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The relationship between lifestyle components and dietary patterns

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We conducted a narrative review on the interaction between dietary patterns with demographic and lifestyle variables in relation to health status assessment. The food pattern has the advantage of taking into account the correlations that may exist between foods or groups of foods, but also between nutrients. It is an alternative and complementary approach in analysing the relationship between nutrition and the risk of chronic diseases. For the determination of dietary patterns one can use indices/scores that evaluate the conformity of the diet with the nutrition guidelines or the established patterns (*a priori* approach). The methods more commonly used are based on exploratory data (*a posteriori*): cluster analysis and factor analysis. Dietary patterns may vary according to sex, socio-economic status, ethnicity, culture and other factors, but more, they may vary depending on different associations between these factors. The dietary pattern exerts its effects on health in a synergistic way or even in conjunction with other lifestyle factors, and we can therefore refer to a ‘pattern of lifestyle’.

Dietary pattern: Lifestyle: Dietary assessment

Historically, nutritional literature has often reported on issues regarding the role of individual nutrient on health, but not all nutritional compounds in foods have been fully studied. The nutrient composition of foods varies considerably, and there are probably synergistic interactions between the nutritional components within any food, a topic that has been increasingly talked about lately⁽¹⁾. Moreover, difficulties related to these interactions are also reflected in our present knowledge about the dietary patterns that people commonly consume. However, dietary patterns should be included in the development and implementation of nutritional guidelines, which could improve the chances of preventing non-communicable chronic diseases⁽²⁾.

It is worth mentioning that diet, as a lifestyle component, exerts its effects on health in a synergistic way or even in conjunction with other factors, which would not be reflected by examining each individual factor in isolation^(3–5). In nutritional research where only individual life factors were investigated, sophisticated statistical methods such as linear and logistic regression models have been selected to take into account the interaction and synergistic effects between these factors^(6,7).

The prevalence of chronic diseases increases as countries develop and become more industrialised. These diseases include obesity, high blood pressure, CVD, type-2 diabetes, neoplasms and many more. Dietary patterns play an important role in health and therefore in the

Abbreviation: DQI, diet quality index.

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prevention of chronic diseases⁽⁸⁾. Dietary patterns could as such provide a clearer, more accurate picture of a person's eating behaviour⁽⁹⁾. These models represent the interaction of all food choices that form a complete food pattern. These patterns are influenced by many factors, such as climate, demographics, religion, culture and others⁽⁸⁾.

The WHO considers diet to have the most important role in the prevention of chronic diseases and to be one of the most important lifestyle factors, emphasising the importance of understanding its complexity and its relationship with chronic diseases⁽¹⁰⁾. In addition to the unhealthy diet, the WHO identifies other important behavioural factors, such as physical inactivity, smoking and increased alcohol consumption as common risk factors for chronic diseases^(11,12).

Diet is one of the modifiable behaviours that can help reduce cardio-metabolic risk and prevent chronic diseases, so an assessment of the general dietary intake of the population becomes essential⁽¹³⁾.

However, it is imperative to investigate the lifestyle pattern as a whole, in order to better understand its implications on health and disease⁽⁵⁾. The aetiology of chronic diseases is complex and depends more on exposure to more overlapping/cumulative environmental factors rather than on exposure to a single factor, so the adoption of such holistic integration is encouraged. In fact, several prospective, or randomised, epidemiological studies have shown that these modifiable environmental factors, mentioned earlier, are all involved in the prevention and/or management of chronic diseases. There is also a lot of research on the association between each of these factors taken individually and in various chronic diseases. However, lifestyle factors most often exert their effects in a synergistic manner, a fact that would not be clear when studying each individual factor⁽¹⁴⁾.

Compared to the classical methods used in nutritional epidemiology, the approach of the lifestyle pattern confers a holistic representation in investigating the predisposing factors for the emergence of non-communicable chronic diseases⁽¹⁵⁾. Instead of examining a single factor (diet, physical activity, smoking, alcohol consumption and sleep) and its association with health/illness, this approach studies the entire lifestyle pattern and the inter-relationships that may exist between these various lifestyle factors. As a result, a lifestyle pattern is distinguished as a dynamic interaction between factors, rather than emphasising each individual factor. Thus, the effects of a lifestyle pattern on cardio-metabolic health would outweigh those of its components taken individually (diet, physical activity, alcohol, smoking and sleep) and could thus detect more associations and implications in real life⁽³⁾.

Understanding dietary and lifestyle patterns would provide necessary evidence for planning intervention and education strategies⁽¹⁶⁾.

Assessment of dietary intake

Of all the available subjective methods that evaluate a person's nutritional intake: 24-h recall, food record,

food history and FFQ, the last has been the most widely used in epidemiological research. Nutritional data have been obtained either by a trained interviewer or through self-reporting⁽¹⁷⁾.

