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Review

The Mediterranean Diet vs. 21st Century Lifestyle: A Review

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Abstract

The Mediterranean diet (MD) is widely recognized for its health benefits and its association with reduced incidence of noncommunicable diseases. However, modern lifestyles, characterized by increased consumption of ready-to-eat (RTE) foods and limited time for meal preparation, pose significant barriers to maintaining a healthy diet. Although numerous reviews have explored the nutritional benefits of the MD, fewer studies have examined how contemporary lifestyles conflict with dietary and behavioral habits of the Mediterranean lifestyle, and how food systems can adapt to MD principles. Therefore, this review examines the challenges of maintaining the MD in the context of 21st-century urban living and explores practical strategies for its integration into contemporary dietary patterns. The main characteristics and health-promoting components of the MD and Mediterranean lifestyle are reviewed, considering how changes in dietary habits, physical activity, social interactions, and the food environment influence adherence. The review also discusses interventions to promote MD adherence and the potential of RTE foods incorporating Mediterranean ingredients to offer convenient, nutritionally improved alternatives. Additionally, the valorization of Mediterranean agri-food by-products is discussed as an opportunity to incorporate bioactive compounds and functional ingredients into food products.

Keywords: Mediterranean diet; ready-to-eat foods; 21st century lifestyle; food environment; sustainable dietary patterns; by-products

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1. Introduction

The Mediterranean diet (MD) is widely recognized as one of the healthiest dietary patterns worldwide, characterized by a high consumption of olive oil, vegetables, fruits, legumes, whole grains, and nuts, moderate intake of fish, eggs, and dairy products, and a low consumption of red meat and processed foods [1]. This dietary model, traditionally followed by populations living in Mediterranean regions during the mid-20th century,

has been consistently associated with reduced overall mortality and lower incidence of noncommunicable diseases [2].

In addition to its nutritional characteristics, the MD is related to an active lifestyle. Traditional Mediterranean populations engaged in regular physical activity as part of their daily routines, including long walks, fishing, and farming practices. Besides, meals were a social event, where long-time cooking and eating together were a daily activity [3]. Together, those practices formed a healthy lifestyle that contributed to this population's high life expectancy.

Despite its recognized benefits, the adherence to the MD has declined substantially since the 1960s [4]. This decline has occurred with the societal transformations, including urbanization, technological advancements, and changes in work patterns. Contemporary lifestyles are increasingly characterized by long working hours, limited time available for meal preparation, reduced physical activity, and lower social interactions [5].

In this context, modern food systems have progressively adapted to prioritize convenience, scalability, and cost reduction [6]. Ready-to-eat (RTE) foods have increased their demand due to their practicality and accessibility, particularly in urban environments. However, some RTE products are characterized by high energy density and high levels of added sugars, fats, and sodium, while providing limited amounts of micronutrients and bioactive compounds [7]. The increased consumption of such foods has been associated with rising global rates of overweight, obesity, and noncommunicable diseases, trends that are particularly evident among adolescents and young adults [8,9]. At the same time, declining levels of physical activity and increasing physical inactivity have emerged as additional major contributors to these adverse health outcomes worldwide [10].

These observations indicate that the reduced adherence to the MD should not be interpreted only as individual choices, but as a reflection of structural changes associated with modern lifestyles. Although the Mediterranean diet has been extensively studied from a nutritional and clinical perspective, its adaptation to the realities of the 21st century remains comparatively underexplored. This review examines how contemporary lifestyles challenge the preservation of Mediterranean practices and explores strategies to reconcile Mediterranean nutrients with modern demands for convenience, accessibility, and rapid food consumption.

2. Methodology

In this narrative review, to identify the main components of the Mediterranean Diet (MD), the Mediterranean lifestyle, and the challenges associated with adapting it to contemporary living, a comprehensive literature search was conducted across PubMed, Web of Science, ScienceDirect, and Google Scholar between October 2024 and December 2025. The following search terms and combinations were used: 'Mediterranean Diet', 'Mediterranean Lifestyle', 'Mediterranean dietary pattern', 'Mediterranean diet adherence', 'healthy dietary patterns', '21st century lifestyle', 'urban lifestyle', 'modern lifestyle', 'dietary transition', 'nutrition transition', 'ready-to-eat foods', 'convenience foods', 'ultra-processed foods', 'food environment', 'food systems', 'food sustainability', 'sustainable diets', 'noncommunicable diseases', 'cardiovascular diseases', 'obesity', 'physical activity', 'sedentary behavior', 'health promotion', 'functional foods', 'by-products', 'circular economy' and 'bioactive compounds'. These terms were used individually and in combinations, when appropriate, to identify literature relevant to the scope of the review.

Searches included only peer-reviewed scientific articles published in English, with particular emphasis on studies published within the last 10 years. Older publications were also cited when they provided important information or historical comparisons relevant

to the topic. Additionally, the reference lists of selected publications were reviewed to identify further relevant literature.

Publications were selected based on the relevance of their full text to the objectives of the review. However, no formal, predefined exclusion criteria or systematic screening protocol was established. The final reference list contains 116 sources, including journal articles, book chapters, and online resources. As a narrative review without predefined selection criteria or a systematic screening protocol, the publications included may be subject to selection bias and subjective interpretation.

3. The Mediterranean Diet: An Overview

Since antiquity, the Mediterranean basin has been known for healthy eating habits. Its diet can be described as a combination of plant-based foods, highlighting grains, nuts, beans, fruits, and vegetables. Moreover, the Mediterranean diet (MD) is characterized by the consumption of low-to-moderate amounts of seafood and animal products such as meat, dairy, and eggs [1]. What makes the MD unique is its emphasis on olive oil, nuts, and a small intake of red wine during meals [11]. This dietary pattern, along with traditional Mediterranean activities, has shown great potential against several chronic diseases, such as cardiovascular diseases (CVDs) or cancer [2].

