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DEVELOPMENT OF INNOVATIVE TOOLS FOR NUTRITION EDUCATION: A PROMISING STRATEGY
TO TACKLE AND PREVENT MALNUTRITION AND TO REDUCE THE ENVIRONMENTAL IMPACT OF
FOOD THROUGH THE ADOPTION OF HEALTHIER AND MORE SUSTAINABLE DIETS

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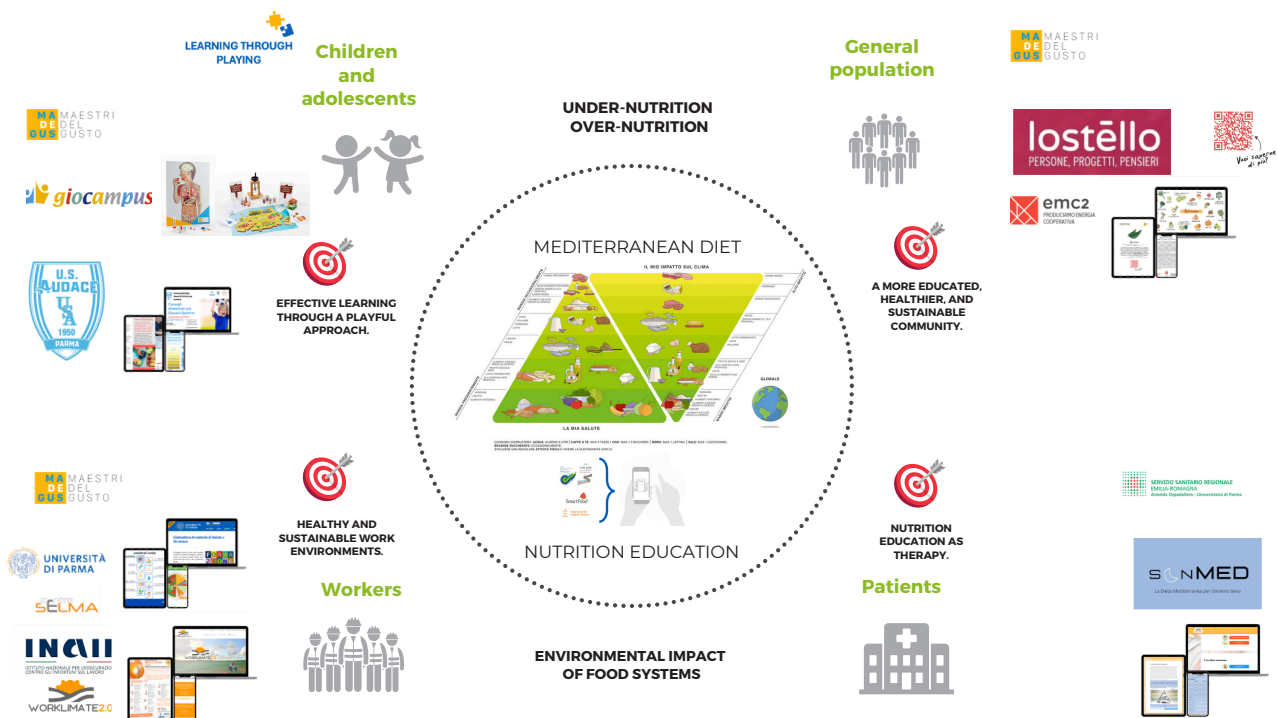
ABSTRACT

Malnutrition is one of today's major global challenges, characterized by the coexistence of undernutrition and overnutrition: two seemingly opposite but often interconnected phenomena. Undernutrition in developing countries is fueled by food insecurity, conflicts, and economic disparities, while industrialized nations face overnutrition due to excessive consumption of calorie-dense, nutrient-poor foods, leading to chronic non-communicable diseases (NCDs). This dual burden places increasing pressure on healthcare systems and the environment, highlighting the urgent need for innovative and sustainable solutions. Simultaneously, the global food system significantly impacts the environment, contributing to greenhouse gas emissions, biodiversity loss, and resource overexploitation. Adopting sustainable dietary patterns, such as the Mediterranean Diet (MD), is essential for addressing these challenges. Characterized by a variety of fresh, local foods—including fruits, vegetables, whole grains, fish, olive oil, and legumes—the MD is recognized for its health benefits, including reduced cardiovascular risk, improved weight management, and anti-inflammatory properties. Additionally, the MD supports environmental sustainability by promoting seasonal and local foods and fostering biodiversity, thus balancing human health and environmental well-being. The transition toward healthier and more sustainable diets requires systemic and tailored interventions. Collective catering, clear food labeling, and the use of digital tools are key in guiding consumer food choices. Technologies such as apps, digital platforms, and educational programs play a pivotal role in supporting informed and sustainable eating behaviors. Nutrition education emerges as a central strategy to prevent and combat malnutrition. Innovative approaches like nudging, which subtly encourages healthier choices, and edutainment, combining education with entertainment, are particularly effective in engaging younger generations and fostering long-term behavioral change. This doctoral thesis, conducted in collaboration with the social enterprise Madegus S.r.l., aimed to promote sustainable food choices by engaging children, adolescents, and adults in diverse settings, including schools, workplaces, and sports organizations.

To achieve this goal, seven research projects were undertaken. **Giocampus Method**, monitored through the **Giocampus Prospective Project**, and the **AUDACE Project** demonstrate the effectiveness of playful, interactive food education for youth, utilizing innovative strategies to instill sustainable and healthy habits. The **LOSTELLO Project** focuses on promoting sustainable eating practices within communities, particularly emphasizing the MD and its health and environmental benefits. In workplace settings, initiatives such as the **Wellness Project** and the **INAIL Workclimate Study** highlight how nutrition education can align with broader goals of health and productivity.

These projects aim to enhance worker well-being by providing educational resources and practical support to encourage informed and sustainable dietary choices. The **SONMED Study**, targeting adults with chronic conditions, explores the potential of the MD in disease management, showing improvements in health markers linked to its adoption. However, long-term monitoring is necessary to confirm and expand on these findings.

These projects provide concrete examples of how targeted, evidence-based educational interventions can address malnutrition, promote healthy lifestyles, and advance environmental sustainability by engaging individuals across different age groups and social contexts. Despite progress, there is a lack of educational tools that effectively integrate health, sustainability, and personalization. Further development of integrated programs that tackle malnutrition and environmental impacts is necessary. These should promote the MD and other eco-friendly dietary models through long-term, multidimensional interventions. The research underscores that collaborative approaches, supported by public policies and digital technologies, can significantly improve eating habits, contributing to healthier lives and a sustainable future.



Graphic Abstract

Chapter 1 INTRODUCTION

A Global Challenge of Our Century: Malnutrition, Coexistence Of Undernutrition And Overnutrition

Malnutrition is a global challenge affecting the world's population, with symptoms as widespread as they are severe (1). This phenomenon takes different forms, being characterised by the coexistence of two extremes: undernourishment, represented by food shortages and deficiencies, and overnourishment, manifested in the epidemic of overweight and obesity. Malnutrition, or food shortage, persists as a public health problem in many parts of the world (2). In 2023, world hunger remained a significant problem, with the situation showing no clear improvement from previous years. According to the State of Food Security and Nutrition in the World (SOFI) report, more than 735 million people are food insecure worldwide. This figure reflects an increase from previous years, partly caused by factors such as conflict, extreme climate change and economic problems, including the debt burden for many low- and middle-income countries (3). Deficiencies in key nutrients such as proteins, vitamins and minerals cause serious diseases, impairing physical growth and cognitive development. This problem is particularly evident in developing countries, where food resources are limited and access to a balanced diet is often compromised (4). Malnutrition is often wrongly associated only with developing countries, whereas reality reveals a growing challenge in industrialised countries as well. While the availability of food may seem abundant, a significant number of individuals in these nations still suffer from malnutrition due to unbalanced and unhealthy diets (5). In fact, many people in industrialised countries follow diets that are high in calories but low in essential nutrients. This form of hidden malnutrition can lead to serious health consequences, including cardiovascular problems, vitamin deficiencies and compromised immune systems. Parallel to malnutrition is overnutrition, in particular the epidemic of overweight and obesity (6). By 2022, more than 1 billion people worldwide were living with obesity, with the rate among adults having more than doubled since 1990. In addition, the number of obese children and adolescents (aged 5-19 years) has quadrupled over the same period. About 43% of adults worldwide are classified as overweight (7). This condition is often associated with a diet high in empty calories, low in essential nutrients and a sedentary lifestyle. The Western diet, characterised by an excess of calorie-dense foods, is a major cause of overweight and obesity: the habit of consuming foods rich in saturated fats, added sugars and highly processed foods contributes to a positive energy balance, increasing the risk of body fat accumulation (8). In addition, a sedentary lifestyle is another key element in the overweight epidemic. Lack of physical activity, often related to sedentary jobs and technological comfort, contributes to weight gain (9). Overweight and obesity are associated with