FFQ is the most appropriate dietary assessment tool because it is easy to apply by the researcher. The method is actually an advanced form of food history. It has two components: a qualitative one that investigates the frequency of consumption of a food, and a quantitative one that estimates the amount of food consumed with the aid of a photographic atlas or using some culinary measures. The subjects answer on how often and how much food they have consumed in a given period of time⁽¹⁸⁾. FFQ can focus on the intake of specific nutrients⁽¹⁹⁾, dietary exposure to a particular group of foods only (which may be linked to a particular disease)⁽²⁰⁾ or on assessing the inter-correlations between nutrients and between foods (i.e. the dietary pattern) with their effects on health status/risk of disease^(21,22).

In addition to nutritional inquiry, particular biochemical markers have been used to measure the dietary intake of specific nutrients or foods^(23–25). Nutritional biomarkers offer objective estimates of dietary exposure in anthropometric and clinical assessment, while 24-h recall, food record, food history and FFQ are subjective estimates⁽¹⁷⁾. However, some biomarkers may be affected by disease or physiologically, by homeostatic regulation, so they cannot provide information on the absolute dietary intake of the subject. In addition, dietary recommendations aimed to change the eating habits of a subject cannot be made solely on the basis of biomarkers⁽²⁶⁾. Thus, direct assessment of food intake through surveys can sometimes be more informative than biomarkers⁽²⁷⁾.

However, in order to obtain the most accurate estimates of food intake, it has been proposed that a combination of methods, such as FFQ with 24-h recall or FFQ with biomarkers, should be used, instead of individual method⁽¹⁷⁾.

Dietary pattern methodology

FFQ is a reliable and inexpensive data collection method, which allows the identification and evaluation of food patterns in epidemiological studies⁽²⁸⁾. Although dietary patterns based on the 24-h recall do not most accurately assess an individual's usual eating patterns, it is also a widely accepted method for evaluating food intake at the population level⁽²⁹⁾.

Food pattern analysis has the advantage of taking into account the correlations that may exist between certain foods or groups of foods, but also between nutrients⁽³⁰⁾. It represents a broader picture of dietary intake, analysing the effects of diet as a whole. It is an alternative and supportive approach to analysing the relationship between nutrition and the risk of chronic diseases, thus being more predictive of the risk of disease compared to individual foods or individual nutrients⁽³¹⁾.

Two different statistical approaches have been used in the literature for analysing dietary patterns⁽³²⁾:

- (1) *a priori* or theoretical approach which consists of defining certain quality scores or indices of the diet based on nutritional recommendations, for different categories of subjects^(33,34);
- (2) *a posteriori* approach which is defined by the use of methods based on exploratory data:
 - (i) dietary patterns based on variations in food intake, using factorial analysis (principal component analysis) or cluster analysis^(35,36)
 - (ii) dietary patterns based on a combination of exploratory data and *a priori* knowledge about a disease (information on the pathological mechanisms of the diseases in relation to certain food models), identified using the low-rank regression^(37,38).

Both factor analysis and cluster analysis are considered *a posteriori* because food models are obtained by statistical modelling of dietary data⁽³⁹⁾. One of the *a posteriori* approaches is to derive food patterns based on the variation in specific markers related to health/disease^(40,41). However, there are some limitations, in the sense that if one cannot take into account the daily variation of dietary intake at the individual level, the statistical power in detecting the correct and real associations between the dietary patterns and certain diseases can be reduced⁽⁴²⁾. Because *a posteriori* approaches generate patterns based on available empirical data, but which do not have an *a priori* hypothesis, they do not necessarily represent optimal models. Conversely, the approach of the quality index also presents some limitations (present knowledge and the ability to understand the diet–disease relationship), as well as uncertainties in selecting the individual components for the composition of the score and uncertainties related to the subjectivity in defining some cutoff points⁽³²⁾.

Although these approaches are based on different methods, all of them can help identify healthy or unhealthy dietary patterns and can be the basis for developing and implementing nutritional guidelines⁽²⁾.

A priori methods

These methods use nutritional variables that are quantified in such a way that they could provide an overall assessment of diet quality, thus being important for the definition of health status⁽⁴³⁾.

A priori approaches based on scores are constructed according to certain dietary guidelines and include selected nutrients and/or foods and/or food groups, according to nutritional recommendations, thus establishing a certain score. Later, the data are grouped, referring to the predefined ones, to obtain a score (a measure of diet quality)⁽⁴⁴⁾.