The conventional model of the MD can be found along the Mediterranean coast in the mid-1960s, where olive trees were quite present. While Greece and Spain are notable examples, other countries used to follow a similar pattern with slight variations, including Italy, France, Morocco, Algeria, Tunisia, Libya, Egypt, and Turkey (Figure 1) [12]. Together, this region has historically been associated with high life expectancy, low rates of obesity, and age-related diseases, united by its shared coastline along the Mediterranean Sea [12]. Thanks to its anti-inflammatory and antioxidant properties, this diet helps prevent numerous chronic diseases, including peripheral artery disease, type 2 diabetes, and cancer [2]. As life expectancy improves, the quality of life also tends to get better, with enhanced global cognitive function, lower levels of dementia, and reduced depressive symptoms [13,14].

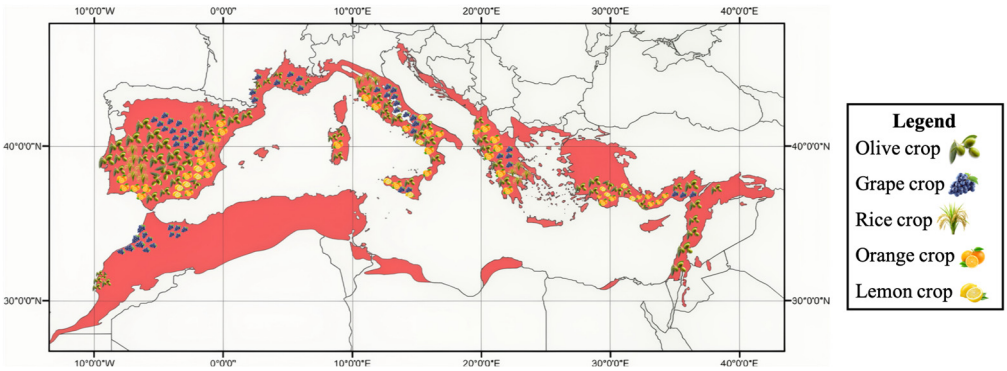


Figure 1. Mediterranean basin and respective geographic limits marked in red. Adapted from [12].

A healthy diet can be described as one that includes a high intake of plant-based foods with low consumption of animal-based products [15]. This combination provides essential amounts of different macronutrients, minerals, and vitamins, while also increasing the intake of complex carbohydrates and fibers and reducing the content of saturated fatty acids [16,17]. MD corresponds with these parameters of a healthy diet, as shown in Figure 2. The pyramid describes, briefly, the frequency with which each type of food should be consumed in the MD, as well as the main macro- and micronutrient content. Its base includes a variety of fruits, vegetables, grains, olive oil, beans, legumes, and herbs, which should be consumed at every main meal. Dairy products, eggs, and poultry should

be eaten regularly, while red meat, fish, and other seafood should be consumed less frequently. At the top are foods that should be eaten occasionally, such as processed meat and sweets [1,18]. Based on a literature review by Davis et al. [19], which compiled nutritional data from eight studies examining the diet across different populations and settings, the MD provides, on average, 2220 Kcal per day, with 37% as fat and 33 g of fiber.

Nutritionally, the base of this pyramid is rich in vitamin C (vegetables and fruits) and vitamin A (carrots, pumpkin, and spinach). However, its nutrients are distributed vertically throughout the pyramid. Vitamin B is found in meat, cereals, and eggs, while vitamin D is present in fish and seafood. Among the minerals, zinc (found in cereals, grains, and meat), iron (found in spinach and seafood), magnesium (found in yogurt and nuts), and selenium (found in nuts and fish) are the most representative [20,21].

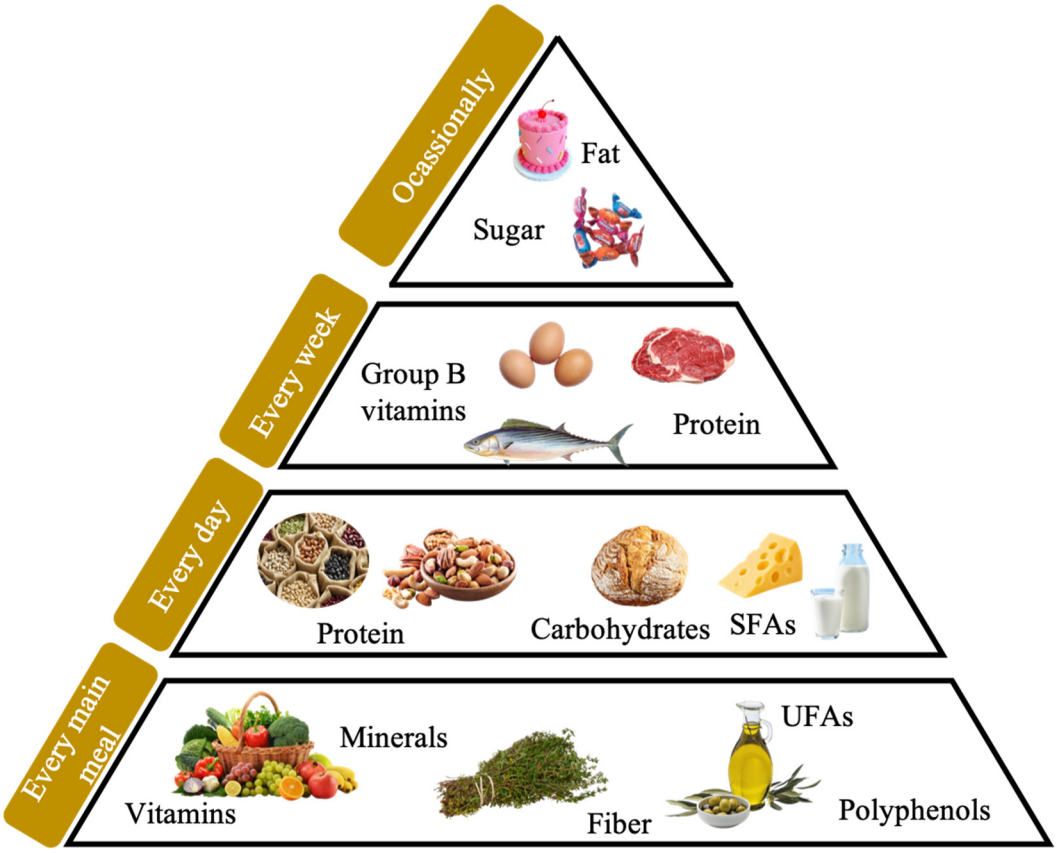


Figure 2. Pyramid of the Mediterranean diet with the main macro- and micronutrients.

