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The Nexus between Mediterranean Diet, Obesity and Climate Change

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ABSTRACT: Obesity and climate change consist of two major problems which have severe economic, environmental, social and health impacts all over the world. Mediterranean diet used to be the traditional diet in Mediterranean region with many nutritious and health benefits and low environmental impacts. However, it has been replaced nowadays with the western diet or other similar diets. The interlinkages among Med diet, obesity and climate change have been studied. The interrelation among them have been analyzed indicating their complex interdependence. Obesity and climate change are mutually interlinked while the use of Mediterranean diet can reduce the obesity rates and mitigate climate change. It has also lower environmental impacts, compared to western diets, leading to sustainable agricultural systems. Climate change has adverse impacts to Mediterranean diet due to harmful impacts on agriculture. Our findings indicate that the broad adoption of Mediterranean diet would reduce the obesity rates, mitigate climate change, reduce the undesired environmental impacts of the food production system and promote the sustainable agriculture which is necessary for the healthy nutrition of an increasing global population. The results could be useful to national and international policy makers who are trying to develop policies for the mitigation of climate change and the reduction of obesity rates promoting nutritious, healthy and sustainable food production and consumption systems.

KEYWORDS: climate change, environmental impacts, health, interrelation, Mediterranean diet, obesity management

1. INTRODUCTION

Obesity and climate change consist of two important global challenges in our era. Mediterranean diet (Med diet) is considered as a traditional, healthy and nutritious diet which has lower environmental impacts compared to modern diets including the western diets. It has been indicated that Med diet results in better human health while its impact to climate change is low compared to other dietary patterns.

The interrelation between diets, health and climate change has been investigated by several researchers [1], [2]. The environmental impacts of Med diet compared with other dietary patterns have been studied [3],[4], [5], [6]. The impacts of climate change on Mediterranean agriculture and diet have been studied [7], [8], [9], [10]. The relation between obesity and climate change has been investigated by several authors [11], [12], [13], [14]. The impact of Med diet on obesity management has been studied [15], [16].

The aim of our work is to study the nexus between Mediterranean diet, obesity and climate change.

The text is structured as follows. After the literature survey the impacts of climate change on obesity and on Med diet are analyzed. Next, the impacts of obesity on climate change are discussed. In the following sections the impacts of Med diet on climate change and on obesity are presented. The text ends with discussion of the findings, the conclusions drawn and the citation of the references used.

The present work fills the current gap related with the nexus of a healthy dietary pattern with three major challenges in our societies which are the unhealthy dietary patterns the high obesity rates and climate change. It has innovative aspects due to lack of similar studies while it could be useful to policy makers who should develop appropriate policies to simultaneously tackle the current challenges which threaten the health and prosperity in our societies.

2. LITERATURE SURVEY

The literature survey is separated in three parts. The first is related with Med diet and climate change, the second with obesity and climate change while the third with obesity and the Med diet.

2.1 Climate change and Mediterranean diet

The environmental and economic sustainability of the Mediterranean diet has been studied [3]. The authors calculated the environmental impacts on the basis of three indexes including: a) the carbon index, b) the ecological index and c) the water footprint.