The diet quality index (DQI)⁽⁴⁵⁾ is a score of the degree to which an individual's diet is in accordance with the specific dietary recommendations. DQI are tools that aim to assess the quality of diets and thus allow individuals to be classified based on the degree to which they have a 'healthy' eating behaviour⁽³⁵⁾. Individuals are scored for each component, then a score is calculated

for each individual; high scores reflect dietary intake according to nutritional recommendations⁽⁴⁶⁾.

Another simple and common score is the dietary diversity score, which takes into account the number of portions in the food groups (i.e. dairy, meat, cereals, fruits and vegetables) or foods consumed regularly^(47,48).

Presently, there are a large number of DQI, most of them being designed, defined or adapted to express the nutritional needs of different population groups and to highlight the compliance to specific food patterns⁽⁴⁹⁾.

There are three major categories of indicators:

- (1) nutrient-based indicators, which need to be transformed from quantity (weight of food) to quality (nutrient content), and subsequently compared with standard requirements⁽³³⁾;
- (2) food/food group-based indicators that use food guides to assess portions, frequencies or food groups⁽⁵⁰⁾;
- (3) a combination of indicators, which refer to dietary variety within and between food groups, to adequate nutrient intake (compared to standard recommendations) or to suitable intake of food groups (quantities or portions), to the frequency of food consumption, and also to a general balance of macronutrients⁽⁵¹⁾.

DQI use a scoring system, which can establish adherence to a dietary model defined *a priori* and can thus be used to measure the quality of diets within a population. The best example is the healthy eating index. This is a DQI, created and validated in 1995 by the US Department of Agriculture, to reflect the nutritional recommendations in the Dietary Guidelines for Americans⁽⁵¹⁾.

The analysis of the updated healthy eating index-2015 captures the variation of diet quality in a way that takes into account the multivariate nature of healthy diets. This method of evaluation, the updated index, captures some elements of real interest: high-quality diets have high scores, scores vary within the population, diet quality varies between different groups of people, diet quality is evaluated independently of quantity, diet quality is multidimensional, distinct dietary components can be captured, and not least, it is associated with a reduced risk of general mortality and morbidity, showing the validity of the criterion⁽⁵²⁾.

The main advantage of the *a priori* method is its generalisation (it can be applied to several populations)⁽⁴⁴⁾. Each DQI has different food and nutrient components, as well as different approaches to score, which makes comparability limited. Moreover, most DQI have been developed only for certain specific populations and cannot be widely used in others. Also, it is difficult to compare the results between studies using different DQI⁽⁵³⁾. The subjectivity of the investigator responsible for the definition of indices, and the fact that they are based on nutritional recommendations, which have been defined for certain populations, thus not making them possible to be applicable to others⁽⁴⁴⁾, could be major disadvantages when analysing data.

A posteriori methods

The study of nutritional patterns using data extraction methods, based on correlations between food groups, has been proposed in nutritional epidemiology by most researchers⁽⁸⁾. For this purpose the statistical techniques used are: factor analysis, cluster analysis and low rank regression⁽⁴⁴⁾.

Factor analysis (principal component analysis) is a multivariate statistical technique, which uses information obtained from FFQ to identify food consumption factors (or patterns)⁽³⁹⁾. It aggregates and reduces the dietary data to a correlation between foods, which would explain the greatest variation in the diet of the studied group⁽⁵⁴⁾. A score is obtained for each model (factor and dietary pattern), which can be used subsequently, by statistical methods of correlation or regression, to examine relationships, such as, for example, nutrient intake, in association with cardiovascular risk factors and other biochemical indicators of health⁽³⁹⁾. The use of factor analysis to identify food patterns may have limitations. The results of factor analysis can be affected by subjective, but important, decisions that need to be taken in defining the food pattern: the allocation of food in food groups, which variables to be included in the analysis to build the patterns, which variables can contribute to the definition of a factor, the number of extraction factors, the rotation method and even the labelling of factors (the name of the pattern). Such decisions can lead to erroneous conclusions⁽⁴⁴⁾. However, this method offers the opportunity to summarise and refines the data to a simpler descriptive model⁽⁵⁵⁾.

Principal component analysis has a long-term reproducibility, stability and validity compared to other methods⁽⁵⁶⁾ that could minimise the risk of errors. Unlike cluster analysis that involves empirical classification, principal component analysis theoretically establishes a causal relationship between indicators (items). It does not describe the natural patterns of the population in the study, but explains the important variation within the population⁽⁵⁶⁾.

However, exploratory analysis is used when there is an *a priori* hypothesis about the factor structure. As such, its advantage is that it reduces some of the subjectivity associated with the exploration procedure and can be applied in different population samples⁽⁴⁴⁾.

