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**Evaluating the Sustainability of International Students' Diets  
Using the Planetary Health Diet Index:  
Insights from the MeditEat Project**

**Valutazione della sostenibilità delle diete degli studenti  
internazionali utilizzando il Planetary Health Diet Index:  
Approfondimenti dal progetto MeditEat**

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## ABSTRACT

This thesis investigates dietary sustainability among international students participating in the MeditEat Project at the University of Pavia, Italy. The project was designed to promote healthier and more environmentally sustainable eating habits through nutritional education and individual counseling based on the principles of the Mediterranean diet. In light of the growing environmental burden associated with modern food systems, identifying dietary patterns that support both human health and ecological sustainability is of increasing relevance.

The Mediterranean diet, characterized by a high intake of plant-based foods, moderate consumption of animal products, and limited intake of processed foods, represents a widely recognized model of sustainable nutrition. In this study, dietary sustainability was evaluated using the Planetary Health Diet Index (PHDI), which assesses dietary patterns according to international recommendations for healthy and environmentally responsible eating.

A total of 19 international students enrolled in the MeditEat program were followed over six months. Dietary intake data were collected at baseline, after three months, and at the end of the intervention. Throughout the study, participants attended educational sessions and received individualized nutritional counseling aimed at improving food choices in line with Mediterranean dietary principles. Dietary habits were assessed using food frequency questionnaires, and intake data were standardized to calculate PHDI scores.

The results showed a clear improvement in overall dietary sustainability over the intervention period. Total PHDI scores increased from baseline to three months and remained stable at six months, indicating a sustained positive effect of the educational program. Improvements were particularly evident in the consumption of plant-based foods such as legumes, nuts, fruits, and vegetables, as well as in increased use of vegetable oils. At the same time, reductions were observed in the intake of red meat, processed meat, and added sugars. The balance among vegetable subgroups remained generally consistent throughout the study.

In conclusion, the findings suggest that structured nutritional education can effectively enhance dietary sustainability among international students. Despite limitations related to sample size and self-reported dietary data, this study supports the Mediterranean diet as a

nutritionally adequate, environmentally sustainable, and culturally adaptable model that can be successfully promoted in international university settings.

## RIASSUNTO

Questa tesi analizza la sostenibilità della dieta degli studenti internazionali che hanno partecipato al progetto MeditEat presso l'Università di Pavia. Il progetto è stato progettato con l'obiettivo di promuovere abitudini alimentari più sane e sostenibili dal punto di vista ambientale attraverso un percorso di educazione nutrizionale e consulenze individuali basate sui principi della dieta mediterranea. Considerato il crescente impatto ambientale dei sistemi alimentari moderni, l'individuazione di modelli alimentari in grado di sostenere sia la salute umana sia la sostenibilità ecologica risulta di particolare importanza.

La dieta Mediterranea, caratterizzata da un elevato consumo di alimenti di origine vegetale, da un'assunzione moderata di prodotti di origine animale e da un limitato consumo di alimenti trasformati, rappresenta un modello consolidato di alimentazione sostenibile. In questo studio, la sostenibilità della dieta è stata valutata mediante il Planetary Health Diet Index (PHDI), uno strumento che misura l'aderenza alle raccomandazioni internazionali per un'alimentazione sana e rispettosa dell'ambiente.

Un totale di 19 studenti internazionali iscritti al programma MeditEat è stato seguito per un periodo di sei mesi. I dati relativi all'assunzione alimentare sono stati raccolti al momento iniziale, dopo tre mesi e al termine dell'intervento. Durante lo studio, i partecipanti hanno preso parte a sessioni educative e hanno ricevuto consulenze nutrizionali individuali finalizzate a migliorare le scelte alimentari in accordo con i principi della dieta mediterranea. Le abitudini alimentari sono state valutate mediante questionari di frequenza di consumo alimentare, e i dati di assunzione sono stati standardizzati per il calcolo dei punteggi PHDI.

I risultati hanno evidenziato un miglioramento complessivo della sostenibilità della dieta nel corso del periodo di intervento. I punteggi totali del PHDI sono aumentati dal basale al terzo mese e si sono mantenuti stabili al sesto mese, indicando un effetto positivo duraturo del programma educativo. I principali miglioramenti hanno riguardato il consumo di alimenti di origine vegetale, quali legumi, frutta secca, frutta e verdura, nonché un maggiore utilizzo di oli vegetali. Parallelamente, è stata osservata una riduzione nel consumo di carne rossa, carni

trasformate e zuccheri aggiunti. La distribuzione dei sottogruppi di verdure è rimasta complessivamente equilibrata durante l'intero periodo di studio.

In conclusione, i risultati suggeriscono che interventi strutturati di educazione nutrizionale possono migliorare efficacemente la sostenibilità della dieta negli studenti internazionali. Nonostante alcune limitazioni legate alla dimensione del campione e all'utilizzo di dati auto-risportati, questo studio conferma la dieta mediterranea come un modello alimentare nutrizionalmente adeguato, sostenibile dal punto di vista ambientale e culturalmente adattabile, applicabile con successo nei contesti universitari internazionali.

# **Chapter One**

## **Introduction**

## **1. Introduction**

### **1.1 Mediterranean Diet: Definition and Characteristics**

The Mediterranean diet (MD) reflects the traditional eating habits of people living around the Mediterranean Sea, which have remained largely consistent until the 1950s economic boom (Woodside et al., 2022). Rather than being a strict diet, it represents a broader dietary style common to Mediterranean countries, with olive oil as a central component (Mediterranean Diet Foundation). Research, including the “Seven Countries Study” from the 1950s, has documented typical food consumption in this region, historically associated with poorer, rural populations (Keys et al., 1986; Trichopoulou et al., 2004). The diet is widely recognized as a healthy model, emphasizing high intakes of fruits, vegetables, whole grains, legumes, nuts, and seeds; moderate amounts of dairy, fish, and poultry; limited red meat; modest red wine consumption; and primarily using extra virgin olive oil as the main fat source (Bach-Faig et al., 2011).

#### **1.1.1 Sustainable diets and the Planetary Health Diet Index**

The Planetary Health Diet Index (PHDI) was developed to gauge how well individuals adhere to the EAT-Lancet dietary guidelines. By scoring intake across various food groups, it assesses the sustainability of a diet by taking into account things like appropriate consumption (like fruits and vegetables), restricting certain foods (like red meat and added sugars), ideal intake ranges (like dairy, eggs, and healthy oils), and particular vegetable ratios. Researchers and public health professionals can evaluate how well a person's diet supports environmental and health goals using the PHDI (Cacau et al., 2021).

#### **1.1.2 Connecting PHDI and the MeditEat Project**

By using the Planetary Health Diet Index (PHDI) on the dietary records gathered during the MeditEat Project, this thesis explores the sustainability of the eating habits of foreign students. The goal is to observe how students' sustainability scores changed over time and whether the six-month curriculum affected their dietary choices. A fuller picture of whether an educational program like MeditEat can promote more sustainable eating habits among transient student populations can be obtained by using the PHDI, which offers a consistent way for analyzing both environmental and health-related components of their diets.

### 1.1.3 Environmental effects of food systems

The world is under a lot of strain from today's food systems. They are in charge of the majority of agricultural water usage, a significant portion of the world's greenhouse gas emissions, and widespread land occupation. While monocropping and large-scale animal farming continue to fuel deforestation and lower biodiversity, a major portion of this area is already undergoing soil deterioration. These effects on the environment are caused by all phases of the food chain, including transportation, processing, preparation, and waste production (Bui et al., 2024).

### 1.1.4 Scores for diet sustainability

To measure adherence to the EAT-Lancet reference diet and assess its impact on the incidence of noncommunicable disease risk and death, many planetary health diets scores have been created.

Seven indicators of sustainable diets were found: Planetary Health Diet Index (PHDI), Sustainable Diet Index (SDI), EAT-Lancet diet score (ELD-I), New EAT-Lancet diet score (EAT), and Figure 1: components evaluated by the World Index for Sustainability and Health (WISH), the innovative Nutrient-Based EAT index (NB-EAT), and the Sustainable-Healthy-Diet (SHED) (Neta et al., 2023) (Figure 1).

**Figure 1. Main diet sustainability indexes (Neta et al., 2023)**

Index (Abbreviation)	Scoring Structure	Main Components	Assessment Method
EAT-Lancet Diet Score (ELD-I)	Binary (0–1 per component; 0–14 total)	14 food/quantity thresholds (whole grains, fruits, dairy, meats, added sugar)	2×24-h recalls or FFQ
New EAT-Lancet Diet Score (EAT)	Modified version of ELD-I (refined thresholds)	Similar plant- and animal-based foods	Cohort FFQs
Planetary Health Diet Index (PHDI)	16 components; range 0–150	Plant foods (whole grains, legumes), animal products, oils	FFQ-based evaluation
Sustainable Diet Index (SDI)	Multiple sub-indices: nutrition, environment, economic, social, cultural	Nutrition (11 items), environment (5), economy, sociocultural, food safety	Food-frequency questionnaire
Sustainable-Healthy-Diet (SHED)	PCA-derived scoring aligned with EAT-Lancet	Food groups reflective of a sustainable diet	Cross-sectional questionnaires
Nutrient-based EAT Index (NB-EAT)	Binary nutrient/food targets; varying max scores	Nutrients (alpha-linolenic acid, fibre), foods (protein, fats, Na)	2×24-h recalls

Index (Abbreviation)	Scoring Structure	Main Components	Assessment Method
World Index for Sustainability and Health (WISH)	13 food components (0–10 each); total ~0–130	9 healthy foods, 4 unhealthy foods	2-day dietary recalls

### 1.1.5 Reasons and Criteria for a New SINU Pyramid

The Mediterranean diet was first represented as a food pyramid in 1995 by Walter Willett and his colleagues, including Italian nutrition scientist Anna Ferro-Luzzi. Since then, several versions have been developed as new research has deepened our understanding of nutrition and of the environmental effects of food production. Recently, the Italian Society of Human Nutrition (SINU) created a new version of the pyramid to promote healthy and sustainable eating patterns and to prevent chronic diseases. This update was guided by recent scientific evidence, international recommendations from FAO–WHO and the EAT–Lancet Commission, and national references such as the CREA Dietary Guidelines and the latest LARN values. The new model places greater emphasis on plant-based foods and environmentally responsible choices.

The updated SINU Mediterranean food pyramid, which illustrates these concepts, is presented below (Figure 1).

**Figure 2. A new version of the traditional Mediterranean diet pyramid**



Fig. 1. SINU Mediterranean diet pyramid.

The base of the Mediterranean diet pyramid emphasizes daily consumption of fruits, vegetables, and high-quality extra-virgin olive oil (EVOO). These foods are traditional staples of the Mediterranean diet and have well-established health benefits. EVOO, in particular, is highlighted for its historical significance in Mediterranean agriculture and its proven role in preventing cardiovascular disease. High-quality EVOO is preferred due to its higher content of antioxidants and anti-inflammatory compounds.

Each day's main meals should include three fundamental components: cereals, fruits and vegetables, and occasionally a small portion of legumes or beans. One to two servings of cereals per meal are recommended, preferably whole or partially refined grains such as bread, pasta, rice, couscous, or bulgur. At least two servings of vegetables should be consumed daily, with at least one served raw, particularly at lunch or dinner. Fruits should be included in one to two servings per meal, typically as a main dessert. Eating a variety of fruits and vegetables in different colors ensures a wide range of minerals and beneficial plant compounds. Cooking methods that use less heat help preserve nutrients and reduce energy use, lowering the environmental impact.

Wholegrain cereals also play a central role as a main source of carbohydrates and energy. Traditionally common in Southern Italy, foods such as pasta, rice, and bread are now widely consumed throughout the country. Wholegrain options are emphasized for their dietary fiber, vitamins, bioactive compounds, and beneficial metabolic effects, including a lower post-meal blood sugar response compared with refined cereals. It is recommended to combine cereals with vegetables and/or legumes, following Mediterranean culinary traditions and supported by strong evidence of their nutritional and metabolic benefits.

Nuts and dried fruits, particularly figs and apricots, are characteristic of Mediterranean eating habits. Historically, bread and figs—fresh or dried, depending on the season—were staple foods for field workers in Southern Italy. Nuts are recommended in moderation (about 30 g per day) due to their energy content, but are valued for their polyunsaturated fatty acids, vitamins, minerals, and other bioactive compounds. Regular consumption of these traditional Mediterranean foods justifies their placement alongside cereals at the foundation of the Pyramid.

Special attention is given to dairy products. Historical data show that milk consumption in Southern Italy during the 1950s was low, while cheese—especially hard varieties like “caciocotta” made from sheep's and goat's milk—and fresh cheeses like ricotta or “mortedda” were common. Today, Italian dietary guidelines recommend daily consumption of partially skimmed milk and yogurt, noting that some saturated fatty acids in dairy have

little effect on cholesterol and that lactose supports calcium absorption. Milk and yogurt are thus placed in the Pyramid's foundation alongside cereals and nuts, while cheese is positioned in the middle for less frequent, weekly consumption, with a preference for fresh over hard, highly salted types.

## **1.2 The Middle Tier: Weekly Food Choices**

The central part of the Pyramid includes foods to be consumed weekly, primarily sources of plant and animal protein. Legumes and fish, together with fresh dairy products, form the lower section. Legumes are a traditional Mediterranean food that, when eaten 3–4 times per week, provide fiber, vitamins, bioactive compounds, and help lower LDL cholesterol and blood pressure. Replacing some animal protein with legumes also benefits the environment.

Fish is another staple, especially along Mediterranean coasts. Consuming 150 g of fatty fish two to three times per week provides sufficient omega-3 fatty acids to reduce heart disease risk. Preference is given to small local fish due to their nutritional value and lower environmental impact, while large predatory fish like tuna and swordfish should be limited because of mercury content and overfishing concerns.

The upper section includes other animal protein sources such as eggs, white meats (poultry), and hard cheeses, along with potatoes as an alternative carbohydrate. Meat consumption has increased compared to traditional diets, but replacing red and processed meats with plant-based proteins reduces health risks. Eggs and poultry are recommended weekly, while red and processed meats are reserved for occasional consumption.

Potatoes have been moved from daily to weekly consumption, as they are often eaten as side dishes and can increase post-meal blood sugar and diabetes risk if consumed daily alongside other carbohydrates. They should be eaten in moderation, ideally in meals with reduced or no other major carbohydrate sources.

## **1.3 The Apex: Foods for Occasional Consumption**

The apex, or top, of the Mediterranean diet Pyramid represents foods that should be eaten only occasionally. This section includes red and processed meats, as well as foods high in added sugars, such as sweets, sugary drinks, biscuits, snacks, and candies. Italian dietary guidelines recommend that total sugar intake should not exceed 15% of daily energy—about 75 g per day in a 2000 kcal diet—including both naturally occurring sugars in fruits, vegetables, and milk, and added sugars from food processing. Following the recommended daily intake of fruits, vegetables, and milk already brings sugar intake close to this limit,

leaving little room for additional added sugars. Traditionally, in the Mediterranean diet, sweets were reserved for special occasions, although dried fruits like figs and apricots were used as energy sources for laborers.

#### **1.4 Sugar, Salt, and Alcohol: The Less, the Better**

A healthy Mediterranean diet limits sugar, salt, and alcohol, as excessive intake contributes to chronic diseases. Modern diets include more processed foods, salty breads, cheeses, and meats, raising overall salt consumption. Reducing discretionary salt, choosing iodized salt, and recognizing hidden salt in processed foods are recommended.

Alcohol should not be consumed habitually. While moderate wine consumption was historically seen as protective for heart health, evidence shows that risks—including cancer and cardiovascular conditions—outweigh any benefits. Wine and beer can be consumed consciously and moderately on special occasions with meals. Beverages like coffee or ginseng are generally safe for healthy adults but require caution for children, adolescents, older adults, pregnant women, hypertensive patients, or those with anxiety or sleep issues.

#### **1.5 Lifestyle and Environmental Considerations**

A healthy Mediterranean lifestyle involves more than food choices. It includes staying well-hydrated, sharing meals socially, engaging in regular physical activity, favoring fresh seasonal foods over heavily processed products, using herbs and spices to enhance flavor, reducing food waste, and making environmentally responsible dietary decisions.