several negative health consequences. Cardiovascular diseases, type 2 diabetes, osteoarticular diseases and certain types of cancer are among the main complications associated with excess weight (10). Furthermore, obesity can have significant impacts on mental health, contributing to problems such as depression and anxiety (11). Rising obesity rates in industrialised countries have also caused an increase in healthcare costs, exerting significant financial pressure on national healthcare systems (12). In the European context, malnutrition takes on complex facets. Some countries still face the problem of undernutrition, while others are dealing with a significant increase in overweight. Obesity and overweight are a growing challenge in Europe (13). According to the latest data from the WHO, around 59% of European adults are overweight and 23% are obese. The problem also affects children, with one third of school-age children overweight or obese. Trends suggest that the COVID-19 pandemic has exacerbated this situation, contributing to more sedentary lifestyles and an increase in poor eating habits (13). In Italy, malnutrition presents a clear ambivalence. In Italy, the rates of overweight and obesity among the population are significant (14). According to data collected by the PASSI surveillance system, in the period 2020-2021, 43% of the adult population (18-69 years) was overweight: 33% were overweight and 10% obese. These values correspond to approximately 17 million overweight and 4 million obese people. The prevalence of obesity increases with age, peaking at 59% in the 65-74 age group. However, the phenomenon shows different trends depending on region and socio-economic situation, with higher rates in southern regions and among people with fewer economic resources (14). In Italy, malnutrition, which includes both malnutrition and nutritional deficiencies, mainly affects people with inadequate diets, regardless of age. Malnutrition is not solely a matter of the quantity of food consumed but also of the quality of the food selected. It is often assumed that malnutrition pertains exclusively to undernutrition (insufficient food intake); however, “hidden malnutrition” also exists. This occurs when an individual consumes an adequate or excessive number of calories but fails to obtain the essential nutrients required for proper physiological function. Micronutrient deficiencies, particularly those involving vitamins and minerals, are prevalent among individuals who do not maintain a balanced diet. A dietary pattern predominantly composed of highly processed foods, refined sugars, and simple carbohydrates—without sufficient intake of fruits, vegetables, and whole grains—can lead to significant nutritional deficits. Even those who meet or exceed their caloric needs may experience malnutrition if their diet lacks essential nutrients. Thus, it is imperative not only to regulate food intake in terms of quantity but also to prioritize its nutritional quality by selecting fresh, natural, and micronutrient-rich foods (14). In Italy the causes of undernutrition may

be mainly associated with unfavourable socio-economic conditions, poor nutrition education and limited access to nutritious food, while the Western diet is among the main causes of overweight and obesity (14). Child malnutrition is also a critical and growing problem in Italy, with a high prevalence of both undernourished and overweight and obese children (15). According to data from Okkio alla Salute 2023, the prevalence of overweight children in Italy is 19%, while 10% suffer from obesity (15). Although there have been improvements over previous years, these percentages indicate that a significant number of young people continue to experience weight-related problems. These data highlight the need to strengthen policies and initiatives to promote a healthy lifestyle and proper nutrition among children and young people in Italy (15,16). One of the fundamental causes of childhood overweight and obesity in Italy is the lack of nutritional education and thus the absence of awareness of the importance of a balanced diet and an active lifestyle. Many children adopt bad habits in their families with a diet rich in high-calorie foods and often low in essential nutrients. The excessive consumption of high-calorie foods, rich in sugar and saturated fats, is in fact a common trend among young Italians (16). Malnutrition, in all its forms, remains a complex challenge today that requires comprehensive interventions and integrated strategies. Educating the population, starting with the youngest generation, on the importance of a balanced diet, ensuring access to nutritious food and promoting an active lifestyle are key elements in tackling this problem. However, the lack of widespread nutrition education programs limits awareness and the ability to make informed dietary choices, exacerbating the issue (17–20). Scientific research continues to play a key role in understanding the dynamics of malnutrition and developing effective solutions to promote global health. Only through concerted and collaborative international efforts can we hope to mitigate the impacts of malnutrition and improve the quality of life for future generations (21).

A Global Challenge of Our Century: Environmental Impact Of Diet

Growing environmental awareness has raised the urgent need to study and promote sustainable diets, with the aim of contributing to global efforts to conserve our planet and ecosystem. Sustainable diets are not just a matter of individual well-being; they are a fundamental imperative to preserve the environmental balance. The main consequences of this issue include loss of biodiversity, climate change, depletion of natural resources and compromised food security (22,23). Unsustainable diets, such as modern Western diets, have a significant impact on the environment and our planet (23). According to FAO, the global food system is a major contributor to the greenhouse gas emissions that cause climate change. The full cycle of food production, processing, transport and consumption generates about 31% of global greenhouse gas (GHG) emissions.

Agricultural activities, particularly livestock and meat production, account for a significant proportion of these emissions (24). Livestock farms release large amounts of methane, a potent greenhouse gas, mainly through the digestion of ruminant animals such as cows and sheep and the management of their waste (24). Deforestation to create new agricultural land, together with the use of chemical fertilisers, is a major contributor to carbon dioxide and nitrous oxide emissions. Intensive agriculture and the expansion of arable land are linked to the loss of biodiversity and soil erosion, further exacerbating environmental impacts(25). Food transport and waste also have a negative impact: around 14% of food produced globally is lost or wasted, contributing to unnecessary emissions (26). The consequences of these high-impact diets on the planet are serious and numerous. Loss of biodiversity is one of the most obvious effects, as the conversion of natural habitats to agricultural land and the intensive use of pesticides and fertilisers lead to a reduction in the diversity of plant and animal species (25). Climate change is another significant impact, as greenhouse gas emissions from agricultural practices contribute to rising global temperatures and extreme weather events (27). We are also facing the depletion of natural resources such as fresh water, which is used in significant quantities for irrigation, livestock production and food processing. This overexploitation has serious consequences for the hydrological balance of basins and the availability of drinking water for the population (26). In the European context, unsustainable diets are a serious environmental problem with significant environmental and public health impacts. According to the report of the European Commission's Food in a Green Light project, around 37% of total greenhouse gas emissions in the EU are linked to the food system. Intensive agriculture, excessive use of fertilisers and pesticides, and long-distance food transport are key factors contributing to the environmental impact of unsustainable diets in Europe (28). Italy is one of the largest consumers of meat in Europe, with a significant impact on the use of natural resources and greenhouse gas emissions (29). In fact, in Italy, the traditional MD once synonymous with sustainability, has gradually been replaced by food models with a high environmental impact (30). High-impact diets, such as those prevalent in Europe and Italy, not only negatively affect public health, but also pose a significant threat to the environment and the sustainability of the planet. These diets are characterised by a high dependence on high-impact foods, such as meat and highly processed products, which require significant natural resources for production and transport (31). Furthermore, the intensive agriculture associated with these diets contributes to deforestation, soil erosion, water pollution and loss of biodiversity. In Europe, the food sector is a major contributor to GHG and environmental degradation (26). Italy, despite having a rich culinary tradition, has seen

a decline in the spread of MD, associated with lower environmental impact and health benefits (32,33). The failure to adapt to sustainable agricultural practices and the preference for imported foods with a high environmental impact have contributed to worsen the situation. Promoting a transition to more sustainable diets, such as MD, is key to addressing this challenge (34). This implies not only increased food awareness and education, but also public policies aimed at supporting the production and consumption of local and seasonal food, reducing food waste and encouraging environmentally friendly farming practices (35,36).

Two Problems and One Solution: The Mediterranean Diet

In the current era of growing concern about malnutrition and the environmental impact of the food system, the MD emerges as a nutritional paradigm that stands out for its ability to address both problems simultaneously (37). The MD is a traditional eating pattern inspired by the culinary habits of the countries surrounding the Mediterranean basin. This dietary pattern has been widely studied for its benefits on human health and its positive impact on the environment (38,39). Numerous epidemiological studies have demonstrated the health benefits of MD: it is associated with a significant reduction in the risk of cardiovascular disease; the large presence of omega-3 fatty acids in fish, combined with the beneficial effects of antioxidants and polyphenols found in vegetables and olive oil, helps protect the heart and improve cholesterol levels (40). MD has also been associated with better body weight control, thus preventing overweight and obesity, and a reduced risk of developing type 2 diabetes (41). Low glycemic index foods, the presence of fiber, and the combination of healthy fats promote insulin management and prevention of body fat accumulation. In particular, the high fiber content from fruits, vegetables and whole grains contributes to increased satiety, reducing overall caloric intake; while the inclusion of monounsaturated fatty acids, prevalent in olive oil, is associated with a lower incidence of obesity (41). MD is also known for its anti-inflammatory effects due to the presence of antioxidant-rich foods. Phytochemicals found in vegetables, fruits, and olive oil act synergistically to reduce inflammation and protect cells from free radical damage (42). MD emerges as a complete and varied dietary pattern, as demonstrated by the MD food pyramid, with a proper balance of macro- and micro- nutrients, providing all the essential nutrients needed to prevent nutritional deficiencies and promote optimal health (43). Early adoption of MD during childhood represents a crucial opportunity to foster the development of healthy eating habits in children, thus helping to prevent nutritional deficiencies and reduce the risk of overweight and obesity in childhood and adulthood (44). The richness and variety of foods in MD provide a complete and balanced nutritional base, which is essential for meeting energy and

