ABSTRACT: The objective of this paper is to discuss the advantages of using the dietary pattern approach in evaluating the role of diet in cardiovascular diseases (CVD) prevention and management and to report on the association between major dietary patterns and CVD risk factors among Lebanese adults. The significance of this type of research to primary care physicians is also highlighted.

The dietary pattern approach overcomes the inconsistent findings of single nutrient analysis in evaluating diet-disease associations, takes into consideration the synergistic effects of nutrients, and provides culture specific recommendations. Using data from the national Nutrition and Non-Communicable Disease Risk Factor Survey, we appraised the association of dietary patterns with CVD risk factors among Lebanese adults.

Two major dietary patterns were identified: Western pattern, characterized by high intake of fast food sandwiches, desserts, and carbonated beverages and the traditional Lebanese pattern, characterized by high intakes of fruits and vegetables, olives and olive oil, and traditional dishes. Only the Western pattern was associated with increased risk of obesity (abdominal obesity), hyperglycemia and the metabolic syndrome.

These findings demonstrated the valuable results that can be obtained using the dietary patterns approach in evaluating the association between diet and CVD risk factors and provided evidence that this approach can be used as a tool to push for desirable dietary changes in the country.

Keywords: dietary patterns, cardiovascular diseases, family care physicians, Lebanon

INTRODUCTION

Since 1970, the incidence of cardiovascular diseases (CVD) in high-income countries dropped by 42%, from 163 to per 100,000 person years [1]. This decline was coupled to an increased public awareness of CVD risk factors including high blood pressure, high blood cholesterol, and cigarette smoking [2]. By contrast, during the same period, the incidence of CVD in low-income and middle-income countries increased by more than 100%, from 52 to 117 per 100,000 person years [1], to the extent that currently, around 80% of CVD mortality occurs in these countries [3]. The Middle East and North Africa (MENA) countries, including Lebanon, represent...
a region where CVD are the main underlying causes of morbidity and mortality. In Lebanon, CVD account for around 60% of all-cause mortality in persons aged 50 years and older [4]. These statistics sparked research into better understanding the burden and risk factors of CVD, particularly in the MENA region. The importance of lifestyle modifications, particularly diet, to the prevention of CVD is undisputable [5]. Early evidence came from data on trends in food consumption and ecological studies showing associations between prevalence of CVD and fat intake across and within countries [6]. For many years to follow, research continued to document a relationship between diet and CVD risk factors. Specifically, epidemiologic, experimental, and clinical trial studies have demonstrated a relationship between diet, nutrients, and blood lipid levels, blood pressure, and coronary heart disease (CHD). Improvements in diet and reduction in weight were shown to lower the risk of CVD by exerting favorable changes on CVD risk factors including obesity, high blood pressure, elevated serum lipids, and diabetes [7]. Accurately assessing and understanding the role of diet in the prevention and management of CVD is crucial in developing and implementing strategies to minimize the heavy burden of CVD.

Traditional nutrition epidemiology investigating the association between diet and CVD has focused on a single or few nutrients and foods. This conventional approach has several limitations mainly the interaction between nutrients, confounding by foods/nutrients not eaten and the problem of collinearity [8]. To overcome these limitations, nutritional epidemiologists have recently proposed studying dietary patterns as an alternative approach to evaluate diet-disease associations [9-11]. This novel approach looks beyond the single nutrient or food and attempts to capture the broader picture of diet that is hypothesized to discriminate between health and disease [12]. The derivation and analysis of dietary patterns have been done either empirically using data-driven methods or theoretically using hypothesis-driven methods [8, 13-16]. Cluster analysis and factor analysis are broadly categorized as “empirically-driven” approaches that derive a posteriori patterns, while index analysis is a “hypothesis-driven” approach that creates patterns based on a priori decisions [17]. Whether derived theoretically or empirically, dietary patterns analyses have been consistently shown in the literature to be a valid and reproducible approach of investigating diet disease association. The reproducibility and validity of dietary patterns over periods of time, varying from one to seven years, have been recently examined. Confirmatory factor analysis, discriminate analysis as well as correlation analysis between pattern scores at baseline and pattern scores at different points of time, showed good reproducibility and stability of the derived patterns [9, 18-24].

