.22) |
| MD (Spain) | | | |
| $1^{st}$ tertile | 1 | 1 | 1 |
| $2^{nd}$ tertile | 1.15 (0.91-1.45) | **1.27 (1.05-1.55)** | 1.63 (0.93-2.84) |
| $3^{rd}$ tertile | **1.39 (1.03-1.88)** | **1.52 (1.17-1.98)** | 1.67 (0.80-3.47) |
| MED_DQI (France) | | | |
| $1^{st}$ tertile | 1 | 1 | 1 |
| $2^{nd}$ tertile | 1.02 (0.80-1.30) | 1.14 (0.94-1.40) | **2.10 (1.13-3.90)** |
| $3^{rd}$ tertile | 1.32 (1.00-1.73) | **1.60 (1.27-2.03)** | 1.42 (0.70-2.87) |
| rMed (Spain) | | | |
| $1^{st}$ tertile | 1 | 1 | 1 |
| $2^{nd}$ tertile | 0.98 (0.76-1.27) | 1.02 (0.83-1.26) | 1.25 (0.68-2.30) |
| $3^{rd}$ tertile | 1.09 (0.85-1.40) | **1.37 (1.11-1.69)** | 1.17 (0.63-2.14) |
| MDS (Europe) | | | |
| $1^{st}$ tertile | 1 | 1 | 1 |
| $2^{nd}$ tertile | 0.89 (0.68-1.15) | 0.89 (0.72-1.10) | 0.67 (0.35-1.28) |
| $3^{rd}$ tertile | 0.89 (0.70-1.14) | 1.12 (0.92-1.38) | 0.68 (0.37-1.24) |

Table 3.7. Age and sex adjusted association between various Mediterranean diet score (including the Lebanese score) with obesity (BMI and WC) and the Mediterranean score using logistic regression.

| | Obesity | | Metabolic Syndrome |
|---|---|---|---|
| | BMI | WC | |
| Lebanese dietary pattern | | | |
| 1st tertile | 1 | 1 | 1 |
| 2nd tertile | 1.05 (0.80-1.38) | 1.07 (0.85-1.35) | 0.87 (0.44-1.71) |
| 3rd tertile | 1.04 (0.79-1.37) | 1.08 (0.85-1.36) | 1.51 (0.79-2.85) |
| MSDPS (Boston) | | | |
| 1st tertile | 1 | 1 | 1 |
| 2nd tertile | 0.93 (0.71-1.22) | 1.02 (0.81-1.29) | 0.86 (0.44-1.69) |
| 3rd tertile | 1.05 (0.80-1.37) | 1.19 (0.94-1.51) | 1.10 (0.57-2.10) |
| MS (Canada) | | | |
| 1st tertile | 1 | 1 | 1 |
| 2nd tertile | 1.19 (0.92-1.56) | 1.14 (0.91-1.44) | 0.95 (0.48-1.85) |
| 3rd tertile | 0.91 (0.70-1.18) | 1.05 (0.84-1.31) | 1.68 (0.90-3.15) |
| MD (Spain) | | | |
| 1st tertile | 1 | 1 | 1 |
| 2nd tertile | 1.02 (0.79-1.30) | 1.06 (0.86-1.31) | 1.54 (0.85-2.76) |
| 3rd tertile | 1.18 (0.86-1.61) | 1.22 (0.92-1.63) | 1.49 (0.68-3.26) |
| MED_DQI (France) | | | |
| 1st tertile | 1 | 1 | 1 |
| 2nd tertile | 0.87 (0.67-1.12) | 0.88 (0.71-1.09) | **2.45 (1.26-4.77)** |
| 3rd tertile | 0.93 (0.69-1.25) | 1.00 (0.78-1.29) | 1.54 (0.71-3.35) |
| rMed (Spain) | | | |
| 1st tertile | 1 | 1 | 1 |
| 2nd tertile | 0.89 (0.68-1.16) | 0.87 (0.69-1.09) | 1.24 (0.65-2.36) |
| 3rd tertile | 0.80 (0.61-1.04) | 0.91 (0.72-1.14) | 1.06 (0.54-2.06) |
| MDS (Europe) | | | |
| 1st tertile | 1 | 1 | 1 |
| 2nd tertile | 0.83 (0.63-1.09) | 0.81 (0.64-1.03) | 0.71 (0.36-1.40) |
| 3rd tertile | **0.75 (0.58-0.97)** | 0.91 (0.73-1.14) | 0.63 (0.33-1.20) |

Table 3.8. Multivariate association between various Mediterranean diet score (including the Lebanese score) with obesity (BMI and WC) and the Mediterranean score using logistic regression.

| | Obesity | | Metabolic Syndrome |
|---|---|---|---|
| | BMI | WC | |
| Lebanese dietary pattern | | | |
| 1st tertile | 1 | 1 | 1 |
| 2nd tertile | 0.99 (0.74-1.32) | 1.01 (0.80-1.29) | 0.86 (0.42-1.74) |
| 3rd tertile | 0.93 (0.70-1.25) | 0.99 (0.77-1.27) | 1.59 (0.79-3.22) |
| MSDPS (Boston) | | | |
| 1st tertile | 1 | 1 | 1 |
| 2nd tertile | 0.94 (0.71-1.25) | 1.02 (0.80-1.30) | 0.92 (0.45-1.88) |
| 3rd tertile | 1.02 (0.77-1.36) | 1.14 (0.89-1.46) | 1.28 (0.63-2.62) |
| MS (Canada) | | | |
| 1st tertile | 1 | 1 | 1 |
| 2nd tertile | 1.14 (0.86-1.50) | 1.07 (0.84-1.36) | 0.91 (0.45-1.84) |
| 3rd tertile | 0.89 (0.67-1.17) | 0.99 (0.79-1.25) | **2.00 (1.01-3.96)** |
| MD (Spain) | | | |
| 1st tertile | 1 | 1 | 1 |
| 2nd tertile | 0.92 (0.71-1.19) | 0.98 (0.78-1.22) | 1.55 (0.83-2.90) |
| 3rd tertile | 1.19 (0.85-1.65) | 1.20 (0.89-1.61) | 1.61 (0.71-3.66) |
| MED_DQI (France) | | | |
| 1st tertile | 1 | 1 | 1 |
| 2nd tertile | 0.84 (0.64-1.09) | 0.87 (0.70-1.09) | **2.48 (1.24-4.99)** |
| 3rd tertile | 0.89 (0.65-1.20) | 0.92 (0.70-1.21) | 1.52 (0.68-3.43) |
| rMed (Spain) | | | |
| 1st tertile | 1 | 1 | 1 |
| 2nd tertile | 0.89 (0.67-1.17) | 0.82 (0.64-1.04) | 1.42 (0.72-2.80) |
| 3rd tertile | 0.79 (0.60-1.05) | 0.86 (0.67-1.09) | 1.06 (0.52-2.15) |
| MDS (Europe) | | | |
| 1st tertile | 1 | 1 | 1 |
| 2nd tertile | 0.87 (0.66-1.16) | 0.83 (0.65-1.06) | 0.76 (0.37-1.55) |
| 3rd tertile | 0.78 (0.59-1.02) | 0.91 (0.73-1.15) | 0.70 (0.36-1.36) |