Using factor analysis, most researchers identified two major patterns. The first pattern, labelled 'prudent', is in general characterised by a higher intake of vegetables, fruit, legumes, whole grains and fish, while the second pattern, labelled 'western', is characterised by a higher contribution of processed meat, red meat, butter, high fat dairy products, eggs and refined grains. The main patterns identified by factor analyses are in accordance with the *a priori* knowledge⁽³²⁾. Another common pattern identified in European studies is the Mediterranean one, characterised by increased intake of vegetables, fruit, fish and olive oil⁽²²⁾. Moreover, this statistical methodology has been extended to other regions of the world, making it possible to identify another pattern, the traditional one. For example, the traditional Japanese

pattern⁽⁵⁷⁾, characterised by consumption of vegetables, seafood, soya, fish, fruit, green tea, miso soup; or the traditional Brazilian pattern⁽⁵⁸⁾, characterised by the consumption of white rice, grains, beer, fresh and processed meat.

Cluster analysis is another multivariate statistical method that allows the characterisation of food patterns. Unlike factor analysis, cluster analysis aggregates individuals into relatively homogeneous subgroups that have similar diets. Individuals can be classified into separate groups or similar groups based on the frequency of food consumed, the percentage of energy contributed by each food or food group, the average amount of food intake (g), nutrient intake or a combination of dietary and biochemical measures⁽³⁹⁾. A certain amount of subjectivity is also included in this method: the choice of variables to be included in the analysis and the number of factors to be included or at what level of significance to apply the variables⁽⁴⁴⁾.

The RRR (reduced rank regression) statistical method combines two sources of information (preliminary data and study data). RRR reduces the size of predictor variables (e.g. food intake or specific food groups) to the size of response variables (e.g. nutrients as biomarkers)⁽⁵⁹⁾. RRR analysis produces a linear combination of food groups that explains the maximum variation of response variables⁽⁶⁰⁾. RRR identifies linear functions of predictors that explain as many response variations as possible⁽⁶¹⁾. As with other *a posteriori* approaches, it is difficult to assess whether the food model can be applied to different groups of populations, and to compare the results later⁽⁶⁰⁾.

The results obtained by either of these methods indicate which food/beverage combination best predicts the health/disease condition. However, this approach itself does not take into account other non-dietary variables and thus cannot provide information on whether these associations between dietary pattern and health/disease persist after adjusting for socio-demographic or other lifestyle factors⁽³⁷⁾.

Other lifestyle components in relation to dietary patterns

From an epidemiological point of view, diet is a complex combination of exposures. However, experimental epidemiological studies often fail to certify the effects observed for all dietary components. The conventional approach adopted in food consumption investigations is focused on assessing the intake of energy, nutrients or foods as independent variables, and this does not take into account the effect of the diet as a whole on risk diseases, and confusions and interactions that may occur between different dietary components are not properly considered^(62,63).

Dietary patterns are supposed to illustrate the real situation of dietary availability and dietary practices of the studied population⁽⁶⁴⁾. As a result, they facilitate the identification of subgroups that adopt dietary habits that are compatible with risk or protection against chronic diseases and provide credible scientific support for developing dietary guidelines⁽⁶⁵⁾.



Diet is a major modifiable determinant of most chronic diseases. It is known that dietary choices are strongly influenced by socio-demographic determinants and other lifestyle factors. Therefore, identifying the determinants of food consumption is essential for examining their possible contribution to the prevalence of the disease⁽⁶⁶⁾.

Indeed, several individual factors have been shown to be associated with food patterns⁽⁹⁾. Both healthy and unhealthy dietary patterns may vary according to sex, socio-economic status, ethnicity, culture and other factors^(32,67), but moreover, they may vary depending on different associations between these factors. In recent years, researchers have tended to group lifestyle factors. These risk factors are not arbitrarily spread in the population, but they appear in combination with other lifestyle risk factors. The grouping of the risk factors of the lifestyle is related to a higher degree of association with different diseases than we would expect from each of the individual risk factors. Because lifestyle groups in a community can be associated with different patterns of demographic and social risk factors⁽⁶⁸⁾, identifying different lifestyle patterns and associated factors across the country may be helpful in finding high risk subgroups, which require appropriate interventions⁽⁶⁹⁾. For example, age and education are positively associated with a healthy diet (characterised mainly by high intake of fruit, vegetables or fish)⁽⁷⁰⁾. In addition, the connection between physical inactivity, smoking and young age was associated with an unhealthy diet⁽⁷¹⁾. Healthy diet (and its major healthy dietary components), moderate alcohol consumption, non-smoking status, normal weight and regular physical activity have been associated with a lower risk of premature mortality and a longer life expectancy⁽⁷²⁾. Moreover, there is much evidence that stresses the role of nutrition, in relation to that of physical activity and sleep, on health and mortality^(73,74).