In this paper, we aim to shed light on the advantages of using the dietary patterns approach in evaluating the role of diet in CVD prevention and management and to report on the effect of major dietary patterns on CVD risk factors among Lebanese adults. The significance of this type of research to primary care physicians is also discussed.

USING THE DIETARY PATTERNS APPROACH
THE ADDED VALUE

Until recently, nutrition research has largely focused on the reductionist approach, with investigations into relationship between diet and CVD addressing single nutrients or food groups and specific biological effects or markers [25]. While this type of research has greatly advanced our understanding of the dietary risk factors for CVD, this approach has several conceptual and methodological limitations for implementing changes.

In the real world, foods are actually consumed in various characteristic combinations that deliver a variety of nutrients which can have either synergistic or interactive metabolic actions. For this reason, it is often difficult to separate out the specific effects of nutrients or foods. For example diets high in fiber tend to be high in vitamin C, folate and carotenoids, magnesium and potassium. Thus the presence of any association between fiber and CVD is not certain to be due solely to fiber. The traditional approach based on single nutrient or food resorted to multiple linear and logistic regression models to account for the interaction and synergistic effects of the remaining nutrients and foods. However, with many correlated exogenous variables, these models are unstable and may result in large confidence intervals for the regressions parameters [26]. Furthermore, when a large number of variables are entered in a regression model, it is likely to obtain significant association simply by chance [8].

As a result, the single nutrient approach precluded consistent confirmation of relationships between diet and CVD. Studies at the nutrient level have often reported null associations or findings inconsistent with established knowledge with regards to the role of specific foods or nutrients in the etiology of CVD. A recent example relates to the association between saturated fatty acids intake and the risk of CVD. While saturated fat has long been recognized as the most important fat to avoid, 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) [27]. 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 [28], however, these findings were challenged by three case control studies that found no protective effect of dietary intake, plasma or adipose concentrations of n-3 fatty acids on nonfatal myocardial infarction [29-31]. While the “oxidation modification hypothesis of LDL” supports a biological role for vitamin E in preventing CVD, the results of RCTs conducted to assess the effect
of vitamin E intake on CVD were disappointing [32]. A meta-analysis of seven randomized placebo-controlled trials of vitamin E supplementation, with doses ranging between 50 to 800 IU, showed no benefits for total or CVD mortality [33]. While researchers and policymakers can justify the need for continued study to confirm or refute a certain link between nutrients and CVD, the health care practitioner as well as the general public may become confused and skeptical as messages change regarding nutrients recommendations for CVD prevention and management.

Consequently, there has been a growing appreciation that the overall dietary pattern, rather than any single nutrient, need to be considered in relation to studying the association between diet and disease. Cardiovascular diseases, in particular, have complex etiology and it is unlikely that their development will be mediated by a single nutrient or food [8, 13-14, 16, 34]. So, conceptually, the evaluation of the overall dietary patterns appears closer to the real world as people “do not eat nutrients they eat food” [8]. The use of the dietary pattern approach to study diet-disease association might help capture the complexity of diet that is often lost in nutrient-based analyses. Furthermore, this approach accounts for the collinearity or inter-correlations between nutrients or foods [15]. Interventions studies have indicated focusing on the dietary patterns led to more consistent findings in relation to CVD risk factors as compared to single nutrient approach and resulted in a decreased blood pressure and reduction of cardiovascular complications [35-36].

Lastly, studying dietary patterns are more likely to have important public health implications because the overall patterns of dietary intake might be easy to interpret or translate by the public as well as by health care professionals into diets and dietary recommendations [37]. Furthermore, given the fact that recommendations stemming from the dietary pattern approach are culturally sensitive, their integration and adoption by the general public is more likely. In fact, the prevailing dietary guidelines emphasize dietary patterns in the prevention of CVD [38]. Studying dietary patterns in relation to disease outcomes thus provides a practical way to evaluate the health effects of adherence to dietary guidelines by individuals [39].