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The economic index was calculated on the basis of cost per person. They stated that Med diet has a lower environmental impact compared to the actual diet of Italian population. They also mentioned that the average monthly food budget of an Italian family is comparable with the necessary budget to adopt the Med diet. The carbon dioxide (CO_2) emissions related to Med diet have been estimated [9]. The authors stated that Med diet is environmentally friendly since the higher adherence to Med diet results in lower CO_2 emissions. The climate change impacts and the adaptation strategies of agriculture in Mediterranean climate regions have been investigated [7]. The authors stated that climate change will result in lower precipitation and in increasing droughts which are going to have adverse impacts on local agriculture since water is considered as the most critical resource in agriculture in Mediterranean countries. Additionally, climate change is foreseen to increase the mean average temperature which is going to increase the evapotranspiration of various crops. These changes are going to reduce the yield and the quality of the agricultural products. They also mentioned that adaptation of agriculture to climate change in Mediterranean region requires improvement of the agronomic practices and genetic improvements of the cultivated crops The impact of climate change to Mediterranean agriculture has been studied [8]. The author stated that the impacts of climate change are already visible. Frequent droughts, flash floods, reduced precipitation, loss of biodiversity, higher mean average air temperatures, more frequent mega-fires et cetera have adverse impacts in agricultural production particularly in marginal rural zones. He also mentioned that climate change is going to intensify the problem of water scarcity and land degradation affecting negatively the sustainability of agriculture in Mediterranean basin. The environmental sustainability of Med diet has been studied [4]. The authors evaluated the impact of Med diet on land, water and energy utilization as well as on (Greenhouse Gas) GHG emissions focusing on Spain. They stated that according to their estimations replacing the local diet with Med diet was related with lower land utilization (- 0.71 m^2/capita/day), lower water consumption (- 58.88 lt/capita/day), lower energy use (- 0.86 MJ/capita/day) and lower GHG emissions (- 0.73kgCO_2e/capita/day). The impact of global dietary guidelines on climate change has been studied [2]. The authors estimated the carbon emissions of healthy and sustainable dietary guidelines in several countries. They stated that different dietary patterns in various countries have unequal carbon emissions. They also mentioned that in the dietary patterns studied the GHG emissions were in the range of 702 KgCO_2e/capita/year (for India) to 1,837 KgCO_2e/capita/year (for USA). The environmental footprint of Med diet and western diet focusing on Spain has been evaluated [5]. The authors compared the environmental footprint of three dietary patterns: The Spanish, the Western and the Mediterranean. They stated that change from the Spanish dietary pattern to Mediterranean dietary pattern will reduce the GHG emissions by 72%, the land use by 58%, the energy consumption by 52% and the water consumption by 33%. The impact of changing dietary behavior on biodiversity preservation has been studied [17]. The authors investigated the impacts of three dietary patterns – the European, the Western and the Mediterranean – in terms of land use, water use, and GHG emissions. They estimated that the shift from European diet to Med diet would result to 10 m^2/capita/day land saving, 240 lt/capita/day water savings and 3 kgCO_2e/capita/day GHG emission savings. Additionally, shift from western diet to Med diet would result to 18 m^2/capita/day land saving, 100 lt/capita/day water saving and 4 kgCO_2e/capita/day GHG emissions savings. The environmental footprint associated with the Med diet, the EAT-Lancet diet and the sustainable healthy diet has been estimated [10]. The authors stated that animal protein is the highest contributor to GHG emissions and to land use while fruits and vegetables contribute mostly to water consumption. They also mentioned that Med and EAT-Lancet dietary patterns should be included in national dietary guidelines. The sustainability dimensions of Med diet have been reviewed [6]. The authors analyzed 32 published studies related to Med diet. They stated that Med diet had a lower environmental impact than western diets showing a carbon footprint between 0.9 kgCO_2/day/capita and 8.88 kgCO_2/day/capita, a water footprint between 600 lt/day/capita and 5,280 lt/day/capita and an ecological footprint between 2.8 m^2/day/capita and 53.42 m^2/day/capita. They also mentioned that Med diet has a high nutritional quality while its cost is almost similar to other diets varying between 3.33 €/capita/day and 14.42 €/capita/day. The impacts of Med diet on environmental sustainability have been assessed [18]. The authors analyzed data from 5,800 participants who followed for one year the Med diet. They stated that after one year intervention the consumed energy was reduced by 125.1 kcal/capita/day, the GHG emissions by 361 gCO_2e/capita/day, the energy use by 842.7 KJ/capita/day and the land use by 2.2 m^2/capita/day. They also mentioned that meat products had the greatest environmental impact. Additionally, they stated that other studies have shown that changes to healthy dietary patterns could reduce up to 70% the land use and the GHG emissions. The climate impact of Med diet and the current food pattern in several EU countries has been evaluated [19]. The authors estimated the GHG emissions associated with the current dietary patterns in 7 Mediterranean countries and in 21 EU non-Mediterranean countries in 2017. They stated that the GHG emissions associated with the ideal Mediterranean dietary pattern is 2.3 kgCO_2e/capita/day. However, they mentioned, the

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GHG emissions associated with the current food consumption in 7 Mediterranean countries and in 21 EU non-Mediterranean countries deviate significantly from the GHG emissions associated to the ideal dietary pattern being at 4.46 $kgCO_2e$/capita/day and 4.03 $kgCO_2e$/capita/day correspondingly. The optimum dietary patterns in the 21st century to combat obesity, undernutrition and climate change have been examined [20]. The authors stated that it is necessary to create food systems that nourish people and sustain the planet. These new healthy food systems should be less expensive that modern food systems while they should be based on traditional and indigenous food diets which historically were supporting human nutrition and health while they were maintaining the balance with nature.