The health consequences of adopting unhealthy lifestyle habits cannot be overestimated and, therefore, specific policy strategies or an appropriate action plan are needed to reduce adhering to an unhealthy diet and/or promote healthy diets, to reduce physical inactivity and/or promote physical activity or to reduce the increased consumption of alcohol and tobacco⁽¹⁶⁾. Given the potential for synergistic relationships between diet, physical activity, sleep, concomitant improvement of multiple lifestyle behaviours may have the potential to deliver greater health benefits compared to single behavioural improvement⁽⁷⁵⁾. Thus, identifying groups with healthier eating patterns would allow better nutritional strategies in terms of population nutrition⁽⁵⁶⁾.

Sex

In the literature, it is commonly found that women generally have higher scores for the pattern considered healthy and lower scores for the pattern considered unhealthy⁽⁷⁶⁾, while men are usually associated with unhealthy patterns (Western, Western-like or others, which are characterised by high fat, meat or fast-food intake)^(77,78).

Age

Several socio-demographic characteristics and family lifestyle were related to the child's eating patterns⁽⁷⁹⁾ and the nutritional status of the child⁽⁸⁰⁾. These factors are thus important to consider when studying the relationship between diet and weight status.

During childhood and adolescence, the evaluation and monitoring of food intake and other health behaviours is particularly important⁽⁸¹⁾, as these are decisive steps in forming eating habits and maintaining them into adulthood⁽⁸²⁾. In recent years, due to the increased prevalence of overweight worldwide, the need to monitor eating habits among young people has increased⁽⁸³⁾. One method that helps nutritional assessment in children/adolescents is the development of particular online nutritional surveillance systems, designed to collect periodic information on weight status (based on BMI), food consumption, hours of physical activity or sedentary behaviour, food consumption at school meals. Such data allow the following of anthropometric parameters, food patterns and other healthy/unhealthy behaviours, as well as their association with weight status^(81,84).

Changes in daily patterns, such as daily school hours or the weekends, clearly and significantly contribute to changes in food intake, to a pattern of physical activity, and ultimately to energy balance⁽⁸⁵⁾. In children, a so-called 'traditional' pattern was identified, characterised by a consumption of certain foods reported on school days, i.e. on weekdays (different from food consumption on non-school days, weekends or holidays). Food quality was found to be lower at the end of the week compared to the weekdays, with a significantly higher intake of total sugars⁽⁸⁶⁾, sweetened beverages, confectionery, pastry, snacks and at the same time, with lower consumption of fruit and vegetables⁽⁸⁷⁾. Therefore, school meals seem to play a particularly important role in promoting healthy eating, by creating opportunities and benefits for expanding the diversity of food groups and establishing a benchmark for healthy eating⁽⁸¹⁾.

Exploratory data-based methodologies to examine the interrelationships between eating patterns, physical activity and sedentary behaviours in children and adolescents have shown that healthy and unhealthy patterns are grouped in a variety of ways that are both beneficial and harmful to health⁽⁸⁸⁾. Thus, one can talk about the 'mixed' eating pattern, which is characterised by the presence of both healthy and unhealthy foods⁽⁸¹⁾.

A multitude of internal and external factors can influence adolescents' eating patterns. Internal factors include: self-image, physiological needs, individual health, values, preferences and psychosocial development. And among the external factors, there are mentioned: family habits, friendships, social and cultural values and rules, the media, individual tendencies, personal experience and knowledge⁽⁸⁹⁾.

The nutritional status of adolescents is the result of interrelated factors, influenced by the quality and quantity of food consumed and by the physical health of the

individual and has important implications for their health, thereby playing a key role in the development/prevention of several chronic diseases. During adolescence, changes in an individual's lifestyle may affect eating habits and choices, but there are also physical changes that affect the nutritional needs of the body⁽⁹⁰⁾.

One of the most common patterns among adolescents includes: snacks (usually high-energy foods), lack of a main meal (especially breakfast) or irregular meals, the predominance of fast-foods, with reduced consumption of fruit and vegetables⁽⁹⁰⁾. Thus, unhealthy eating patterns among young people could promote the prevalence of obesity and cardiovascular risk factors in this population group⁽⁹¹⁾. It is evident from epidemiological research that the pattern characterised by intake of meat and French fries has been associated with an increase in the prevalence of diabetes⁽⁹²⁾ and acute myocardial infarction, while a pattern characterised by fruit and vegetables has been proven to be protective⁽⁹³⁾.