3.1. The Core Foods of the Mediterranean Diet

Mediterranean inhabitants used to consume, on average, 25 to 50 mL of olive oil per day, being the main and a healthy source of fat [22]. This widespread use, whether as cooking oil or as a dressing on salads and vegetables, is deeply rooted in Mediterranean culinary practices. It provides high levels of vitamin E to the organism, which is responsible for antioxidant effects that reduce oxidative stress and inflammation [23]. Extra virgin olive oil (EVOO), the highest quality form, is extracted through cold pressing without heat and chemicals, preserving its nutritional integrity and making it a rich source of unsaturated fatty acids. EVOO is characterized by a high content of oleic acid, which is a ω-9 monounsaturated fatty acid, and polyphenols, mainly secoiridoids, lignans, phenylethanoids, flavonoids, hydroxy-isocromans, and phenolic acids [24–27].

Another essential component of this diet is nuts, which, while popular all over the world, hold an important role in the Mediterranean area [28]. Commonly consumed nuts in this area include almonds, walnuts, hazelnuts, and pistachios, each contributing to the

diet's overall nutritional profile [29]. Concretely, their nutritional profile is characterized by a high content of vitamins, including water-soluble vitamins, such as ascorbic acid (vitamin C), vitamins B1, B2, B3, B6, as well as the fat-soluble vitamin E; a high content in minerals such as magnesium (Mg), potassium (K), and calcium (Ca); and a high content in proteins and essential amino acids [30]. These nutrient-dense foods are consumed by these inhabitants as desserts, snacks, or as part of salads or meals, whether whole, chopped, roasted, raw, in spreads (almond paste), or as oils [29].

Vegetables and legumes are another pillar of a healthy diet pattern, being highly present in MD. The Mediterranean area is marked by the diversity of its legumes, with peas, lentils, chickpeas, and fava beans all originating from this land [31]. Thus, the FAO recommends a daily intake of at least 400 g to promote health and reduce the risk of noncommunicable diseases [32]. In developing countries, 90% of the average calories consumed are provided by plant-based foods, in which legumes are responsible for 10% of them [33].

Dairy products, such as yogurt, cultured cream, and cheese, remain included in nearly every dietary guideline due to their health benefits [34]. Mediterranean citizens traditionally consumed these products after natural fermentation, a process that occurred spontaneously at room temperature over several hours or even days [35]. Probiotic bacteria (specifically lactic acid bacteria such as *Lactobacillus* spp., *Lactococcus* spp., and *Streptococcus*), highly present in fermented dairy products, are associated with immune system improvement, since these bacteria are able to adhere to the intestinal epithelial cells and produce signals that stimulate the immune cells associated with the lamina propria [36]. The consumption of products with probiotic bacteria is also linked to the improvement of blood lipid profile, thanks to their ability to reduce serum cholesterol levels [37].

Red wine has traditionally been consumed in moderation as part of some Mediterranean dietary patterns [38]. Although it contains antioxidants and polyphenols, which have been associated with reduced risk of CVDs, these compounds do not necessarily translate into health benefits from wine consumption itself [39]. Excessive ethanol intake is well established as associated with chronic harms, such as an increased risk of cancer [40]. Therefore, Mediterranean inhabitants' wine consumption should be understood in its cultural context rather than as a health recommendation.

Moderate wine consumption still carries ambiguities regarding its health effects [41]. While excessive ethanol intake is well established as associated with chronic harms, such as an increased risk of cancer, red wine does offer some health benefits, mainly due to its content of antioxidants and polyphenols, which contribute to a reduced risk of CVDs [39]. Among alcoholic beverages, wine is generally considered to have a lower potential for harm compared to beer and other liquors [42].

Finally, fish and seafood are the primary source of animal protein in this diet, with average protein contents of 12% in mussels, 16% in crustaceans and cephalopods, and 18% in fish. Moreover, these foods are rich in polyunsaturated fatty acids, highlighting the ω-3 fatty acids α-linoleic, eicosapentaenoic, and docosahexaenoic acids. Fish and seafood are also excellent sources of vitamins and minerals, with group B vitamins and iodine (I), calcium (Ca, iron (Fe), zinc (Zn), selenium (Se), and phosphorus (P) as the most representative. These nutrients are described as beneficial for health since they are linked to reduced risks of CVDs, cancer, inflammation, and neurocognitive disorders [43–46].

Together, these food groups form the nutritional basis of the MD, with their relative consumption and contribution varying according to local food availability and culinary traditions. Table 1 summarizes the main Mediterranean food groups, their relevant nutritional components, and associated health benefits.

Table 1. Mediterranean foods, key components, and their potential health benefits.

Type of Food	Key Contents	Health Benefits	Ref.
Olive Oil	Vitamin E, UFAs, polyphenols	Antioxidant, anti-inflammatory, neuroprotective, cardioprotective, anticancer, anti-obesity, antidiabetic, antimicrobial, antisteatotic.	[23,47,48]
Nuts	Healthy FA, proteins, vitamins E and K, folate, minerals, antioxidants	Inversely associated with heart diseases, cancer, and all-cause mortality.	[49–51]
Fruits, Vegetables, and Legumes	Fiber, complex carbohydrates, vitamins C, A, and K, minerals (K, Fe), phytochemicals	Associated with human health and reduced risk of non-communicable diseases.	[32,52–54]
Dairy Products	Probiotic bacteria, Ca, protein, vitamins D and B12	Improves the immune system, blood lipid profile, and intestinal health.	[34,55]
Fish and Seafood	PUFAs, EAAs, bioactive peptides, vitamin D, minerals (e.g., I, Ca, Zn, Se)	Reduces the risks of cardiovascular diseases, cancer, inflammation, and neurocognitive disorders.	[43–46]

Abbreviations: UFAs: unsaturated fatty acids; FA: fatty acids; PUFAs: polyunsaturated fatty acids; EAAs: essential aminoacids; K: potassium; Fe: iron; I: iodine; Ca: calcium; Zn: zinc; Se: selenium.