Sustainable diets should be not only health-promoting but also environmentally sustainable, culturally appropriate, and economically accessible. The updates to the Mediterranean Diet Pyramid reflect these principles, although some recommendations may take time to be widely adopted due to traditional habits or industry practices. Collaboration among food producers, small and medium enterprises, public catering, food scientists, and health authorities can support the adoption of these practices, benefiting both human health and the environment.

## 1.6 Mediterranean diet and sustainability

Sustainable diets are those that have minimal negative effects on the environment and support the security of food and nutrition, as well as the health of current and future generations. Sustainable diets maximize natural and human resources while protecting and honoring biodiversity and ecosystems, as well as being culturally acceptable, easily accessible, equitable, and reasonably priced. They are also safe, healthful, and nutritious. The decline in Mediterranean populations' adherence to the Mediterranean diet is concerning since it has unfavorable effects on social, cultural, economic, and environmental developments in the Mediterranean region, in addition to health.

Figure 3 shows the main indicators used to assess the sustainability of the Mediterranean diet.

These indicators are divided into four areas: nutrition and health, environment, economy, and society and culture. This classification allows for a broad evaluation of the Mediterranean diet, considering not only its nutritional and health aspects but also its environmental, economic, and cultural dimensions.

Thematic area	Proposed indicators
A. Nutrition and health	A1. Diet-related morbidity/mortality A2. Fruit and vegetable consumption/intake A3. Vegetable:animal protein consumption ratio A4. Average dietary energy adequacy A5. Dietary diversity score A6. Dietary energy density score A7. Nutrient density A8. Food biodiversity composition and consumption A9. Nutritional anthropometry A10. Physical activity/physical inactivity prevalence A11. Adherence to the Mediterranean dietary pattern A12. Rate of local/regional foods and seasonality A13. Rate of eco-friendly food production and/or consumption
B. Environment	B1. Water footprint B2. Carbon footprint B3. Nitrogen footprint B4. Biodiversity
C. Economy	C1. Food consumer price index (FCPI): cereals, fruit, vegetables, fish and meat C2. Cost of living index (COLI) related to food expenditures: cereals, fruit, vegetables, fish and meat C3. Distribution of household expenditure per groups: food C4. Food self-sufficiency: cereals, fruit and vegetables C5. Intermediate consumption in the agricultural sector: nitrogen fertilizers C6. Food losses and waste
D. Society and culture	D1. Proportion of meals consumed outside home D2. Proportion of already prepared meals D3. Consumption of traditional products (e.g. proportion of product under PDO or similar recognized traditional foods)

**Figure 3. Potential indicators for assessing the sustainability of the Mediterranean diet**

### 1.6.1 A Comparison Between Past and Present

The traditional Mediterranean diet (MD) was historically the foundation of eating habits in Mediterranean countries, largely shaped by local farming practices and culinary traditions. Over time, factors such as globalization, urbanization, and Western influences have gradually altered these habits, leading to a decline in adherence to the original dietary model.

Experts generally agree on the characteristics that define the traditional MD. Still, many suggest that it should be updated to accommodate modern lifestyles, address environmental concerns, and respond to contemporary health challenges such as obesity and cardiovascular disease. The updated MD emphasizes the consumption of fresh, seasonal, and locally sourced foods, promotes moderation, and encourages a greater emphasis on plant-based meals.

Since 1995, the Mediterranean food pyramid has served as a visual guide illustrating the recommended frequency of consumption for different food groups. Beyond dietary guidance, the pyramid also emphasizes cultural values, shared meals, regular physical activity, and sufficient rest as integral components of a healthy and sustainable lifestyle.

It is important to note that the pyramid reflects the ongoing evolution of the Mediterranean diet within Mediterranean societies (see Figure 4)

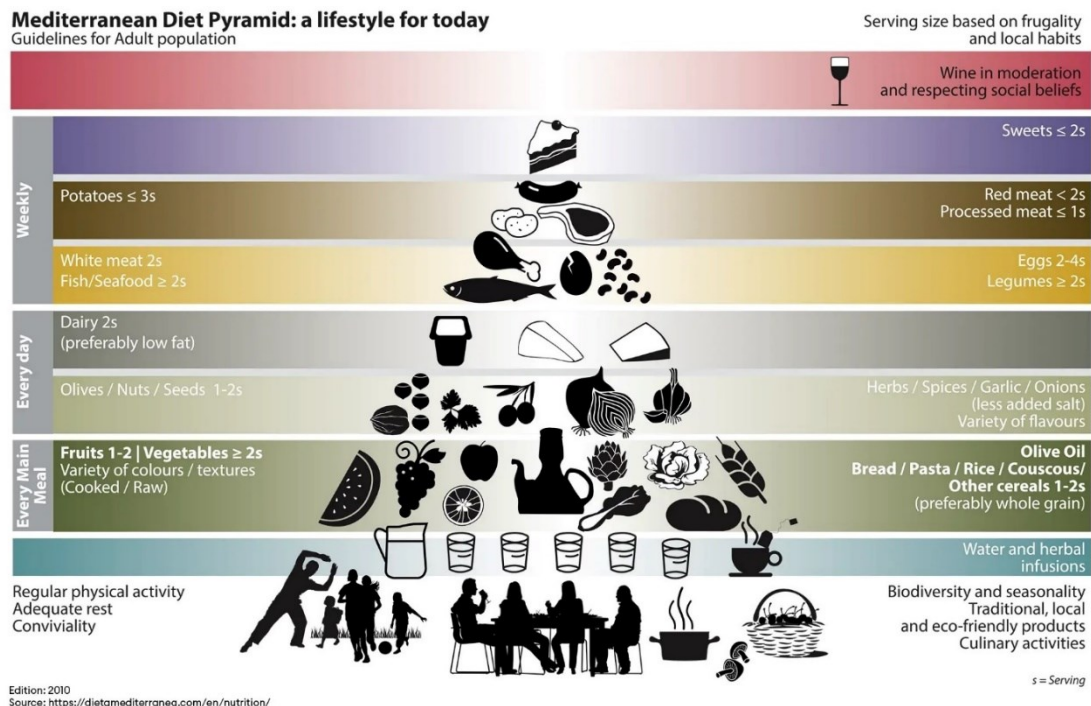


Figure 4: old version of Mediterranean Diet Pyramid (Bach-Faig A. et al., 2011).

The new Mediterranean food pyramid aims to encourage stronger adherence to this healthy eating pattern in Mediterranean countries and beyond. It outlines both the quantity and quality of foods to be consumed, showing the ideal proportions and frequency for each food group. The pyramid keeps the traditional layout, placing plant-based foods that should form the base of the diet at the bottom, while foods higher in sugar, fat, or of animal origin appear at the top and should be eaten in moderation.

It also highlights the importance of balanced meals that combine fruits, vegetables, and cereals, complemented by moderate amounts of dairy products and protein sources.

### 1.6.2 Sustainable Benefits of the Mediterranean Diet

The Mediterranean diet provides multiple benefits that extend beyond individual health. Researchers have identified four key dimensions of sustainability associated with this dietary pattern: (I) major health and nutrition benefits; (ii) low environmental impact and richness in biodiversity; (iii) high sociocultural food values; and (IV) positive local economic returns.

These four dimensions are integrated into the **Med Diet 4.0 framework**, which applies the principles of sustainability to the Mediterranean diet. The framework visually summarizes how these interconnected benefits contribute to a diet that is both healthy and sustainable (see Figure 5).

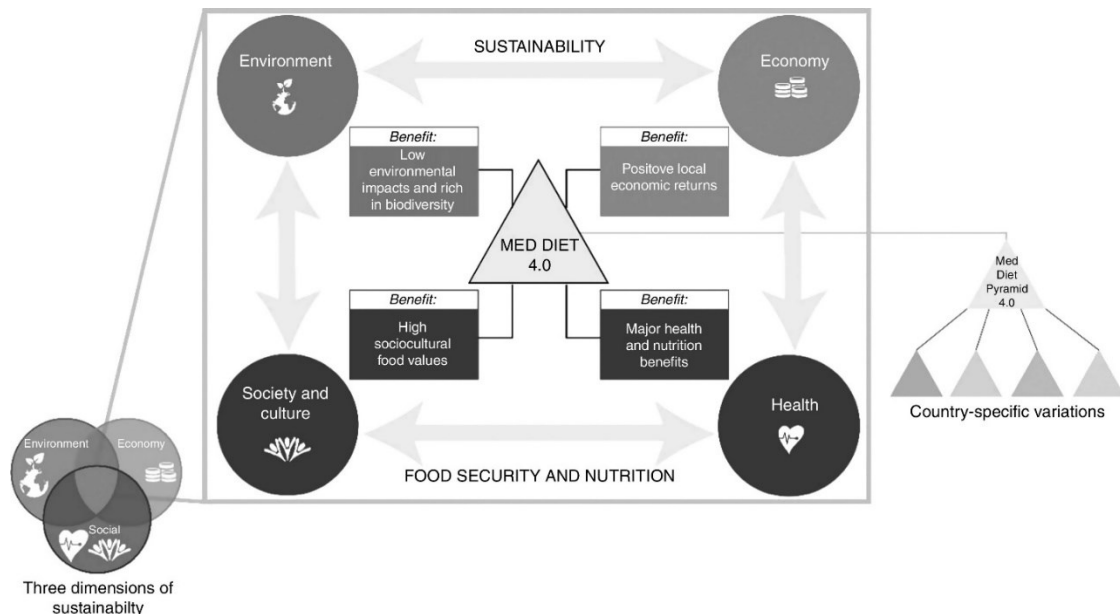


Figure 5. Sustainable benefit Med Diet(Dernini, Berry et al. 2011)

**Health Benefits:** The Mediterranean diet has been shown to contribute to the prevention of chronic diseases, including cardiovascular conditions, type 2 diabetes, obesity, and certain types of cancer. Its balanced, nutrient-rich composition, emphasizing fruits, vegetables, whole grains, legumes, nuts, and moderate animal products, promotes overall health and longevity.

**Environmental Benefits:** By prioritizing local, seasonal, and primarily plant-based foods, the diet reduces greenhouse gas emissions, conserves water and land resources, and supports biodiversity. Traditional agricultural knowledge and the use of diverse crops are maintained, enhancing ecological sustainability.

**Sociocultural Benefits:** Recognized by UNESCO as an Intangible Cultural Heritage, the diet fosters communal meals, strengthens cultural identity, encourages hospitality and intercultural dialogue, and preserves culinary traditions and social practices across generations.

**Economic Benefits:** The Mediterranean diet promotes local food production and traditional crafts, stimulates rural economies, encourages sustainable consumption, minimizes food waste, and reduces dependence on imported food products, contributing.

The Seven Countries Study was the first to draw attention to the Mediterranean diet (MDP), which has since gained widespread recognition for its ability to prevent cardiovascular disease and a host of other chronic illnesses. High adherence to the MDP has been shown to reduce the risk of several malignancies, particularly those associated with the liver, digestive tract, and hormonal systems. In terms of nutrition, it outperforms Western diets in supplying adequate micronutrients (except for vitamin D). The MDP has also been linked in studies to a lower risk of type 2 diabetes and metabolic syndrome, a smaller waist circumference, a healthy body weight, and a slower rate of cognitive decline, including protection against dementia and Alzheimer's. Better vascular health, decreased inflammation, increased immunity, enhanced mental well-being, and an improved quality of life are further advantages. Adopting the MDP is an economical way to address problems associated with obesity.

### **1.6.3 Factors Associated with Dietary Acculturation:**

Food instability is one of the many issues that affect international students' food acculturation. Due to limited financial resources, students often opt for more affordable and convenient foods over traditional ones, resulting in a decrease in their vegetable intake and an increase in their consumption of animal products. Chronic illnesses and weight gain are

associated with poor diets. Accessibility and affordability are crucial factors in food acculturation, as psychological stress during acculturation can have an additional impact on eating patterns, and the high cost of traditional foods can accelerate dietary changes. :( Dean J. et al., 2022)

**Transition in Nutrition:** Dietary acculturation is one of the primary variables influencing changes in the lifestyles and health of immigrants, in addition to the broader phenomenon of nutritional transition. The nutritional transition began in high-income nations and has since spread to low-income nations, initially in urban areas and subsequently in rural ones, driven by industrialization and the globalization of food markets. Urbanization increases the availability of cheap, highly processed, high-energy foods while decreasing physical exercise. Both practices expose consumers to highly processed meals while simultaneously expanding their access to fresh foods, reflecting a quicker transition for immigrants from low-income to high-income contexts.

Compared to Western diets, the Mediterranean diet (MDP) has less of an impact on the environment since it emphasizes plant-based foods and uses fewer animal products, which lowers greenhouse gas emissions, land use, energy demand, and water consumption. Its beneficial environmental impact is confirmed by studies conducted in Italy and Spain. A hotspot for biodiversity, the Mediterranean region is threatened by habitat degradation and the decline of native crops. The MDP preserves ecological and cultural heritage, promotes biodiversity, and conserves traditional knowledge by encouraging the consumption of seasonal, local, and diversified foods.

The Mediterranean diet, which embodies lifestyle, customs, and cultural identity, is not only a recognized UNESCO Intangible Cultural Heritage of Humanity but also a healthy eating pattern. It highlights the social significance of food, hospitality, diversity, and thrift. Sharing a meal fosters communal relationships, encourages conversation, and promotes conviviality. It represents the diverse array of Mediterranean food cultures and culinary systems, with its roots in centuries of customs, faiths, and civilizations. It links production, consumption, biodiversity, sustainability, and cultural heritage more than food. Maintaining the Mediterranean diet serves as a paradigm for sustainable development and cross-cultural understanding by ensuring responsible, local, and sustainable consumption.

By maintaining traditional practices, crafts, and food systems, the Mediterranean diet supports local economies and fosters harmony between people and their land. Although it is widely known in developed nations, it remains less well-known in other regions of the Southern and Eastern Mediterranean. Due to its widespread recognition as a nutritious diet,

Mediterranean foods have the potential to be marketed and produce profitable results, particularly in small rural communities. Increased adherence might lead to increased domestic production and a reduction in reliance on imports, especially in North Africa and the Near East. Food waste is decreased, farmers are empowered, and sustainability is promoted by promoting traditional products through labeling, quality standards, and innovation. ((Dernini & Berry, 2020)

#### **1.6.4 Impact of Migration on Dietary Habits**

The complex process by which immigrants adopt the eating habits of their new country, influenced by environmental, cultural, and personal factors, is known as food acculturation. Dietary patterns often shift with migration, and these shifts can be beneficial or detrimental. Both healthy and unhealthy ingredients can be found in traditional cuisines. For example, while the host populations enjoy native cuisines, Mexican immigrants in the United States tend to consume more foods from the Western diet and fewer whole grains and legumes. While consuming less saturated fat is beneficial, consuming more sugar-filled beverages is detrimental.

Dietary acculturation, the process by which immigrants and international students adjust to the food environment of their new country, has a significant influence on eating patterns. Positive effects could include better habits picked up from locals, while negative changes include eating fewer fruits and vegetables, eating more snacks, and eating irregular meals are common. As seen by Australia's varied cuisines, such as Chinese and Indian, these shifts are shaped by environmental variables, including food availability, affordability, and convenience. Individual characteristics such as independence, cooking abilities, time constraints, curiosity, and food familiarity also affect how migrants strike a balance between their new eating habits and traditional diets. The availability of traditional foods, cultural integration, and social position are some of the elements that frequently impact the dietary changes seen in migrants.

Dietary acculturation among immigrants exhibits both beneficial and detrimental alterations. While cutting back on saturated fats is a positive change for Spanish immigrants (Bermudez OI. Et al., 2000), substituting traditional fruit-based drinks with sugary ones is seen as detrimental. Rice consumption among Asian immigrants tends to stay consistent, while milk and sandwiches occasionally take the place of traditional dishes. These modifications show how difficult it is to adjust to the diets of the host nation, where lifestyle, food availability,

and cultural customs all have a significant impact on eating patterns. The dual character of dietary acculturation in influencing immigrant nutrition and general health is highlighted by the fact that although certain beneficial aspects are preserved or enhanced, others are lost. (Satia JA. Et al., 2000; Yang GP. Et al., 1979; Lee SK. Et al., 1999. Minorities may prepare traditional dinners using foods from their host country, which is an intriguing element of dietary acculturation. For instance, a study of 102 Chinese immigrants in Nebraska revealed that they adapted by preparing traditional Chinese foods with American products, like canned veggies. (Yang GP. Et al., 1979. Research indicates that while the Western diet more readily influences breakfast and lunch, immigrants are more likely to eat traditional meals for dinner. (Satia JA. Et al., 2000; Raj S. et al.,1999).