2.2 Obesity and climate change

The obesity disorders related with Med diet have been studied [21]. The authors stated that many popular diets, including Med diet, have been used for the prevention and management of obesity. They also mentioned that substantial weight loss and reversal of obesity can be achieved with low-calorie Med diet combined with adequate physical activity. The sustainability of Med diet and its role on obesity treatment has been reviewed [15]. The authors stated that dietary patterns related with Med diet have numerous health benefits including the prevention and management of obesity. They also mentioned that Med diet is not just a food model but also a lifestyle plan for the pursuit of healthcare sustainability. The behavioral therapy in obesity treatment focusing in the role of Med diet has been studied [16]. The authors stated that Med diet has many health benefits regarding obesity treatment based on behavioral therapy. They also mentioned that behavioral therapy helps the patients to adopt proper habits to attain the healthiest weight. Med diet provides them a healthy and sustainable dietary pattern facilitating the treatment of obesity. The interrelation of obesity management and climate change in Greece has been studied [11]. The author stated that two major problems of our era are climate change and obesity. He also mentioned that climate change has undesired and harmful impacts on obesity in Greece while obesity treatment results in the mitigation of climate change in the country. The obesity management and the achievement of Sustainable Development Goals (SDG) in Greece have been investigated [22]. The author stated that obesity management was not included in the 17 SDGs of United Nations (UN). He also mentioned that many international studies have indicated that obesity treatment is indirectly related with the achievement of several SDGs. The interplay between diets, health and climate change has been studied [1]. The authors identified 11 typical diets used in several countries in the past decades. These diets deviate from the recommended healthy diet using either too much red meat or too little fruits and vegetables. Diets with low calories are related with undernourishment and underweight while diets with high calories are related with obesity. They concluded that sustainable and healthy diets can nourish the population and reduce the environmental impacts of agriculture. The genetic basis of childhood obesity has been reviewed [23]. The authors investigated the correlation between the genetic characteristics of children and adults with their Body Mass Index (BMI). They reviewed 27 studies which have analyzed genetic data of 7,928 overweigh and obese children and adults. They stated that 24 genetic loci were significantly associated with complex metabolic imbalances and disorders which resulted in high BMI and obesity. The achievement of sustainability on earth has been studied [24]. The authors proposed three changes for achieving sustainability in the global food production and consumption system including: a) changes in agricultural technologies and techniques to become more sustainable, b) changes in our dietary patterns, and c) minimization of overconsumption and waste of food.

2.3 Obesity and Mediterranean diet

The climate co-benefits of obesity reduction have been studied [25]. The authors stated that rising obesity rates may contribute to GHG emissions both directly through increased food production and indirectly through higher passengers' weight and sedentary lifestyles. The authors analyzed data in USA over the period 1997 to 2011 estimating that the decrease of obesity rates during this period could reduce the annual CO_2 emissions in the country by 2.8%. The relation between climate change and obesity has been examined [12]. The authors stated that climate change and obesity consist of two major challenges of mankind. They mentioned that there is a bidirectional relationship between adiposity and global warming. With rising air temperatures people will have less adaptive thermogenesis and will become less physically active, while they are producing a higher carbon footprint. The link between obesity and climate change has been analyzed [13]. The authors stated that obesity and climate change are two modern world dilemmas. They mentioned that large-scale interventions have had minimal impact on both of them. They suggested that health and environmental scientists should work closely to develop cross-disciplinary initiatives to tackle both of them. The obesity and the climate change mitigation in Australia have been investigated [14]. The author stated that policies which could reduce obesity and