nutritional needs during critical stages of growth and development, ensuring optimal health in childhood and in the long term (45). In conclusion, adherence to MD emerges as a useful approach in preventing and combating malnutrition, whether due to deficiency or excess, and thus in promoting overall health status (32). MD is presented not only as a healthy nutritional paradigm, but also as a sustainable food model, showing significant environmental, social and economic benefits in comparison with other food patterns (46,47). Numerous studies attest that MD, compared to Northern European or North American dietary patterns, reduces the environmental impact required to obtain 100 calories by an average of 60% (48,49). This finding underscores the inherent sustainability of MD, which relies more on vegetables, grains, and fish at the expense of meat and animal fats. In addition, MD's preference for grains, fruits, vegetables, and legumes results in more efficient use of natural resources, such as soil and water, reducing greenhouse gas emissions compared to more meat- and fat-intensive animal eating patterns. This aspect contributes to environmental sustainability through judicious management of available resources (50). MD also promotes seasonality of food, reducing the need for greenhouse crops and limiting environmental impacts related to sourcing from distant countries. In addition, respect for biodiversity is ensured through the practice of diversified sowing and crop rotation, thus contributing to the conservation of genetic variety and food security (51). The concept of frugality typical of MD, characterized by moderate portions and consumption of whole and fresh foods, is reflected in a lower environmental impact of eating behaviors; in fact, reducing the quantities consumed and food processing contributes to environmental sustainability (52). Finally, MD also offers tangible social and economic benefits; health promotion through the prevention of many diseases results in a decrease in national health care expenditure. The spread of MD also promotes the enhancement of local businesses and Mediterranean territories, contributing to the creation of income and employment through increased commercial demand for natural products and their derivatives (53). In conclusion, the MD stands out as a sustainable and healthy food model that is also environmentally friendly. This concept is well represented by the double food and environmental pyramid elaborated by the Barilla Center for Food & Nutrition Foundation (BCFN), which highlights how the healthiest foods are also those with a lower environmental impact (54). Unlike other dietary models characterised by high consumption of meat and industrial products, which require more natural resources and generate more greenhouse gas emissions, MD favours the consumption of fruit, vegetables, whole grains, legumes and olive oil, thus promoting a diet with a low ecological impact and sustainable in the long term. This synergy between health and environmental sustainability makes MD not only an ideal

nutritional approach for human wellbeing, but also a virtuous model for reducing ecological impacts, in contrast to diets high in animal protein and ultra-processed foods, which contribute to intensive use of resources and pollution of the planet (54). Despite proven benefits, increased adherence to MD is still a public health challenge today. Factors such as globalization of eating habits, availability of processed foods, and lack of cultural awareness may compromise the adoption of this dietary pattern. Addressing this challenge requires a nutrition-focused educational approach (55).

How To Increase Adherence to The Mediterranean Diet: Nutrition Education

Food education is a key element in the promotion of correct and sustainable food choices, represented by the Mediterranean food model. Through this approach, people acquire not only knowledge about the nutritional composition of food, but also practical skills related to food preparation and consumption. It fosters a critical attitude towards food behaviour, encouraging reflection on everyday choices and their impacts on health and the environment (56,57). A key aspect of nutrition education is its ability to address the growing challenges related to non-communicable diseases, such as diabetes, obesity and cardiovascular diseases (58). Indeed, good nutrition education improves the understanding of nutrition and promotes healthy eating practices, thus contributing to the prevention of these diseases. In this sense, it is an essential tool for improving public health (59,60). However, to achieve these objectives, nutrition education must involve various actors, each with a specific role. Consumers, for example, are encouraged to understand their food needs, recognise misinformation and make healthier choices (61). Parents, for their part, acquire new knowledge and skills that enable them to provide their children with a good start in life. Schools, through educational programmes, learn how to provide healthier meals and snacks, while families develop the ability to prepare nutritious food in a safe and hygienic manner, planning and shopping for healthy meals within their budget (62,63). In this context, people are encouraged to enjoy cooking and eating healthier foods, while food producers receive support to produce and market better foods. In addition, governments work to integrate nutrition education into national policies, ensuring that communities can make more effective use of their traditional and local foods. Finally, policy makers understand the importance of regulating the advertising of foods that are harmful to children (64). A complementary strategy within food education is the use of *nudging*, which leverages subtle environmental or contextual changes to guide individuals toward healthier food choices without restricting their freedom (65). For instance, placing healthier options at eye level, providing smaller portion sizes by default, or enhancing the visual appeal of nutritious foods can influence decision-making. This approach has proven effective in promoting sustained

behaviour change and is particularly useful in schools, workplaces, and public spaces (66,67). To ensure the effectiveness of nutrition education, it is crucial that it is tailored to the specific characteristics of each population. Nutritional needs, food preferences and access to resources vary widely, making it necessary to implement tailor-made education programmes (68,69). For example, it is essential that education is adapted to different physiological conditions, such as pregnancy, lactation, menopause and chronic diseases, considering demographic and cultural variations (68,70). Nutrition education must also consider the socio-economic context of communities, as eating habits are deeply rooted in local traditions and people's living conditions. A standardised approach may be ineffective. For this reason, it is important to provide practical information on how to implement healthier food choices in daily life, fostering a lasting adoption of healthy eating habits. In conclusion, nutrition education is crucial to promote healthy and sustainable food choices. It not only improves public health and contributes to disease prevention, but also encourages a conscious and critical approach to one's diet. By adapting education to the specific needs of communities and considering factors such as health status and age, nutrition education can facilitate a positive and lasting change in people's eating habits, contributing to individual and collective well-being (71–73).

Healthy Eating from a Young Age: How Nutrition Education Shapes Our Children's Future
Nutritional education plays a crucial role in shaping children's development, as eating habits acquired at an early age can significantly impact their long-term health. Teaching children to make nutritious food choices from childhood is essential not only for promoting their physical well-being but also for preventing diseases and supporting environmental sustainability (74,75). Establishing an environment that fosters healthy food choices from a young age helps prevent health issues such as obesity and diabetes, while raising awareness about the importance of balanced diets and sustainable eating practices (76). Schools serve as ideal settings for nutrition education, offering opportunities to integrate nutrition into students' daily activities. School-based nutrition initiatives can go beyond conveying information about food groups, incorporating practical experiences such as cooking workshops, school gardens, and field trips to local markets. These hands-on experiences help children understand the origins of food, preparation techniques, and the benefits of choosing fresh, seasonal produce (77). An effective approach to nutrition education is the use of playful methodologies, like "learning by playing," which transforms nutrition education into an engaging, enjoyable experience (78). Through games, practical activities, and creative projects, children can actively learn and develop skills that encourage them to make healthier food choices. This

experiential learning not only makes the educational process more interesting but also aids retention and the application of knowledge in daily life (78,79). In this context, introducing *edutainment*—a blend of education and entertainment—offers a powerful way to engage children (80). While technological tools like interactive apps, animated videos, and digital games are effective in delivering nutritional messages in an engaging and memorable manner, *edutainment* can also take place through live activities (81,82). Role-playing games, interactive storytelling, food-themed scavenger hunts, and cooking challenges in schools can captivate children’s interest and make learning fun. School fairs or workshops led by nutritionists and chefs can further reinforce healthy habits by involving children in hands-on, collaborative experiences that bring nutritional concepts to life (83). The role of families and communities is also critical in supporting children’s nutritional education. Parents can actively contribute to creating a healthy food environment at home by offering fresh, nutritious foods and involving children in meal preparation (84,85). Additionally, communities can host awareness events, farmers' markets, and culinary workshops to promote healthy, sustainable eating. Nutrition education should be integrated into a holistic health program that empowers children by providing them with the knowledge and skills to make healthy and informed food choices. Learning opportunities about healthy diets, including school-based nutrition education activities, can give children the information and abilities to select and consume wholesome foods and beverages (86). Furthermore, research has shown that adequate nutrition education not only improves children's understanding and appreciation of food but also prepares them to become responsible consumers in the future (87). By teaching them early on about the importance of a balanced, sustainable diet, we can build a generation of informed adults committed to their health and the planet's well-being. In summary, nutrition education for children is a fundamental investment in the future, not only for their personal health but also for environmental sustainability. Creating opportunities for nutritional learning that engage the entire community, using playful and practical approaches, can transform children's perception of and relationship with food, promoting healthy and responsible eating habits for life (88).

The Transformative Role of IT Devices, New Technologies, and Social Media in Nutritional Education

IT devices, new technologies, and social media are profoundly reshaping nutritional education, simplifying access to information and making it more interactive and personalized (77). Tools like mobile apps, online platforms, digital games, and social media provide innovative ways to engage a

wide range of individuals—from children to adults—while advocating for healthy dietary models such as the MD, celebrated for its health benefits and environmental sustainability (78,79). These technologies not only disseminate detailed nutritional knowledge but also offer practical resources, such as recipe ideas and meal preparation tips aligned with MD principles. The MD, characterized by a high intake of fruits, vegetables, whole grains, fish, and healthy fats like olive oil, is well-suited to integration into daily routines, thanks to the customizable features of digital tools (66,80). Apps enable users to monitor nutrient intake, identify areas for improvement, and adjust their dietary habits with ease. Social media enhances nutritional education by serving as an accessible platform for sharing information, recipes, and advice. It allows nutritionists, chefs, and influencers to interactively communicate the importance of healthy eating, fostering curiosity and raising awareness. The rapid dissemination of content ensures that educational materials reach a broad audience, including those with limited access to traditional learning programs (81,82). Interactive technologies such as games, quizzes, and playful activities are particularly effective in engaging younger generations. These tools make learning about nutrition enjoyable, helping children grasp the importance of a balanced diet and encouraging them to experiment with healthy foods. This playful approach cultivates lasting positive habits from an early age (66,67). The integration of *edutainment* and *nudging* within digital tools further enhances their impact. For children, gamified challenges stimulate curiosity and make learning engaging (85,86). Adults benefit from apps that provide subtle guidance through reminders, goal-setting features, and visual aids like color-coded rankings (87). Older adults, on the other hand, can use user-friendly interfaces tailored to their needs, addressing dietary concerns such as managing chronic conditions or exploring traditional food options. These strategies, adaptable to various socio-economic and cultural contexts, ensure inclusivity and relevance for diverse communities (88). Another key strength of these technologies is their ability to deliver personalized learning experiences. Apps and online content can be tailored to individual needs, preferences, and goals, making educational efforts more effective and motivating users to participate actively. This customization fosters a deeper engagement with nutrition and supports lifelong healthy habits (79,80). However, challenges must be addressed. Limited access to digital devices and the internet risks creating inequalities, while the increasing reliance on technology underscores the importance of protecting personal data. Additionally, the abundance of online information necessitates careful selection of credible sources to ensure that content is accurate and evidence-based, preventing the spread of misinformation (90). In conclusion, IT devices, new technologies, and social media are transforming nutritional

education, offering powerful tools to promote healthy lifestyles and sustainable practices. By leveraging these innovations, it is possible to enhance public health and raise awareness about the benefits of the MD, contributing not only to individual well-being but also to planetary protection (91).