**DIETARY PATTERNS & CARDIOVASCULAR DISEASES RISK FACTORS**

Regardless of what method is used to derive dietary patterns, most of the studies depict two main patterns: the “Prudent” pattern, generally characterized by vegetables, fruit, legumes, fish, poultry, and whole grains, and the “Western” pattern, characterized by red meat, processed meat, refined grains, french fries, and sweets/desserts. In both the Nurses Health Study (NHS) [40] and the Health Professionals follow-up study (HPHS) [41], the Prudent pattern was associated with reduced risk for CHD (Q5 vs. Q1 NHS RR = 0.76, 95% CI: 0.60-0.98, p for trend = 0.03; Q5 vs. Q1 HPFS RR = 0.70, 95% CI: 0.56-0.86, p for trend = 0.0009) while the Western pattern was associated with significantly increased risk (Q5 vs. Q1 NHS RR = 1.46, 95% CI: 1.07-1.99, p for trend = 0.02; Q5 vs. Q1 HPFS RR = 1.64, 95% CI: 1.24-2.17, p for trend < 0.00001). In the Nurses Health Study, the Prudent diet was also associated with 28% lower CVD mortality (95% CI: 13-40%) [42]. Similar results were shown in the World Health Organization-Monitoring Trends and Determinants in Cardiovascular Disease study in Denmark, where the Prudent pattern was associated with lower CVD mortality (RR for 1 SD increase = 0.63, 95% CI: 0.44-0.90) in women, but not men [43]. As dietary patterns analysis has moved beyond North America and Europe, many studies have identified ethnic or country-specific “traditional” patterns in addition to the Western and the Prudent patterns [15]. The association between “traditional” patterns and the risk of CVD depends to a large extent on the population studied [44].

In addition to the empirically derived patterns described above, there is a compelling evidence, from both observational and intervention studies, that Mediterranean and the Dietary Approaches to Stop Hypertension (DASH) patterns, both of which are hypothesis-driven patterns, possess a protective effect for CVD risk factors [44]. The Mediterranean dietary pattern has been described to include (i) daily consumption of unrefined cereals and cereal products, vegetables (2-3 servings), fruit (4-6 servings), olive oil, dairy products (1 or 2 servings), and red or white wine (1-2 wine glasses); (ii) weekly consumption of potatoes (4-5 servings), fish (4-5 servings), olives, pulses, and nuts (more than 4 servings) and eggs and sweets (1-3 servings); and (iii) monthly consumption of red meat and meat products (4-5 servings) [45]. The DASH pattern is rich in fruit, vegetables, and low-fat dairy products, includes whole grains, poultry, fish, and nuts, and limits saturated fat, red meat, sweets, and sugar containing beverages [46].

**DIETARY PATTERNS & CARDIOVASCULAR DISEASES RISK FACTORS: THE CASE OF LEBANON**

In Lebanon, our Public Health and Nutrition (PHAN) research group at the American University of Beirut recently reported on the various dietary patterns among Lebanese adults (aged 18 years and above) and their association with cardiovascular metabolic risk factors using data from the national Nutrition and Non-Communicable Disease Risk Factor survey conducted between years 2008 and 2009 [47-48]. The sample for this survey was drawn from randomly selected households based on a stratified cluster sampling: The final distribution of the study sample (n = 2048) by sex and 5-year age group was similar to that of the Lebanese population as estimated by the Central Administration for Statistics in Lebanon [49]. Details about the design and conduct of the study are published elsewhere [47-48]. Briefly, face-to-face interviews were conducted using a standard...
questionnaire that included information about basic socio-demographic, lifestyle characteristics and co-morbidity. In addition, blood pressure, anthropometric measurements, including weight, height and waist circumference, were taken using standardized techniques and calibrated equipment. Dietary intake was assessed by a 61-item food frequency questionnaire (FFQ) that estimated food and beverage intake over the past year. Biochemical measurements including serum levels of TAG, HDL-C, and glucose were taken from a subsample of survey participants (n = 323) who consented to give a fasting blood sample.