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mitigate climate change can be categorized as: a) policies replacing car use with low-emissions active mode of transport, b) policies improving diets and reducing emissions from the food system, and c) economic policies to reduce the over-consumption of food and fossil fuel energy. An investigation regarding the impact of weight loss to global warming has been implemented [26]. The authors stated that according to their estimations a 10 kg weight loss of all obese and underweight people would result in a decrease of 49,560 MtonCO_2/year which is equal at 0.2% of the global CO_2 emissions in 2007. The global syndemic of obesity, undernutrition and climate change has been reported [27]. The report stated that three current pandemics – obesity, undernutrition and climate change – represent the global syndemic. It is also stated that the problem of obesity has four parts: a) the prevalence of obesity is increasing in every region of the world, b) the existing policies for halting obesity have not shown satisfactory results so far, c) although obesity has enormous health and economic burdens there is not political will for the development of appropriate policies to manage it, and d) obesity has been considered so far in isolation with the other major global challenges. The impact of global warming on obesity has been investigated [28]. The authors analyzed temperature fluctuations in 152 countries from 1975 to 2016. They stated that according to their estimations global warming has significantly increased obesity rates in countries located in temperate zone while has caused a reduction in a small number of tropical countries. They also mentioned that their evaluations indicated that 1^{o}C increase in the mean annual air temperature would result in a global increase of obese people at 79.7 million. A national e-health program for the management of obesity in Greece has been developed [29]. The authors stated that the prevalence of overweight and obesity for children and adults in Greece exceeds 30-35%. To address this problem an e-health program has been developed offering personalized multidisciplinary treatment to overweight and obese patients. They mentioned that after one year of supporting 2,400 children and adults the prevalence of obesity was decreased by 32.1% while of overweight by 26.7%.

3. THE IMPACT OF CLIMATE CHANGE TO OBESITY

Climate change has significant impacts on obesity, primarily through its effects on food systems, physical activity patterns, and socioeconomic conditions. Climate change disrupts food production by causing extreme weather events, altering growing seasons, and reducing crop yields. This can lead to food shortages and higher food prices, especially for fresh fruits, vegetables, and other healthy foods. As healthy foods become more expensive and less accessible, people may turn to cheaper, calorie-dense, and nutrient-poor options, which are often high in sugars and fats, contributing to weight gain and obesity. Climate change can also affect the nutritional quality of food. For example, higher carbon dioxide levels can reduce the nutrient content of staple crops like wheat and rice. This means that even if calorie intake remains the same, the nutritional value of those calories may decrease, leading to a higher risk of obesity as people consume more food to meet their nutritional needs. In regions affected by climate change, disruptions in local food production might increase dependence on imported or processed foods, which tend to be higher in calories, fats, and sugars. These dietary shifts can contribute to the rising prevalence of obesity. Climate change is increasing the frequency of extreme weather events like heatwaves, storms, and heavy rainfall. These conditions can limit opportunities for physical activity, as people are less likely to engage in outdoor exercise when it's too hot, too cold, or unsafe due to weather conditions. Reduced physical activity is a significant risk factor for obesity. Climate change can accelerate urbanization as people migrate from rural areas affected by climate-related disruptions to cities. Urban environments often have limited green spaces and higher levels of pollution, both of which can discourage physical activity. Additionally, urban areas tend to foster more sedentary lifestyles, contributing to obesity. Climate change can exacerbate economic inequalities, particularly in vulnerable communities. Disruptions to agriculture, fishing, and other climate-sensitive industries can lead to job losses and reduced incomes. Economic stress often leads to poorer dietary choices, as cheaper, less nutritious foods are more accessible. Additionally, financial constraints can limit access to recreational activities and healthcare, further increasing the risk of obesity. Climate-related disruptions to transportation, agriculture, and food processing can lead to temporary or prolonged food shortages. When supply chains are interrupted, the availability of healthy, fresh foods is often the first to decline, while processed foods with longer shelf lives may become more prevalent. This shift can promote unhealthy eating patterns that contribute to obesity. Climate change can drive up the cost of food, particularly fresh produce, lean proteins, and other nutritious options. When healthy foods, like fresh fish, become more expensive, individuals and families, especially those with lower incomes, may opt for cheaper, energy-dense, and nutrient-poor foods, increasing the likelihood of obesity. As climate change alters food availability, traditional diets that are typically healthier and more balanced may become harder to maintain. People may adopt diets that rely more on processed foods and less on fresh produce, whole grains, and lean proteins. This shift can lead to higher calorie intake and a greater risk of obesity. In some regions, climate change is threatening the

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viability of traditional food practices, such as farming or fishing. The loss of these practices can lead to a loss of traditional knowledge about healthy eating, further contributing to dietary changes that increase obesity risk. The impacts of climate change to obesity are presented in table I.