Madegus S.r.l

Madegus S.r.l, a social enterprise since 2024, also known as “Maestri Del Gusto”, has been a leader in nutrition education for over 10 years. Patronized by the University of Parma, Madegus is dedicated to promoting informed food choices across all ages, fostering a healthier and more sustainable lifestyle (89). As a social enterprise, it aims to be a driver of change by addressing health inequalities and making food education accessible to all. Its mission is to provide educational tools that go beyond basic information, promoting a true understanding of nutrition that contributes to the collective well-being. Madegus integrates edutainment into its approach, blending learning with fun and hands-on experience to engage children and young people. Its workshops are adaptable to a variety of settings, such as public events, fairs, shopping malls, summer camps, and sports activities. These interactive experiences allow Madegus to reach a wide audience, including families and corporate employees through welfare programs for the children of workers. This innovative method encourages children and teens to engage with healthy eating in a memorable, enjoyable way, making nutrition education both accessible and enjoyable. The company’s educational activities, grounded in scientific rigor, offer practical learning that helps young generations understand the importance of good nutrition from an early age. For businesses, Madegus provides tailored services that support corporate wellness and sustainability goals. It applies three fundamental principles: scientifically supported learning strategies, a dynamic team with broad expertise, and a strong network of partnerships with universities, professionals, and other organizations. These collaborations enable Madegus to create solutions that are not only effective but also sustainable, contributing to both the health of employees and the environmental impact of food choices. As part of a doctoral research project in nutrition education, collaboration with Madegus provided valuable insights. This partnership allowed for the exploration of innovative ways to integrate nutrition education into both corporate and public settings, emphasizing the importance of sustainability and mindful food choices. Madegus's commitment to continuous research and development in nutrition education reinforced the significance of adapting to evolving dietary trends and market needs. Through this collaboration, the company exemplifies how science, education, and sustainability can be brought together to create a healthier future.

The National Operational Programme for Research and Innovation 2014-2020 (PON)
The present research project was carried out in the context of the National Operational Programme for Research and Innovation 2014-2020 (PON), an initiative through which Italy is committed to improving the quality of higher education and enhancing research, technological development and innovation. The PON aims to achieve the objectives of the European Union's cohesion policy, with a particular focus on the Italian regions considered most disadvantaged. Managed by the Ministry of Universities and Research (MUR), the PON specifically involves transition regions, including Abruzzo, Molise and Sardinia, and less developed regions, such as Basilicata, Calabria, Campania, Apulia and Sicily. Overall, the PON Research and Innovation has a budget of EUR 1,189 million. This programme is conceived in coherence with the strategic objectives of the European programmes Horizon 2020 and Cosme, working in synergy with the National Strategy for Intelligent Specialisation (SNSI) and with the operational programmes and regional strategies for intelligent specialisation. In this way, the PON contributes to strengthening the country's research and innovation capacity, promoting the sustainable development and competitiveness of Italy's less developed regions. In particular, through Ministerial Decree No. 1061 of 10 August 2021, new resources from the European Social Fund (ESF) REACT-EU have been allocated to support active and accredited PhD courses in the context of the XXXVII cycle and for national PhD programmes. The decree provided for the allocation of more than EUR 50 million for PhDs focused on innovation and EUR 180 million for PhDs with green topics, thus promoting research in areas related to environmental sustainability. This PhD project specifically fits into the context of Action IV.5 - Doctorates on green topics of the new Axis IV of the PON Research and Innovation 2014-2020 "Education and Research for Recovery - REACT-EU", foreseen by the new reprogramming of the Programme for the purposes of the new thematic objective of cohesion policies "Promoting overcoming the effects of the crisis in the context of the COVID-19 pandemic and its social consequences and preparing for a green, digital and resilient recovery of the economy" (Regulation (EU) 2020/2221 of the European Parliament and of the Council of 23 December 2020). Action IV.5 had the objective of enhancing human capital through the activation of PhD pathways focused on themes that are fundamental to ecosystem conservation, the promotion of biodiversity, the mitigation of the effects of climate change and the promotion of sustainable development. The research activities were to be closely aligned with the priorities set by the National Smart Specialisation Strategy (SNSI) and the National Recovery and Resilience Plan (NRP), in order to foster an open approach to innovation and promote greater synergy between the worlds of research and production. In order to achieve the goals set in the

PON doctoral programme, which concerned both health promotion and environmental sustainability with innovative digital strategies, a period of close collaboration and synergy with the business sector took place. This collaboration aimed to integrate academic expertise with the needs and resources of the manufacturing world, enabling interdisciplinary and practice-oriented research. Through this synergy, it was intended to foster the development of innovative and sustainable solutions that could respond to current and future challenges in the field of health and the environment, while promoting the transferability of knowledge and the valorisation of scientific findings in the business context (90).

Chapter 2 Aim of The Doctoral Thesis

The global food system, in constant evolution, poses an increasing threat to public health, being intrinsically linked to significant issues of malnutrition. This condition manifests in both overnutrition and undernutrition, creating a double burden that compromises human well-being and drives the development of NCDs such as diabetes, cardiovascular disease, and obesity. These conditions present an ever-growing challenge for healthcare systems, negatively impacting quality of life and increasing healthcare costs. It is therefore essential to implement strategies that address not only the dietary factors contributing to these conditions but also ensure greater awareness of the environmental impact of food choices. In parallel, the impact of food systems on planetary health is undeniable. Unsustainable agricultural practices, biodiversity loss, and the high greenhouse gas emissions associated with food production are just a few of the detrimental effects these systems have on the environment. The transition to sustainable dietary models is crucial to securing a healthy future for current and future generations, underscoring the need for a radical shift in our food systems. In recent decades, the MD has emerged as one of the healthiest and most sustainable dietary models, recognized for its health, environmental, and economic benefits. This diet, characterized by high consumption of fruits, vegetables, legumes, whole grains, fish, and olive oil, has shown to reduce the risk of chronic diseases and promote overall well-being. In this context, nutritional education focused on the MD serves as a fundamental tool for protecting human health and preserving the environment, acting as a preventive intervention. Education on the MD is particularly relevant when introduced from school age, as it helps new generations understand the crucial role of this diet in promoting health and environmental sustainability. Integrating innovative educational technological tools is essential, especially for younger audiences, as it facilitates interactive and engaging learning. Technology plays a key role in delivering information, resources, and practical activities that encourage informed and sustainable food choices across the population. To achieve these goals, it is necessary to implement "smart" technological supports, innovative services, and digital tools by analyzing factors influencing dietary behavior and communication dynamics. The role of food services as an integral part of these strategies must also be considered to ensure a holistic approach to nutritional education.

The primary aim of this doctoral project is to develop educational strategies to promote healthy and safe dietary practices, as well as to encourage awareness and adoption of sustainable lifestyles. This research directly and effectively addresses the environmental implications of dietary choices and the challenge of malnutrition. The focus is on promoting sustainable dietary models and healthier

lifestyles as essential strategies to mitigate diet-related diseases. This requires exploring and implementing innovative nutritional solutions that contribute not only to individual health but also to environmental sustainability, adapted to the diverse needs of various consumer groups. Therefore, the primary objective of this thesis is to identify optimal ways to implement effective strategies to improve dietary literacy and promote sustainable diets through nutritional education across various contexts. To achieve the main objective, complementary tasks have been outlined for different target populations with specific needs and diverse application contexts. This approach considers a wide range of age groups and physiological or pathological conditions, applying preventive or management strategies related to the diseases under consideration. Standard and digital nutrition education models have been employed for each of the identified specific objectives. Projects related to the use of standard food education methods, without the use of technologies, have involved developing a specific educational method for the pediatric school-age population (elementary schools), focusing “learning by playing” approach (**STUDY 1: GIOCAMPUS METHOD**). This method aims to promote the well-being of future generations through a multidisciplinary approach, integrating nutritional education, sustainability, and physical activity. Preliminary results of this educational approach show an improvement in children's dietary knowledge and habits, as well as anthropometric parameters that reflect lifestyle quality (**STUDY 2: PROSPECTIVE GIOCAMPUS**). This study provides descriptive data on the nutritional status and dietary habits of primary school children in Parma. Both projects within the Giocampus context were carried out in close collaboration with the enterprise partner Madegus Srl. Another project targeting the pediatric population has explored the sports context. The educational intervention, based on field-based play learning, involved families and key figures in sports associations (**STUDY 3: AUDACE**). The aim was to assess and monitor the nutritional status and dietary habits of young athletes, optimizing the effectiveness of the educational intervention. Additionally, the educational project LOSTELLO, carried out in collaboration with Madegus Srl, aims to educate the local community in Parma on healthier and more sustainable diets by promoting the consumption of local and seasonal products (**STUDY 4: LOSTELLO**). Through a variety of educational activities, the project aims to raise awareness among participants on the health and environmental benefits of consuming fresh, seasonal, and locally sourced foods. Prevention plays a fundamental role in the educational project aimed specifically at the adult population, particularly employees of the University of Parma (**STUDY 5: WELLNESS PROJECT**). This project included an educational intervention that relies on digital technologies both for information dissemination and progress monitoring. In this context, the study

aims to analyze the level of nutritional knowledge and adherence to the MD among employees, both before and after their participation in the mandatory health and safety training course. An example of a specific educational intervention is the INAIL Project within the Workclimate Project framework (**STUDY 6: INAIL PROJECT**), directed at a population of employees working under extreme heat conditions. This project aims to develop preventive educational strategies to mitigate the effects of heat on workers' well-being, providing informational materials and training interventions. Nutrition education plays a key role in this context, as a balanced diet can contribute to maintaining adequate hydration, energy, and general well-being. Finally, a specific educational intervention for the adult population with pathological conditions is represented by the SONMED Project (**STUDY 7: SONMED PROJECT**). Conducted by the Sleep Medicine Department of Parma Hospital in collaboration with the Human Nutrition Department of the University of Parma, this study evaluates the effectiveness of a nutritional and educational intervention based on the MD compared to conventional therapy alone for adult patients with chronic insomnia. The project aims to provide a comprehensive picture of the intervention's impact on sleep-related parameters and dietary habits.