For each food item listed on the FFQ, a standard portion size was indicated and five frequency choices were given. The FFQ was designed by a panel of nutritionists and included culture specific dishes and recipes. For the purpose of the determination of dietary patterns, food items were grouped based on similarities in ingredients, nutrient profile and/or culinary usage. Food items having a unique composition that differed from other groups (e.g. eggs, olives, and mayonnaise) were classified individually. Exploratory factor analysis was implemented to identify dietary patterns. The rotated factor loadings matrix was extracted (Varimax rotation). The derived dietary patterns were labeled based on food groups having a rotated factor loading greater than 0.4. Factor scores were calculated by multiple regressions.

Dietary patterns among Lebanese adults
Two major dietary patterns were identified: “Western” and the “Traditional Lebanese”. These two patterns explained most of the variance in dietary intake in the studied population. Table I shows the food groups that were included in these dietary patterns. Food items included in each listed food group are listed in Appendix A. The Western pattern was characterized by high intakes of fast food sandwiches in addition to pizzas, pies, desserts, carbonated beverages, butter, juices and mayonnaise. The Traditional Lebanese pattern was characterized by high intakes of fruits and vegetables, olives and olive oil, traditional dishes and desserts, eggs and whole dairy products. In order to further characterize these patterns, their associations with energy, and selected nutrients were investigated using energy adjusted correlation analyses. Though high in both patterns, energy intake was higher in the Western pattern. The latter was characterized by high intake of total fat, saturated fats, sodium and sugars. On the other hand, the Traditional Lebanese pattern was associated with higher intake of protein, carbohydrates, fiber, calcium, omega-6 fatty acids and cholesterol (Figure 1).

<table>
<thead>
<tr>
<th>Western Pattern</th>
<th>Traditional Lebanese Pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fried potatoes</td>
<td>Fruits</td>
</tr>
<tr>
<td>Pizza and pies</td>
<td>Vegetables</td>
</tr>
<tr>
<td>Regular soda</td>
<td>(including starchy vegetables)</td>
</tr>
<tr>
<td>Fast food sandwiches</td>
<td>Legumes</td>
</tr>
<tr>
<td>Mayonnaise</td>
<td>Burghol</td>
</tr>
<tr>
<td>Sweets</td>
<td>Whole milk and milk products</td>
</tr>
<tr>
<td>Cured meat</td>
<td>Eggs</td>
</tr>
<tr>
<td>Meat and poultry</td>
<td>Dried fruits</td>
</tr>
<tr>
<td>Bottled fruit juices</td>
<td>Grains</td>
</tr>
<tr>
<td>Ice cream</td>
<td>Vegetable oil</td>
</tr>
<tr>
<td>Butter</td>
<td>Nuts and dried fruits</td>
</tr>
<tr>
<td></td>
<td>Traditional sweets</td>
</tr>
<tr>
<td></td>
<td>Traditional Lebanese dishes</td>
</tr>
<tr>
<td></td>
<td>Shawarma and falafel sandwiches</td>
</tr>
</tbody>
</table>

FIGURE 1. Energy and energy adjusted nutrients characterizing the Western and Traditional Lebanese patterns. Association between the dietary patterns and energy and energy adjusted nutrients were evaluated using Pearson correlation coefficients. Energy adjustment was carried out using the residual method as described by Willet et al., 1997.
Association between dietary patterns and socio-demographic, lifestyle characteristics

Further analysis of the survey data conferred consistent associations of certain socio-demographic and lifestyle characteristics with adherence to dietary patterns as assessed by multiple linear regressions. For instance, younger subjects followed the Western pattern while females were more likely to consume a traditional Lebanese pattern. Although both patterns were associated with snack consumption, only the Traditional Lebanese pattern was associated with a higher frequency of breakfast consumption per week. Eating while watching television and eating out were two features that were found to be associated with the consumption of the Western pattern [47-48].