Table I: The impacts of climate change to obesity

1	Climate change creates endocrine disruption to humans
2	Higher air temperatures encourage obese people to use vehicles' transportation, instead of walking and biking, resulting in less physical activity, less energy consumption and increased obesity
3	Higher air temperatures discourage obese people to be physically active, doing exercises and sports, resulting in less energy consumption and increased obesity
4	Climate change is related with droughts and extreme weather events which affect food production. This might affect people to adopt unhealthy dietary patterns
5	Rising air temperatures may increase the sedentary behavior of people which is related with less physical activity, low energy consumption and increased obesity

Source: own estimations

4. THE IMPACTS OF CLIMATE CHANGE TO MEDITERRANEAN DIET

Climate change is having a significant impact on the Mediterranean diet, which is renowned for its health benefits. Rising temperatures are affecting the growing conditions for key Mediterranean crops like olives, grapes, and vegetables. Crops that thrive in specific temperature ranges are becoming less productive, and some may become nonviable in certain areas. The Mediterranean region is already prone to water scarcity, and climate change is exacerbating this issue. Droughts are becoming more frequent and severe, which affects the irrigation of crops like fruits, vegetables, and grains that are staples of the Mediterranean diet. Increased temperatures and extreme weather events, like mega-fires, are leading to soil erosion and degradation, which reduces the land's fertility and its ability to support diverse crop production. The changing climate is leading to lower yields for important crops. For instance, olive oil production is particularly vulnerable to both droughts and rising temperatures, which can lead to lower quality and higher prices. The timing of planting and harvesting seasons is shifting due to climate change. This affects the availability of fresh produce, which is a cornerstone of the Mediterranean diet. Seasonal shifts can also lead to mismatches in the supply chain, causing shortages or overproduction. Many of the herbs, fruits, and vegetables that are key to the Mediterranean diet rely on specific ecosystems that are under threat due to climate change. Loss of biodiversity can reduce the variety of foods available, impacting the diet's diversity. As crop yields decrease and farming becomes more challenging, the costs of these foods are likely to rise. This could make traditional Mediterranean foods like olive oil, wine, and fresh produce more expensive and less accessible. Many small-scale farmers who supply the local markets with fresh produce are particularly vulnerable to climate change. Their ability to continue producing traditional Mediterranean crops may be threatened, leading to economic instability and potential changes in the diet as these products become less available. The Mediterranean diet also heavily relies on seafood, which is affected by overfishing and changes in ocean temperatures and acidity. These changes can lead to a decline in fish populations and alter the types of seafood available. The health of marine ecosystems is crucial for maintaining a sustainable seafood supply. Climate change-induced shifts in marine life distribution and the degradation of marine habitats are likely to impact the availability of traditional seafood. Climate change is threatening the Mediterranean diet by affecting the availability, cost, and quality of the key ingredients that define it. This has implications not only for the health of the populations that rely on this diet but also for the cultural heritage and economic stability of the Mediterranean region. The impacts of climate change on food production in Mediterranean basin are presented in table II.

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Table II. Impacts of climate change on food production in Mediterranean basin

Impact of Climate change	Impact on food production
Lower precipitation	Results in water deficit in an area with limited water resources and lower agricultural production
Higher mean average air temperatures	Affects negatively the crops yields
More frequent droughts	Results in water deficit and lower agricultural production
More frequent mega-fires in forests	Negatively affects crops' yield and biodiversity, increase soil erosion and land desertification
Biodiversity losses	Negatively affects crops yield
Changes in the marine environment and depletion of the fish stock	Lower production and higher price of fishes
More frequent intense weather events	Negatively affects crops yield
Increased land desertification	Lower land availability in agriculture