In conclusion, this doctoral thesis aims to contribute to an innovative and sustainable approach to nutritional education, addressing the challenges of malnutrition and public health. Implementing effective educational strategies that utilize traditional and technological methodologies is essential to promote healthy and sustainable dietary models. Through continuous research and innovation in this field, it is possible to improve individual and collective health, ensuring a healthier and more sustainable future for future generations. The collaboration with the Madegus company component is crucial to the success of several projects, which combine innovative educational strategies and practical applications that address the multifaceted nature of malnutrition and public and environmental health problems.

Chapter 3 Selected Studies

Study1

Feeding the future: The Giocampus Method for Promoting Healthy and Sustainable Diets in Children and Adolescents

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ABSTRACT

Childhood obesity is now recognised as a major global public health challenge, with serious and lasting consequences for the physical and mental well-being of young people. In this context, Nutrition Education has a crucial role to play not only in preventing immediate health problems but also in promoting healthy and sustainable lifestyles in the long term, with benefits extending into adulthood. It promotes informed dietary choices that contribute to both individual health and environmental sustainability. Since 2009, the Giocampus pedagogical Method has aimed to ensure the well-being of future generations through a multidisciplinary approach that integrates nutrition education, sustainability and physical activity. Aimed at children and adolescents in Parma and beyond, the programme is developed in three distinct phases throughout the year: Giocampus School, which takes place during the school year in primary schools; Giocampus Snow, which promotes sports and social activities in a winter environment; and Giocampus Summer, a summer camp that combines physical activities with creative workshops. In addition, Giocampus Together promotes the inclusion of children with disabilities, while Giocampus Green promotes the principles of sustainability in secondary schools. The Giocampus educational method is based on an experiential and playful approach called "learning by playing/doing". This methodology is enriched by the integration of educational games and materials developed by the scientific community of the University of Parma, with the aim of making learning not only interesting but also effective. The activities are carefully structured and monitored by a multidisciplinary scientific committee to guarantee their effectiveness and innovation. The Giocampus School programme currently involves 7,782 students aged 6 to 11 from 28 primary schools in Parma, representing a total of 356 classes. Offered free of charge to both schools and families, the programme aims to promote healthy lifestyles through physical activity and nutrition education, providing 424 hours of physical activity and 999 hours of nutrition and sustainability education per year. Giocampus Green, on the other hand, currently involves 14 secondary schools in the municipality of Parma, reaching 4,186 students in 203 classes. This programme devotes 1,015 hours per year to lessons and workshops on sustainability, raising young people's awareness of sustainable development issues. The impact of the Giocampus Method on the wellbeing of Parma's youth is supported by scientific research, which shows significant improvements in participants' nutritional knowledge, anthropometric parameters and lifestyle habits, bringing them closer to a healthy and balanced diet based on the Mediterranean Dietary model. The success of this project has been internationally recognised, with presentations at prestigious institutions such as Harvard University and the European Parliament and continues to serve as a

best practice model for health education. Giocampus has already extended its reach beyond the province of Parma, and today aims to expand even further through the integration of digital technologies and continuous content renewal. The future of the Giocampus Method is therefore focused on expansion through digital technologies and constant renewal and improvement thanks to continuous scientific research carried out through the “Giocampus Perspective” monitoring project. The fundamental principles of Nutritional Education and sustainability remain essential to raise more informed generations capable of adopting lifestyles that reconcile personal well-being with respect for the environment. The Giocampus Method is an innovative model of integrated education that will have a lasting impact on public health and global sustainability.

INTRODUCTION

Childhood obesity

According to the World Health Organization (WHO), childhood obesity is one of the most complex public health problems, with long-term consequences for both the health and psychosocial well-being of young people. This phenomenon, characterised by excessive accumulation of body fat, has increased at an alarming rate in recent decades (91). In 2016, 9.9% of children and adolescents aged 5-19 years were obese, while around 18.7% were overweight in countries that are members of the Organisation for Economic Co-operation and Development (OECD) (92). These figures highlight a worrying trend, as obesity in adolescence increases the risk of chronic diseases such as type 2 diabetes and cardiovascular problems, which can manifest themselves in adulthood. The situation is even more critical in Mediterranean countries. In Italy, for example, 36.8% of children and adolescents are overweight or obese, with similar rates in Spain (34.1%) and Portugal (32.4%) (92). The causes of this prevalence include changes in dietary habits, characterised by an increased consumption of high-calorie foods rich in sugar and fat, and a decrease in physical activity, exacerbated by a more sedentary lifestyle influenced by the increased use of technology and television (92). In Italy, childhood obesity is a growing concern and the latest data from the OKkio alla SALUTE surveillance system, coordinated by the National Centre for Disease Prevention and Health Promotion (CNaPPS) of the Italian National Health Institute (ISS), provide a detailed picture (93). In 2023, 19% of 8–9-year-old children were overweight, 9.8% were obese and 2.6% were severely overweight. Although the prevalence of overweight has decreased slightly over time, the prevalence of obesity has remained broadly stable, with a slight increase in the last year (94). The surveillance system involves more than 50,000 children and their families in all regions of Italy, providing a comprehensive view of the problem (93). The data collection also reveals dietary and lifestyle behaviours that contribute to overweight. Around 40% of children do not eat an adequate breakfast in the morning, more than half have a large mid-morning snack and one in four drink sugary or fizzy drinks every day. Fruit and vegetable consumption is inadequate, with 37% of children eating pulses less than once a week and the majority consuming sweets more than three days a week. Physical activity habits are also a cause for concern: 20% did no physical activity the day before the interview, over 70% do not walk or cycle to school and almost half spend more than two hours a day in front of electronic devices (93). These behaviours, which are consistent with the 2019 data collection, reveal significant geographical disparities, with higher obesity rates in the south of Italy (95). The socio-economic conditions of families also play a crucial role, influencing both excess weight and overall lifestyle. A focus on the Emilia-Romagna region, based on 2019 data,

shows a slightly better situation compared to the national average. In this region, 26.4% of children are overweight (19.2% overweight and 5.6% obese), with 1.6% suffering from severe obesity. 72.4% of children are of normal weight and 1.2% are underweight (93). Although Emilia-Romagna is at an intermediate level compared to other Italian regions, the data show a slight improvement compared to previous surveys, with a decrease in the prevalence of overweight and obesity. However, some critical issues related to dietary habits remain. Only 57% of children in the region eat a breakfast of adequate quality, while 7% skip breakfast and 36% eat an inadequate breakfast. Half of the children have an adequate mid-morning snack, but 46% have an inadequate snack and 4% have no snack at all. Fruit consumption is also inadequate: only 20% eat fruit 2-3 times a day, while 25% eat it only once a day (96). These data highlight the need for targeted interventions to improve dietary quality and promote more active lifestyles among young people (96).

Nutrition education

The complexity of the childhood obesity phenomenon calls for multi-level intervention involving families, schools and health care institutions to promote healthy lifestyles from an early age (97). Nutrition Education is an effective strategy for teaching children appropriate and sustainable eating habits and promoting regular physical activity (88). Integrating Nutrition Education and healthy lifestyles into school curricula and encouraging children to make informed food choices can help improve their long-term health (98,99). It is essential to promote a comprehensive approach involving families and communities to reduce the prevalence of obesity and build a lifelong culture of well-being (100). Learning to eat right, following the teachings of the Mediterranean Diet (MD) - declared by UNESCO to be the Intangible Heritage of Humanity - helps to achieve two interrelated goals simultaneously: personal well-being and environmental sustainability (101). It is imperative that this message is passed on to future generations, so that knowledge of a healthy lifestyle takes root among those who will guide tomorrow's social, health and environmental policies. Nutrition Education is a primary and effective tool for preserving human health and the environment, both in terms of immediate action and long-term prevention; indeed, nutrition awareness promotes healthy and sustainable food choices, thus contributing to the protection of individual health and the maintenance of a healthier environment. In this context, scientific knowledge about food, nutrition and environmental sustainability is a valuable ally, especially if it is conceived and implemented in age-appropriate language and in a context that stimulates curiosity and learning (102,103). A paradigm of this pedagogical method is Madegus Srl, which specialises in the development of edutainment content on good nutrition, scientifically validated thanks to the

experience gained over the years in contact with schools and various educational environments (104) Nutrition Education plays a key role in the formation of children's eating habits; the acquisition of knowledge and skills related to food choices can contribute to a balanced diet that promotes optimal growth and development during childhood. Eating habits formed in childhood tend to persist into adulthood. Adopting a healthy diet from an early age is crucial to preventing the development of diet-related diseases in adulthood (105). Education programmes on food sustainability, beginning in early childhood, are essential to creating aware and responsible citizens capable of making choices that protect both their health and the environment. Unhealthy diets not only contribute to the rise in obesity, but also have a significant impact on the ecosystem. The high consumption of meat, dairy products and ultra-processed foods is directly linked to a high ecological impact, which contributes significantly to climate change. Educating children about more sustainable food choices will not only help them grow up healthy but will also contribute to reducing global environmental impact (106,107).