## G. Correlates of adherence to the various Mediterranean Dietary patterns and the Lebanese dietary pattern

The correlates of adherence to the various Mediterranean Dietary patterns and the Lebanese dietary pattern considered in this study were shown in Table 3.9. Consistent across all Mediterranean Diets was the association with age, whereby the older the subjects, the higher were their adherence to the Mediterranean Diets. Similarly a higher education level was also associated with higher scores for all of the Mediterranean Diets studied. For the Lebanese pattern, compared to males, females were more likely to adhere to the Mediterranean Diet. A healthier lifestyle, consisting of high levels of physical activity, no smoking and higher frequency of breakfast consumption, was associated with a higher adherence to the Lebanese dietary pattern. A higher frequency of snacking was significantly associated with the Lebanese dietary pattern, MS, MD and MDS, while no significant association was observed with the MSDPS or Med-DQI. A reversed relationship was noted between snacking and adherence to the rMED. While "eating out" was associated with lower adherence to the Lebanese dietary pattern, MD, rMED and Med-DQI, it was positively associated with the scores of the MDS.

Table 3.9. Multiple logistic regression of factors associated with high adherence to the Lebanese and Mediterranean dietary patterns with multiple adjustments (Low versus medium/high tertiles).

| | OR(95%CI) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Lebanese | MSDPS | MS | MD | Med-DQI | rMED | MDS |
| Age | **1.04(1.03-1.06)** | **1.04 (1.03-1.06)** | **1.03(1.02-1.05)** | **1.03(1.02-1.04)** | **1.04(1.03-1.06)** | **1.06(1.05-1.08)** | **1.04(1.03-1.05)** |
| Sex | | | | | | | |
| Male | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Female | **1.67(1.33-2.09)** | **0.53(0.43-0.67)** | 1.23(1.00-1.51) | 1.05(0.86-1.29) | 0.82(0.66-1.02) | **0.72(0.58-0.89)** | **0.80(0.66-0.98)** |
| Income per month | | | | | | | |
| < 1 million | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 1<Income <3 million | **1.37(1.08-1.75)** | 1.03(0.82-1.31) | **1.26(1.01-1.57)** | 1.22(0.98-1.52) | 1.01(0.81-1.28) | 1.01(0.80-1.27) | 0.99(0.80-1.23) |
| > 3 million | 1.34(0.82-2.18) | 0.80(0.50-1.27) | 1.55(0.98-2.46) | 1.07(0.69-1.68) | 1.00(0.63-1.59) | 0.81(0.51-1.30) | 1.30(0.83-2.04) |
| Marital status | | | | | | | |
| Single | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Married | 1.18(0.92-1.51) | 0.91(0.71-1.17) | 1.03(0.82-1.30) | 1.26(1.00-1.58) | 1.02(0.80-1.30) | 1.15(0.90-1.46) | 0.82(0.65-1.03) |
| Education | | | | | | | |
| Illiterate, primary education | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Elementary | 1.10(0.78-1.55) | **1.58(1.14-2.18)** | 1.36(0.99-1.87) | 1.14(0.83-1.57) | 1.10(0.78-1.54) | 1.18(0.85-1.65) | **1.51(1.10-2.07)** |
| Secondary | 1.23(0.85-1.78) | **2.56(1.78-3.67)** | **1.66(1.18-2.34)** | 1.26(0.89-1.78) | 1.29(0.89-1.87) | **1.69(1.17-2.44)** | **1.69(1.20-2.37)** |
| Technical | **1.56(1.02-2.38)** | **2.49(1.65-3.77)** | 1.39(0.94-2.06) | **1.53(1.02-2.28)** | **1.56(1.02-2.39)** | **2.55(1.67-3.90)** | **2.06(1.39-3.06)** |
| University & Higher education | **1.85(1.29-2.64)** | **3.84(2.71-5.44)** | **1.94(1.40-2.69)** | **1.83(1.32-2.54)** | 1.41(0.99-1.99) | **2.82(1.98-4.01)** | **2.28(1.64-3.15)** |
| Family history of obesity | | | | | | | |
| No | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Yes | 1.03(0.85-1.26) | 1.08(0.89-1.32) | 0.99(0.82-1.19) | 1.14(0.95-1.38) | 1.08(0.88-1.31) | 1.02(0.83-1.24) | **0.79(0.66-0.95)** |
| Smoking | | | | | | | |
| No | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Yes | **0.78(0.62-0.97)** | **0.77(0.62-0.96)** | **0.68(0.55-0.83)** | **0.72(0.58-0.88)** | **0.76(0.61-0.95)** | **0.71(0.57-0.88)** | 1.15(0.94-1.41) |
| Physical activity level | | | | | | | |
| Low | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Moderate | 0.97(0.73-1.27) | 0.87(0.66-1.14) | 0.93(0.72-1.20) | 1.01(0.78-1.32) | **0.73(0.55-0.96)** | 1.10(0.84-1.46) | 0.83(0.64-1.08) |
| High | **1.62(1.30-2.03)** | 0.95(0.76-1.18) | **1.51(1.22-1.86)** | **1.45(1.18-1.79)** | 1.02(0.82-1.27) | **1.31(1.05-1.63)** | 1.14(0.93-1.40) |
| Breakfast per week | **1.08(1.05-1.12)** | 1.02(0.99-1.06) | 1.00(0.97-1.03) | **1.04(1.002-1.07)** | 1.03(0.99-1.06) | 1.03(1.00-1.07) | **0.97(0.93-0.996)** |
| Snack per day | **1.26(1.15-1.37)** | 1.04(0.96-1.12) | **1.14(1.06-1.24)** | **1.13(1.05-1.22)** | 0.97(0.90-1.05) | **0.89(0.82-0.96)** | **1.11(1.03-1.19)** |
| Eating at TV per week | 1.01(0.98-1.04) | 0.98(0.95-1.01) | 0.99(0.96-1.02) | 0.98(0.95-1.01) | 0.98(0.95-1.01) | **0.96(0.93-0.99)** | 1.00(0.97-1.03) |
| Eating out per week | **0.93(0.89-0.98)** | 0.97(0.92-1.02) | 0.96(0.91-1.01) | **0.92(0.87-0.97)** | **0.89(0.84-0.93)** | **0.90(0.85-0.95)** | **1.06(1.01-1.11)** |