The flexibility of the MD allows its principles to be adapted beyond the Mediterranean region while maintaining its main dietary characteristics. Such adaptations may reflect differences in food availability, cultural preferences, and traditional culinary practices, rather than requiring strict adherence to specific foods. Therefore, understanding the MD requires consideration not only of its nutritional composition, but also of the lifestyle and cultural context in which it is practiced.

3.2. Mediterranean Lifestyle and Recent Adherence

The adherence to a healthy diet has shown progressive loss since the 1960s all over the world [4]. This low adherence is more common among smokers, individuals experiencing high levels of stress, urban residents, and those who do not engage in physical activity [56]. There is also a strong correlation between socio-economic status and adherence to a diet, with individuals of medium to low-income levels being less likely to follow a dietary pattern [57]. People who tend to eat at home and consume fruits and vegetables are more likely to adhere to the MD, as are adolescents who live and eat with their parents [58]. Regional differences are also evident. Populations from Mediterranean countries tend to maintain higher adherence to the MD and lifestyle than those in non-Mediterranean countries, largely due to cultural dietary traditions and easier access to fresh foods [59].

However, adherence goes beyond the frequency and type of food consumption. A dietary pattern represents the lifestyle, the activities undertaken, and the social and cultural environment of the population involved [60]. The classic Mediterranean lifestyle includes daily activities such as fishing and sheep farming, which increase energy consumption and move away from a sedentary life [61] which is reportedly correlated with all-cause mortality [62]. Additionally, the low consumption of alcoholic beverages is also related to the healthy Mediterranean way of life [63].

Religious practices in the Mediterranean area also influence dietary habits. For Islam, widely practiced in countries such as Turkey, Egypt, and Morocco, the observance of Ramadan involves approximately 30 days of the year, during which no food or drink is consumed during daylight. While Orthodox Christianity is most followed in Greece,

Spain, and Italy, it prescribes periods of fasting, such as Quaresma, which involve abstaining from meat and encourage 48-day vegetarian diet before Easter [64].

Another critical aspect of the MD is its social dimension. Sitting together and sharing a meal represents a fundamental social phenomenon and influences health patterns [3]. As meals are considered communal gatherings, the consumption of snacks between meals was traditionally uncommon, and women, who were mostly responsible for preparing meals, played a key role in disseminating their knowledge, preserving recipes, and maintaining cultural traditions. This social practice is also closely linked to values of hospitality, wellbeing, and the appreciation of land, water, and, ultimately, nature [64].

To objectively evaluate adherence, indices such as the MEDLIFE Index have been developed. This instrument considers not only the amount of Mediterranean and non-Mediterranean food consumption, but also dietary habits such as the structure of the meals and whether snacking occurs between them, and lifestyle behaviors including levels of physical activities and sleep [65]. Structurally, it consists of a 28-item derived index with questions regarding food consumption (15 items), dietary habits (7 items), and physical activity, rest, and social interaction habits (6 items), therefore, it includes an overall assessment regarding Mediterranean lifestyle [65].

Beyond behavioral changes, another important aspect influencing adherence and the potential health benefits of the MD lies in the transformation of food production systems. The advancement of agricultural techniques, which made the exponential growth of the world population possible over the past decades, has also affected the quality of fresh, unprocessed foods available today. Genetic selection, the use of fertilizers and herbicides, as well as concentrated feed for animals, has negatively impacted the concentration of polyphenols, flavonoids, carotenoids, minerals, and beneficial fatty acids [66].

Taken together, these behavioral, social, and food-system changes have contributed to a progressive decline in adherence to the Mediterranean lifestyle. Rather than reflecting individual dietary choices alone, this decline is closely related to broader changes in how people live, work, eat, and interact with the food environment. These transformations have become particularly evident in the 21st century, creating new challenges for the maintenance of traditional dietary practices.

4. 21st Century Lifestyle

Chronic health problems have risen significantly in the 21st century, largely influenced by changes in lifestyle, poor dietary patterns, and low physical activity levels [67]. With the growth of food industries and the rise of urbanization, traditional diets have become increasingly rare, while foods rich in fat, sodium, and sugar are becoming more common in the market [5]. Combined with unhealthy habits, this has resulted in an increasing number of diabetes cases and cardiovascular issues [68]. Since 1990, global obesity rates have more than doubled, while adolescent cases have quadrupled, leading to over 390 million children and adolescents, and 2.5 billion adults living with overweight in 2022 [8]. The continuous declining in children's engagement in active, unstructured play, contributes to this shift [69].

The pace of life in urban areas has become much faster than in the past, and free time for residents is becoming increasingly scarce. As a result, ready-to-eat (RTE) foods have gained relevant interest due to their convenience, practicality, and time-saving benefits, as they require no preparation [31]. This change in dietary habits has coincided with a market expansion of the RTE food market. In 2024, the global market value reached 95.05 billion USD, with projections indicating a further increase to 97.92 billion USD in 2025 and 113.53 billion USD by 2031 [70]. Among all these processed foods, snacks (such as biscuits and crisps), sandwiches, industrial breads, and desserts (e.g., pies and cakes) can be mentioned.

Ultra-processed RTE products are often associated with high contents of fat, added sugars, and sodium, while providing limited amounts of essential micronutrients, nutritional characteristics that have been linked to mental health issues, including adult depression [71]. In particular, these products typically combine higher energy density with a lower cost per calorie when compared with unprocessed foods [9].