Madegus Srl: Food Education and Sustainability for a Conscious Future

Madegus positions itself as a social enterprise dedicated to food education, with a passionate focus on raising awareness across all ages about making healthy and sustainable lifestyle choices (89). Its role is to become a driver of change, aiming to reduce health inequalities and make food education accessible to everyone. Through its educational workshops, Madegus successfully combines learning with fun and experiential education, turning food education into an engaging experience for both children and families. Its workshops are highly adaptable to various contexts, such as fairs, public events, shopping malls, summer camps, and sports associations, as well as corporate welfare events for employees' children. The social enterprise stands out for its commitment to promoting key topics such as guidelines for proper nutrition, mindful use of kitchen tools, sustainable eating, workplace safety, and the exploration of food chemistry and microbiology. A fundamental aspect of Madegus' work is its focus on environmental sustainability, aiming to raise awareness not only about the importance of a balanced diet but also about individuals' environmental impact. Madegus benefits from a strong network of collaborations with universities, research centers, and industry professionals, allowing it to apply a multidisciplinary and innovative approach. With a dynamic team of experts, the company promotes the "science of food" through open innovation strategies, fostering the exchange of knowledge across various scientific disciplines. This approach enables Madegus to stay ahead of new market challenges, offering innovative solutions that respond to the evolving food sector. With continuous investment in research and development, Madegus strives

to structure its services in a unique way, focusing on well-being and sustainability, and helping to build a more conscious and responsible society in its food and environmental choices (89).

Edutainment: "Learning Through Playing" - The Madegus Approach

Edutainment, a fusion of "education" and "entertainment," is at the heart of Madegus' approach to food education. This philosophy emphasizes the idea that learning should not only be informative but also enjoyable, especially for young learners (108) The Madegus team believes that education should be an engaging experience, where children and young people can explore important life skills, such as healthy eating, through play and hands-on activities. By transforming learning into an interactive and fun experience, Madegus helps children grasp complex concepts in a way that feels natural and enjoyable. The concept of "learning through playing" is grounded in the understanding that children are more likely to absorb information when they are actively engaged and having fun. In the context of Madegus, this means creating workshops and activities that involve games, experiments, and collaborative tasks. By using play-based learning methods, the organization ensures that children not only learn about nutrition, food safety, and sustainability but also develop a positive relationship with these topics. The importance of edutainment in the early years of a child's development cannot be overstated. During childhood, the brain is highly receptive to new information, and experiences that are enjoyable tend to stick with children far longer than those that are purely academic. Play fosters creativity, critical thinking, and problem-solving skills, all of which are essential in forming healthy habits. When children can participate in activities that connect food education with their natural love for play, they are more likely to internalize the lessons and apply them in their daily lives. Furthermore, the Madegus approach ensures that learning is not just fun but also purposeful. The goal is to equip children with the tools and knowledge they need to make informed decisions about their food choices. By integrating sustainability and nutrition into engaging activities, Madegus encourages children to develop a sense of responsibility towards their own health and the environment. This early exposure helps lay the foundation for healthier lifestyles that last a lifetime. In summary, Madegus uses the concept of edutainment to create a learning environment where children are not just passive recipients of information but active participants in their educational journey. This approach to "learning through playing" helps foster a love for healthy habits, promotes critical thinking, and empowers young learners to make better food choices, setting them up for a healthier and more sustainable future (89).

Giocampus: Promoting Health, Education, and Sustainability through Madegus' Edutainment Approach

One of the main projects in which Madegus is involved is Giocampus, an educational initiative founded in 2001 with the goal of ensuring the well-being of future generations and the environment (109,110). The project aims to promote healthy and sustainable lifestyles through a specific program of Nutrition Education, sustainability, and physical activity for children and adolescents. This project, unique in Italy, is supported by a public-private alliance involving various institutions and educational bodies in the city of Parma, including local authorities, universities, regional educational offices, sports organizations, and private companies (110). The collaboration between public entities, academic institutions, sports groups, and private companies allows for an integrated approach to education, health, and sustainability. Madegus, with its approach based on edutainment and “learning through playing”, contributes to teaching healthy lifestyles through activities that make learning engaging and fun. The "Maestri del Gusto" (MDG), experts from the Madegus team, work closely with children, using an educational method that combines theory and practice in a playful way, such as in cooking workshops and interactive activities (78,108). All the content and methodologies of the Giocampus project are designed and approved by a multidisciplinary scientific committee to ensure appropriate and effective activities (111). The project stands out for its adherence to scientific standards, with studies and continuous monitoring by a scientific community that includes pediatricians, nutritionists, experts in sports and physical activity, developmental psychologists, and educators. This commitment to scientific excellence ensures that the educational practices are based on solid academic foundations, thereby reinforcing the positive impacts on the education and health of the children involved (112). The Giocampus educational project is divided into three main phases, spread throughout the calendar year, each of which aims to promote physical activity, nutritional education and socialisation among young people. The first phase, **Giocampus School**, runs from September to June and takes place in Parma's primary schools, where specific lessons are given on the importance of physical activity and correct nutrition (113). The second phase, **Giocampus Snow**, takes place during the winter months of January and February and offers 9- to 16-year-olds a residential experience in a winter sports camp, promoting not only snow sports but also the acquisition of autonomy and relational skills (113). The third phase, **Giocampus Summer**, which runs from June to September, is a multidisciplinary summer camp that offers sports activities and creative workshops for children aged 5 to 14, with the aim of giving them a summer full of educational and fun experiences (113). Alongside these three main initiatives is **Giocampus Together**, a transversal programme launched in 2017 and dedicated to the

inclusion of children with physical and mental disabilities (113). This project is based on the fundamental principle of inclusion, ensuring that all children, regardless of their abilities, can participate and benefit from the proposed activities (109). The urgency of addressing global challenges related to the environment and climate change has placed education for sustainability at the forefront of pedagogical priorities (114). For this reason, the **Giocampus Green** project will also be active in Parma's secondary schools from 2019, based on the idea that disseminating the principles of sustainability to today's youth is essential to ensure a deep understanding and active commitment to protecting our planet. Giocampus Green is the sustainability education project that focuses its educational efforts on helping young people understand the meaning of sustainability and the components of sustainable development. Giocampus Green was launched in the 2019-2020 school year as a new project aimed at testing the Giocampus methodology in secondary schools, thanks to the collaboration of several comprehensive institutes in Parma. The Green project provides students and teachers with the tools to build a "vertical curriculum", i.e. educational continuity between primary and secondary schools, as required by the Ministry's national guidelines (109,113).

AIM

The aim of this paper is to provide an analytical and detailed description of the Giocampus Method, implemented within the "Giocampus School" project, focusing on nutrition education and the promotion of sustainable food practices. Specifically, this work will explore how Giocampus, through its "Learning by Playing" approach, fosters responsible food awareness among young people, encouraging healthier and more environmentally respectful lifestyles. The paper will examine the pedagogical and scientific principles that underpin the project's educational activities, highlighting how its practical and interactive approach effectively engages children and adolescents in making balanced and sustainable food choices. Special attention will be given to the teaching methodologies used in the workshops, which blend theory with hands-on practice, ensuring that learning is both engaging and meaningful for participants.

MATERIAL AND METHODS

Giocampus School

Educational Project Design and Setting

Giocampus School food and sustainability education is led by expert educators and involves all primary school classes in Parma, from first to fifth grade. A total of 999 hours of educational activities on food and sustainability are offered each school year: two hours for the first and second classes, three hours for the third and fourth classes and four hours for the fifth class (**Table 1**). The topics covered, both nutritional and environmental sustainability, are identified by the Giocampus Scientific Committee based on the most relevant nutritional priorities and issues, following a propaedeutic pathway with respect to the subsequent topics (115). In particular, the nutritional topics included in the educational lessons have been carefully selected and validated by researchers from the Department of Human Nutrition of the University of Parma. These topics are based on sources of high scientific value, including the Reference Intake Levels for Nutrients and Energy for Italian Population (LARN) and the Guidelines of the Council for Research in Agriculture and Analysis of Agricultural Economics (CREA). (116,117). These documents are authoritative reference points in the field of nutrition for the Italian population, guaranteeing an educational approach based on solid, recognised scientific foundations.

Table 1 Educational Hours and Games by Grade

Grade	Number Of Lesson Hours	Number Of Educational Games
First	2	2
Second	2	2
Third	3	3
Fourth	3	3
Fifth	4	4

The pedagogical approach is carried out in collaboration with general practitioners, classroom teachers and with the support of appropriate teaching materials. The methodology of the Giocampus educational model, which includes all the proposals, guidelines and programmes that the project has followed over the years, is primarily based on the Ministerial Guidelines for the Curriculum (118). This involves planning, always shared with the classroom teaching team, structured in modules that promote the achievement of objectives for the development of expected

competences. Specific themes have been identified for each age group to gradually guide the children in discovering a proper diet that is not only healthy but also sustainable for the planet. The educational programme on nutrition and environmental sustainability extends from first to fifth grade. Each school year, Giocampus introduces educational games tailored to the evolving interests and abilities of children, with varying numbers, types, complexities, and prerequisites. In the first and second grades, students engage in two educational games each, while those in the third and fourth grades participate in three games, each addressing specific educational themes. By the fifth grade, which marks the culmination of the educational journey, four more complex games are introduced, designed to summarize and integrate the full range of topics covered in previous years (**Table 1**). This progression ensures that the educational experience remains comprehensive and cohesive, with each game building on previous knowledge. The educational games not only aim to improve the health and well-being of children and their families but also emphasize the positive environmental impact of making responsible food choices. Designed in collaboration with the University's Human Nutrition Unit, these games transform science-based learning into an engaging, hands-on experience. The MDG coordinates the teams, fostering competition to stimulate attention and participation. Validated by a study involving over 8,000 children, the methodology effectively combines fun and learning, integrating the "learning by playing" approach to Nutrition Education. Ultimately, the Giocampus Method ensures that children not only learn to eat healthily and sustainably but also find joy in the process, making the lessons memorable and impactful.