## H. The socio-demographic, lifestyle characteristics and meal patterns distributed over the tertiles of adherence to the Lebanese dietary pattern

In the table below, the mean age was significantly higher in the 3rd tertile of adherence. Moreover, the percentage of participants having a high level of physical activity is the highest among subjects in the 3rd tertile of adherence.

Table 3.10. Distribution of the socio-demographic, lifestyle characteristics and meal patterns over the tertiles Lebanese dietary pattern

| | 1st Tertile | 2nd Tertile | 3rd Tertile | Significance |
|---|---|---|---|---|
| Age | 34.08 ± 9.90 | 34.95 ± 9.80 | 36.23 ± 10.04 | $p<0.05$ |
| Gender | | | | |
| Male | 275 (40.3) | 293 (42.8) | 356 (52.2) | $X^2$= 21.58 |
| Female | 407 (59.7) | 391 (57.2) | 326 (47.8) | $p<0.05$ |
| Income per month | | | | |
| <1 million LBP | 515 (75.7) | 478 (70.1) | 454 (66.6) | |
| 1 million LBP<Income<3million LBP | 136 (20.0) | 172 (25.2) | 193 (28.3) | $X^2$=14.44 |
| >3 million LBP | 29 (4.3) | 32 (4.7) | 35 (5.1) | $p<0.05$ |
| Education | | | | |
| Illiterate, primary education | 87 (12.8) | 74 (10.8) | 108 (15.8) | |
| Elementary | 187 (27.4) | 166 (24.3) | 161 (23.6) | |
| Secondary | 112 (16.4) | 113 (16.5) | 121 (17.7) | |
| Technical | 77 (11.3) | 84 (12.3) | 60 (8.8) | $X^2$=15.03 |
| University and higher education | 219 (32.1) | 247 (36.1) | 232 (34.8) | $p>0.05$ |
| Family history of obesity | | | | |
| Yes | 303 (44.8) | 297 (43.5) | 306 (44.9) | $X^2$= 3.19 |
| No | 370 (54.7) | 385 (56.5) | 376 (55.1) | $p>0.05$ |
| Marital Status | | | | |
| Single | 337 (49.4) | 285 (41.7) | 239 (35.1) | $X^2$=28.71 |
| Married | 345 (50.6) | 398 (58.3) | 442 (64.9) | $p<0.05$ |
| Smoking | | | | |
| No | 409 (60.0) | 438 (64.0) | 420 (61.6) | $X^2$=2.43 |
| Yes | 273 (40.0) | 246 (36.0) | 262 (38.4) | $p>0.05$ |
| Physical activity | | | | |
| Low | 320 (47.0) | 297 (43.4) | 239 (35.0) | |
| Moderate | 134 (19.7) | 127 (18.6) | 100 (14.7) | $X^2$=43.43 |
| High | 227 (33.3) | 260 (38.0) | 343 (50.3) | $p<0.05$ |
| Breakfast per week | 4.73 ± 2.86 | 4.75 ± 2.91 | 4.50 ± 2.96 | $p>0.05$ |
| Snack per day | 1.41 ± 1.16 | 1.63 ± 1.35 | 1.72 ± 1.38 | $p<0.05$ |
| Eating at TV per week | 3.04 ± 3.18 | 3.44 ± 3.16 | 3.02 ± 3.10 | $p<0.05$ |
| Eating out per week | 1.57 ± 2.17 | 1.67 ± 2.16 | 1.63 ± 2.10 | $p>0.05$ |
| Obesity | | | | |
| BMI<30 | 545 (80.7) | 522 (77.1) | 506 (75.1) | $X^2$=6.40 |
| BMI≥30 | 130 (19.3) | 155 (22.9) | 168 (24.9) | $p<0.05$ |
| Metabolic Syndrome | | | | |
| Yes | 26 (27.1) | 25 (27.8) | 38 (39.2) | $X^2$=4.10 |
| No | 70 (72.9) | 65 (72.2) | 59 (60.8) | $p>0.05$ |
| Waist circumference | | | | |
| Normal WC | 359 (52.9) | 318 (46.7) | 299 (44.2) | $X^2$=11.11 |
| Enlarged WC | 319 (47.1) | 363 (53.3) | 378 (55.8) | $p<0.05$ |

* Categorical variables are expressed as n (%), continuous variables are expressed as Mean±SD
**Significance is derived from ANOVA for continuous variables and Chi square test for categorical variables

# CHAPTER IV

# DISCUSSION

## A. Major Findings of the Study

The major findings in this study were: there was a moderate agreement between the different Mediterranean patterns. Out of the six Mediterranean indexes chosen in the literature namely MSDPS from Boston, MS from Canada, MD from Spain, Med-DQI from France, rMED from Spain and MDS from Europe, the Mediterranean index the most associated with the Lebanese pattern was the MD. Moreover, the Lebanese dietary pattern was not found to be associated with obesity or the Metabolic Syndrome. Finally, the characteristics of the Lebanese population, as represented in this study, suggest that older age and higher educational levels are associated with increased adherence to all Mediterranean Diets studied, including the Lebanese dietary pattern. A healthier lifestyle, consisting of high levels of physical activity, no smoking, higher frequency of breakfast consumption, and lower frequency of eating out was also associated with adherence to the Lebanese dietary pattern. However these results did not apply to all the other Mediterranean indexes.