Source: Own estimations

5. THE IMPACT OF OBESITY TO CLIMATE CHANGE

Obesity affects climate change in complex ways related to energy consumption, food production, and resource use. Obesity is associated with higher caloric intake, which typically means consuming more food than necessary. This increased demand for food, particularly calorie-dense and often environmentally intensive foods like meat and processed foods, can lead to higher greenhouse gas (GHG) emissions. Food production, especially of animal-based products, is a significant contributor to GHG emissions due to factors like deforestation, methane emissions from livestock, and energy-intensive farming practices. Obesity is also linked to food waste, as individuals who consume more may also waste more. The production of food that ultimately gets wasted still involves resource use and emissions, contributing to climate change without providing nutritional benefits. Obesity can lead to increased energy demands in several sectors. For instance, transportation systems may need to accommodate larger individuals, which can lead to increased fuel consumption. Public transportation systems might require more energy to operate if they need to carry more weight, either in terms of individual passengers or additional equipment. Obesity is often linked with sedentary lifestyles and increased reliance on cars which also lead to higher emissions. Car dependency, in particular, results in more fuel consumption and associated emissions, contributing to climate change. Obesity is associated with a range of health issues, leading to greater reliance on healthcare services. The healthcare sector, in turn, has a significant carbon footprint due to the energy required to operate medical facilities, produce pharmaceuticals, and manage medical waste. The increased demand for healthcare associated with obesity indirectly contributes to climate change through higher energy consumption. To meet the increased demand for food linked to higher consumption, more land may be required for agriculture. This can lead to deforestation and conversion of natural ecosystems into farmland, which releases stored carbon into the atmosphere and reduces the planet's capacity to absorb CO_2. Producing more food also requires more water, fertilizers, and other agricultural inputs. Intensive farming practices can deplete natural resources, contribute to water scarcity, and increase pollution, all of which exacerbate climate change. Obesity is often associated with lifestyles that involve high consumption of processed foods, sugary drinks, and red meat—products that have large carbon footprints due to their production, processing, and transportation requirements. These consumption patterns contribute to higher GHG emissions. Obesity affects climate change through increased demand for food, energy, and resources, which leads to higher GHG emissions and environmental degradation. The relation between Body Mass Index and obesity is presented in table III while the impacts of obesity to climate change are presented in table IV.

Table III: The relation between Body Mass Index and obesity

Body Mass Index	Status
18-25	Healthy
25-30	Overweight
>30	Obese

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Table IV: The impacts of obesity to climate change

1	Obesity is related with unhealthy western-type diets resulting in significantly higher carbon emissions compared to Mediterranean dietary patterns
2	Obesity is related with diets rich in meat. Cattle breeding results in high GHG emissions including CH_4 emissions
3	Obesity is related with eating large quantities of processed food with high energy content resulting in higher GHG emissions
4	Obese people often use vehicle's transportation using fossil fuels and releasing CO_2
5	Since the mean air temperatures will rise due to climate change obese people would require more frequently air-conditioning resulting in higher energy consumption and carbon emissions

Source: own estimations

6. THE IMPACT OF MEDITERRANEAN DIET TO CLIMATE CHANGE

Use of Mediterranean dietary patterns affect climate change in various ways. The Mediterranean diet emphasizes the consumption of plant-based foods, such as fruits, vegetables, legumes, nuts, and whole grains, along with moderate amounts of fish, poultry, and dairy. It limits the use of red meat and processed foods. This plant-centric approach is more sustainable compared to diets rich in animal products, which typically have a higher environmental footprint. Traditionally, the Mediterranean diet is based on locally sourced and seasonal foods. This reduces the need for transportation, refrigeration, and other energy-intensive processes, thereby lowering GHG emissions. Animal agriculture is one of the leading sources of GHG emissions, particularly methane, which is produced by livestock. By minimizing red meat consumption, the Mediterranean diet contributes to lower emissions. The Mediterranean diet promotes the cultivation of a diverse range of crops, which supports agro-biodiversity. This diversity is crucial for resilient ecosystems that can better withstand climate change impacts. Many Mediterranean regions use traditional farming practices that are less intensive and more in harmony with the natural environment. These practices help preserve soil health and local ecosystems, contributing to long-term sustainability. The GHG emissions for different healthy dietary guidelines in several countries are presented in table V.