Not all dietary changes brought about by acculturation are detrimental, though some immigrants may completely adopt the eating customs of their new nation. Migrants should be educated about choice, preparation and cooking of healthy foods, reading nutrition labels, and lowering fat and sugar intake; physicians should improve migrants' health literacy regarding ideal body weight and obesity risks, especially since overweight/obese African women often underestimate their weight; awareness may increase interest in counseling and treatment; promoting physical activity, while respecting cultural and religious backgrounds, can help prevent nutrition-related diseases and obesity.

### **1.6.5. Historical Overview**

In contrast to the northern "barbaric" diet of meat, animal fats, and beer, the Mediterranean diet (MD) has ancient roots, stemming from the classical Greco-Roman emphasis on grains, olive oil, and wine. The ancient food culture, which eventually proved essential to the MD, was maintained by farmers in southern Italy. The "Mediterranean diet" was first described by Ancel and Margaret Keys in the 1970s, who linked southern Italy's traditional eating habits to increased life expectancy and lower cardiovascular mortality. Today, the MD serves as a scientific and cultural model that UNESCO has acknowledged for its heritage and health significance.

### **1.6.6 Factors Influencing Diet and Physical Activity in Ethnic Minorities**

Ethnic minority groups in Europe have high rates of non-communicable diseases, including obesity, type 2 diabetes, and cardiovascular disease (Faskunger et al., 2009; Patel et al.; Leung et al., 2011; Hayes et al., 2002). Differences in diet and physical activity compared with host populations likely contribute to these health outcomes (Hayes et al.,

2002; Babakus et al., 2012; Besharat Pour et al., 2014; De Munter et al., 2013; Hansen et al., 2008; Hornby-Turner et al., 2014; Dagkas et al., 2006).

Although variations exist between ethnic groups, first- and second-generation migrants may share lifestyle patterns distinct from the general population (Södergren et al., 2008; Rawlins et al., 2013; Satia et al., 2002). Understanding these factors is crucial for developing public health interventions aimed at ethnic minority populations in Europe (Figure 6).

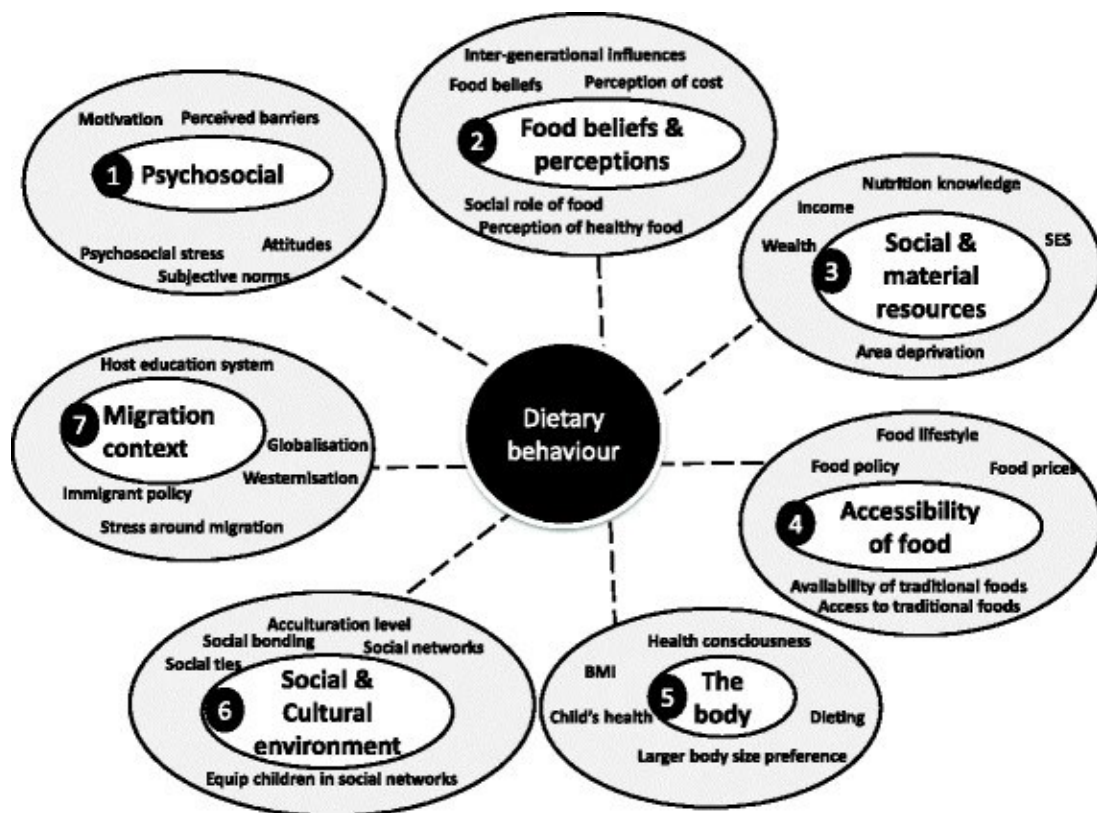


Figure 6: A systematic overview of priority factors and clusters influencing eating behaviors in ethnic minority populations living in Europe (Holdsworth M. et al., 2017).

The factors listed within each cluster are the top five factors identified by experts from various disciplines, and the numbers indicate the ranking of the clusters. Three criteria were used to evaluate these: "potential effect size on behavior," "expected modifiability," and "research priority." Although they may not always indicate causal linkages, the dashed lines suggest that characteristics within each cluster are associated with specific behaviors.

It is also important to understand the factors that influence eating behaviors and physical activity and how they overlap (Figure 7).

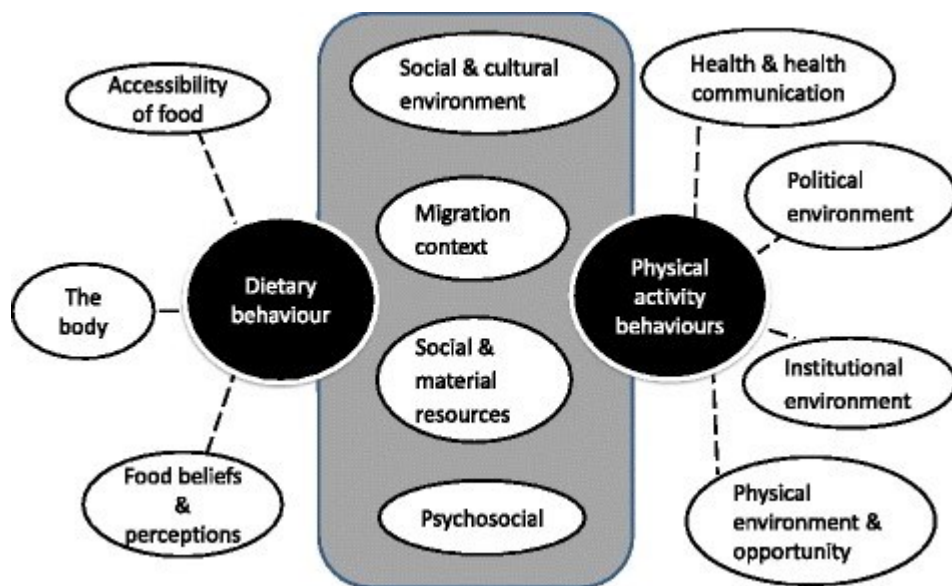


Figure 7: Figure shows an integrated framework for the major categories of variables that affect physical activity and eating habits, as well as how they overlap (Holdsworth M. et al., 2017).

An integrated, systems-based framework of the clusters affecting the nutrition and physical activity habits of European ethnic minorities. Although dot lines indicate that behaviors are linked to components within the cluster, they do not establish causality. (Holdsworth et al., 2017)

The variety among European ethnic minority populations must be acknowledged. Factors in one cluster may influence actions differently depending on other clusters, indicating that different clusters of factors probably interact. Furthermore, as populations fluctuate over time, these clusters are dynamic and subject to change. Therefore, rather than assuming static requirements, research and interventions should be creative and flexible, meeting the changing demands of ethnic minority communities.

**A comparison between foods and preparation methods of Mediterranean and non-Mediterranean countries.”**

Mediterranean Europe was the area that experienced the greatest number of changes in availability since the 1960s. Food availability changes in this area include: (I) an emergent increase of sugar and sweeteners, as with other Mediterranean countries, (ii) an increase of 822·71 kJ (196·5 kcal)/person/day of meat, namely poultry meat; (iii) one of the highest availability of vegetable oils, mainly sunflower seed oil; (iv) an increase of about 40 % of animal fats, but still below the availability amounts in Northern Central Europe; (v) a

decrease of 50 % in the availability of alcoholic beverages; and, (vi), a decrease in the availability of cereals and wine (not statistically significant) and legumes ( $P < 0.05$ ). Despite all these shifts, this area maintains the highest availability of olive oil and fruit. Over time, a slight increase in the availability of vegetables, fish, and seafood was found. Previous studies have also observed an increase in vegetables and fruits (Schmid Huber and Traill<sup>33</sup>), as well as a decrease in cereals and wine (Garcia-Closas, Berenger, and Gonzalez<sup>23</sup>), and legumes. In terms of data on oil food groups, the fact that these food groups exhibit the greatest difference between availability and actual intake (Schmid Huber and Trail, 33)

Should be taken into account. In the case of olive oil, regions such as North America and non-Mediterranean Europe, as well as countries like Japan, Australia, and Brazil, have been reported to import a considerable portion of the olive oil produced in Mediterranean areas (Alexandratos<sup>34</sup>, Alexandratos<sup>41</sup>).

Thus, Mediterranean foods seem to be gaining ground in the competitive market.

(Dernini, Berry et al. 2011))

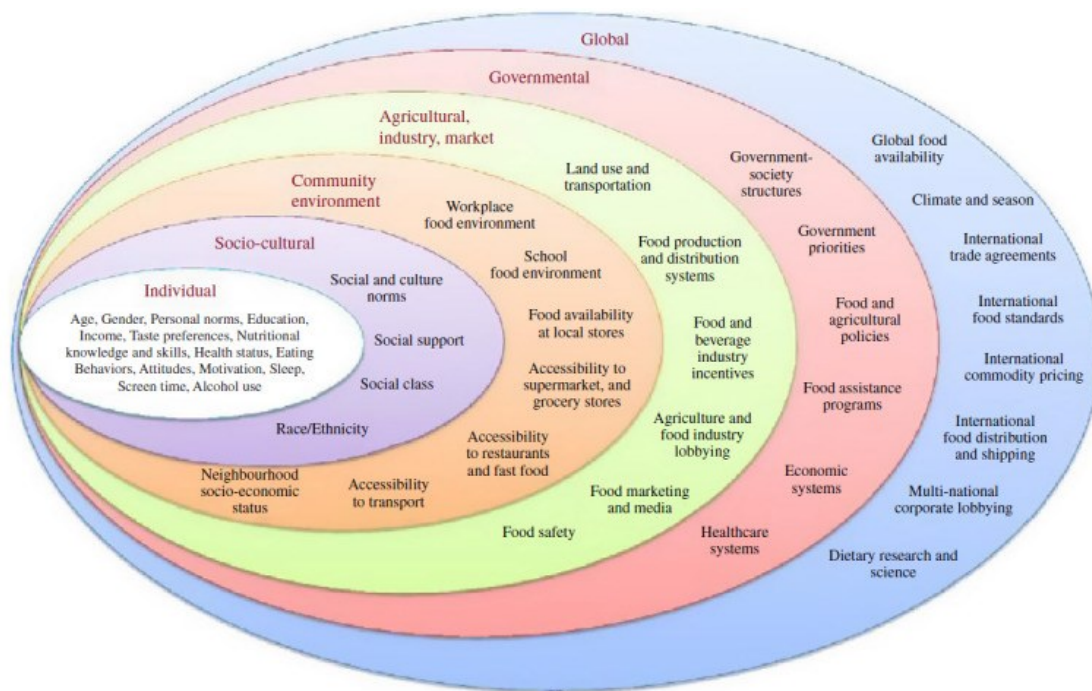
The comparison between Mediterranean and non-Mediterranean countries highlights substantial differences in food choices, preparation methods, and cultural habits. Olive oil consumption, for example, is a key distinction, while vegetable preferences vary widely, from fresh mixed salads in Greece to boiled vegetables in Northern Europe. Preparation techniques also affect nutrient retention, with Mediterranean soups and stews preserving water-soluble vitamins better than Northern boiling practices. Differences extend to fruit intake, which is generally higher in Southern Europe, and nut consumption, where Mediterranean populations favor walnuts, almonds, and hazelnuts, while Northern countries consume more peanuts. Legume use also follows a north-south gradient, with higher consumption in Mediterranean areas. Dairy products differ as well, with Mediterranean diets emphasizing cheese and yogurt from sheep and goat milk, while Northern Europe relies mainly on cow's milk products. Even meat and alcohol consumption patterns vary, with Mediterranean practices generally offering a healthier nutrient profile and more moderate drinking habits. These variations strongly influence nutrient intake, bioavailability, and long-term health outcomes.

### **Culturally adapting the Mediterranean Diet pattern – a way of promoting more 'sustainable' dietary change?**

Type 2 diabetes and cardiovascular disease are two non-communicable diseases that are associated with poor diet quality, which is common in the UK. Intake of fruits and vegetables

is still below recommended levels, and there hasn't been much progress in recent years. To address this, one must take into account the environmental, social, economic, and individual aspects that affect dietary choices. Multi-level interventions in contexts such as schools, workplaces, and communities are necessary for long-term behavior change. These interventions must be paired with policy efforts, changes to the food environment, and stakeholder engagement. In order to promote public health and lessen health disparities, the food system must undergo a sustainable shift.

As shown in **Figure 8**, potential policy strategies can be applied across various levels — individual, social, environmental, industrial, governmental, and global (Muzaffarabad et al., 2016). It is essential to ensure these strategies also address and reduce health inequalities.



**Figure 8: Barriers and opportunities for healthy eating. (Woodside J. et al., 2022).**

This figure highlights the main barriers that may prevent individuals from maintaining a healthy dietary model, such as the Mediterranean diet. Achieving sustainable behavioral change requires interventions across multiple levels — individual, socio-cultural, environmental, industrial, governmental, and global — consistent with the diverse determinants that influence food choices (Mozaffarian et al., 2016).

Moreover, research indicates that while flexibility is crucial for adapting the Mediterranean diet to non-Mediterranean contexts, it is equally important to preserve its traditional characteristics and to limit or exclude foods that contradict the fundamental principles of the Mediterranean dietary model (Martínez-González et al., 2017)

### **1.6.7 Transferability of the MD to non-Mediterranean regions:**

The Mediterranean diet is known for its health benefits, and promoting this dietary model in non-Mediterranean countries could help reduce environmental impact and lower rates of chronic diseases (Woodside J. et al., 2022). Studies on its transferability—such as research conducted in the United States—suggest replacing packaged snacks with healthier options like nuts and fruit, choosing water instead of sugary drinks, allowing moderate wine consumption for adults, and using fresh fruit as a regular dessert instead of sweets and high-fat dairy products (Martinez-Gonzalez et al., 2017). Reducing snacking and replacing red or processed meats with fish and legumes may also improve diet quality.

However, several challenges exist. Levels of adherence to the Mediterranean diet vary across countries (Benhammou et al., 2016), and access to key foods—such as extra virgin olive oil—can be limited. Cultural, religious, and economic factors, as well as traditional cooking habits, must be considered when encouraging adoption (Martinez-Gonzalez et al., 2017; Kontogianni, 2018). Resistance to changing food preferences may also occur, making culturally appropriate nutritional advice essential (Phull S. et al., 2015; Kuhlen BM. et al., 2019).