## B. MD: The Mediterranean Index the Most Associated with the Lebanese Score

The MD in this study was found to be the Mediterranean index the most associated with the Lebanese score. Therefore, in the absence of an index specific to Lebanon, MD might be used to assess the adherence to the Mediterranean diet. The food items pertaining to this index were olive oil, fruits, vegetables or salad, fruits and vegetables, legumes, fish, wine, meat, white bread and rice or whole grain bread. The consumption of food items expected to be beneficial against CVD or increasing its risk was taken into consideration as follows while calculating the score (Martinez-Gonzalez et al. 2004):

Table 4.1. Grades attributed to dietary items according to quantity consumed.

| Food item | Quantity | Points |
|---|---|---|
| Olive oil | ≥ 1 spoon per day | + 1 |
| Fruit | ≥ 1 serving per day | + 1 |
| Vegetables or salad | ≥ 1 serving per day | + 1 |
| Fruit and vegetables | ≥ 1 serving per day each | + 1 |
| Legumes | ≥ 2 servings per week | + 1 |
| Fish | ≥ 3 serving per week | + 1 |
| Wine | ≥ 1 glass per day | + 1 |
| Meat | < 1 serving per day | + 1 |
| White bread and rice or whole-grain bread | < 1 serving per day for bread, < 1 serving per week for rice and > 5 serving per week for whole grain bread | + 1 |

## C. The Association between the Lebanese Score and the Mediterranean Scores

The association between the MD and the Lebanese score was strong but in general, all the indexes were fairly to moderately positively associated, which translates the common foundations of the Mediterranean diet, and at the same time, the differences present from one index to another pertaining to different countries like Spain and France. The plausible cause of these differences can be, as mentioned in Milà-Villarroel et al.'s study (2011), the different type and the weight of components included in the indexes. For example, while comparing different Mediterranean indexes, these researchers found that the source of divergence between indexes could be the lean meat and dairy products components. When these components were excluded from their statistical trials, the indexes under study appeared to be more similar.

## D. Food Groups Specific to the Lebanese Dietary Pattern

Food groups specific to the Lebanese dietary pattern and that could have been a source of divergence from the other Mediterranean indexes include bulgur, dried fruits, dairy products and fats and oils.

Bulgur, or crushed whole wheat, is a characteristic of the traditional food heritage of Lebanon and several other Eastern Mediterranean countries including Turkey, Iraq, Iran, Syria and Egypt (Babadoğan, 2010). As an example, it is an ingredient of one of the most consumed salad in Lebanon called tabbouleh (Issa et al., 2009).

Similarly, the diet in Lebanon as well as in other countries of the Eastern Mediterranean basin is characterized by the consumption of dried fruits such as raisins, figs, dates, apricots and apples, which are typically consumed as snacks or are used as raw material in bakery and confectionary industries (Trager, 1995).

Dairy products were also found to be component of the Lebanese Dietary pattern although it was considered as a negative component in some Mediterranean indexes. Lebanon, as well as other countries of the Levant including Syria and Jordan, traditionally consume large quantities of dairy products, which are typically consumed as fermented milk products such as yogurt, strained yogurt (labneh) and white cheese in brine (Alqaisi, 2010).

The fourth different component is fats and oils which as a food group, included butter, ghee and vegetable oil. Olive oil which is considered as a vegetable oil was part of this food group; however, it was not represented as an individual component like in most other Mediterranean indexes.

## E. Food Components Pertaining to the Mediterranean Diet and Missing from the Lebanese Dietary Pattern

Other food components pertaining to the Mediterranean diet did not appear in the Lebanese Dietary pattern extracted and could also act as a source of divergence with fish being the main one.

### *1. Fish and alcohol*

As shown by a previous food consumption survey conducted in Beirut, fish consumption in Lebanon is low (19.7 g/day among Lebanese adults), with 74 % of adult subjects consuming <2 servings of fish per week and 65 % <1 serving per week (Nasreddine et al., 2006). This feature is not unique to Lebanon as the annual consumption of fish and shellfish for countries of the region is also low, averaging 5.1 kg per caput per annum, which is less than half the average figure of 12.1 kg for world consumption (White, 1988). This low intake of fish may be partially explained by the relatively high price index of seafood in these countries. Additionally, this low intake may be a reflection of social taboos or antipathies toward eating fish and seafood which appear to be common among the Muslim populations of the Mediterranean basin (but not of the Gulf) (Zubaida, 2014). Certain Muslim sects have clear prohibitions against shellfish consumption as well as fish with no scales or fins, and in common customs and mentalities regular fish is not popular (Zubaida, 2014). This social/ethnic aspect of fish consumption has been partly reflected by the observed association between fish consumption and alcohol drinking in one of the patterns identified in Lebanon (Naja et al. 2011). Moreover Lebanon having the Muslim religion as one of the main religions in the country (Central Intelligence Agency, 2012) it is therefore not surprising that the Lebanese dietary pattern did not include alcohol as compared to other Mediterranean indexes who recommend the intake of alcohol in moderation like MSDPS, MD, rMED and MDS scores. Some indexes specify the type of alcohol to be consumed by including wine in particular as a component in the index (Rumawas et al. 2009; Martinez-Gonzalez et al., 2004; Buckland et al., 2009; Trichopoulou et al., 2005).

### F. Common Denominators between the Lebanese Dietary Pattern and All the Mediterranean Indexes

As opposed to the divergent components, in our current study the common denominator between the Lebanese Dietary Pattern and all the Mediterranean indexes considered were fruits and vegetables. Nasreddine et al. confirms these findings where in 2006, the mean intake of fruits and vegetables of the Lebanese population was relatively higher than the levels reported by the WHO for less developed countries. The possible explanation of these results provided by the author was the availability and accessibility of these products on the Lebanese Market, their high national production and their relatively low cost. Milà-Villarroel et al. (2011) also concluded in their comparison that fruits and vegetables were the most correlated components of indexes designed to assess adherence to the Mediterranean diet. This makes fruits and vegetables the main food groups in the Mediterranean pattern.

## G. Major Reason behind the Different Food Components in Mediterranean Dietary Indexes and the Lebanese Pattern

The major reason behind the different food components causing disparities between Mediterranean dietary indexes, and no perfect correlation, is the fact that these indexes all originate from different European countries. Moreover, none of them represents the Eastern Mediterranean Region, which Lebanon is part of. These countries have food pattern variations that can be explained by numerous factors like sociocultural, religious and economic differences (Bach et al. 2006). Although there is a common ground to the food components of the Mediterranean pattern related to its health benefits, the variations between Europe and the Eastern part of the Mediterranean region should be taken into consideration.