Intervention

The Giocampus Method is an innovative, structured and scientifically based pedagogical approach that offers children a comprehensive and engaging educational experience. Its implementation is based on a teaching sequence that integrates theory and practice, dividing each lesson into two main phases. In the first phase, key concepts related to the day's nutrition topics are presented, providing the context for the students to engage in the activities that follow. The central phase consists of educational games, which are essential tools for the learning process (**Table 3**). A full description of the games can be found in the **supplementary materials**. These playful activities not only deepen and consolidate the concepts presented, but also serve as an immediate assessment method, allowing the effectiveness of learning to be monitored and teaching strategies to be adapted. One of the main principles of the Giocampus Method is "learning by playing", which emphasises learning through direct experience. Children not only acquire knowledge, but also

develop a critical awareness of their food choices. The approach aims to create a dynamic and interactive learning environment where children become the protagonists of their educational journey, making Nutrition Education both informative and memorable. In addition, the educational approach is enriched by various resources, including MDG support, teacher support and the use of games and educational worksheets. Indeed, each child receives specific worksheets for each of the objectives outlined in the nutrition and environmental sustainability education programme. These worksheets have a section dedicated to practical and quick suggestions, as well as innovative and accessible ideas, facilitating the application of basic concepts for the well-being of the child and the environment. The playful-experiential approach allows children to apply what they have learned in a playful way, engaging peers, teachers and parents, and integrating this knowledge into the daily routines of families. An educational worksheet is provided for each game: 2 worksheets for first and second graders, 3 worksheets for third and fourth graders, and 4 worksheets for fifth graders, for a total of 14 educational worksheets (**Table 3**). An example of the pedagogical worksheets is available in the supplementary materials.

Table 3 Games and Educational Sheets For Each Grade

Grade	Game	Game Title	Game Description	Educational Sheets
First	Game 1	LET'S EXPERIENCE THE 5 SENSES	A multisensory adventure that engages children in exploring ingredients through the five senses, stimulating touch, smell, hearing, sight, and taste.	Let's Train the Five Senses
	Game 2	FOOD HUNTERS	A hunting game that educates children to distinguish between animal-based and plant-based foods, using a treasure map and various challenges.	Animals or Plants: This is the Dilemma
Second	Game 1	THE KNIGHT OF 5 COLORS	Children explore fruits and vegetables of five colors, completing a puzzle and answering questions to learn the importance of a varied diet.	There's More Flavor When There's Variety at the Table
	Game 2	MR. H2O AND THE MAGIC OF WATER	An interactive game teaching the importance of water for the human body, using a puppet and practical activities to visualize water content in foods.	Water, My Best Friend
Third	Game 1	ENERGY BREAKFAST	A journey to explore the importance of a balanced breakfast, using tools to measure calories and evaluate food choices based on daily activities.	A Good Start Begins with Breakfast
	Game 2	MSS. MERENDERA AND THE HEALTHY CHOICE	Children create a balanced menu for the day, selecting healthy snacks based on their activity level.	The Importance of a Snack
	Game 3	THE WORLD OF CARBOHYDRATES	A laboratory that distinguishes between simple and complex carbohydrates through a game with toy trains and questions about carbohydrate sources.	Carbohydrates: The Fuel for Our Body
Fourth	Game 1	DIETARY FIBER	A hands-on experience to explore the benefits of fiber, using various foods and visual demonstrations of its role in gut health.	There's More Flavor if I Go Whole Grain
	Game 2	MR. BEAN AND PLANT-BASED PROTEINS	An educational game that involves children assembling "proteins" with Lego bricks, learning the difference between animal and plant proteins.	Legumes: Building Blocks for Your Body
	Game 3	5 MEALS A DAY	A game that helps children compose a complete daily menu, emphasizing the importance of a balanced and varied diet.	I Eat Healthy if I Have Five Meals a Day
Fifth	Game 1	THE FOOD PYRAMID	A practical game to understand the foods in a balanced diet, through experiments and the production of cheese and butter.	I Eat Deliciously if I Conquer the Food Pyramid
	Game 2	THE ENVIRONMENTAL PYRAMID	Children explore the concept of sustainability through a game that compares food supply chains and their environmental impact.	I Eat Deliciously and Conquer the Planet if ...
	Game 3	FOOD WASTE	A competitive game that educates on reducing food waste and proper storage practices, promoting awareness on the topic.	Waste Doesn't pay
	Game 4	NUTRITIONAL LABEL	Children analyze food labels to understand their importance and information, integrating digital elements for a modern and critical approach to nutrition.	The Identity Card of Foods

Giocampus Green

The Giocampus Green project, part of the Giocampus Method, aims to raise young people's awareness of sustainability and ensure educational continuity between primary and secondary school. The program allocates 1,015 hours per year to lectures and workshops on sustainable development issues. The Giocampus Green method is based on the "learning by doing" approach, which emphasizes learning through hands-on experience and active discovery, making it particularly suitable for adolescents, the target group of the project. At this stage of development, it is essential to provide tools that encourage direct exploration and critical thinking, rather than focusing solely on play. This approach allows young people to engage with sustainability through real, concrete activities, encouraging reflection on food choices, sustainable development, and the environmental impact of their actions. The goal is to develop a sense of personal and collective responsibility in students, linking their choices to future impacts on the environment and society, making the learning process more mature and conscious. Through this approach, Giocampus Green enables young people to internalise the key concepts of sustainability, not only by understanding them theoretically, but also by applying them to their own experiences, thus preparing a generation of young people who are more aware and attentive to the challenges of today's world. The method aims to help young people understand the deep meaning of sustainability and its fundamental components, and to encourage them to reflect on their future choices in relation to these issues. Giocampus Green stands out for its scientific and multidimensional approach to sustainability, addressing economic, environmental and social aspects. The project actively involves students in a comprehensive educational pathway that includes the analysis of food supply chains, the identification of sustainable practices and the evaluation of environmental impacts. The aim is to provide a solid scientific understanding and to encourage the development of critical and global thinking in relation to the challenges of sustainable development. The Giocampus Green method not only educates, but also creates a scientifically based foundation that promotes a deep awareness of sustainability, preparing students to face future challenges responsibly and knowledgeably. Five different experiential workshops, 3 of which are specifically dedicated to food sustainability, led and coordinated by a team of academically trained professionals, are offered each year to each class from the first to the third year of secondary school. Each year focuses on a topic related to food sustainability, with a specific educational worksheet summarising the main concepts and suggesting various educational activities (**Table 4**). In the first year, the concept of food waste, which is already introduced in primary schools with a specific lesson, is addressed, highlighting how our model of food production and consumption is characterised by the presence of the so-called

"three global food paradoxes". In the second year, "taste routes" are explored, taking students on a journey to discover the different food cultures of the world, to understand how the food we consume is strongly influenced by the cultural context in which we live. Although there is great diversity in what people in different parts of the world recognise as food, some common characteristics can be identified that underpin healthy and sustainable diets. Finally, in the third year of secondary school, the educational pathway on food sustainability started in primary school is completed with a specific lesson on sustainable nutrition. Starting with the double food and environmental pyramid, it is emphasised how our food choices affect not only our health but also the environment (119). All the things we use every day, including food, require a certain number of resources - such as water, land, energy and raw materials - to produce. Following the principles of the MD is a healthy, energy-balanced, nutritious and sustainable way to eat.

Table 4 Experiential Workshops Specifically Dedicated to Food Sustainability

Grade (Secondary School)	Sustainability Lesson Title	Main Topics Covered
First Year	FOOD WASTE	Introduction to the concept of food waste, analysis of the "three global food paradoxes," connection between food production and consumption, and the global impact of waste.
Second Year	TASTE ROUTES	Exploration of food cultures around the world, understanding the influence of cultural context on eating habits, identification of common characteristics for a healthy and sustainable diet.
Third Year	SUSTAINABLE NUTRITION	In-depth study of the double food and environmental pyramid, impact of food choices on health and the environment, resources required for food production, importance of the MD for a balanced and sustainable diet.

IMPACTS AND DISCUSSION

The Giocampus School project currently involves 7,782 students aged 6-11 from 28 primary schools in Parma, with a total of 356 classes (**Table 5**). The aim of the programme, which is offered free of charge to both schools and families, is to promote a healthy lifestyle through physical activity and Nutrition Education. Giocampus Green now involves 14 secondary schools in the municipality of Parma, with 4,186 students in 203 classes (**Table 5**).

Table 5 Participants in The Giocampus School And Giocampus Green Project In The Last 3 Years

Academic Year	Program	Age Group	Number of Schools	Number of Classes	Total Participants
2021-2022	Giocampus School	6-11 years	28	356	7880
	Giocampus Green	11-14 years	13	173	4113
2022-2023	Giocampus School	6-11 years	28	358	7904
	Giocampus Green	11-14 years	14	198	4122
2023-2024	Giocampus School	6-11 years	28	356	7782
	Giocampus Green	11-14 years	13	203	4186

The Giocampus Method, successfully implemented in primary schools through the Giocampus School project, is now being extended to the provincial level with the **Giocampus Beyond Borders** project. It offers a multidisciplinary opportunity to 10 schools in 7 municipalities, involving 67 classes and 1,541 students, with 122 hours of food and sustainability education. Municipalities can request the intervention of professionals to provide 2 hours of physical activity in classes from first to third grade and to promote Nutrition Education in classes from first to fifth grade, using MDGs.