Including locally produced and culturally accepted foods with similar nutritional profiles could improve adherence (Kuhlen BM. et al., 2019; Woodside J. et al., 2022). Regional adaptations are also important from environmental and economic perspectives (Moore et al., 2018; Phull S. et al., 2015; Kuhlen BM. et al., 2019; Woodside J. et al., 2022; Middleton G. et al., 2015). Some studies highlight the value of focusing on local foods, which are often more readily accepted (Bonaccio M. et al., 2017)

# **Chapter Two**

## **Aim**

## **2.1 Aim**

This thesis examines the sustainability of the diets of international students using the Planetary Health Diet Index (PHDI), based on the EAT-Lancet recommendations. The study is part of the MeditEat Project, which promotes healthier and more environmentally friendly eating among international students at the University of Pavia. Using dietary data from nineteen students, the research evaluates whether the nutrition education sessions led to changes in diet sustainability and identifies which parts of their diets follow recommended patterns and which do not. More broadly, the study adds to current knowledge on sustainable eating among young, mobile student populations and offers insights that may help future nutrition programs and policies designed for international students.

## **2.2 Erasmus students in Pavia**

Following a six-month nutritional education program, this study assesses the adherence of Erasmus students at the University of Pavia to the Mediterranean diet.

# **Chapter Tree**

## **Materials and methods**

### 3. Materials and methods

#### 3.1. Participants

Participants' selection of the sample group for this project was selected among the participants to the MeditEat program, organized by the University of Pavia: all the participants were recruited by convenience, they voluntarily accepted to take part in the project and signed a consent term (it must be noted that the project was approved by the Ethical Committee of the University of Pavia). The program was aimed at international students coming from different cultural and food-related backgrounds.

#### 3.2. Intervention

With the scope of the project being the improvement of these students' diets throughout a 6-month period during which they would be involved in a series of "nutrition education" sessions, as the project organizers defined it. During these, the participants would be informed of the benefits and advantages of the Mediterranean diet, and they would be given personalized help to integrate some of its main factors into their own culinary habits to hopefully improve their health conditions and at the same time the sustainability of their diets (Figure 9).



Figure 9: medit eat pamphlet:

The six-month intervention comprised multiple meetings. After completing an online survey, participants attended the first in-person session where they were given individualized counsel, a basic body composition evaluation, and general nutrition education. The second meeting was conducted virtually and concentrated on providing customized advice based on

a more thorough analysis of their body and dietary data. Participants went to another in-person session with a fresh physical evaluation and questionnaire at three months. Following that, there were two more online gatherings where participants received one-on-one assistance in achieving their nutritional objectives.



Figure 10: Mediterranean food pyramid, fruits and vegetables, and advice on how to increase their consumption:



Figure 11: The Mediterranean food pyramid standard of bread, pasta, olive oil, and how to consume them in the right way.

The typical serving sizes for fruits and vegetables are shown in Figure 10. After that, the lesson discusses cereals, emphasizing their function as a source of energy and endorsing whole grains. According to LARN recommendations, standard portion proportions for foods high in carbohydrates are also displayed. An outline of extra-virgin olive oil's composition and nutritional worth follows the explanation. There are also useful suggestions, including cutting back on animal fats and utilizing healthier cooking techniques, like adding raw olive oil and opting for steaming, baking, or cooking in foil.

Figure 11 offers helpful advice on how to utilize extra-virgin olive oil correctly and efficiently.

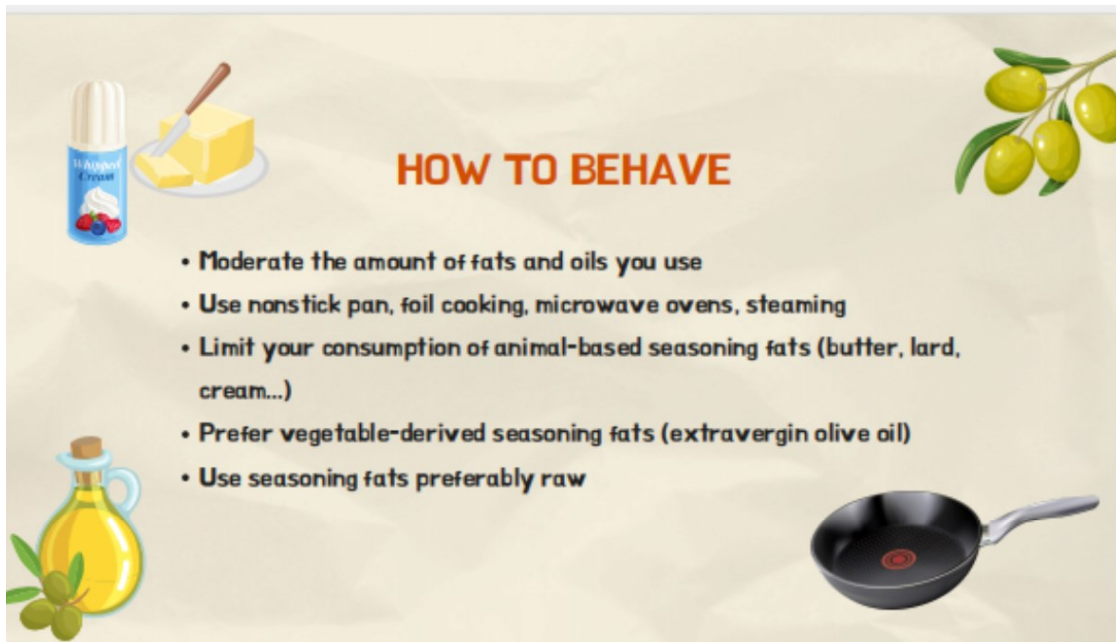


Figure 12: Practical advice on how to properly use extra virgin olive oil.

Students are invited to choose one of the suggested tasks after going over these ideas, as illustrated in Figure 13.

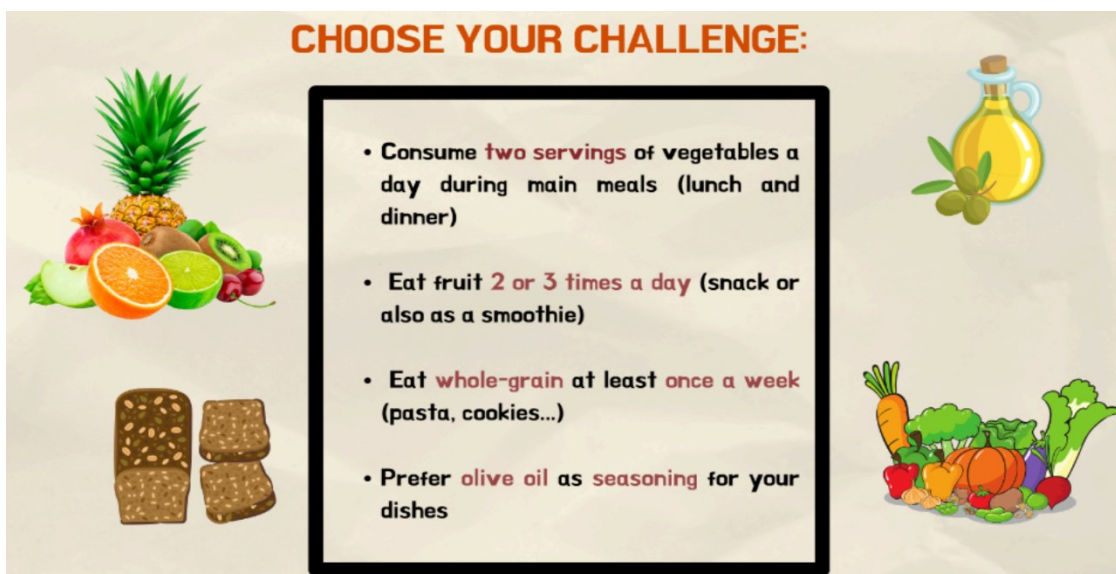
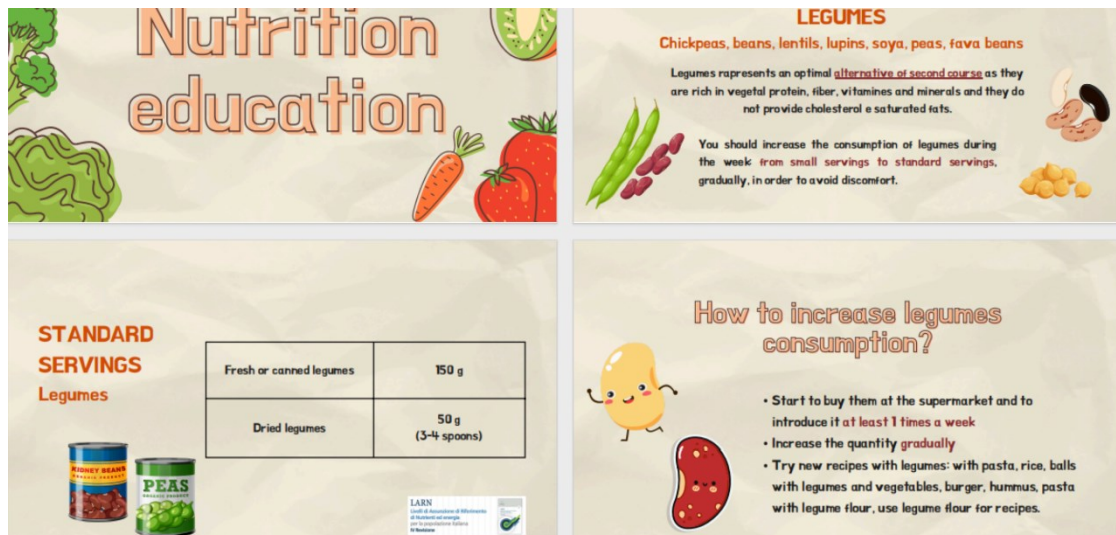


Figure 13: “First topic of the challenge”

“Second topic”



**Figure 14: lists the advantages of legumes, promotes the use of plant-based proteins instead of animal ones, illustrates LARN-recommended standard quantities, and offers helpful advice on how to boost legume intake, such as incorporating them into meals once a week and experimenting with new recipes like hummus or legume burgers.**

The definition, typical serving sizes, and useful recommendations for boosting legume consumption are shown in Figure 14.

An example of a recipe using legumes is shown in Figure 15. After that, the session introduces fragrant herbs, outlining the most popular ones and promoting their use in place of salt. The foods that are most likely to contain salt are listed, along with the health hazards associated with high sodium intake. The section also discusses nuts, outlining the many varieties, health advantages, nutritional composition, and LARN-recommended serving sizes.



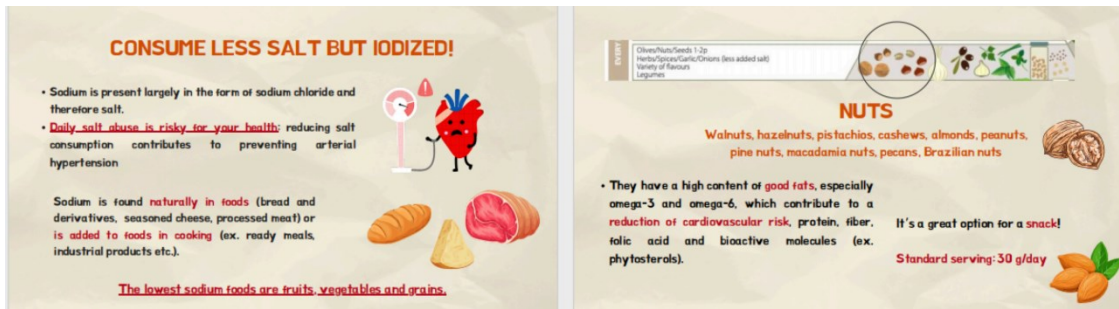


Figure15: “Example of a recipe with legumes; aromatic herbs; sodium; dried fruit”

The nutritional makeup and health advantages of olives are shown in Figure 16, along with suggestions for including them in a diet. Additionally, it specifies dairy products and discusses how often each variety should be consumed.

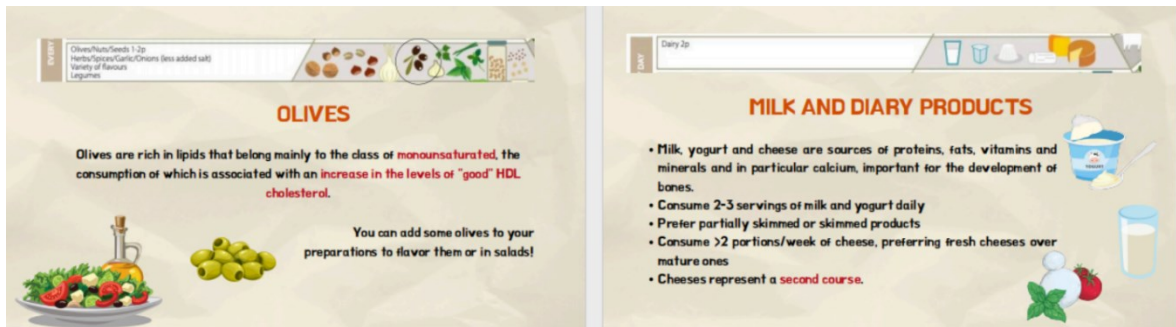


Figure 16: Definition of olives and dairy products"

The LARN rules for typical dairy product portion sizes are displayed in Figure 17.

LARN  
Livelli di Assunzione di Riferimento  
di Nutrienti ed energia  
per la popolazione Italiana  
11<sup>a</sup> Revisione

**STANDARD SERVINGS**  
Milk and dairy products

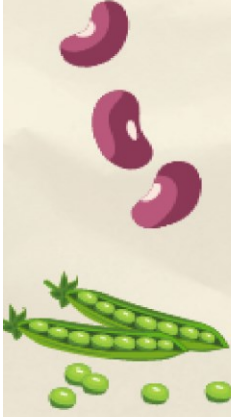


Milk	125 ml
Yogurt	125 g
Fresh Cheese	100 g
Aged Cheese	50 g

Figure 17: "Standard portions according to the LARN for dairy products"

Students are invited to choose one of the suggested tasks after going over these ideas, as shown in Figure 18.

**CHOOSE YOUR CHALLENGE:**



- Start consuming **legumes 2-3 times a week** by gradually increasing the portion as main protein source
- For snack pick at least once a day: **nuts, or milk, or yogurt**
- Reduce **processed food (high in sodium)** at maximum once a week






Figure 18: Challenge second topic"

The nutritional makeup of fish, eggs, white meat, red meat, and processed meats is shown in Figure 19, emphasizing which of these foods is better.

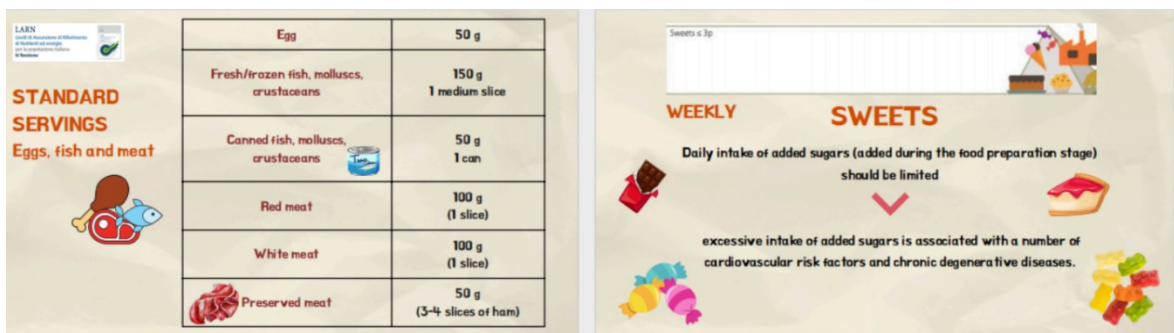


Figure 19: Definition of the nutritional composition of fish, eggs, white and red meat, and processed meat.



Figure 20 explains why sweets, which are at the top of the Mediterranean food pyramid, should be consumed in moderation and displays the typical portion sizes for main courses in accordance with LARN guidelines.

Figure 20: "Standard portions of main courses according to the LARN; definition of risks associated with excessive consumption of sweets."