## H. The Association between the Mediterranean Indexes, the Lebanese Dietary Pattern and Obesity or the Metabolic Syndrome

Depending on the index used, the study population presents a variable degree of adherence, thus affecting its association with diseases. For example, high scores of adherence could apply in one index whereas another index could generate lower values (Milà-Villarroel et al. 2011). This could explain our finding in this study which is the lack of association between the different Mediterranean indexes and obesity or the Metabolic Syndrome. The results of other studies are controverted. However the effect of the Mediterranean Pattern on these two health problems is based on the quality and quantity of its components. At the same time, these might also explain why our study did not find an association between the Lebanese Dietary Pattern and Obesity or the Metabolic Syndrome.

***1. Fruits and Vegetables***

For example, the important role of fruits and vegetables in the Mediterranean pattern is due to their richness in polyphenolic compounds like flavonoids and phenolic acids. Flavonoids exert a wide range of biological effects, such as antioxidant and anti-inflammatory properties (Kris-Etherton et al., 2004). Results of a randomized intervention trial showed that following a Mediterranean-style diet rich on antioxidant containing foods significantly decreases insulin resistance in patients with the Metabolic Syndrome (Shröder, 2007).

***2. Olive Oil***

Fruits and Vegetables were present in the Lebanese dietary pattern. However, olive oil which is also considered as having an important role in the benefits of the Mediterranean Diet, was included in a food group which also contained butter and ghee. Butter consists mainly of the fat from milk. It usually contains about 82 percent fat, with a trace of protein and carbohydrate; the rest is water. Ghee is made by heating butter to precipitate the protein, which is then removed. Ghee contains 99 percent fat, no protein or carbohydrate (Latham, 1997). They are both higher in saturated fatty acids and lower in PUFA and MUFA compared to olive oil (Gundu HR Rao, 2005) which largely attenuate the possible protective role of olive oil in the food group on health. This protective role can be explained by different mechanisms. The metabolic fate of dietary fat is either oxidation or storage. Therefore the capacity of our body to oxidize fat is important for energy balance and depends on the type of fat. Human studies have shown that PUFA are better oxidized than SFA (Shröder, 2007). This may provide a physiological explanation of why olive oil consumption is less prone to promote weight gain. Moreover, Oleic acid found in olive oil is considered to be antithrombotic compared with SFA, and diets high in MUFA compared to PUFA are less likely to be involved in the oxidation of LDLs, a process thought to increase the risk of atherogenesis and CHD. It was also found that substitution of olive oil for carbohydrates in certain short term clinical studies might increase HDLs without increasing LDLs (Willett et al. 1995).

Finally consumption of olive oil is highly related to consumption of vegetables and legumes increasing their palatability which are as mentioned above, major components of the Mediterranean diet and have their own advantages (Schröder, 2007). Although olive oil was part of our dietary assessment, it was included in a group that does not reflect its health benefits and therefore weakens the association of the Lebanese dietary pattern with obesity and the Metabolic Syndrome which was inexistent in our results.

### *3. Dairy Products*

A third food component that was part of the Lebanese dietary pattern is the dairy products which are also high is SFA and were taken into consideration in the Mediterranean indexes to be consumed as low as possible. Being part of this pattern might have attenuated its relation with obesity and the Metabolic Syndrome. SFA might have detrimental effects on health as shown in the study of Klein-Platat et al. (2005), where in overweight subjects, FA composition was associated with Metabolic Syndrome features independently of body fat. The odds ratios of Metabolic Syndrome for a 0.1 increase in the ratio of polyunsaturated FAs (PUFA) to SFAs (PUFA:SFA) were 0.91 in phospholipids (P=0.03) and 0.90 in CEs (P=0.06). Moreover, in a parallel controlled-feeding trial conducted in 20 abdominally overweight subjects, the consumption of a SFA diet resulted in a proinflammatory "obesity-linked" gene expression profile; Whereas consumption of a MUFA diet caused a more antiinflammatory profile. This suggests that replacement of dietary SFA with MUFA could prevent adipose tissue inflammation and may reduce the risk of inflammation related diseases such as Metabolic Syndrome (Van Dijk et al., 2009).

### *4. Fish*

All aspects of the Metabolic Syndrome have been closely associated with chronic inflammation. Just as inflammation has been strongly linked to Metabolic Syndrome comorbidities, dietary fat intake has long been proposed as another cause. In this regard, not necessarily the quantity, but the quality of dietary fat consumed and consequently plasma FA strongly predicts the prevalence of Metabolic Syndrome (Fessler et al. 2009). For example, plasma FA composition was associated with weight status in healthy adolescents in the study of Klein-Platat et al. (2005). High intake of long-chain PUFAs, especially n_3 PUFAs, was associated with a possible protection of obese subjects against the Metabolic Syndrome and low-grade inflammation as early as adolescence (Klein-Platat et al. 2005). Fish is known to be high in n_3 PUFAs (Kris-Etherton et al., 2002). Since the Lebanese Dietary pattern did not include fish like other Mediterranean indexes, this can be considered as a fourth factor explaining why the Lebanese Dietary pattern was not protective against obesity and the Metabolic Syndrome.

### *5. Alcohol*

Like fish, alcohol was not present in the Lebanese dietary pattern. However, studies like the cross-sectional analysis of data from the Third National Health and Nutrition Examination Survey showed that after adjustment for age, sex, race/ethnicity, education, income, tobacco use, physical activity, and diet, subjects who consumed 1–19 and ≥ 20 drinks of alcohol per month had odds ratios for the prevalence of the Metabolic Syndrome of 0.65 and 0.34, respectively ($P < 0.05$ for all), compared with current nondrinkers. These findings were particularly significant for beer and wine drinkers. Alcohol consumption was significantly and inversely associated with the prevalence of the following three components of the Metabolic Syndrome: low serum HDL cholesterol, elevated serum triglycerides, high waist circumference, as well as hyperinsulinemia ($P < 0.05$ for all) (Freiberg et al. 2004).