Regarding older subjects, the literature found that they usually have a higher adherence to the fruit and vegetable patterns and are more likely to consume foods included in the healthy eating index⁽⁹⁴⁾ and a lower adherence to the meat and French fries pattern⁽⁷⁶⁾. However, also among the elderly, there was also a high score for the pattern with high fat and sugar intake. This could be due to several factors, including hypogeusia⁽⁹⁵⁾ or a decrease in financial capacity (which forces older people to buy less expensive, sweeter or high-fat foods)⁽⁹⁶⁾. Important components of the ageing process are included in the healthy eating pattern, as they contain nutrients that protect against systemic inflammation and endothelial dysfunction⁽⁹⁷⁾. Adopting this pattern would delay the onset of age-related diseases⁽⁹⁸⁾. The association between a healthy eating pattern and adherence to at least two other factors of a healthy lifestyle has been shown to be correlated with decreased mortality in the elderly⁽⁹⁹⁾.

Socio-economic determinants

Several variables (such as education, income, type of employment and some characteristics of the particular areas in which populations live) that characterise the socio-economic status of different populations around the world are closely linked to diet quality. However, there is no unanimity on how education or income levels affect diet quality⁽⁵³⁾.

Very complex interactions between education, income level and occupation are identified. A low level of education, a low income or a low professional position were associated with an unhealthy dietary pattern⁽⁷⁾ and with low quality diet, characterised by lower fibre, mineral and vitamin intake⁽¹⁰⁰⁾, while a higher educational level or higher professional position were associated with a healthy dietary pattern⁽¹⁰¹⁾.

Although not generally valid, in most cases the urban environment is associated with healthy eating patterns, which include greater dietary diversity and yet with a food intake of animal origin. In contrast, rural dwellers from low-income countries, and even some middle-income

countries, still rely on unhealthy food preservation methods (e.g. salting or smoking)⁽¹⁰²⁾.

The relationships between diet quality and socio-economic status internally are important to evaluate, as diet quality can be influenced by other factors (target population, unemployment, occupation of different family members, access to food, urbanisation in countries with small or large gross domestic products)⁽¹⁰³⁾. Unhealthy behaviours tend to be present, especially in people with low socio-economic status⁽⁶⁷⁾.

Highly educated participants had higher scores for fruit and vegetables and lower scores for fried meat and potatoes and to a lesser extent for fat and sugar models, a finding repeatedly reported in the literature⁽⁷⁶⁾. One likely explanation is that the dietary intake of highly educated persons is in line with dietary recommendations⁽¹⁰⁴⁾. These people tend to have higher incomes that allow them to buy more fruit and vegetables than less educated people⁽⁹⁶⁾.

Lower education has been associated with unhealthy eating patterns. Cheaper, unhealthier, high-risk foods for chronic diseases have been found more often especially among low-educated women⁽¹⁰⁵⁾.

Students

The Western lifestyle has led to changes in eating habits among young students in developing countries. The populations of university students are characterised by physical inactivity, sedentary behaviours and unhealthy dietary behaviours, i.e. irregular meals, inadequate snacks, high consumption of fast food and insufficient consumption of fruit and vegetables⁽¹⁰⁶⁾. To enable them to cope with the energy needs of the body, as they carry out their normal academic activities⁽⁹⁰⁾, most students consume frequent snacks outside the main meals. Low levels of physical activity and unhealthy eating patterns are not compatible with national recommendations for a healthy active lifestyle for young people and may contribute to increasing the rate of overweight and obesity in this population⁽¹⁰⁷⁾, and therefore individuals are more prone to developing type-2 diabetes mellitus and CVD^(108,109).

Smoking

There is extensive information on the relationship between nutrient intake and smoking; smoking is associated with less healthy eating behaviour, regardless of culture, ethnicity or region⁽¹¹⁰⁾. Smoking is associated with both reduced antioxidant intake and increased turnover of these micronutrients⁽¹¹¹⁾. Smokers usually have lower scores for the prudent model⁽¹¹²⁾. Present smoking selectively affects the consumption of specific foods. Possible explanations include non-adherence to dietary recommendations⁽¹⁰⁴⁾, as well as tobacco-induced changes in the sensory system, taste impairment⁽¹¹³⁾ and decreased olfactory capacity⁽¹¹⁴⁾, causing smokers to select foods with stronger/saltier/unhealthier flavours⁽⁹⁾.

Compared to non-smokers, smokers are more likely to adopt an unhealthy dietary pattern if they have a low educational level, but a lower probability of such pattern

if they have a high educational level⁽⁶⁷⁾. A low level of education, in combination with physical inactivity and smoking were linked also to a lower adherence to a Mediterranean-style diet⁽¹¹⁵⁾.