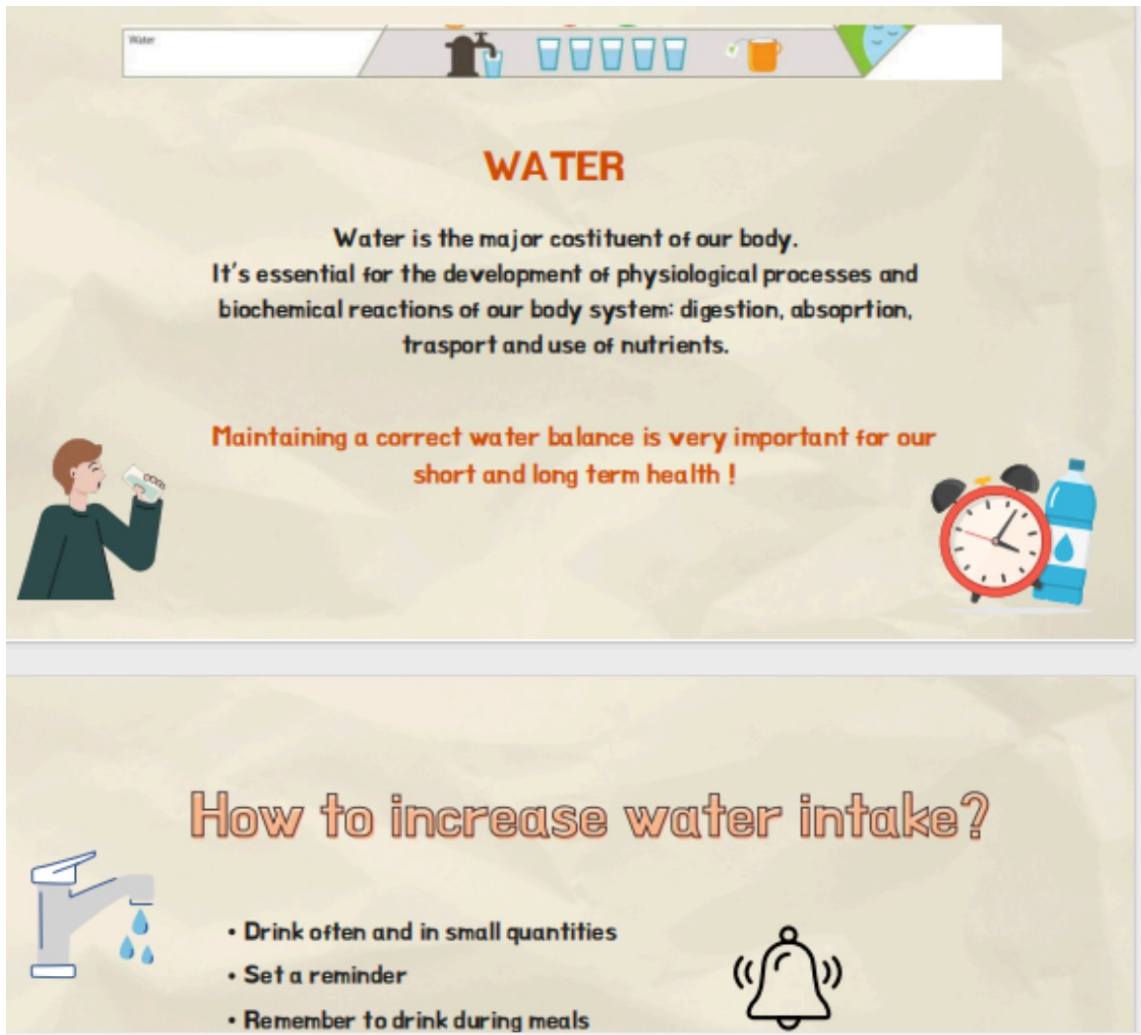


As seen in Figure 21, students are invited to select one of the suggested challenges after going over these ideas.



**Figure 21: Third challenge:**

Figure 22, which shows the LARN-recommended daily intake for adult men and women, emphasizes the value of water and maintaining enough hydration. There are many useful suggestions for boosting daily water intake, like drinking little quantities often, setting reminders, drinking during meals, or drinking tea and herbal infusions. The graphic also highlights the need of drinking water instead of sugary drinks, outlining the health hazards associated with sugary drinks, such as an increased risk of type 2 diabetes, metabolic syndrome, and exposure to colorants, chemicals, and added sugars.



The infographic is divided into two horizontal sections. The top section has a header bar with a 'Water' label, a faucet icon, five glasses of water, a mug, and a water drop icon. The main text in this section defines water as the major constituent of the body, essential for physiological processes like digestion, absorption, transport, and use of nutrients. It emphasizes that maintaining a correct water balance is crucial for short and long-term health. Illustrations include a person drinking from a bottle and a red alarm clock next to a water bottle.

## WATER

Water is the major constituent of our body.  
It's essential for the development of physiological processes and biochemical reactions of our body system: digestion, absorption, transport and use of nutrients.

**Maintaining a correct water balance is very important for our short and long term health !**

### How to increase water intake?

- Drink often and in small quantities
- Set a reminder
- Remember to drink during meals

Figure 22: Definition of water, the need to stay well hydrated, the LARN's suggested daily water intake for adult males and females, useful advice for increasing water intake, and the detrimental effects of consuming too many sugary drinks on one's health.

**LARN**  
Livelli di Assunzione di Riferimento di Nutrienti ed energia per la popolazione italiana IV Revisione

**STAY HYDRATED**

## REFERENCE VALUES FOR A CORRECT WATER INTAKE

Age	Water intake (ml)
18- >75 years	2500 ml (Males)
	2000 ml (Females)

### SOFT DRINKS

It's important to reduce soft drinks at special occasions because:

- Its consumption increases the risk of type 2 diabetes and metabolic

Although moderate drinking of red wine is permitted, Figure 23 highlights the significance of limiting alcohol consumption due to its detrimental health effects, which are detailed in depth. Additionally, the figure shows the daily consumption level deemed low-risk and conventional serving sizes for alcoholic beverages, emphasizing that lower intake is always preferred.



Figure 23: “Negative health consequences related to excessive alcohol consumption and standard portions of alcoholic beverages according to the CREA Guidelines.

As seen in Figure 24, students are asked to choose one of the suggested tasks after going over these ideas.



Figure 24: “Fourth topic of the challenge”

As seen in Figure 25, students are invited to select one of the suggested challenges after going over these ideas.

The suggested challenge for the fifth topic is shown in Figure 25.



Figure 26 offers helpful advice on how to better understand nutrition labels, such as selecting goods with shorter ingredient lists, comparing comparable products from other brands, and looking beyond calorie content by examining saturated fats, fiber, sugars, and salt. In an effort to assist consumers in reducing food waste, the figure also explains the distinction between "use by" and "best before" dates.



## NUTRITIONAL LABELS

**Nutritional Table**

- Useful to compare two products of the same category
- Do not dwell too much on the caloric intake of a product, it is not always useful to understand its nutritional quality. It is much more important to understand what nutrients calories come from.
- Compare sugar, saturated fat, salt, fiber content

**Date of expiry**

- "To be consumed by":** final date by which products can be safely consumed. The product cannot be consumed after the stated expiry date.
- "Preferably to be consumed by":** final date by which the product retains its organoleptic qualities. The food can then be consumed even after the date indicated, after checking that appearance, smell and taste are acceptable.

**First In First Out:** the foods with the earliest date of expiration or use-by date must go in front or at the top of the storage system




Figure 26: describes the essential components of a nutrition label, provides helpful advice on how to read it correctly, and clarifies the distinction between "use by" and "best before" dates.

As seen in Figure 27, students are invited to select one of the suggested challenges after going over these ideas.

## CHOOSE YOUR CHALLENGE:



- At the supermarket: read at least 2 nutritional labels
- At home: check at least 5 nutritional labels from your food supply.



Figure 27: The sixth topic's challenge

The idea of a diversified diet is explained in Figure 28, along with its significance.


### VARIED DIET

#### What is meant for a varied diet?

A varied diet means making choices that allow you to build a complete and balanced food style, able to bring psychophysical benefits, diversifying flavours and preventing nutritional imbalance.

**VARYING FOOD MEANS:**

- Making everyday different food choices in the same food group



### Why varying your meals is so important?

- A complete food that contains all the necessary substances and in the right quantities, able to satisfy our energy needs, doesn't exist.
- According to the similar characteristics each food is grouped in different food groups (cereals and derivatives: meat, fish, eggs and legumes: milk and dairy products: condiment fat).

So combining different food, each with different nutritional characteristics is essential!

Figure 28: "Definition and importance of a varied diet"

As seen in Figure 29, students are asked to select one of the suggested challenges after going over these ideas.

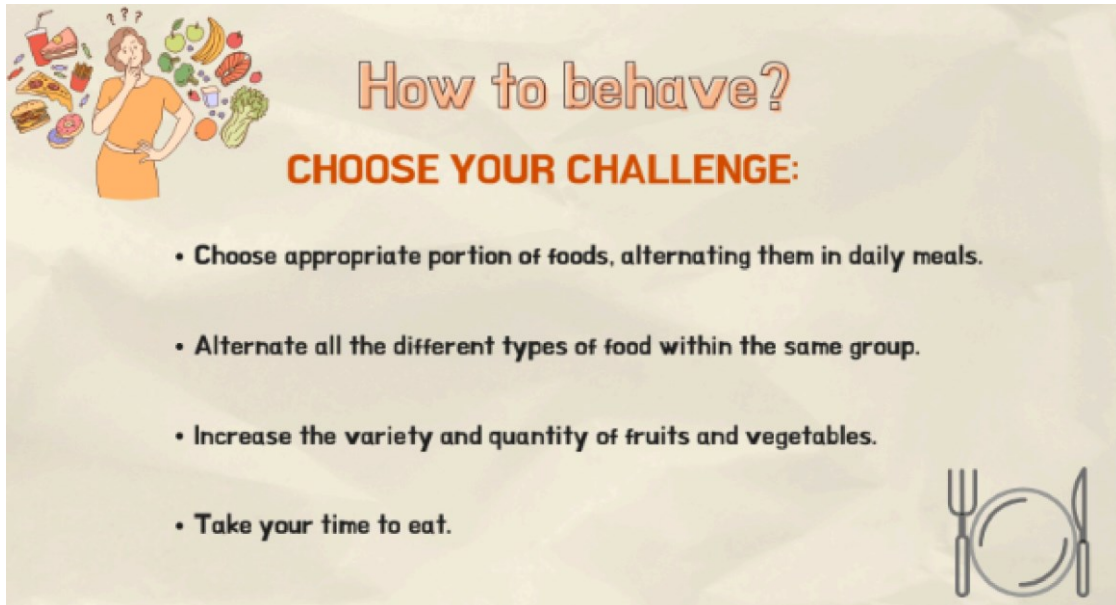


Figure 29: “Seventh topic of the challenge”

The idea of a sustainable diet and the effects of various foods on the ecosystem are explained in Figure 30. Increasing plant-based foods, selecting items with less packaging, creating shopping lists to cut down on waste, repurposing leftovers to make new meals, and properly storing food to prevent spoiling are just a few of the useful suggestions offered for embracing a more sustainable diet.



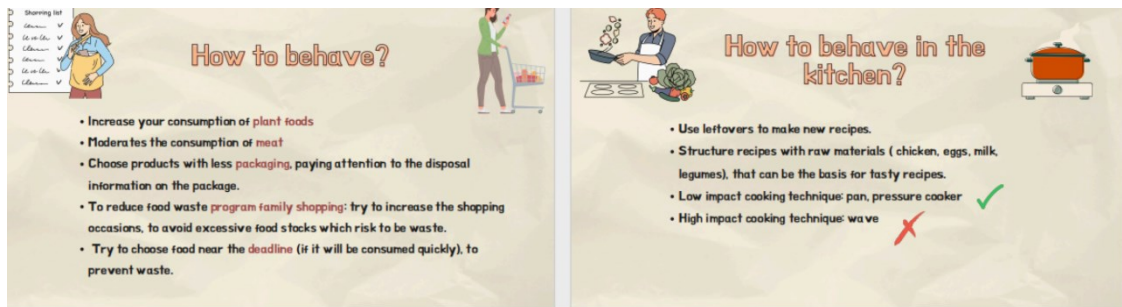


Figure 31: “Definition of a sustainable diet and its importance; practical tips on how to adopt it.”

A real-world example of implementing a sustainable diet is shown in Figure 32, with a particular emphasis on efficient grocery shopping planning.



Figure 32: “Practical tips on how to plan a sustainable grocery shopping.”

As seen in Figure 33, students are invited to choose one of the suggested tasks after going over these ideas.



Figure 33: “Eighth topic of the challenge”

"Figure 34 demonstrates the fundamental concept of conviviality and emphasizes its benefits.

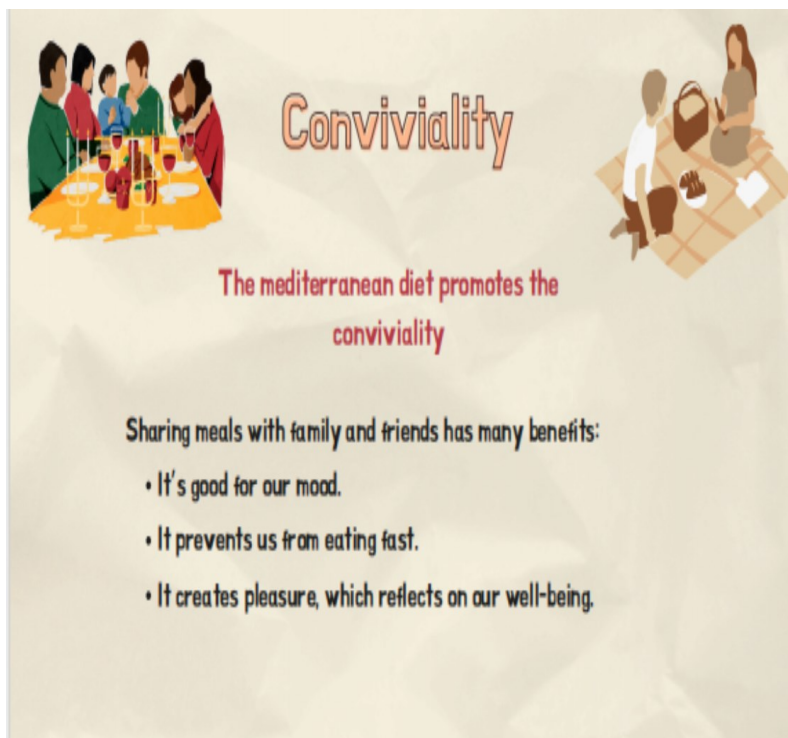


Figure 34: Explanation of the concept of conviviality and its importance.”

"Having reviewed these ideas, the student is invited to select one of the challenges presented, as seen in Figure 35."