The adult's lifestyle is related to the habits and behaviours experienced during their respective adolescences. A study conducted in the United Kingdom with adolescents aged 16 to 18 revealed that 21% of the participants were classified as obese or overweight. Furthermore, 80% of them did not meet the recommended intake levels of vegetables and fruits, and 90% did not engage in daily physical exercise [72], once one in five Europeans reported sitting more than 7.5 h per day [73]. This can be translated to Mediterranean adolescents. In a cross-sectional study, data from 5 Mediterranean countries (Italy, Spain, Portugal, Egypt, and Lebanon) were analyzed in order to determine children's and adolescents' adherence to the MD. Results showed fruits, vegetables, legumes, and cereals as the least consumed groups. Moreover, individuals with sleep duration ranging from 8–10 h, as well as an intermediate level of physical activity, showed a higher adherence to MD [74].

Unhealthy habits are also strongly present in the university environment. High alcohol consumption, poor nutrition, and emotional eating, due to high levels of stress, are some examples commonly found [75,76]. These behaviors appear to contribute significantly to the rising incidence of psychological disorders within this environment. Notably, a healthy diet pattern is associated with lower anxiety levels among university students in Spain [76]. At the same time, transition from secondary school to university represents a critical period for physical activity, with evidence suggesting a decline in moderate-to-vigorous physical activity as young people enter higher education [77].

At the same time, healthy diets are not affordable for a range of 3 billion people around the world [78]. To facilitate food production and distribution, food systems have evolved from being dominated by local farmers to becoming a complex global network involving thousands of operators before reaching consumers' homes [6]. Otherwise, the farm-to-table and the less processed foods, such as roots, tubers, and legumes, have declined, while animal-based products have emerged [79]. In fact, the price of ultra-processed foods is almost one-third of the price of unprocessed ones. In 2019, 100 kcal cost \$0.55 and \$1.45, respectively [9]. This coincides with the food technology and fast-food industry now involved, becoming cheaper for consumers to meet the daily energy needs [5,6].

As a result, the mortality rates for noncommunicable diseases, including diabetes mellitus, endocrine disorders, CVDs, and digestive diseases, have increased drastically in most Mediterranean countries since the 1960s. Figure 3, based on the WHO data [80], illustrates the death rate per 100,000 population for Italy, Greece, Spain, Portugal, France, and Egypt. With Egypt as an exception, most Mediterranean countries have experienced a significant rise over the decades. However, these trends should be interpreted with caution, as mortality patterns may also reflect broader demographic and epidemiological changes, including population aging and variation in risk factors such as smoking and air pollution exposure. Therefore, the observed trend cannot be solely attributed to changes in dietary patterns.

These changes in lifestyle and food environments have contributed to shifts in dietary habits. Lower time availability, with urbanization, reduced physical activity, and wide availability of caloric RTE foods have modified eating behaviors, promoting convenience over nutritional quality. In this context, traditional dietary patterns such as the MD are more difficult to maintain in daily life, particularly among younger and urban populations.

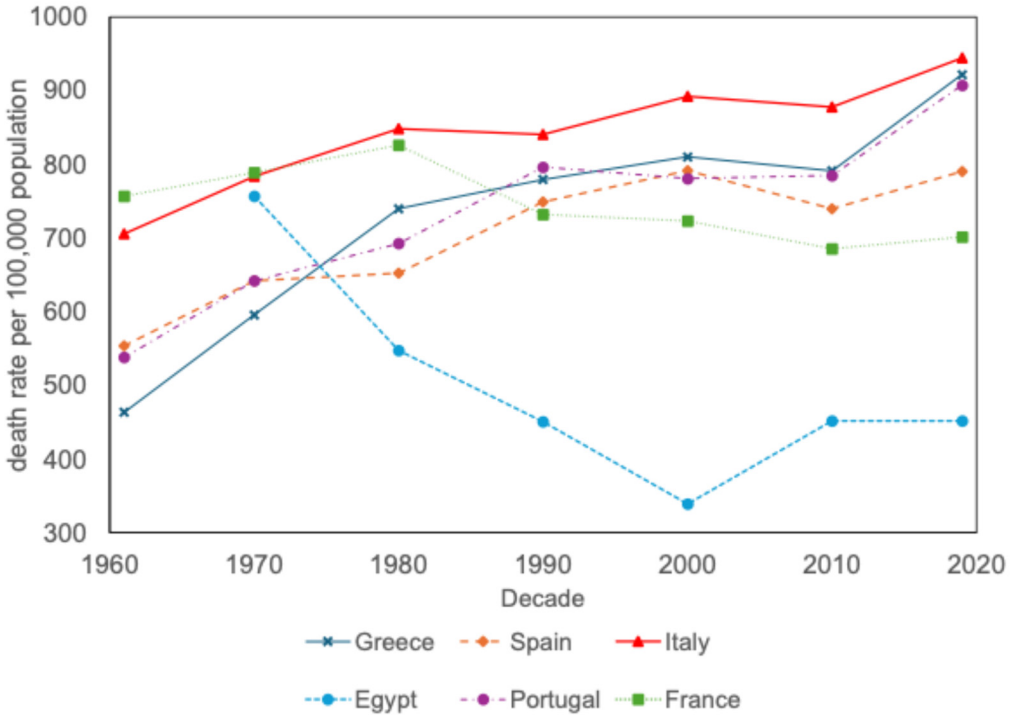


Figure 3. Trends in noncommunicable disease mortality rates in some Mediterranean countries (1960–2020) [80]. These trends should be interpreted in the context of broader demographic and epidemiological changes.