### *6. Overconsumption of Food*

Since all the Mediterranean indexes were not inversely associated with obesity and the Metabolic Syndrome in our study, and the Lebanese dietary pattern was not an exception, there should be an additional possible explanation for this lack of association. Taking into consideration the differences mentioned above, the index the least associated with the Lebanese score is the MSDPS. This index has a unique feature since it accounts for overconsumption of foods pertaining to the Mediterranean diet pyramid. Exceeding the recommended intake of foods in the Mediterranean diet pyramid incurs a penalty by subtracting a point proportionally to the number of servings consumed that exceeded the recommended intake for that group (e.g. exceeding the recommendation by 60% would result in a score of 4). Due to this overconsumption penalty, the score of a food group can be negative (i.e. for exceeding the recommendation by 100%). In this case, the negative score was defaulted to zero (Rumawas et al. 2009). This lack of association with obesity or the Metabolic Syndrome shows that the Lebanese population might follow the Mediterranean diet however in excess quantities. Excess food consumption is associated with excess energy intake which is a risk factor for obesity and subsequent Non-Communicable diseases (Swinburn et al., 2004). This hypothesis is displayed in the results where a positive association was found between the Lebanese dietary pattern and obesity. However, this association became not significant after adjustments. A possible reason behind these results is the increase in portion size which is a trend pertaining to globalization and leads to higher intake of energy-dense foods (WHO, 2002).

## I. Globalization

WHO (2002) defines globalization as “the increased interconnectedness and interdependence of people and countries, which is generally understood to include two interrelated elements: the opening of borders to increasingly fast flows of goods, services, finance, people and ideas across international borders; and the changes in institutional and policy regimes at the international and national levels that facilitate or promote such flows. It is recognized that globalization has both positive and negative impacts on development.”

## J. Correlates of the Lebanese Population and the Various Mediterranean Patterns among Lebanese Adults

Apart from higher intake of energy-dense foods, another negative impact of globalization is the radical dietary shifts in many developed and developing nations from traditional patterns of eating to the Western diet high in animal products and refined carbohydrates and low in whole grains, fruits, and vegetables (WHO, 2002). This nutritional transition may be further accentuated in Lebanon because this country is heavily dependent on imported food, with domestic cereal production for example covering on average around 17% of consumption needs only (UNHCR, 2013), which puts the country under more influence of globalization. One of the consequences of globalization is NCDs and its precursors which apply to Lebanon with the odds of obesity being 2 times higher in 2009 compared to 1997 (Nasreddine et al. 2012). Moreover, in the study of Sibai A-M et al. conducted in 2007, the prevalence of the Metabolic Syndrome among adults attending health centers, aged 18–65 years old, was shown to be 31.2% with men presenting with a significantly higher rate than women.

The shift in diet that took place within 100-200 years in the West occurs within a few decades in the developing countries (Popkins, 2002) like Lebanon. It is accelerated by a high urbanization rate, which is usually accompanied by decreased physical activity level, and increased overweight and obesity. Moreover, eating away from home is not only related to economic development, but also to urbanization. It is linked to a shift in work environment, e.g. working outside the home versus a domestic role (WHO, 2002).

The third finding of our study confirms the above. When the socio-demographic and lifestyle characteristics of the Lebanese population were defined, we could describe who is resisting the transition and is adherent to the Mediterranean diet. This outcome suggests that older age and higher educational levels characteristics are associated with increased adherence to all Mediterranean Diets studied, including the Lebanese dietary pattern.

### *1. Age*

The observed direct association between age and adherence to the Mediterranean Diet is in accordance with previous investigations. For instance, findings reported by Patino-Alonso et al. (2013) showed that, in Spain, adherence was lower among individuals younger than 49 years of age compared to older individuals. A possible explanation may be that older adults tend to maintain traditional dietary habits as compared to younger generations who have greater exposure to new food products exposed from globalization (Hu, 2013).

### *2. Education*

The results of this study also suggested that less educated subjects tend to have lower adherence to the Mediterranean diet, thereby suggesting a possible inverse socioeconomic gradient in healthy eating. These findings are in agreement with those reported by previous studies (Hu, 2013 & León-Muñoz et al. 2012) and are in line with the conclusions reported by Darmon and Drewnowski (2008) indicating that higher-quality diets are mainly consumed by better educated individuals. Higher education levels may in fact be associated with higher nutrition knowledge, an essential precursor to healthy dietary habits (Darmon & Drewnowski, 2008). Alternatively, the lower adherence to the Mediterranean diet among subjects from lower education and socioeconomic backgrounds may, in part, reflect an economic obstacle to the adoption of a Mediterranean dietary style (Olmedo-Requena et al. 2013). A study conducted in Spain showed that a Mediterranean diet is more expensive to follow than a Western dietary pattern, suggesting food cost as a prohibitive factor to adherence (Lopez et al. 2009). However, in the present study, income was not shown to be associated with adherence to the Mediterranean diet.

### *3. Gender*

In this study, adherence to the Lebanese dietary pattern was shown to be higher among women compared to men. These findings are in agreement with those reported by Patino-Alonzo et al. (2013) in Spain. The observed associations are in line with other studies reporting women as being more health-conscious and followers of dietary recommendations than men (Nassreddine et al. 2006 & Fagerli et al. 1999) and are reinforced by the results shown in table 3.1 where first BMI was significantly lower for women when compared to men, second, women tended to have higher physical activity, smoke less, and have a lower mean of eating out or in front of the TV per week and third the percentage of woman having the Metabolic Syndrome was significantly lower than men. These results were all significant. However, for the rest of the indexes, these findings were different.

### *4. Lifestyle*

Similarly, in the present study, and in agreement with several previous reports (Schröder et al. 2004), a healthier lifestyle, consisting of high levels of physical activity, no smoking, higher frequency of breakfast consumption, and lower frequency of eating out was associated with adherence to the Lebanese dietary pattern. These results may be interpreted as a recurrent manifestation of the well-known clustering of behavioral risk factors, including smoking, physical inactivity and unbalanced diet (Schröder et al. 2004), a clustering that is increasingly prevalent in countries undergoing the nutrition transition, including Lebanon and other countries of the Eastern Mediterranean region (Sibai et al. 2010). A distinctive feature of the nutrition transition is the erosion of the traditional lifestyle, the shift toward an increasingly energy dense dietary pattern, and the adoption of a sedentary mode of living. This departure from the tradition lifestyle, a lifestyle repeatedly shown to decrease the risk of NCDs and all-cause mortality (Zazpe et al. 2014), has been accompanied by an alarming increase in the prevalence and burden of obesity and other nutrition-related diseases in countries of the region (Sibai et al. 2010). In Lebanon, obesity prevalence rates among adults have increased from 17 % in 1997 to 28.2 % in 2009 (Nassreddine et al. 2012), an increase that surpasses that reported from several developed countries during the past decade, including the US

(Finucane, 2011). The prevalence of cardiovascular diseases and Type 2 Diabetes in countries of the region are also among the highest in the world (Sibai et al. 2010).