Table V. Greenhouse Gas Emissions for different healthy dietary guidelines in several countries

Country	Greenhouse gas emissions per capita including household wastes ($KgCO_2e$/capita/year)	Greenhouse gas emissions per capita including household wastes ($KgCO_2e$/capita/day)
India (vegetarian)	702	1.92
India(non-vegetarian)	757	2.07
Germany	1,403	3.84
Canada	1,620	4.44
China	1,552	4.25
Australia	1,807	4.95
USA	1,837	5.93
WHO- Healthy diet	1,288	3.53

Source: [2]

The environmental impact of Mediterranean diet is presented in table VI.

Table VI. The environmental impact of Mediterranean diet (results for 32 studies)

Parameter	Value
Carbon footprint	0.9 - 8.88 $kgCO_2e$/capita/day
Water Footprint	600 – 5,280 lt/capita/day
Ecological footprint	2.8 – 53.42 m^2/capita/day
Cost of Med diet	3.33-14.42 €/capita/day

Source: [6]

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The environmental impact of Mediterranean and the typical Italian diet are presented in table VII.

Table VII. Environmental impact of Mediterranean and the typical Italian diet

Parameter	Med diet	Italian diet
Carbon footprint ($kgCO_2e$/capita/day)	2.43	24.09
Water Footprint (lt/capita/day)	1,969	2,392
Ecological footprint (m^2/capita/day)	18.43	24.26
Cost of Med diet (€/capita/day)	5.33	5.23

Source: [3]

7. THE IMPACT OF MEDITERRANEAN DIET TO OBESITY

The Mediterranean diet has a significant impact on obesity, primarily through its balanced and nutritious approach to eating. The impacts include: A) Balanced Macronutrients: The Mediterranean diet is rich in healthy fats (mainly from olive oil, nuts, and fish), moderate in protein, and high in complex carbohydrates from whole grains, fruits, and vegetables. This balance helps regulate blood sugar levels and keeps you feeling full, which can prevent overeating and support weight management. B) High Fiber Content: The diet includes plenty of fiber-rich foods like fruits, vegetables, legumes, and whole grains. Fiber is known to promote satiety, which reduces overall calorie intake and helps with weight loss. C) Low in Processed Foods: The Mediterranean diet minimizes processed and sugary foods, which are often high in empty calories and contribute to weight gain. Instead, it focuses on whole, nutrient-dense foods that provide more nutrition for fewer calories. D) Healthy Fats: While the diet includes fats, they come from sources like olive oil, nuts, and fatty fish, which are healthier than the saturated and trans fats found in many processed foods. E) Lifestyle Approach: The Mediterranean diet is often part of a broader lifestyle that includes regular physical activity, which is essential for maintaining a healthy weight. The cultural emphasis on walking, gardening, and other forms of physical activity complements the diet and aids in preventing obesity. F) Blood Sugar Control: The Mediterranean diet helps regulate blood sugar levels and improve insulin sensitivity, which reduces the risk of developing type 2 diabetes—a condition closely linked to obesity. This regulation helps prevent weight gain and facilitates weight loss in those who are already overweight. G) Heart Health: The diet is known for its heart-healthy benefits, such as reducing bad cholesterol (LDL) levels and improving cardiovascular function. A healthy heart and metabolism are crucial for maintaining a healthy weight. H) Portion Control and Eating Habits: The Mediterranean diet encourages mindful eating practices, such as enjoying meals slowly and paying attention to hunger and fullness cues. This helps prevent overeating, which is a common contributor to obesity. I) Social and Cultural Aspects: Meals in Mediterranean cultures are often social events, promoting a more relaxed and mindful approach to eating. This contrasts with the fast-paced eating habits that can lead to overeating and weight gain. G) Sustainable Weight Loss: The Mediterranean diet is not a restrictive or fad diet, making it easier for people to stick with it long-term. Sustainable dietary changes are more effective for long-term weight management compared to quick-fix diets that often lead to weight regain. K) Anti-Inflammatory Properties: The diet is rich in antioxidants and anti-inflammatory foods like olive oil, nuts, fruits, and vegetables. Chronic inflammation is associated with obesity and metabolic disorders, so reducing inflammation can help in managing and preventing obesity.

Therefore, the Mediterranean diet is effective in combating obesity through its balanced and nutritious approach to eating. It promotes weight loss and weight management by emphasizing whole, unprocessed foods, healthy fats, and high fiber intake, while also encouraging physical activity and mindful eating habits. Its long-term sustainability and positive effects on metabolic health make it a powerful tool in preventing and reducing obesity. The comparison of dietary patterns between Mediterranean and Western diets is presented in table VIII.