5. Opportunities to Incorporate Elements of the Mediterranean Lifestyle

Given the progressive decline in adherence to MD and lifestyle in modern society, several interventions have been implemented focusing on modifying the food environment. For instance, a longitudinal intervention study evaluated the feasibility of introducing MD ingredients in a food-at-work context. A total of 96 male workers followed the MD provided by the work canteen (lunch) for 12 months, showing an improvement in the Mediterranean diet score (MDS) from 4.8 to 7.4. Moreover, there was a statistical correlation between the MD adherence of the workers and an improvement of parameters such as waist circumference, HDL cholesterol, and systolic and diastolic blood pressure. After 12 months of intervention, results also showed a decrease in metabolic syndrome (MS) incidence from 24% to 15.6%, a MS reversion rate of 48%, and a MS incidence rate of 4.1% [81].

In another cluster randomized clinical trial, 485 enrolled US career firefighters from 52 fire stations followed an MD for 12 months. In this study, participants were provided with access to supermarket discounts, free samples of Mediterranean foods, online educational platforms, and chef demonstrations in order to increase adherence to the Mediterranean lifestyle. Results showed an improvement of adherence to MD by 10%, supporting that combining easy access to MD ingredients with education programs may be an effective intervention strategy in the workplace to increase MD adherence [82].

The MD adherence was also assessed in the university environment. For instance, in a cross-sectional study, 1485 participants from US universities were submitted to the KIDMED and Sustainable-Healthy-Diet questionnaires in order to determine the parameters affecting MD adherence. Results showed that students with higher MD adherence corresponded with those following physical activities and regularly attending the university canteen [83]. This suggests that encouraging programs related to physical activities and facilitating access to the canteen in university environments can be a suitable approach to the Mediterranean lifestyle among students.

In another interventional study, the effects of a nutrition education program were assessed in students from the 6th grade in Cyprus. The program consisted of nine lessons of 80 min, in which 150 students had access to cooking activities, food tasting, and parental involvement. Results showed that students who participated in the activities had a significant increase in nutritional knowledge and MD Quality Index score compared to students who did not participate [84]. This suggests that not only diet intervention, but also educational programs are feasible and effective approaches to increase MD adherence.

Together, these interventions demonstrate that when individuals receive adequate education, support, and consistent access to balanced meals, adherence to the Mediterranean diet tends to increase substantially. However, most of these studies were conducted in controlled environments, such as workplace canteens, schools, or research settings. Those environments benefited from prepared meals, accessible ingredients, guidance, and educational activities. Therefore, there is still a need for large-scale strategies capable of reaching broader segments of the population, especially those living in fast-paced urban settings. Approaches such as free online education programs, affordable delivery services offering Mediterranean-style meals, or technology-driven solutions that facilitate daily healthy choices may represent essential next steps to effectively translate these interventions into contemporary society.

Moreover, considering the difficulties of adherence to the MD and Mediterranean lifestyle in today's life, the formulation of accessible, RTE products with ingredients from the MD is suggested as a suitable strategy to diminish the incidence of noncommunicable diseases. RTE foods are known for being more energy-dense compared to traditionally homemade meals, with a higher content of fat and lower micronutrient content [7]. However, RTE foods can be produced with Mediterranean ingredients, offering a convenient, nutritious, and healthy meal that does not require high caloric content or the use of refined sugars and can easily be consumed by the population.

5.1. Ready-to-Eat Foods and Snacks: Technological Feasibility and Relevance to Mediterranean Principles

Despite the growing availability of RTE foods, most commercially available products remain nutritionally unbalanced. These foods are frequently characterized by high energy density and excessive amounts of saturated fats, sodium, and refined sugars, while providing limited quantities of micronutrients and bioactive compounds [85]. Consequently, the nutritional quality of these products differs significantly from that of freshly prepared meals. In this context, the development of RTE foods aligned with MD principles remains limited, and existing studies are scarce, reinforcing the need to explore the capability and potential benefits of RTE products formulated with Mediterranean-based ingredients. To explore the technological feasibility and potential benefits of developing RTE products adapted to local dietary patterns and culinary traditions, existing studies can provide useful insights into ingredient selection, macronutrient composition, and sensory acceptability.

For instance, RTE and dehydrated soups were formulated with rice (*Oryza sativa* L.), sweet corn (*Zea mays*), pumpkin (*Cucurbita moscata*), rice bran oil, and tilapia (*Oreochromis* sp.). The target consumer was elderly people, and different proportions of ingredients were used in order to achieve a high sensory score while keeping the recommended macronutrient distribution. The formulation with a better score consisted of 15 g of rice, 32.5 g of pumpkin, 12.5 g of sweet corn, 17.5 g of red tilapia, 1 g of bran rice oil, and 21.5 g of water in the case of RTE soup, leading to a 58:23:20 carbohydrate:protein: lipid ratio. Considering the importance of shelf-life maintenance of these products, authors also included a storage-condition assessment, being 4 weeks under refrigeration in the case of RTE soups, and 4 months at room temperature for the powder formula [86]. Although the

ingredients and rice bran oil reflect Thailand's culinary context rather than Mediterranean traditions, this study illustrates how RTE can be formulated in line with a dietary pattern. For products specifically inspired by the MD, comparable formulations could be explored using Mediterranean ingredients, with extra-virgin olive oil as the fat source.

Similarly, an RTE multigrain snack was formulated and nutritionally evaluated. The ingredients used were sorghum (*Sorghum bicolor*), pearl millet (*Pennisetum americanum*), grain amaranthus (*Amaranthus gangeticus*), Bengal gram (*Cicer arietinum*), green gram (*Phasleolus aureus*), and soya bean (*Glycine max*), combined with sugar, honey, sunflower oil, skimmed milk powder, and groundnut seeds. The final snack contained 14 g of protein, 59 g of carbohydrates, 14.5 g of fat, and 6.3 g of dietary fiber, with a shelf-life of 90 days at room temperature using low-density polypropylene pouches [87]. With the exception of Bengal gram, the grains used as ingredients in this multigrain snack are not present in the MD. However, it is important to evaluate the macronutrient proportions achieved as well as the quality of the nutrients present. In this sense, the carbohydrate:protein: fat proportion obtained in the formulated snack was 67:16:17, which is similar to the macronutrient distribution range of MD, usually representing 43–60% for carbohydrates, 15–20% for proteins, and 25–37% for fat [88].