Association between dietary patterns and CVD risk factors among Lebanese adults

Table II presents a summary of the associations found between the “Western” and the “Traditional Lebanese” patterns with cardiovascular risk factors. These risk factors included obesity and the metabolic syndrome and its abnormalities, consisting of elevated blood pressure, blood levels of TAG, LDL and glucose and elevated waist circumference. Linear regression analyses showed that the greater the adherence to the Western pattern, the higher were the body mass index (BMI) and waist circumference ($\beta = 0.49$, 95%CI: 0.21-0.76 and $\beta = 1.08$, 95%CI: 0.39-1.76 respectively) net of the effect of other confounding variables.

Multiple logistic regressions analyses showed that subjects belonging to the fifth quintile of the Western pattern factor scores had higher risk of hyperglycemia (OR: 3.81; 95%CI: 1.59-9.14) and three times the odds of metabolic syndrome (OR: 3.13; 95%CI: 1.36-7.22). The Traditional Lebanese pattern, on the other hand, showed no association with any of the cardiovascular metabolic risk factors considered in both studies.

The Traditional Lebanese pattern is generally considered a Mediterranean pattern; however it is important to note that Mediterranean diets may vary from one country to the other among the countries of the Mediterranean basin [50]. The Traditional Lebanese pattern is highly loaded on fruits and vegetables which are likely to associate negatively with the risk of cardiovascular metabolic risk factors. However, some energy dense foods such as whole dairy products and traditional sweets were also heavily consumed in this dietary pattern and may have counteracted the protective effects of fruits and vegetables on CVD risk factors. A recent study in rural Lebanon indicated that adherence to a Mediterranean diet, as assessed using the widely used Mediterranean diet score (MDS), is negatively associated with obesity and visceral adiposity among adults [51]. With few modifications, the Traditional Lebanese pattern found in our study could encompass most features of the typical Mediterranean diet. Such modifications include limiting the intake of refined grains and replacing them with unrefined cereals and cereal products and adding weekly consumption of fish (4-5 servings). This modified Traditional Lebanese pattern could eventually produce protective effects on the CVD risk factors (similar to the Mediterranean diet) while keeping the culture-specific nature of a traditional diet.

**SIGNIFICANCE OF DIETARY PATTERNS RESEARCH TO PRIMARY CARE PHYSICIANS**

The advantages of the dietary patterns approach in evaluating diet-disease associations are of particular significance for health care providers. Until a dietitian or a nutritionist is fully integrated within the primary health care team, the primary care physicians and family physicians are uniquely positioned to provide nutrition counseling to the majority of health care consumers [52]. Furthermore, patients perceive family doctors as one of the most reliable sources of information on food and nutrition. However, almost every published study about physicians and nutrition counseling showed that primary care physicians, although supportive, were not delivering nutrition services to their patients [53]. When asked about the barriers to providing nutrition counseling, family care physicians cited, among other barriers, lack of time, the contradictory and complex nature of nutrition recommendations, and the lack of cultural adaptability of most of these recommendations. The study of the association between dietary patterns and the risk of CVD offers family care physicians a simple, consistent and culturally sensitive tool to be used in nutritional counseling.

Family care physicians in Lebanon are encouraged to integrate in their nutritional counseling the results of research on dietary patterns association with CVD risk factors particularly those stemming from the Lebanese
population. Table III outlines the messages that could be used in nutritional counseling by family care physicians to prevent and manage CVD. The two main messages are 1) limiting the consumption of Western dietary pattern, and 2) encouraging the adoption of a neo-Traditional Lebanese pattern.

CONCLUSION

Findings from dietary patterns research provide invaluable evidence towards a more effective nutritional counseling tool for CVD prevention and management. Their usefulness was reported by James (2009) who stated “Examining dietary patterns rather than specific nutrients may better allow public health professionals to translate dietary goals into practical dietary recommendations that are culturally relevant” [54].