Figure 35: "Ninth topic of the challenge"

Dietary patterns are characterized by high consumption of vegetables, fruits, legumes, nuts, whole grains, fish, and olive oil, moderate intake of dairy products and wine, and minimal consumption of red meat, sweets, sugary beverages, and butter (figure 36)

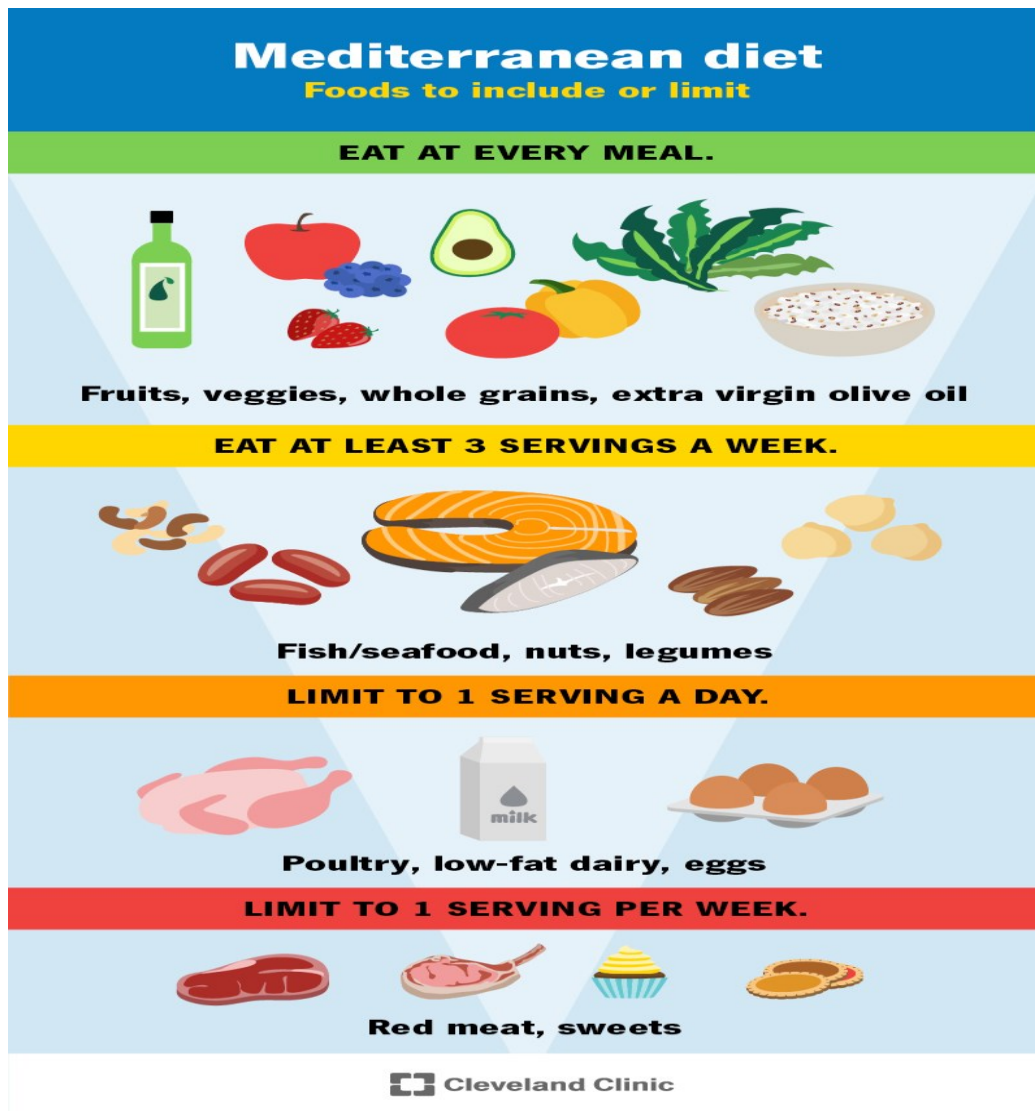
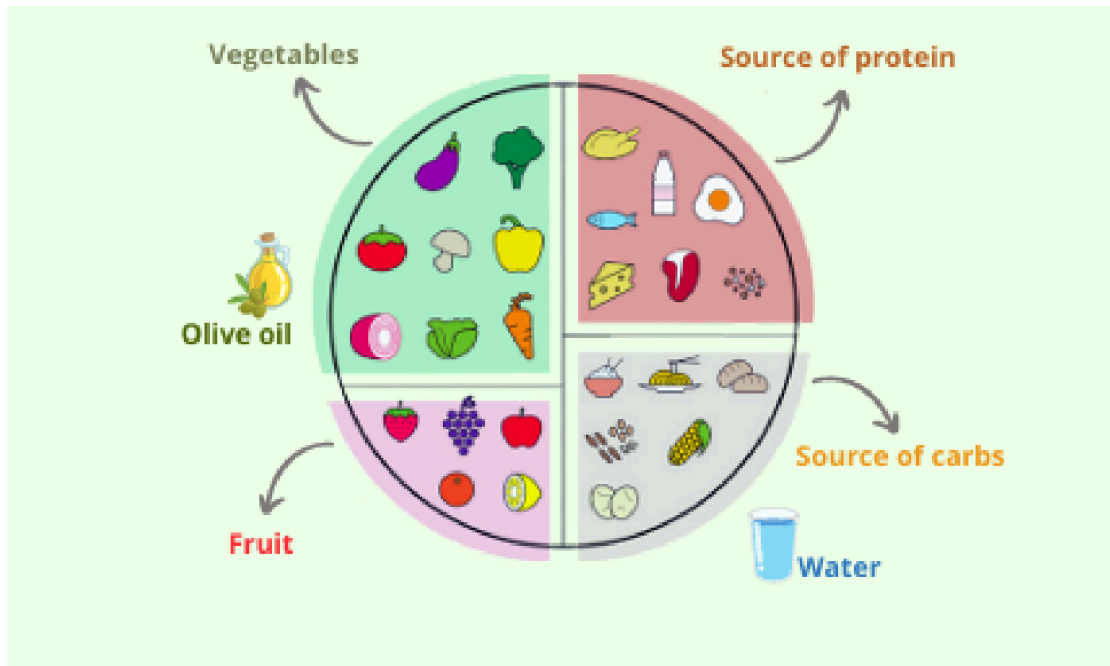


Figure 36: Mediterranean diet food to include or limit:

"Figure 37 presents a visual depiction of the healthy plate alongside a sample daily menu, including lunch and dinner options aligned with the Mediterranean diet, designed to offer Erasmus students a practical reference."



Source of minerals, vitamins and fiber (VEGETABLES)	Source of carbs (prefer whole grains)	Source of healthy proteins
Lettuce, spinach and silverbeet	Whole rice/whole pasta	Legumes: lentils, beans, peas, chickpeas, ...
Celery, asparagus	Whole bread	Lean fish: cod, bass, sea bream Fish rich in omega 3: salmon, tuna, mackarel
Cucumber and zucchini	Cous cous	Eggs
Cauliflower, brussel sprouts, broccoli	Whole barley	White meat: poultry, turkey (Red meat, 1 a week: beef, pork meat)
Tomatoes	Potatoes	Fresh cheese: ricotta, mozzarella, feta, primosale Seasoned cheese (0-1 a week): Parmesan cheese, edam, gorgonzola,

"Figure 37 Sample lunch and dinner following the Mediterranean diet, with a visual illustration of the healthy plate."

### 3.3 Anthropometric and Body Composition Measurements

#### Metrics of Anthropometry

An experienced dietician used standardized protocols to record anthropometric data, such as weight (kg), height or length (cm), arm circumference (cm), and skinfold thickness (mm) (Lohman, 1988).

## Measurements of Body Composition and Anthropometry

BMI was calculated as weight (kg) divided by height<sup>2</sup> (m), with height and weight measurements taken with precision to within 0.1 kg and 0.5 cm. To quantify body fat using the Durnin & Womersley and Siri formulas, skinfolds (triceps, biceps, subscapular, and suprailiac) were measured in triplicate, and arm, waist, and hip circumferences were recorded at standard points. Using electrodes on the wrist and ankle, bioelectrical impedance analysis (BIA) measured body fat, lean mass, and hydration while the subjects were fasting and in a supine position.

In all in-person sessions (T3 and T6), anthropometric measurements are taken after the participant's medical, weight, family, and health history have been gathered during the initial session (T0). The concepts of the Mediterranean diet and general or specific recommendations are explained through slideshows in both in-person and online nutritional education sessions. Participants select a "challenge" to adhere to between sessions, such as eating more legumes, consuming more fruits and vegetables, using extra-virgin olive oil, getting eight hours of sleep, or planning their meals each week. Six sessions cover eight educational subjects that are customized to the participant's past habits and expertise.

Mediterranean diet for international students:

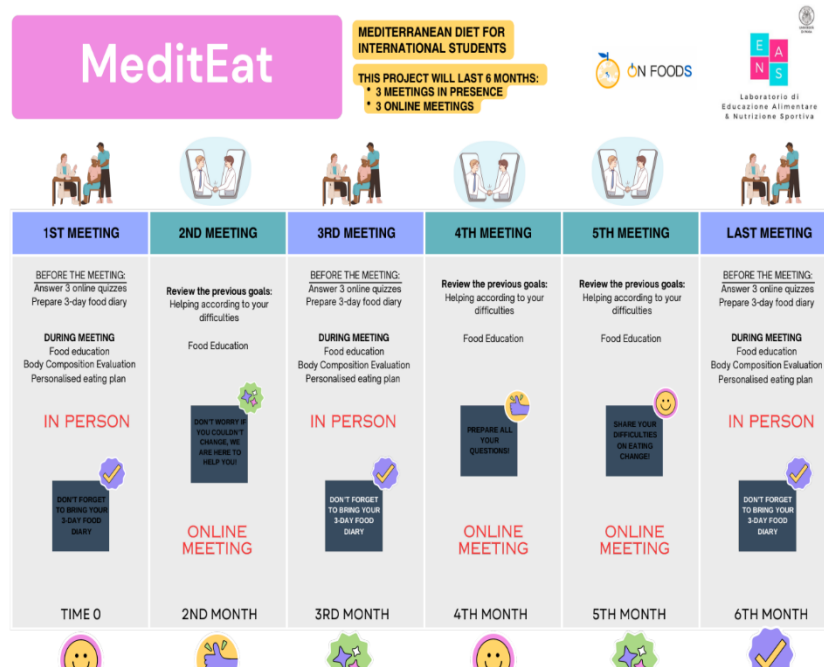


Figure 38: “Shown the organization of the study”

Organization of the experimental project meetings.

The overall experimental project lasts 6 months. The monthly meetings are designed to evaluate changes in participants' dietary habits and address any issues related to adopting the Mediterranean diet. With an average age of roughly 29.8 years (range 21–43), nineteen overseas students participated in the study. The majority were in their mid-20s to early 30s, which is consistent with being students. India, Iran, Guatemala, Turkey, Jordan, Germany, Peru, Brazil, Mexico, Myanmar, and Portugal were among the many nations represented in the group, resulting in a culturally diverse sample. There were just three male participants, indicating a significant female preponderance. This combination of genders, ages, and backgrounds provides helpful context for interpreting the study's results because these variables may influence eating patterns.

### **3.4. Data collection**

A dietary frequency questionnaire was given to participants at each in-person session. These standardized instruments, which are widely tested and available in several languages, have 114 food items categorized by category, and participants indicate how frequently they consume each one. While the later questionnaires were designed to track changes before and after the individualized counseling sessions and educational activities, the first one reflected the participants' typical eating patterns before getting any nutritional guidance. Figure 39 is the English version used in our project.

## Food Frequency Questionnaire (English version)

### General instructions

This questionnaire refers to your eating habits during the previous year prior to the diagnosis of disease. Please answer the questions as best you can. If you are unsure of the answer, make an estimation. An estimated response is better than an empty space. Blacken the corresponding box (circle) to indicate how often, on average, you have eaten the specified food. If an error occurs write "NO" next to the wrong signs and then blacken the correct answer. Enter an answer on every line. For any questions feel free to ask.

MEAT AND FISH	NEVER	PER MONTH		PER WEEK		PER DAY			
		1 per month	2 per month	1 per month	2 - 3 per week	4 - 5 per week	1 per day	2 - 3 per day	4 - 5 per day
Red meat (beef, horse meat) (slice, 100g)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Pork (roast, stew, sausage) (slice, 100g)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Fast food (Hamburger, Kebab) (1 portion)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
White meat (chicken, turkey) (slice, 100g)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Processed meat (ham, salami) (50g)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Cod, sole (100g)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Mackerel, Spanish mackerel (100g)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Swordfish (100g)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Masculino, anchovies (100g)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Tuna (fresh or canned) (1 can)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Salmon (fresh or smoked) (100g)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Seafood and shellfish (100g)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Eggs (1 egg)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

SWEETS AND SNACKS	NEVER	PER MONTH		PER WEEK		PER DAY			
		1 per month	2 per month	1 per month	2 - 3 per week	4 - 5 per week	1 per day	2 - 3 per day	4 - 5 per day
Various pastries (3 cookies/2 pastries/1 snack)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ice cream or slush (1 glass/cup)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Milk chocolate (4 squares)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Dark chocolate (4 squares)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Chips or other salty snacks (1 package)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Chestnuts (6 chestnuts)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Peanuts(10 peanuts)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Pistachios (10 pistachios)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Walnuts (5 walnuts)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Almonds (10 almonds)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hazelnuts (10 hazelnuts)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jam, marmalade, honey (2 teaspoons)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Spreads (nutella) (2 teaspoons)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

DRESSING	Frequencies			
Salt added during cooking	<input type="radio"/> NEVER	<input type="radio"/> sometimes	<input type="radio"/> often	<input type="radio"/> always
Salt added after cooking	<input type="radio"/> NEVER	<input type="radio"/> sometimes	<input type="radio"/> often	<input type="radio"/> always
Sugar added to coffee or tea	<input type="radio"/> NEVER	<input type="radio"/> half teaspoon	<input type="radio"/> 1 teaspoon	<input type="radio"/> 2 teaspoons
Sweeteners	<input type="radio"/> NEVER	<input type="radio"/> 1 drop/tablet	<input type="radio"/> 2 drops/tablets	-
Olive oil (1 spoon)	<input type="radio"/> NEVER	<input type="radio"/> less than 1 time per day	<input type="radio"/> 1 time per day	<input type="radio"/> 2 or more times per day
Seed oil (1 spoon)	<input type="radio"/> NEVER	<input type="radio"/> less than 1 time per day	<input type="radio"/> 1 time per day	<input type="radio"/> 2 or more times per day

VEGETABLE	NEVER	PER MONTH			PER WEEK		PER DAY		
		1 per month	2 per month	1 per month	2 - 3 per week	4 - 5 per week	1 per day	2 - 3 per day	4 - 5 per day
Carrot (1 carrot)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Spinach (120g)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Broccoli (100g) (SEASON)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Sprouts, Bruxell sprouts (100g) (SEASON)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Cauliflower (70g) (SEASON)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Peas (100g)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Green beans (150g) (SEASON)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Zucchini (100g)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Chicory (120g)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Asparagus (100g) (SEASON)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Onion (4 slices)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Garlic (1 clove)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Mushrooms (150g) (SEASON)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Green salad, lettuce (100g)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Tomatoes (100g)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Fennel (half)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Corn (100g)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Beans (100g)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Chickpeas (100g)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Lentils (100g)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Fava beans (100g)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Artichokes (1 artichoke) (SEASON)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Soy, veggie burgers, tofu (100g)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Pepperoni (1 pepper)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Eggplant (half eggplant)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Green olives (4 olives)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Black olives (4 olives)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

FRUIT	NEVER	PER MONTH			PER WEEK		PER DAY		
		1 per month	2 per month	1 per month	2 - 3 per week	4 - 5 per week	1 per day	2 - 3 per day	4 - 5 per day
Apple (1 fruit)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Pear (1 fruit)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Citrus fruits (1 fruit) (SEASON)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Blood orange (1 fruit) (SEASON)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Banana (1 fruit)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Grapes (6 grains) (SEASON)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Melon (1 slice) (SEASON)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Watermelon (1 slice) (SEASON)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Peaches (1 fruit) (SEASON)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Apricots (1 fruit) (SEASON)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Strawberries (4 strawberries) (SEASON)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Kiwi (1 fruit) (SEASON)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Cherries (6 cherries) (SEASON)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Red fruits (SEASON)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Pomegranate (1 fruit) (SEASON)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Prickly pear (1 fruit) (SEASON)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Prunes, plums (1 fruit) (SEASON)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Figs (2 figs) (SEASON)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

DRINKS	NEVER	PER MONTH			PER WEEK		PER DAY		
		1 per month	2 per month	1 per month	2 - 3 per week	4 - 5 per week	1 per day	2 - 3 per day	4 - 5 per day
Black tea or herbal tea (1 cup) (without fruit)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Green tea	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Tea, herbal teas or fruit infusions	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Coffee (espresso) or cappuccino (1 cup)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Coffee (espresso) or cappuccino decaffeinated (1 cup)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Red wine (half glass)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
White wine (half glass)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Beer (1 can)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Liqueurs (1 shot)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Soft drinks (1 glass)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Juices or smoothies (fresh fruit)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Juices or smoothies (confectioned)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Water (glasses a day)	≤ 3 (600ml)	4	5	6 (1,2 lt)	7	8 (1,6 lt)	9	10	≥11 (>2 lt)

CEREALS AND BREADS	NEVER	PER MONTH			PER WEEK		PER DAY		
		1 per month	2 per month	1 per month	2 - 3 per week	4 - 5 per week	1 per day	2 - 3 per day	4 - 5 per day
Bread and bakery products (biscuits, crackers) (100g)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Bread and flour products whole wheat (100g)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Corn flakes, wheat cereal (30g)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Rice (80g)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Pasta (80g)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Rice or pasta whole wheat (80g)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
French fries (100g)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Potatoes: boiled, baked, mashed (100g)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Pizza (half pizza)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Street food (arancini, cipolline)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

DAIRY	NEVER	PER MONTH			PER WEEK		PER DAY		
		1 per month	2 per month	1 per month	2 - 3 per week	4 - 5 per week	1 per day	2 - 3 per day	4 - 5 per day
Milk (1 cup, 250ml)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Soy milk, rice milk (1 cup, 250ml)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Yogurt (1 cup)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Yellow/hard cheese (50g)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Cottage cheese, soft cheese low fat (50g)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Mozzarella (1 mozzarella)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Cream cheese (Philadelphia) (30g)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Butter (10g)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Margarine (10g)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Dietary supplements and herbs	NEVER	PER MONTH			PER WEEK		PER DAY		
		1 per month	2 per month	1 per month	2 - 3 per week	4 - 5 per week	1 per day	2 - 3 per day	4 - 5 per day
Name and type: _____	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Name and type: _____	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Figure 39: Questionnaire given to the participants

### Thanks for completing the questionnaire!

Initially, the data were unprocessed and had to be arranged by participant and questionnaire submission date. The next step was to calculate each person's food intake to calculate the sustainability index scores once all the response data had been arranged neatly.