Alcohol

Moderate alcohol intake is an important component of the Mediterranean pattern⁽¹¹⁶⁾, which has been shown to be a protective factor against cardiovascular mortality, myocardial infarction or stroke⁽¹¹⁷⁾. Those who consume wine in moderation usually have healthier lifestyles than other types of alcohol consumers, smoke less and take more physical activity, with increased fruit and vegetable consumption and reduced red meat and fried foods⁽¹¹⁸⁾.

Increased alcohol consumption has been associated with the risk of hypertension⁽¹⁶⁾ and stroke⁽¹¹⁹⁾. Those who consume alcohol in high amounts tend to have associated unhealthy behaviours, such as poor quality diets, low physical activity and a general tendency for reckless actions that lead to an increased risk of mortality⁽¹²⁰⁾.

Previous dieting

The literature reports that those who have followed different diets over time have higher scores for the prudent model and lower scores for models characterised by meat, fries, fats and sugar, possibly due to increased awareness of the importance of food intake⁽¹²¹⁾. Due to the large variation in the type of diet, it is not possible to accurately assess the associations between each type of previous diet and the presently different dietary patterns⁽⁹⁾.

Sedentariness

Sedentary lifestyle is associated with a low adherence to the fruit/vegetable pattern and has the tendency to be associated with a higher score for the unhealthy pattern (animal fats and sweets). Such findings have been repeatedly reported in the literature⁽¹¹²⁾. Food patterns are closely linked to several lifestyle features⁽⁹⁾, which relate to sedentary behaviours, including watching TV. These behaviours were related to high consumption of sweetened beverages, ready-made products, sweet foods, snacks, fast food and alcohol⁽¹²²⁾.

Obesity

People with obesity may underestimate the intake of foods they consider to cause obesity. In general, increased BMI is associated with unhealthy dietary patterns⁽⁹⁾. The anthropometric parameters are related to the model 'fats and sugar, meat and fries'. This association may be due to the fact that most people do not consider meat as obesogenic⁽¹²³⁾. In addition, a better BMI is associated with the 'fruit and vegetables' pattern⁽¹²⁴⁾. Thus, frequent consumption of fruit and vegetables, while respecting restrictions on the amount of food consumed and at least moderate physical activity during leisure, are associated with a lower probability of overweight/obesity⁽¹²⁵⁾.

Sleep

Sleep disorders, including short sleep duration, are recognised as a risk factor for the negative outcomes of an unhealthy lifestyle⁽¹²⁶⁾. Sleep is a key modulator of metabolic functioning, including energy metabolism, glucose regulation and appetite⁽¹²⁷⁾; research conducted in recent years has focused on the effects of sleep duration and dietary intake, especially as sleep may present a modifiable risk factor for chronic non-communicable diseases, such as obesity⁽¹²⁸⁾. Short sleep duration is associated with a lower variety of foods and thus a lower intake of protein, carbohydrates, fibre and fat compared to normal sleep duration⁽¹²⁹⁾. In particular, total serum carotenoid concentrations were associated with a higher probability of short sleep duration (5–6 h per night) compared to normal sleep duration (7–8 h per night)⁽¹³⁰⁾.

The relationship between sleep and diet quality is bidirectional⁽¹³¹⁾. Sleep has an impact on diet, but conversely, diet/specific foods/dietary patterns have an impact on sleep⁽¹²⁸⁾. Short sleep duration is associated with weight gain through effects on appetite, physical activity and/or thermoregulation⁽¹³²⁾. An inverse association between sleep duration and BMI is described, however, long sleep on weekdays was associated with a lower score of healthy eating pattern compared to normal sleep duration⁽¹³³⁾. Another important consideration is not only the types of foods, but also regular meals, as well as the last meal at which these foods are consumed, which may be important for sleep⁽¹³¹⁾.

Transitions

The literature shows that dietary habits change over time (in the same individual or at the population level), and this helps us understand how changes in eating pattern are reflected in the health status⁽²⁸⁾. Diet and dietary pattern can undergo drastic changes during transitional periods: from a single person to a married person, or during certain significant events in the marital sphere (i.e. death and divorce), which have been shown to have repercussions on food consumption⁽¹³⁴⁾. Thus, further research should focus on and address changes in dietary patterns throughout life (with a greater focus on important life transitions).

Population movement within the same countries, from rural to urban areas, may also be related to these changes in diets, frequently to some healthier models⁽¹³⁵⁾. The linguistic region of a country is another major determinant of patterns, which have a particular distribution among the linguistic regions, apparently reflecting the cultural influence of the respective neighbouring countries on the food patterns⁽⁶⁶⁾.

When it comes to relationships, women in a couple are more likely to adhere to a healthy eating pattern, compared to single women, who are less likely to follow dietary recommendations⁽¹³⁶⁾.