**K. Strengths and Limitations:**

In the primary data analysis, a research team develops a research project designed to address specific questions addressed by the project, and performs and publishes their own analyses of the data they have collected. Although this is not the case in secondary data analysis where the researchers have to analyze data at hand which might not exactly fit the research question, the data used in our study was valuable and we were able to use it efficiently to serve our research question. Only some variables were defined or categorized differently than needed. This was applicable to olive oil whereby, as mentioned above, was not solely represented but instead was added to a food group which prevented us from analyzing its individual effect. (Cambridge University Press, n.d.).

The dietary intake data used for this study were collected using a semi-quantitative FFQ. It is important to note that the food frequency questionnaire used in this study was not validated in our study population; however, in another study investigating dietary patterns and metabolic syndrome among Lebanese males, using the same FFQ, significant correlations were found between dietary cholesterol intake and plasma cholesterol and LDL levels (Pearson correlation r = 0.3 and 0.2 for cholesterol and LDL, respectively) (Naja & Nasreddine, 2012, unpublished data). Another study using the same FFQ produced plausible results where the scores of the Western pattern were significantly positively associated with BMI and WC (Naja et al. 2011). In addition, the shortcomings of the use of the FFQ for dietary assessment, such as measurement errors, reliance on memory, the limited number of food items included in the food list and the high proportion of low energy reporters, should be taken into account (Caan, et al. 1999). Nevertheless, studies have shown that the FFQ remains the most suitable dietary data collection tool in large epidemiological studies as it provides information on the habitual diet over longer periods of time and allows ranking of individuals according to food or nutrient intake (Caan, et al. 1999 & Martinez, et al. 1998). The dietary intake data was analyzed using a 1993 non-Lebanese nutrient database; however due to lack of resources in the setting of the study, it was not possible to obtain a more updated database. However, in order to improve the accuracy of this database, traditional Lebanese recipes were added to the database. These recipes were derived from the cooking book "Aleph Baa" for cooking. It also remains noteworthy to mention that the use of such database will affect energy and nutrients intakes derivation but not the assessment of foods/food groups' consumption. The potential change in food composition between years 1993 and 2008 may have resulted in attenuation of the observed associations. Furthermore, among the factors believed to affect dietary patterns is religion. However, given the political tension in the country among various religious parties, no data about religious beliefs were collected.

### L. Conclusions and Recommendations for further Research

The study of dietary patterns through diet quality indexes has been recently used to examine interactions between group of dietary components and their effect on health and diseases. One of these patterns known as the Mediterranean dietary pattern appeared to have a positive effect on health. However, despite the available documented protective effects of the Mediterranean diet against Non-Communicable diseases, and despite the fact that the Lebanese dietary pattern was defined as a Mediterranean one in our study, the Lebanese dietary pattern and the Mediterranean dietary patterns were not found to be protective against obesity and the Metabolic syndrome. The variations between the indexes and globalization might be a reason behind these findings. Given that these variations can interfere with the efficiency of the available Mediterranean indexes to describe the Lebanese population's food intake, an index for assessing adherence to a Middle Eastern version of the Mediterranean diet as represented by the traditional Lebanese dietary pattern could be created. Taking in consideration the quantity of food consumed, the food groups specific to the Lebanese Dietary pattern that should be included in this new index in addition to the usual Mediterranean components are: bulgur, dried fruits, dairy products in moderation and olive oil. Another reason reinforcing this initiative is that this pattern was previously shown to be protective against Type 2 Diabetes (Naja, et al. 2012).

Moreover, the lack of efficient national policy to promote and sustain production and consumption of foods distinctive to the Mediterranean area or more specifically to Lebanon and resist against transition to a Western diet, shows that means of public awareness should be elaborated to encourage the Lebanese population to preserve their Lebanese diet and at the same time to decrease quantities consumed. The Lebanese Dietary index to be developed could be a useful tool in this process.

# APPENDIX

Appendix 1: The Food Frequency Questionnaire

**Think about your eating patterns during the past year while answering this questionnaire. Please indicate your usual intake of each of the following food items per Day, Week, or Month.**
**<u>For example:</u> Apple. If you consume 3 apples daily, write 3 in the "Day" column, if you think you average 3 apples a week over the year, write 3 in the "Week" column. However, if you rarely consume a food, let's say once or twice a year, then tick below "Rarely/Never".**
**Please be precise as much as you can.**
**Remember! The accuracy of the study results depends on the accuracy of your answers.**

| **Food item** | **Serving size** | **Day** | **Week** | **Month** | **Rarely / Never** |
|---|---|---|---|---|---|
| **Example: Apple** | 1 item | | 3 | | |
| **Bread and Cereals** | | | | | |
| 1. White bread (1 slice) | 1 slice (30g) | | | | |
| 2. Brown or whole wheat bread | 1 slice | | | | |
| 3. Breakfast cereals, regular/ bran | 1 cup | | | | |
| 4. Rice, white, cooked | 1 cup | | | | |
| 5. Pasta, plain, cooked | 1 cup | | | | |
| 6. Wheat, whole, cooked / Bulgur | 1 cup | | | | |
| **Dairy products** | | | | | |
| 7. Low-fat milk (2% fat) | 1 cup | | | | |
| 8. Whole fat milk | 1 cup | | | | |
| 9. Fat free / low fat yogurt | 1 cup | | | | |
| 10. Whole fat yogurt | 1 cup | | | | |
| 11. Cheese regular | 1 slice (30g) | | | | |
| 12. Cheese low fat | 1 slice (30g) | | | | |
| 13. Labneh | 2 Tbsp | | | | |
| **Fruits & Juices** | | | | | |
| 14. Citrus Orange (1 item) / Grapefruit (1/2 item) | 1 serving | | | | |
| 15. Deep Yellow or orange( Peach, plums, etc..) | 1 item | | | | |
| 16. strawberry | 1 cup | | | | |
| 17. grapes | 1 cup | | | | |
| 18. Others: Banana, medium /Apple, fresh, small | 1 item | | | | |
| 19. Dried fruits: raisins (2 Tbsp), dates (2), apricots (4) | 1 serving | | | | |
| 20. Fresh fruit juice | 1 cup | | | | |