The advantages of the dietary pattern approach coupled with evidence-based associations between dietary patterns and CVD risk factors in Lebanon lay ground for a potential benefit to use this novel approach in nutritional counseling, especially by family care physicians. The main recommendations derived from our research is to discourage the intake of fast food and other energy dense foods such as pies and pizzas, fried potatoes and sweets and, second, promote the consumption of a modified Traditional Lebanese dietary pattern based on fruits, vegetables, traditional mixed dishes and rich in nuts, olive oil and fish consumption.

REFERENCES

50. Kastorini CM, Milionis HJ, Esposito K, Giugliano D, Goudevenos JA, Panagiotakos DB. The effect of Mediterr-


---

**APPENDIX A**

FOOD ITEMS INCLUDED IN THE FOOD GROUPS USED IN FACTOR ANALYSIS FOR DIETARY PATTERNS DERIVATION

<table>
<thead>
<tr>
<th>FOOD GROUP</th>
<th>COMPONENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bottled fruit juices</td>
<td>All types of sweetened and bottled fruit juices</td>
</tr>
<tr>
<td>Burghol</td>
<td>Crushed parboiled wheat</td>
</tr>
<tr>
<td>Butter</td>
<td>Butter and ghee</td>
</tr>
<tr>
<td>Cured meat</td>
<td>Luncheon, sausages, offals</td>
</tr>
<tr>
<td>Eggs</td>
<td>Eggs both boiled and fried</td>
</tr>
<tr>
<td>Fast food sandwiches (including hamburger)</td>
<td>Burgers and fahitas</td>
</tr>
<tr>
<td>Fried potatoes</td>
<td>Potato fried, potato chips</td>
</tr>
<tr>
<td>Fruits</td>
<td>Deep yellow orange fruits, bananas and apples, strawberries, citrus fruits, grapes, fresh fruit juices</td>
</tr>
<tr>
<td>Grains</td>
<td>Bread whole and refined, rice and rice products, pasta</td>
</tr>
<tr>
<td>Ice cream</td>
<td>All types of ice cream, traditional and packaged</td>
</tr>
<tr>
<td>Legumes</td>
<td>Beans, lentils, chickpeas, favo beans</td>
</tr>
<tr>
<td>Mayonnaise</td>
<td>All types of mayonnaise salad dressing</td>
</tr>
<tr>
<td>Meat and poultry</td>
<td>All types of red meat and poultry cooked, fried or broiled</td>
</tr>
<tr>
<td>Nuts and dried fruits</td>
<td>Nuts, both raw and roasted, dried raisin, prunes, and apricots</td>
</tr>
<tr>
<td>Olives and olive oil</td>
<td>All types of pickled olives in addition to olive oil</td>
</tr>
<tr>
<td>Pizza and pies</td>
<td>Pizza, manaæesh cheese, manaæesh thyme, manaæesh kishk (kishk is a traditional yogurt based product)</td>
</tr>
<tr>
<td>Regular soda</td>
<td>Sugar sweetened carbonated beverages</td>
</tr>
<tr>
<td>Sweets</td>
<td>Cakes, cookies, doughnuts, muffins, honey, jam, sugar, chocolate.</td>
</tr>
<tr>
<td>Traditional sweets</td>
<td>All kinds of traditional sweets including baklava, ma’amoul, knafeh and traditional ice cream</td>
</tr>
<tr>
<td>Vegetable oil</td>
<td>Vegetable oil</td>
</tr>
<tr>
<td>Vegetables (including starchy vegetables)</td>
<td>Dark green yellow vegetables, tomato, salad season, zucchini and eggplant, cauliflower and potato</td>
</tr>
<tr>
<td>Whole milk and milk products</td>
<td>Whole milk, regular cheese, lebneh, regular yogurt</td>
</tr>
</tbody>
</table>