### 3.5. Daily Intake and Calorie Calculation

Daily food intake and calories were calculated using data from the Food Frequency Questionnaire (FFQ). First, the portion of each food was converted to grams, multiplied by the reported consumption frequency, and divided by the relevant time period to obtain the daily intake. For foods reported in units (e.g., eggs or pizza), the average weight per unit was obtained from reliable sources such as CREA. This site, managed by the Italian Council for Agricultural Research, provides accurate nutritional tables for most foods and was very useful for this project.

Daily caloric intake was then calculated by multiplying the daily gram intake by the calories per gram for each food (from CREA tables). Total daily calories were obtained by summing all foods, and the percentage contribution of each food to total daily calories was calculated. Mixed foods containing multiple ingredients (e.g., pizza) were divided proportionally by ingredient to assign calories to the relevant food groups. These percentages were later used to calculate the PHDI sustainability score.

Examples

#### 1. Red Meat

- Portion: 100 g
- Frequency: 2–3 times per week → standardized to midpoint 2.5/week
- Daily frequency:  $2.5 \div 7 \approx 0.36/\text{day}$
- Daily intake:  $100 \times 0.36 = 36 \text{ g/day}$
- Calories:  $127 \text{ cal}/100 \text{ g} \rightarrow 1.27 \text{ cal/g} \rightarrow 36 \times 1.27 \approx 45.7 \text{ cal/day}$
- Percent of total daily calories (total = 3945 cal/day):  $(45.7 \div 3945) \times 100 \approx 1.16\%$

#### 2. Salmon

- Portion: 100 g
- Frequency: 1/week →  $1 \div 7 \approx 0.14/\text{day}$
- Daily intake:  $100 \times 0.14 \approx 14 \text{ g/day}$
- Calories:  $206 \text{ cal}/100 \text{ g} \rightarrow 2.06 \text{ cal/g} \rightarrow 14 \times 2.06 \approx 28.8 \text{ cal/day}$
- Percent of total:  $(28.8 \div 3945) \times 100 \approx 0.73\%$

#### 3. Pizza (Margherita)

- Portion: 400 g
- Frequency: 1/month →  $1 \div 30 \approx 0.033/\text{day}$
- Daily intake:  $400 \times 0.033 \approx 13.33 \text{ g/day}$
- Calories:  $255 \text{ cal}/100 \text{ g} \rightarrow 2.55 \text{ cal/g} \rightarrow 13.33 \times 2.55 \approx 34 \text{ cal/day}$
- Percent of total:  $(34 \div 3945) \times 100 \approx 0.86\%$

- Ingredient breakdown:
  - Flour 50% → 0.43%
  - Mozzarella 30% → 0.26%
  - Tomato sauce 10% → 0.086%
  - Olive oil 10% → 0.086%

This procedure ensures accurate and standardized calculation of daily intake, daily caloric intake, and percentage contribution for each food, forming the basis for PHDI sustainability scoring.

### 3.6. Calculation of index scores

In order to assess the sustainability of each participant's diet, the PHDI index is used to assign each person a score of 31. As previously mentioned, the PHDI index is broken down into 16 food component groups, each of which has an ideal daily percentage of consumption to which the highest sustainability score is assigned. Depending on the component, the score then decreases with varying proportionality, as Table 40 illustrates.

Components	Scores (Points) <sup>1</sup>				
	0	5	10	5	0
<b>Adequacy component</b>					
Nuts and peanuts	0.0	←————→			≥11.6
Legumes $\phi$	0.0	←————→			≥11.3
Fruits	0.0	←————→			≥5.0
Vegetables	0.0	←————→			≥3.1
Whole cereals	0.0	←————→			≥32.4
<b>Optimum component</b>					
Eggs	0.0	←————→			0.8   ←————→   ≥1.5
Fish and seafood	0.0	←————→			1.6   ←————→   ≥5.7
Tubers and potatoes	0.0	←————→			1.6   ←————→   ≥3.1
Dairy $\S$	0.0	←————→			6.1   ←————→   ≥12.2
Vegetable oils $^{\circ}$	0.0	←————→			16.5   ←————→   ≥30.7
<b>Ratio component</b>					
DGV/total ratio $\neq$	0.0	←————→   29.5		29.5	←————→   100
ReV/total ratio $\equiv$	0.0	←————→   38.5		38.5	←————→   100
<b>Moderation component</b>					
Red meat $\pounds$	≥2.4	←————→			0.0
Chicken and substitutes	≥5.0	←————→			0.0
Animal fats $\ddagger$	≥1.4	←————→			0.0
Added sugars	≥4.8	←————→			0.0

Figure 40: Scoring table for PHDI Index of Sustainability (Cacau et al., 2019)

Food groups are categorized into four types by the PHDI index. The first five, referred to as "adequacy components," have a minimum intake required to receive a full score; consuming more does not raise the score. Only within a certain intake range do the next five "optimal components" gain maximum points; amounts above or below this lower the score. Generally speaking, four "moderation components" are discouraged; the maximum score is awarded when they are missing, and as intake increases, the score gradually drops until it reaches zero. Finally, the percentage of calories from dark green versus red-orange vegetables relative to total vegetable calories is used to grade "ratio components." The overall PHDI score ranges from 0 to 150, with the majority of components having a maximum of 10 points and the ratios being capped at 5.

### **1. Adequacy components**

A score of 10 points is assigned if the percentage of calories associated to the component equivalent or higher than a certain minimum, for any value lower than that, a normal proportionality formula is used: (N% represents the known percentage, M% the minimum value and X the unknown score)  $M\% \div 10 = N\% \div X \rightarrow X = (N\% \times 10) \div M\%$

Example: the percentage of nuts and peanuts is calculated at 36.7% and the index minimum is 11.6%, the assigned score is:  $(36.7\% \times 10) \div 11.6\% = 5.78$  The total caloric intake from the nuts and peanuts group—including nuts, pistachios, almonds, peanuts, and coconut pulp and milk—was calculated for each participant. For example, one participant had 1031.55 cal/day from this group. The PHDI score for nuts and peanuts was then determined by multiplying this value by 100 and dividing by the participant's total daily calories, giving the percentage contribution of this food group for scoring.

### **2. Optimum Components**

A score of 10 points is assigned if the caloric percentage for the component is exactly equivalent to the optimal value; if the percentage is lower than it, the same normal proportionality is applied; if the percentage is higher, the score will decrease, and if it is higher than the index threshold, the assigned score will be null. In the case the percentage is higher than optimal but lower than the threshold value, a linear interpolation formula is used to calculate the accurate score: linear interpolation allows us to determine proportional values oscillating between 2 sets of known variables, in our case, optimal and threshold percentages, and 10 and 0 points respectively. (N% represents the known percentage, O%

the optimal value, T% the threshold value and X the unknown score)  $X = 10 + (N\% - O\%) \times (0 - 10) \div (T\% - O\%)$

Example: the caloric percentage of fish and seafood is 10.95%, the optimal value is 1.6% and the index threshold value is 5.7%, the score is calculated at:  $10 + (10.95\% - 1.6\%) \times (0 - 10) \div (5.7\% - 1.6\%) = -12.80$

Since the score cannot be negative and the observed percentage exceeds the threshold, the final assigned score is 0 points.

### 3. Moderation components

A score of 10 points is assigned for a caloric percentage of the individual component equivalent to 0%, the score decreases if the value increases up to a maximum, after which the score assigned is 0. To calculate the score in this case, an inverse proportionality formula is used:

(N% represents the known percentage, M% the maximum value, and X the unknown score)

$$X = (M\% - N\%) \times (10 \div M\%)$$

**Example:** the caloric percentage of red meat is 0,3076%, the maximum index value is 2,4%, the score is:

$$(2,4\% - 0,3076\%) \times (10 \div 2,4\%) = 8,718539$$

### 4. Ratio components

The scoring for these components works in the same way as the optimum ones, but the highest assigned score is 5 instead of 10. To determine the DGV/Tot ratio, the daily caloric intake of the vegetables belonging to the dark green category is summed up, divided by the total intake of all vegetables, and multiplied by 100. For the ReV/Totratio, the calculation is the same, but it is the caloric intake from red and orange vegetables to be summed up and divided.

$$(DGV \text{ cal} \div TOT \text{ Veg cal}) \times 100 \mid (ReV \text{ cal} \div TOT \text{ Veg cal}) \times 100$$

the optimal values are 29,5% for DGV and 38,5% for ReV (being a percentile ratio, the maximum threshold value for both is 100% at which both score 0 points). A score of 0% is assigned if the calculated ratio is 0%; a score of 5 is awarded if the value is precisely 29.5%; the linear interpolation formula is applied if the value is between 29.5% and the 100% maximum; and, finally, a score of 0% is assigned if the value is equal to 100%.

### **3.7. Final Scoring Formula for Participant-Level Calculation**

To calculate the final score assigned to each participant for components with an optimal range, the following linear interpolation formula is used:

$$X = \text{Maximum Point} + (\text{Participant Percentage} - \text{Ideal Point}) \times (\text{Maximum Point} - \text{Minimum Point}) \div (\text{Maximum Percentage\%} - \text{Ideal Point})$$

Where:

- Participant Percentage = the observed percentage for the participant
- Ideal Percentage = the optimal reference value
- Maximum Percentage = the threshold percentage
- Maximum Point = the highest possible score (typically 10)
- Minimum Point = the lowest possible score (typically 0)
- X = calculated score assigned to the participant

This formula ensures that the participant's score is proportionally adjusted based on how closely their value aligns with the ideal reference, while remaining within the defined scoring range.

# **Chapter Four**

## **RESULTS**

## 4. RESULTS

### **Baseline Observations and Dietary Sustainability**

A total of 19 student participants were included in the study, with a predominance of female participants. Their ages ranged from 21 to 43 years, representing a young to middle-aged adult population. The sample included student participants from diverse geographic regions, including the Middle East, Europe, Asia, and Latin America. Mediterranean diet adherence scores varied considerably among the student participants, ranging from 1.58 to 4.92, reflecting levels of adherence from low to high. Overall, the student participants demonstrated a moderate level of adherence to the Mediterranean dietary pattern. Those from Portugal, Peru, and Iran had higher adherence scores, suggesting closer alignment with Mediterranean dietary principles. In contrast, participants from China, Mexico, and Turkey had lower scores, indicating less alignment with the diet.

From a sustainability perspective, student participants with higher adherence to the Mediterranean diet tended to follow dietary patterns that included more plant-based foods, such as fruits, vegetables, legumes, whole grains, and nuts, while consuming animal products in moderation. These dietary patterns are widely considered more environmentally sustainable, as they require fewer natural resources, produce lower greenhouse gas emissions, and place less pressure on land, water, and biodiversity compared with diets high in red meat and processed foods. Higher adherence was also linked to the consumption of seasonal and minimally processed foods, which further reduces environmental impact.

Many student participants reported having limited time for cooking and meal preparation, often due to academic workload and part-time work commitments. As a result, they frequently relied on convenient or quick-to-prepare foods, such as sandwiches, eggs, salads, and ready-made or processed items. This reliance on simple and processed foods contributed to lower sustainability scores for some participants and explains the limited variety observed in their initial diets.

Overall, the findings suggest that closer adherence to the Mediterranean diet not only improves nutritional quality but also promotes more environmentally sustainable dietary behaviors, highlighting the diet as a practical model for healthy and responsible eating

among student participants. Table 43 presents baseline dietary data across multiple food groups relevant to dietary sustainability. The results show substantial variability among participants in the consumption of plant-based and animal-based foods, which translated into different levels of dietary sustainability.

Participants with higher sustainability scores reported greater intake of vegetables, legumes, nuts, whole grains, and vegetable oils. In particular, higher values for legumes and nuts indicate a stronger reliance on plant-based protein sources. This dietary pattern is considered more sustainable, as plant-based foods generally require fewer natural resources and generate lower greenhouse gas emissions compared with animal-derived products.

Vegetable oil consumption, especially olive oil, was also higher among participants with better sustainability scores. This reflects closer adherence to Mediterranean dietary principles, where olive oil represents a central fat source and contributes to both nutritional quality and environmental sustainability.

In contrast, participants with lower sustainability scores showed higher consumption of red meat and added sugars. The table indicates that greater red meat intake was associated with less sustainable dietary profiles, due to the higher environmental impact of livestock production. Higher intake of added sugars further suggests a greater dependence on processed and convenience foods, which are typically linked to lower sustainability.

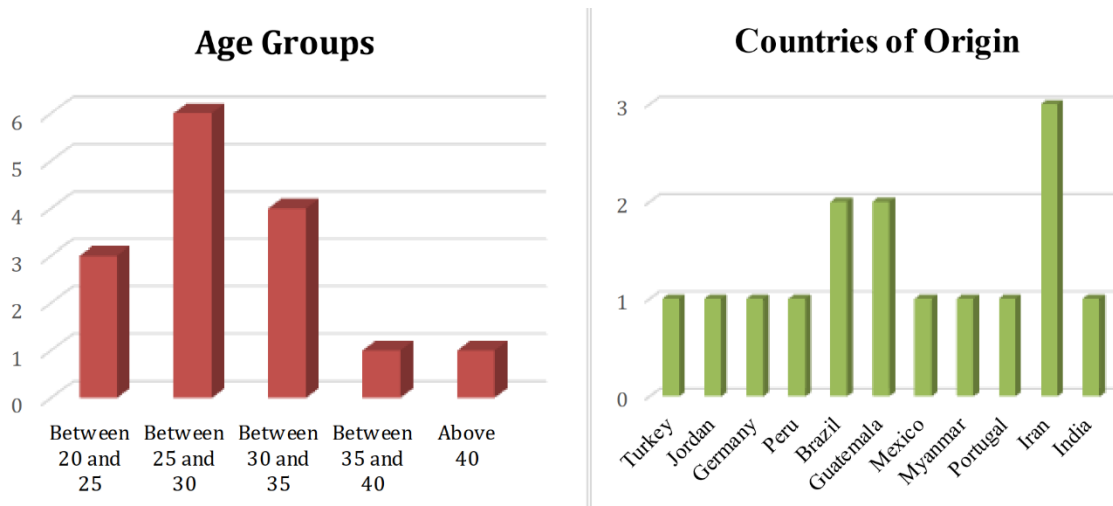
Chicken, eggs, and dairy products were consumed in moderate amounts across most participants. These foods appeared to have a smaller impact on sustainability outcomes when consumed alongside adequate amounts of plant-based foods. However, diets with limited variety and lower vegetable intake tended to score lower overall.

Overall, the baseline results demonstrate that dietary sustainability among the participants was mainly driven by the balance between plant-based and animal-based food consumption. Diets characterized by higher intake of vegetables, legumes, nuts, whole grains, and vegetable oils, together with lower intake of red meat and added sugars, were associated with more sustainable dietary patterns. These findings provide a clear baseline against which changes following the intervention can be assessed.