| | | | | | |
|---|---|---|---|---|---|
| 21. Fruit drinks: canned/bottled | 1 cup | | | | |
| **Vegetables** | | | | | |
| 22. Salad – green: lettuce, celery, green peppers, cucumber | 1 cup | | | | |
| 23. Dark green or deep yellow vegetables (e.g.: spinach, hindbeh,, carrots , …) | 1 cup | | | | |
| 24. Tomatoes, fresh, medium | 1 item | | | | |
| 25. Corn / green peas, cooked | 1 cup | | | | |
| 26. potato, baked / boiled / mashed | 1 item | | | | |
| 27. Squash, summer (kussa), Eggplant /cooked | 1 cup | | | | |
| 28. Cauliflower/ Cabbage/ broccoli | 1 cup | | | | |
| **Meat & Alternates** | **Serving size** | **Day** | **Week** | **Month** | **Rarely / Never** |
| 29. Legumes: lentils, broad beans, chickpeas, etc., cooked | 1 cup | | | | |
| 30. Nuts and seeds: peanuts, almonds, sunflower seeds, etc. | 1 cup | | | | |
| 31. Red Meat | 1 item (3 oz.) | | | | |
| 32. Poultry | 1 item (3 oz.) | | | | |
| 33. Fish, ( including Tuna) | 1 serving (3 oz.) | | | | |
| 34. Eggs, whole, large | 1 item | | | | |
| 35. Organ Meats( Liver, kidneys, brain) | 1 cup | | | | |
| 36. Luncheon meats: Mortadell, Jambon, salami, turkey, etc. | 1 slice (20g) | | | | |
| 37. Sausages, makanek, hot dogs | 1 item (30g) | | | | |
| **Fats and oils** | | | | | |
| 38. Oil: corn / sunflower / soy/olive | 1 Tbsp | | | | |
| 39. Olives | 1 item | | | | |
| 40. Butter/ghee | 1 Tbsp | | | | |
| 41. Mayonnaise | 1 Tbsp | | | | |
| **Sweets &Desserts** | | | | | |
| 42. Cake, Cookies ,Donut, muffin, croissant | 1 item | | | | |
| 43. Ice cream | 1 cup | | | | |
| 44. Chocolate bar | 1 item | | | | |
| 45. Sugar, , honey, jam, molasses | 1 Tbsp | | | | |
| 46. Arabic sweets, baklawa, maamoul, Knefeh | 1 item (40g) | | | | |
| **Beverages** | | | | | |
| 47. Soft drinks, regular (1 can = 1½ cup) | 1½ cup (11 fl. oz) | | | | |
| 48. Soft drinks, diet (1 can = 1½ cup) | 1½ cup (11 fl. oz) | | | | |
| 49. Turkish coffee (1 small cup = ¼ cup) | ¼ cup (2 fl oz) | | | | |
| 50. Coffee/Nescafe or tea | 1 cup | | | | |
| 51. Hot chocolate or cocoa | 1 cup | | | | |
| 52. Beer, regular (1 can = 1½ cup) | 1½ cup | | | | |

| | | | | | |
|---|---|---|---|---|---|
| 53. Wine: red, white, or blush | ½ cup (4 fl. oz) | | | | |
| 54. Liquor: whiskey, vodka, gin, rum | 1/6 cup (1.5 fl oz.) | | | | |
| **Miscellaneous** | | | | | |
| 55. Manaeesh, zaatar, cheese | 1 large | | | | |
| 56. French fries | 1 cup | | | | |
| 57. Chips: potato, corn, tortilla | 1 cup | | | | |
| 58. Falafel sandwich, medium | 1 item | | | | |
| 59. Chawarma sandwich, medium | 1 item | | | | |
| 60. Burgers( Beef, chicken, fish) | 1 item | | | | |
| 61. Pizza | 1 slice | | | | |

**Are there any other foods not mentioned above that you usually eat at least once per week?**

| Other foods that you usually eat at least once /week | Usual serving size | Servings/week |
|---|---|---|
| | | |
| | | |

Appendix 2: Food Groups Used in the Factor Analysis

| | Food group | Components |
|---|---|---|
| 1. | Alcohol beverages | Non wine alcoholic beverages, beer, wine |
| 2. | Whole bread | Whole wheat bread |
| 3. | Breakfast cereals | Regular corn flakes |
| 4. | Bulgur | Crushed parboiled wheat |
| 5. | Coffee | Turkish coffee |
| 6. | Cured meat | Luncheon, sausages, offal |
| 7. | Low fat dairy products | Half skimmed milk, low fat cheese, low fat yogurt |
| 8. | Whole dairy products | Whole milk, regular cheese, lebneh, regular yogurt |
| 9. | Dried fruits | Raisin, prunes, etc… |
| 10. | Eggs | Eggs boiled and fried |
| 11. | Fast food sandwiches | Chawarma sandwiches, falafel sandwiches, hamburger |
| 12. | Fats and oils | Butter, ghee, vegetable oil |
| 13. | Fish | Fried and broiled fish |
| 14. | Fried potato | Potato fried, potato chips |
| 15. | Fruits | Deep yellow orange fruits, bananas, apples , strawberries, citrus fruits, grapes, fresh fruit juices |
| 16. | Bottled fruit juices | All types of sweetened and bottled fruit juices |
| 17. | Hot drinks | Cocoa, Nescafe, tea |
| 18. | Ice cream | All types of ice cream, traditional and packaged |
| 19. | Legumes | Beans, lentils, chickpeas, fava beans |
| 20. | Mayonnaise | All types mayonnaise salad dressing |
| 21. | Meat and poultry | All types of red meat, poultry, cooked fried or broiled |
| 22. | Nuts and seeds | Nuts and seeds salted and roasted |
| 23. | Olives | All types of pickled olives |
| 24. | Pizza and pies | Pizza, manaeesh cheese, manaeesh thyme, manaeesh kishk (kishk is a traditional yogurt based product) |
| 25. | Refined grains | Bread white, rice and rice products, pasta cooked |
| 26. | Light soda | All kinds of sugar free carbonated beverages |
| 27. | Soda regular | Sugar sweetened carbonated beverages |
| 28. | Starchy vegetables | Potato, corn and peas |
| 29. | Sweets | Cakes, cookies, doughnuts, muffins, Arabic sweets, honey, jam, sugar, chocolate |
| 30. | Vegetables | Dark green yellow vegetables, tomato, salad season, zucchini eggplant, cauliflower |

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