Table VIII. Comparison of dietary patterns between Mediterranean and Western diets

Foods	Mediterranean diet	Western diets
Vegetables	Every main meal (>2 servings)	Rarely
Fruits	Every main meal (1-2 servings)	Rarely
Bread, pasta, rice, other cereals	Every main meal (1-2 servings preferable whole grain)	Rarely whole grain cereals, often refined grains

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Olive oil	Every main meal (3-4 servings preferably extra virgin oil)	Rarely olive oil, often replaced with margarine and butter
Nuts, seeds, olives	Every day (1-2 servings)	Occasionally
Dairy foods	Every day in moderate portions (2 servings, preferably low fat)	Often, high fat dairy food
Herbs, spices, garlic, onions	Every day (less added salt)	Less often
Legumes	Weekly (> or = 2 servings)	Less often
Potatoes	Weekly (< or = 3 servings)	Less often
Eggs	Weekly (2-4 servings)	Less often
Fish/seafood	Weekly (> or = 2 servings)	Less often
White meat	Weekly (2 servings)	Less often
Red meat	Weekly (< 2 servings)	Often
Processed meat	Weekly (< or = 1 servings)	Often
Sweets	Weekly (< or = 2 servings)	Often

Source: [15]

8. DISCUSSION

The results of several studies indicate that Med diet contributes in the decrease of obesity rates and in the mitigation of climate change. Its use improves the human health while it has lower environmental impacts, including energy consumption, carbon emissions, water use and ecological footprint compared to other diets including the modern western diet. It has been reported that the carbon footprint of several dietary patterns varies significantly in the range of 1.99 kgCO_2e/capita/day to 5.93 kgCO_2e/capita/day. Several studies indicate that the cost of Med diet is affordable, varying in the range of 3.33-14.42 €/capita/day, while it is not higher than the cost of several local diets. Obesity and climate change are mutually linked and interconnected. Increase in obesity rates has adverse impacts on climate change while climate change does not facilitate the decrease in obesity rates. It has been reported that in countries located in temperature zones the increase in air temperature by 1^{o}C increases the obesity rates. Existing studies have also indicated that the shift from local diets to Med diet significantly decreases the climate and environmental footprint of food consumption. Therefore, the basic principles of Med diet should be recommended by policy makers as well as by national and international authorities. Our work is based on existing studies and their results. Consequently, the accuracy of our findings is based on the accuracy of the results of previous research. Taking into account that Mediterranean basin is a popular global tourism destination visited by mil. of tourists every year further research should be focused on the impacts of using Med diet instead of western diets in several hotels and tourism accommodations in Mediterranean countries.

9. CONCLUSIONS

The nexus between Mediterranean diet, obesity and climate change has been studied. Med diet, obesity and climate change are interlinked and interrelated.

1. Climate change has a significant impact on obesity, primarily through its effects on food systems and physical activity patterns.
2. Climate change is having a significant impact on the Mediterranean diet. Rising temperatures, lower water precipitation, increasing droughts and extreme weather events result in land desertification and in reduced yields of many Mediterranean crops.
3. Obesity affects climate change in complex ways related to energy consumption, food production, and resource use. Increased obesity rates have negative impacts on climate change.
4. Mediterranean dietary patterns mitigate climate change in various ways. Traditionally, the Med diet is based on locally sourced and seasonal foods. This reduces the need for transportation, refrigeration, and other energy-intensive processes, thereby lowering greenhouse gas emissions. Animal breeding is one of the leading sources of greenhouse gas emissions,

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particularly methane, which is produced by livestock. By minimizing red meat consumption, the Med diet contributes to lower GHG emissions. Adoption of Med diet leads to a more sustainable food production and consumption system.

5. Mediterranean diet is effective in combating obesity through its balanced and nutritious approach to eating. It promotes weight loss and weight management by emphasizing whole, unprocessed foods, healthy fats, and high fiber intake, while also encouraging physical activity and mindful eating habits.

Therefore, it is necessary to promote the Mediterranean dietary pattern in order to tackle the three major global challenges of our era, malnutrition, obesity and climate change.

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