<b>Participate ID Code</b>	<b>Gender</b>	<b>Country of Origin</b>	<b>Date of Birth</b>	<b>Age</b>
AMI1991	F	Turkey	28/5/1991	34
HPY1997	F	Myanmar	14/10/1997	28
SHI1997	F	India	15/12/1997	28
ESQ2000	F	Mexico	9/6/2000	25
SOT1988	F	Iran	1/11/1988	27
ASS1992	M	Jordan	4/4/1992	33
TUR1997	F	Guatemala	2/9/1998	27
DAR1996	M	Guatemala	23/6/1996	28
IDA1984	F	Iran	10/1/1984	41
REZ1992	F	Iran	3/12/1992	33
PPS1982	F	Brazil	1/5/1982	43
CER1997	M	Peru	15/1/1998	27
DAI1992	F	Brazil	8/10/1992	33
MIA1986	F	Iran	8/10/1986	40
MOU2004	F	Portugal	13/12/2004	21
HOS1998	F	Iran	1998	27
KRA2002	F	China	2002	23
BAA2001	F	Germany	8/2/2001	24
ZAI00	F	Iran	2000	25

**Figure 41 General information for all participants**

Instead, Figure 41 graphs display the participants' age and cultural groupings. There is a noteworthy diversity of nations, with three Iranian subjects having the highest frequency.



**Figure 42** Distribution of age groups and nationalities among participants

Legume	Fruit	Vegetable	Fish and Sea Column1	Tuber and PColumn2	Eggs	Dairy	Vegetable OilColumn3	Dark Green vegetable	Red orange vegetables	Chicken and substitut	Animal Fats	Added Sugar	sum	average
0	10	0	0	10	0	0	0	5.830008115	4.215514125	0	0	0	30.04552	1.581343
2.73	10	10	4.51	0	0	0	2.38181818	6.065886574	4.15940868	8.222591362	10	3.625	71.6947	3.773406
1.68	10	10	2.55	10	0	0	1.04242424	5.844336241	4.020561479	4.557836	10	0	69.69516	3.668166
6.58	10	10	2.43	0	0	0	0	5.847577683	4.062257655	6.19912	0	0	49.75003	2.618423
2.32	10	7	2.69	0	0	0	2.69090909	6.21912879	4.780524481	8.3738	0	1.46833333	49.9177	2.627247
2.38	10	7	2.69	0	0	0	1.96363636	6.06892853	4.760217198	8.569	10	1.5	70.38363	3.704402
8.79	10	0	0	0	0	0	7.35757576	6.132938291	3.809608437	0	0	0	44.81012	2.358427
3.62	10	0	0	0	0	0	6.85454545	6.111386141	3.804869869	0	0	0	38.5208	2.027411
5.3	10	3	0	0	0	8.35081967	0.95757576	5.971338918	4.290706431	7.44	10	9.39569167	74.70613	3.931902
2.63	10	9	0	0	0	0	2.63030303	6.076188443	4.026476892	0	0	0.80395833	45.16693	2.377207
0	0	1	10	0	0	0	3.19393939	5.895425929	3.953157311	0.5803388	0	1.22125	41.4453	2.181332
6	10	10	9	10	0	6.68852459	0	8.441396082	4.251056093	0	10	1.45541667	93.46931	4.919438
2.15	10	0	0	0	10	0	2.97575758	5.847225339	4.139655614	0	0	0	45.11264	2.374349
10	10	0	2.25	0	0	3.45901639	8.36969697	5.904445853	3.768293931	0	10	6.39645833	63.59791	3.347258
5.48	10	4	3.7028842	0	0	5.45454545	4.15757576	7.005247989	4.81921642	9.0644	10	10	93.68387	4.93073
3.53	10	4	10	0	0	1.70491803	4.43636364	5.941221114	4.098164511	6.4466	0	0.45208333	60.60935	3.189966
10	2.24	4	0	0	0	8.48484848	6.69990762	5.005968542	0	0	0	0	46.43072	2.443722
6.56	10	2.4	0	0	0	0	3.9030303	5.987518516	4.709690109	1.5746	9.07981429	0	61.32644	3.227707
1.66	10	7.47	0	0	0	0	5.37575758	5.850867913	5.263826592	3.2556	10	0	63.80485	3.35815

**Figure43** Scoring data tables for each participant, including final scores

**Figure44** Demographic characteristics of participants and Mediterranean Diet adherence scores

Participate ID Code	Gender	Country of Origin	Date of Birth	Age	Media ± SD
AMI1991	F	Turkey	28/5/1991	34	1.58± 3.69
HPY1997	F	Myanmar	14/10/1997	28	3.77 ± 4.01
SHI1997	F	India	15/12/1997	28	3.66± 4.29
ESQ2000	F	Mexico	9/6/2000	25	2.61± 3.72
SOT1988	F	Iran	1/11/1988	27	2.62± 3.33
ASS1992	M	Jordan	4/4/1992	33	3.70 ± 3.78
TUR1997	F	Guatemala	2/9/1998	27	2.35± 4.01
DAR1996	M	Guatemala	23/6/1996	28	2.02 ± 3.57
IDA1984	F	Iran	10/1/1984	41	3.93± 4.08
REZ1992	F	Iran	3/12/1992	33	2.37± 3.89
PPS1982	F	Brazil	1/5/1982	43	2.18± 3.49
CER1997	M	Peru	15/1/1998	27	4.91± 4.04
DAI1992	F	Brazil	8/10/1992	33	2.37± 4.04
MIA1986	F	Iran	8/10/1986	40	3.34± 3.95
MOU2004	F	Portugal	13/12/2004	21	4.93 ± 3.54
HOS1998	F	Iran	1998	27	3.18± 3.77
KRA2002	F	China	2002	23	2.44 ± 3.95
BAA2001	F	Germany	8/2/2001	24	3.22 ± 3.84

# **Chapter Five**

## **Discussion**

## **5. Discussion**

The impact of the MeditEat project in promoting more sustainable and healthful eating practices among international students residing and studying in Italy is examined in this thesis. Participants engaged in a variety of interventions over the course of six months, such as general dietary advice, individualized nutritional counseling, and medical evaluations. Examining the Mediterranean Diet as a sustainable nutritional plan and determining how effectively people from various cultural backgrounds may embrace it was another goal of the experiment.

### **5.1 Key outcomes**

The lessons successfully increased awareness of the Mediterranean diet and sustainable food choices, as evidenced by the PHDI scores, which dramatically improved by the third month and remained high at six months. A shift toward healthier, plant-based, and sustainable eating practices was evident in the participants' increased consumption of legumes, nuts, and olive oil, while they decreased their intake of processed foods, red meat, and added sugar. Smaller increases in seafood and whole grain cereal consumption are likely due to cultural preferences, higher costs, and limited availability. Because students frequently rely on eggs for quick lunches, egg intake first climbed but later decreased; this might be improved with longer project durations and focused mentoring. Consumption of the usually favored dark green vegetables was balanced by a rise in the consumption of red and orange vegetables. Targeted dietary instruction and counseling successfully improved the nutritional quality and environmental sustainability of the international students' diets, as evidenced by the improvement in both the overall PHDI and its component scores. The findings also demonstrate that, despite its flaws, the Mediterranean diet can have a good effect on sustainability and be modified to fit a variety of dietary and cultural circumstances.

### **5.2 Comparing and contrasting earlier works and literature**

Our results are consistent with a wealth of data demonstrating that Mediterranean eating habits promote sustainability and good health. The increase in PHDI scores is indicative of recommendations that are well-supported, particularly the increased consumption of legumes, nuts, and vegetable oils and the decreased consumption of red and processed meat. Reducing red meat consumption is known to significantly reduce greenhouse gas emissions (Clark & Tilman, 2017; Herrero et al., 2013; Springmann et al., 2018), but major frameworks

like the EAT-Lancet Commission and FAO/WHO guidelines emphasize plant-based foods for improving health and reducing environmental impact (Willett et al., 2019; FAO/WHO, 2019). There is evidence that eating more legumes, nuts, and vegetable oils lowers the risk of cardiometabolic disease (Fresán et al., 2018; Guasch-Ferré & Willett, 2021). The use of the PHDI index, which is regarded as a trustworthy instrument for evaluating adherence to EAT-Lancet guidelines and is hence well adapted to finding dietary disparities in our sample, strengthens this study from a methodological standpoint (Cacao et al., 2021). The adequacy and moderation features of the diet were captured by this paradigm. To better capture the entire ecological impact of food changes, future research could improve the study by combining dietary data with direct environmental indicators, such as greenhouse gas emissions, water consumption, or biodiversity consequences (Neta et al., 2023). This would provide a more thorough knowledge of how student diets affect environmental outcomes.

### **5.3 Compare the Mediterranean diet to the Asian food pyramid**

In the Asian food pyramid, several aspects reflect similarities with the Mediterranean diet (MD), although adapted to regional traditions. At the base, fruits and vegetables provide a nutritional contribution comparable to that of the MD. Whole grains are also encouraged as daily staples, but in the Asian context, they are promoted as a healthier alternative to the frequent use of white rice. Sesame oil, rich in unsaturated fats, plays a role similar to that of olive oil, making it suitable for both cooking and seasoning. Legumes, especially soybeans, along with mushrooms and algae, provide a complete amino acid profile and represent a sustainable source of protein, aligning with the MD's emphasis on plant-based foods. A distinctive element of the Asian model is the inclusion of edible insects, which, unlike the MD, provide a culturally relevant option with high nutritional value and low environmental impact. As you can see in Figure 45

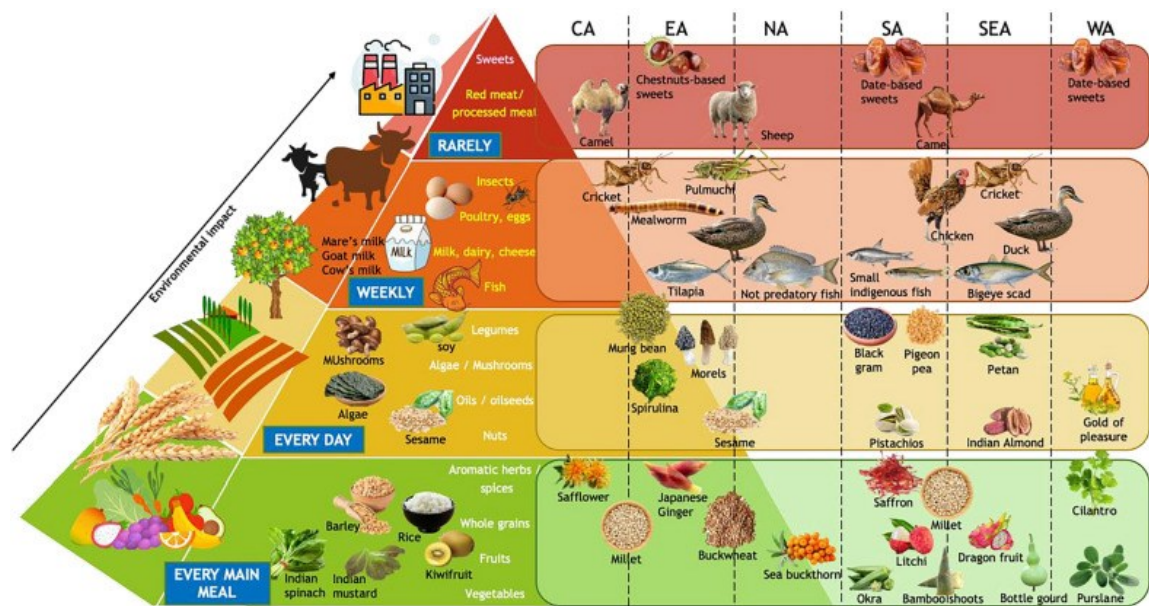


Figure 45: The new proposal for a Mediterranean-based food pyramid in Asia

#### 5.4 Compare the Indian diet to the Mediterranean diet:

Participants from India, Iran, and other non-Mediterranean regions occasionally had trouble with foreign foods, which can be explained by comparing Indian diets with the EAT-Lancet reference, which reveals distinct cultural disparities in grain and protein choices (Sharma et al., 2020). Our finding that many international students continued to choose inexpensive, convenient foods like eggs and refined carbohydrates despite increased awareness is consistent with studies that show cost, time, and accessibility have a significant impact on eating habits (By et al., 2019; Turner et al., 2018; Johnston et al., 2014). These considerations explain why gains were weaker for more expensive or culturally unfamiliar ingredients like fish, eggs, and whole cereals and stronger for less expensive products like legumes, nuts, and oils. Mention in Figure 46

Total caloric intake (kcal)	Whole grains	Tubers and starchy vegetables
Urban India	218 (212, 223)	12 (12, 13)
Rural India	464 (458, 471)	24 (23, 25)
Highest MPCE - Urban	53 (20, 86)	17 (13, 21)
Highest MPCE - Rural	536 (481, 592)	19 (14, 23)
Lowest MPCE - Urban	258 (236, 280)	17 (14, 20)
Lowest MPCE - Rural	348 (321, 374)	18 (15, 22)
North India	407 (400, 415)	37 (36, 38)
South India	304 (295, 313)	-25 (-25, -24)
East India	535 (524, 547)	67 (65, 68)
West India	172 (161, 183)	-6 (-7, -5)
North East India	646 (612, 680)	14 (13, 16)
Central India	491 (475, 507)	6 (5, 7)

Figure 46: A comparison of the Indian diet with the EAT-Lancet reference diet

According to one study, dangerous drinking behaviors and alcohol consumption increased among Italian students studying overseas, suggesting that lifestyle problems go beyond nutrition (Aresi et al., 2016). Another suggested the "healthy immigrant effect," pointing out that, in contrast to our international student group's declining nutrition quality, migrants frequently have better health outcomes than native populations (Moullan et al., 2014). Other studies take different approaches. For example, one study (Tirelli et al., 2013) connected food choices to consumer decision-making and marketing influences, which is only partially related to our focus on sustainability. Another study (Spruance et al., 2023) looked at ethnicity as a predictor of school meal participation, which is very different from the independent eating habits of international students.

All things considered, these comparisons indicate that the MeditEat study is in line with previous studies showing that dietary interventions based on the Mediterranean can enhance sustainability and nutrition in a variety of different populations. The results also support earlier findings that dietary changes are influenced by cultural and structural constraints. Contrasting research, on the other hand, expands the discussion by emphasizing other elements like socioeconomic inequality, alcohol consumption, and marketing influences. Instead of contradicting our findings, the reviewed literature shows that effective interventions need to take into account affordability,

accessibility, and cultural appropriateness, in addition to education to improve adherence to sustainable eating habits.

### **5.5 Benefits and Drawbacks of the Experiments**

The study's shortcomings included a small sample size, a preponderance of female participants, and a dependence on self-reported data, all of which could have an impact on its accuracy and generalizability. Additionally, insights regarding long-term adherence are limited by the brief timeframe. However, three data collection locations made it possible to trace dietary changes over time, and the Planetary Health Diet Index offered a trustworthy indicator of sustainability and nutrition. By concentrating on international students, unique perspectives and insightful cultural knowledge are added.

## **5.6 Proposal for Future Development of the Project**

To improve the impact of the project, a broader approach could be adopted that combines healthy eating with other aspects of lifestyle, such as stress management, regular physical activity, and sleep habits. An interactive platform, like a mobile app or website, could help students track their behaviors, receive guidance, and stay motivated. Practical activities, such as cooking workshops, meal planning sessions, and introducing affordable and culturally adaptable food options, would give students the skills to apply healthy eating habits independently. Partnering with universities to provide accessible Mediterranean-style meals in cafeterias could make following the diet easier. This approach could also support long-term studies to evaluate how these changes affect health and sustainable behaviors over time in diverse international student populations.

## **5.7 Conclusion**

The Mediterranean diet is a workable paradigm that helps both health and the environment, as demonstrated by the MeditEat initiative, which successfully increased the sustainability of the diets of international students. Higher overall scores on the Planetary Health Diet Index resulted from participants consuming more legumes, nuts, and vegetable oils while consuming less red meat and added sweets. Smaller advances in fish, whole grains, and eggs reflect persisting cultural and structural problems, recommending that future programs should focus on accessibility, cost, and adjusting to varied cultural patterns. The study offers insightful information despite its limited sample size and dependence on self-reported data. Overall, the results point to the Mediterranean diet as a versatile, sustainable strategy for communities around the world.

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