During pregnancy, dietary composition can play an important role in pregnancy and fetal weight⁽¹³⁷⁾. During pregnancy it is essential that the dietary pattern be prudent, which provides the energetic and nutritional intake necessary for maternal health, so as to contribute



to the prevention of pregnancy-related diseases and to allow for fetal growth and development under favourable conditions. The nutritional status of the mother during the preconception and/or during pregnancy may affect the perinatal phase of the pregnancy outcome⁽¹³⁸⁾. Higher weekly weight gain is linked to greater adherence to a dietary pattern characterised by high intake of sweets, fast foods and snacks, while a pattern characterised by increased intake of vegetables, fruit and fish was not associated with gestational weight gain⁽¹³⁹⁾. Also, it was observed that the patterns do not change significantly over time. Therefore, a correct assessment of the food intake obtained at any given time during pregnancy can provide basic information about the dietary pattern throughout the pregnancy⁽¹⁴⁰⁾.

Breakfast

There is scientific evidence to suggest that the pattern of a meal is an important determinant of diet quality, energy consumption and nutrient content and, thus, cardio-metabolic health^(141,142). For example, skipping breakfast is associated with poor diet quality⁽¹⁴³⁾ and thus with adverse cardio-metabolic health outcome⁽¹⁴⁴⁾. The nutritional composition of breakfast should also be taken into account when this meal is present⁽¹⁴⁵⁾, as is the pattern of the other meals throughout the day⁽¹⁴²⁾.

In adults it has been shown that daily breakfast intake improves the intake of nutrients, the selection of food groups and therefore the quality of diet^(143,146). In general, breakfast consumption is associated with improved adiposity parameters⁽¹⁴⁷⁾, decreased cardiovascular risk factors⁽¹⁴⁸⁾ or decreased risk of adverse effects related to glucose and insulin metabolism. Breakfast can contribute to a healthier diet, which can also lead to cardio-metabolic improvements⁽¹⁴⁹⁾. Breakfast skipping is a very common practice among students and, despite this fact, and even if the consumption of certain food groups is avoided, the proportion of young people with overweight and obesity tends to increase⁽¹⁵⁰⁾.

Late meal in the evening/late night

Several cross-sectional studies have shown an association between late night food intake, in combination with skipped breakfast, and a higher risk of adverse health effects⁽¹⁴⁹⁾, including metabolic syndrome⁽¹⁵¹⁾.

This particular form of the late-meal pattern is present more frequently in young adults and students^(152,153) and refers to the chronological type, i.e. the individual preferences for sleep time and eating behaviour; morning or evening type⁽¹⁵⁴⁾. In terms of eating behaviour, studies show that evening types associate less healthy eating habits (main meal later in the day both on work- and non-working days, a tendency towards fewer meals daily, with larger portions, higher energetic intake and inadequate vitamins and minerals) and have a higher BMI^(154,155). Night time eating, in particular, has been identified as a risk factor for metabolic syndrome and obesity^(156,157).

The late evening meal was found to be associated with sleep apnoea, with lower levels of HDL-cholesterol and

higher levels of stress hormones⁽¹⁵⁴⁾. Night meals are also associated with a higher risk of obesity⁽¹⁵⁸⁾.

Occasional/out-of-home meals

Neutral terms 'occasionally eaten' or 'eaten at an event' or 'outside the home' are used to describe any occasion where food or drink is consumed and therefore includes all types of foods. Meals are described taking into account: modelling (e.g. frequency, regularity, irregularity, spacing and timing), format (e.g. different food combinations and nutritional content) and context (e.g. eating together with others or with the family, eating meals in front of the television or outside the house)⁽¹⁴²⁾.

Regarding sex, it is known that men consume more meals that are not prepared at home than women⁽¹⁶⁾. Meals prepared outside the house, especially fast foods, contain high levels of energy and a low amount of nutritional compounds⁽¹⁵⁹⁾. Therefore, the frequency of food consumption in restaurants is positively associated with the increase in body fat in adults. In general, people with obesity choose a larger quantity of food in the restaurant than the normal-weight people⁽¹⁶⁰⁾. Conversely, frequent consumption of home-cooked meals is associated with a lower risk of developing cardio-metabolic disease, such as diabetes⁽¹⁶¹⁾ or obesity⁽¹⁶²⁾.

Conclusions

The complex interconnections between nutrients, foods and dietary patterns imply that no individual component of the diet can provide a complete picture of the favourable/unfavourable effects of diet on health, thus a methodical approach using evidence-based on dietary patterns is warranted.

It is clear that lifestyle, of which an important component is the diet, is of great importance for health. The dietary pattern exerts its effects on health in a synergistic way or even in conjunction with other lifestyle environmental factors, and we can therefore acknowledge the role of a 'healthy lifestyle pattern'.

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Conflict of Interest

None.

Authorship

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