Another RTE fish soup was elaborated using salmon waste, salt, black pepper, carrot, leek, cereals, and onion concentrate, resulting in a hard jelly mixture which can be easily prepared in hot water. Although authors did not evaluate the final product nutritionally, considering the rich PUFA and protein content of salmon and the vitamin content of the vegetables used, the final product is expected to have a nutritious profile. Moreover, authors determined the shelf-life of the RTE soup at 4 °C, with no spoilage until the 18th week [89].

Overall, these studies demonstrate strategies for formulating RTE foods that achieve macronutrient distributions comparable to those of the MD, while maintaining sensory acceptance and adequate shelf life. However, the use of ingredients from non-Mediterranean culinary traditions means their relevance lies mainly in formulations and processing approaches, rather than in their direct representation of the MD. The use of salmon by-product [89] in one of these formulations also illustrates how RTE product development can extend beyond conventional formulations, but also include the valorization of nutritious underutilized food resources, potentially enhancing the nutritional profile while promoting sustainability.

5.2. Modern Techniques for Nutrient Incorporation and Zero Waste Strategy

While essential compounds are present in low amounts in the diets of much of the 21st century population, agro-industrial and food processing residues often contain significant quantities of these important compounds, such as proteins, fibers, and bioactive molecules, which are frequently discarded. Consequently, the valorization of these bioresidues has been increasingly studied as a strategy to reduce economic losses and ecological impact, promoting concepts such as zero-waste processing and the circular economy [90,91].

Vitamins are responsible for supporting various biological activities in the human body. Even when following a balanced diet, supplementation of certain vitamins is often necessary to ensure the recommended daily intake [92]. Therefore, the incorporation of vitamins into foods has been increasingly applied, leading to the development of functional foods [93]. A major challenge, however, lies in the instability of their structure, as industrial applications can lead to degradation in the presence of light, high and low pH, high temperature, and oxygen [94]. Therefore, microencapsulation, such as spray-drying, can enhance its stability up to 80% [93].

The extraction of bioactive compounds, such as vitamins and phenolic compounds, has been extensively studied, and emerging extraction technologies have demonstrated good yields in an environmentally friendly manner, often using plant residues. In recent years, techniques such as supercritical fluid extraction, microwave- or ultrasound-assisted extraction, as well as novel solvents, like Natural Deep Eutectic Solvent (NADES), have shown promising results for subsequent applications in food products, animal supplementation, or even as fertilizers. The conditions for vitamin E extraction from canola seeds using supercritical CO_2 have been evaluated [95], while ultrasound-assisted extraction has been applied to recover vitamin B12 from green edible seaweed [96]. These approaches enable the development of functional foods, and the use of green methods can contribute to sustainable food systems. For instance, a functional ready-to-drink beverage rich in protein with extracted polyphenols from blueberry pomaces has been developed [97].

Proteins are essential nutrients due to their nutritional functions, and their low consumption is associated with stunted growth and cognitive delay [98]. Its presence is not only found in animal sources, but it is also abundant in plant materials. As the population grows (estimated to reach 9.7 billion by 2050), higher quantities of protein will be required, and new sources of sustainable proteins will be necessary to supply the demand, as animal protein is increasingly associated with environmental, economic, and health concerns [99]. While traditional solvents, such as ethanol, methanol, and acetone, are widely used due to their simplicity, novel methods can present lower environmental impact, energy consumption, and higher yields [91]. The use of NADES, Ultrasound, Microwave, and/or supercritical fluid extraction is one of the emerging techniques for protein extraction. For instance, while conventional organic solvents typically achieve yields of 40–70% with potential residual toxicity, NADES-based extraction can reach 70–90% yields using biodegradable solvents with lower energy requirements and minimal ecological footprint [91].

Although some byproducts do not even have to go through an extraction procedure, they are applied directly into food formulations. Brewer's spent grain, sugar beet pulp, and apple pomace were added to corn-based snacks, replacing part of the corn grits [100]. This incorporation led to significant improvements in dietary fiber and protein content, total phenolic compounds, and antioxidant activity. At the same time, the incorporation of avocado seed flour (an agro byproduct) into weaning food formulations increased protein, fiber, minerals, and overall sensorial acceptance [101].

In this context, the Mediterranean food system also generates a considerable amount of byproducts. These materials can represent promising sources of bioactive compounds for the development of sustainable and functional food formulations.

5.3. Mediterranean Byproducts and Their Promising Contribution

The Mediterranean agri-food sector generates a diverse range of byproducts with considerable potential for valorization. Often regarded as residues by the industry, these materials are widely distributed among fruits and vegetables, and their applications are being increasingly explored. Beyond their technological functionality and bioactive and nutritional profiles, many of them can be incorporated into food formulations or used as natural additives, colorants, and preservatives.

Olive leaves, from Olea europea, represent one of the most abundant byproducts from olive cultivation and olive oil industry, representing approximately 25% of the residues generated [102]. Rich in bio compounds, those leaves are often discarded or burned, making this waste of resources an environmental problem. The high concentration of phenolic compounds present in its structure, particularly oleuropein, hydroxytyrosol, hydroxytyrosol hexoside, verbascoside, and apigenin-7-glucoside, has attracted considerable attention due to their bioactivities, such as antioxidant, antimicrobial, and anticarcinogenic [103]. These compounds can be present in much higher concentrations in the leaves

than in the olive oil itself. For this reason, in recent years, olive-leaf extracts have been increasingly used in the food industry, not only as ingredients or functional additives, but also as active compounds in edible coating and bioactive food packaging [104]. Therefore, the valorization of olive leaves aligns with circular economy principles and sustainable industrial practices, transforming a low-value residue into a valuable source of functional compounds.

While dates (*Phoenix dactylifera* L.) are considered a high-value product, date pits (or seeds) are typically discarded during industrial pitting or after consumption [105]. According to the Food and Agriculture Organization [106], more than 9 million tons of dates were produced in 2023, and pits can account for 10–15% of the total weight, generating large volumes of waste. They contain approximately 6% crude protein, approximately 70% fiber, and good levels of phenolic and antioxidant compounds [107]. These seeds (in powder form) have been applied to bread and cookies to increase the content of dietary fibers and the phenolic content, respectively, as well as a caffeine-free beverage to substitute for daily coffee [108].

Grapes (*Vitis vinifera* L.) play a central role in the MD, not only as a widely consumed fruit, but also through their transformation into wine, an emblematic beverage from the Mediterranean area. The industry of wine can generate high amounts of residues, and grape pomace (mostly peels and seeds) can represent 20–25% of the total mass of grapes [109]. This byproduct is mainly composed of dietary fibers (20–30%), carbohydrates (5–15%), protein (8–15%), and polyphenols (5–10%) [110]. The wine production only extracts around 30% of the total phenolic compounds, resulting in approximately 60–70% of these bioactive molecules remaining in the pomace [111]. For this reason, many studies have applied and or extracted grape pomace into food matrices, such as yogurt, burgers, spaghetti, and biscuits, resulting in increased phenolic compounds, antioxidant capacity, lipid oxidation, and/or color stability [112]. In addition, grape skins are rich in anthocyanin compounds that give grapes their reddish-purple color [113]. These compounds can be extracted and act as natural colorants in multiple food applications. Some studies have investigated extraction methods to obtain green and cheap anthocyanins, and several studies have focused on developing cheap, effective, and environmentally friendly extraction methods for anthocyanins. While conventional solvents such as ethanol typically yield low to moderate concentrations (around 2.5 mg anthocyanins/g biomass) [114], better conditions can lead to higher yields. For instance, extraction using NADES combined with adequate water content, solid-liquid ratio, and stable pH resulted in 21 mg anthocyanins/g biomass [115].

Interestingly, several Mediterranean byproducts exhibit complementary functional profiles. While olive leaves and grape pomace are exceptionally rich in phenolic compounds and/or anthocyanins, date seeds contribute dietary fibers and structural carbohydrates, while almond shells provide lignocellulosic reinforcement for biodegradable packaging matrices. Together, Mediterranean byproducts can act as an abundant and cheap source of functional ingredients, with well-studied antioxidant, antimicrobial, and technological properties. These byproducts hold strategic relevance not only because of their biochemical richness, but also because they represent stable, year-round, available sources that can be easily integrated into food formulations. Focusing on the circular economy, this strategy can align with sustainability in food development.

5.4. Physical Activity as a Core Component of the Mediterranean Lifestyle

Historically, physical activity in Mediterranean populations was naturally incorporated into daily life through active transportation, occupational activities, walking, outdoor recreation, and other forms of informal movement across all ages. In contrast, contemporary lifestyles have progressively reduced opportunities for incidental and informal

physical activity, particularly in urban environments. Active, unstructured play among children is declining [69] as well as moderate-to-vigurous physical activities among young adults who transition from secondary school to university [77]. This fact becomes particularly relevant in light of evidence suggesting that participation in physical activity during childhood and adolescence as well as during early adulthood tends to track into later adulthood [116].

In the past 3 or 4 decades, urbanization, unsafe roads, reduced access to safe outdoor spaces, increasing availability of screen-based entertainment, changes in daily routines, living arrangements and transportation needs/habits have been leading the drift from the Mediterranean lifestyle, contributing to changes in how children, adolescents and adults spend their leisure time [69,116]. Therefore, promoting physical activity as part of a contemporary Mediterranean lifestyle should not rely exclusively on structured exercise programs. Instead, strategies capable of integrating movement into everyday environments may provide a more sustainable approach.

Active commuting, walking and cycling infrastructure, active breaks, outdoor recreation, informal play, and university- and workplace-based initiatives may help recreate opportunities for daily movement that were more naturally embedded in traditional Mediterranean lifestyles. In this context, technological solutions, including wearable devices and digital platforms, may further support self-monitoring and engagement while adapting physical activity promotion to the demands of contemporary society.

6. Conclusions

Considered one of the healthier diet patterns, MD is strongly associated with reduced risks of chronic diseases, thanks to its levels of antioxidants and anti-inflammatory properties. A good intake of plant-based foods, such as legumes, vegetables, and grains, with moderate consumption of animal products, is also present in other dietary guidelines. However, MD is unique in its substantial use of olive oil, nuts, and small amounts of red wine.

Despite growing awareness of the importance of a healthy lifestyle, many people struggle to maintain a good and nutritious diet, whether due to the fast-paced life in urban areas or the high cost of fresh fruits and vegetables. This often leads to increased consumption of RTE foods, some of which are typically high in saturated fats and sodium. To bridge the gap between the ideals of the MD and the realities of modern life, it is essential to propose practical and accessible solutions. Interventions such as offering MD meals in canteens at workplaces, schools, and universities have proven effective in improving adherence, as have educational programs. Furthermore, evidence consistently shows that higher levels of physical activity are positively associated with MD adherence, reinforcing the need for lifestyle approaches as well.

Alongside the development of RTE foods with MD ingredients, it could offer a nutritious option that aligns with contemporary needs. A Mediterranean-inspired snack can help restore important nutrients lost with decreased MD adherence, such as fiber, unsaturated fats, and polyphenols. Moreover, ingredient byproducts, such as olive leaves, date seeds, and almond shells, could serve as sources of bioactive compounds and be used as food additives. Ultimately, this type of snack exemplifies how innovation, convenience, and sustainability can converge to make the core principles of the Mediterranean diet more accessible to today's population.

Together with dietary adaptation, the integration of physical activity into modern daily routines may therefore represent an important opportunity to preserve the broader principles of the Mediterranean lifestyle while responding to the environmental and behavioural challenges of contemporary food and urban systems.

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Abbreviations

The following abbreviations are used in this manuscript:

MD	Mediterranean Diet
RTE	Ready-to-eat
CVDs	Cardiovascular diseases
NCDs	Noncommunicable diseases

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