The Giocampus Method is configured as a model of best practice in the field of nutritional and physical education, thanks to an approach based on solid scientific principles, innovative practices, and the ability to adapt to contemporary challenges. One of the distinguishing elements of the Giocampus Method is its "learning by playing/doing" approach, which has proven effective in improving children's awareness of healthy foods and sustainable lifestyles. One of the most innovative interventions is the educational game "Miss Merendera", developed from the "Energy

Kids" study (2018-2019), which analyzed the energy needs of 78 children during school days and summer camps. This study suggested the importance of teaching children how to choose what to eat based on the activities they engage in, thus integrating nutrition and physical activity (120). Additionally, an analysis conducted on 172 children revealed a progressive departure from traditional MD habits, highlighting the importance of timely interventions. The Giocampus Method directly addresses these issues by responding to the increase in sugar and saturated fat intake through targeted educational activities (121).

The dynamic nature of the Giocampus Method, characterized by a constant update of activities based on scientific research, ensures that the project remains relevant and responsive to new challenges in the educational context. This proactive approach to innovation is fundamental for maintaining high quality and effectiveness over time. The replicability potential of the Giocampus Method is further confirmed by European projects such as SWITCHtoHEALTHY, Strength2Food, and PRomedLiFE which highlight the possibility of adapting the model to different contexts at the international level (122–124). The ability to translate its strategies into diverse cultural and educational settings amplifies the positive impact and promotes the dissemination of effective educational practices.

The growing interest from institutions in the Giocampus Method underscores its importance in promoting healthy and sustainable lifestyles for future generations. The approval and support from public authorities legitimize the project and facilitate broader and more systematic implementation. In summary, the Giocampus Method is not just an educational program; it represents an example of best practice that unites scientific rigor, innovative practices, and adaptability, with a significant impact on the well-being of future generations.

After 24 years of activity, indeed, the Giocampus Method has gained international recognition for its excellence in Nutrition Education and sustainability, emerging as an innovative pedagogical model to promote healthy and sustainable diets (109). This project stands out for its effectiveness in educating young people in correct eating habits, thanks to an integrated approach that combines education, health and well-being. Over the years, Giocampus has participated in numerous scientific events of international relevance (112,115). One of the first moments of institutional recognition occurred on 13 October 2020, when the project was presented at the European Parliament, where a sustainable approach to tackling childhood obesity was discussed (125). This speech analysed the

social, health, educational and scientific impact of the project, emphasising the importance of an integrated and collaborative approach in the fight against childhood obesity. Subsequently, Giocampus participated in the XLII Congress of the Italian Society of Human Nutrition (SINU), held in Naples from 4 to 6 April 2022. On this occasion, the cross-sectional study GiocaMed21 was presented, which highlighted the differences between body size and measured and perceived behavioural parameters in a sample of children and adolescents, providing important insights into the body image and eating habits of young people (126). In May 2022, Giocampus was featured at the 8th International Congress of Nutritionists in Zagreb, where the value of Nutrition Education beyond the classroom was explored. The congress emphasised the importance of extending Nutrition Education beyond the classroom, involving communities and families in supporting healthy lifestyles. Another significant milestone took place on 31 May 2023, when the project was presented at the Harvard T.H. Chan School of Public Health during the workshop 'Human Nutrition and Health: A Workshop on International Community Experiences'(127). On this occasion, the Giocampus initiative was discussed together with other Nutrition Education experiences in the context of the "Parma Model", highlighting the importance of a community approach to promote healthy lifestyles. A month later, from 7 to 9 June 2023, Giocampus took part in the XLIII Congress of the Italian Society of Human Nutrition (SINU) in Arezzo, during which a symposium dedicated to the evolution of breakfast within a healthy diet was organised, with a presentation entitled 'Changing Habits in Developmental Age'. This talk highlighted the crucial role of breakfast in promoting a balanced diet in young people. Lastly, Giocampus participated in the 16th European Public Health Conference (EPH), held in Dublin from 8 to 11 November 2023. During this event, the project was presented in a workshop entitled 'Obesity: the greatest burden of the 21st century and the post-pandemic', with a session dedicated to childhood obesity, offering an opportunity to discuss current and future challenges in the prevention of obesity in children. The excellence and validity of the Giocampus Method has been demonstrated by scientific data collected and published in academic articles (112). This multidisciplinary educational approach has integrated physical activity and Nutrition Education to promote healthy and sustainable lifestyles among young people. Thanks to a solid scientific basis, constant monitoring and a continuous updating process, Giocampus has proven to be effective in improving participants' nutritional knowledge, eating habits and anthropometric parameters. The project has involved thousands of students in Parma schools but has also expanded to the provincial and international level as a replicable model, recognised in important European projects (111).

Giocampus, through the synergy between science and educational practice, thus contributes to the formation of a generation aware of the importance of a healthy and sustainable lifestyle, capable of facing future challenges with innovative and effective tools (128).

FUTURE PERSPECTIVES

In today's digital world, the use of information media in Nutrition Education is becoming increasingly widespread, especially among younger generations. Interactive digital tools, educational games and social platforms create a dynamic and engaging environment for children and adolescents, stimulating a deeper understanding of nutrition and promoting the adoption of healthy and sustainable eating habits (129,130). However, it is essential that such tools are carefully integrated, considering ethical implications and ensuring the quality of the information provided. In this context, the idea of digitizing the games of the Giocampus project represents a significant opportunity to extend the impact of a consolidated educational approach beyond the local reality of Parma. This expansion can become a valuable resource for spreading Nutrition Education to an ever-growing number of children, ensuring that the digital educational environment is safe, scientifically validated and ethically appropriate to the pedagogical needs of young users. A virtual Giocampus Method could overcome physical limitations and provide a "learning by playing/doing" experience even at a distance, making Nutrition Education accessible to a much wider audience.

The Giocampus Method continues to evolve and improve thanks to the Giocampus Perspective project, which will be launched in the 2022-2023 school year. This project aims to monitor the nutritional status, eating habits and lifestyle of primary school children in Parma over a five-year period. Through anthropometric measurements and bioimpedance analysis, as well as the monitoring of eating behaviour and habits related to physical activity and sleep, Giocampus Perspective aims to evaluate the effectiveness of the Giocampus Method in promoting a healthy and sustainable lifestyle. In this way, it will be possible to gain a prospective view of the changes and improvements achieved, and to understand which educational strategies are most effective in the long term for children's health.

At the heart of the Giocampus Method lies the collaboration among children, parents, teachers and counsellors, all united by the common goal of ensuring the future well-being of the little ones and, consequently, of the planet. While the school and the project staff provide the methodological basis, the role of the families is crucial to the success of the programme. Thanks to this synergy, the

Giocampus Method has succeeded in creating an effective collaborative network capable of promoting the healthy growth of children and contributing to a better and more sustainable future for society.

The future of the Giocampus Method is focused on expansion through digital technologies, constant renewal and improvement, nutritional education and sustainability. These key elements remain fundamental to the achievement of the project's main objective: to educate generations more aware of their well-being and capable of adopting a healthy and sustainable lifestyle. The Giocampus Method, which is constantly evolving, aims not only to disseminate nutritional knowledge, but also to raise young people's awareness of their shared responsibility for the planet, creating a synergy among education, health and sustainability that can have a lasting impact on future society.

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SUPPLEMENTARY MATERIAL

Detailed description of the Giocampus Method games for each class

First-grade games

For the first grades, two preliminary games are offered to begin the educational journey.

LET'S EXPERIENCE THE 5 SENSES

The educational game "Let's Experience the 5 Senses" engages children in a multisensory adventure. Using the book "The Wolf Eats Rock Soup and Bark Macedonia," little explorers become culinary scientists. Each animal in the fairy tale donates a mystery ingredient, and children must discover the recipe through the five senses. Touch is



stimulated with a tactile wall of real fruits and vegetables. Smell is involved through jars with liquid flavors, while hearing is represented by simulating the sound of a peeled apple in the bite. For vision, puzzles on the interactive whiteboard or printed cards with pictures are used. The sensory experience offers valuable lessons: going beyond appearances, tasting before judging, and the importance of using our five senses when dealing with food at mealtimes.

FOOD HUNTERS: ANIMAL OR PLANT BASED FOODS

The educational game named "Food Hunters" is designed to educate children about the proper differentiation between animal- and plant- based foods through a playful and scientific approach. The experience involves young players in a hunting adventure, during which they are charged with identifying the secret



ingredients of recipes previously contained in a small suitcase lost by a scientist in the depths of the ocean. Using a treasure map, children are guided during the ingredients search, which must be conquered through participation in various simple tests, riddles and experiments. This methodology

aims to bring young “hunters” closer to the food world, with special attention to the distinction between foods of animal or plant origin.

Second grade games

For second grades, two games are offered to continue with the educational journey.

THE KNIGHT OF THE 5 COLORS

The educational game "*The Knight of 5 Colors*" immerses children in a tasty exploration of fruits, vegetables and seasonality to introduce the important topic of food sustainability at an early age. The knight, drawn on the game board, must eat fruits and vegetables of 5 different colors to protect himself with a colored armor. Only a colored



armor can protect the knight because of the beneficial properties of all the different fruits and vegetables he eats. The experience is accompanied by a puzzle of 5 tiles, one for each color, with images of different fruits and vegetables. Each team must complete the puzzle by correctly answering the questions posed by the MDG. The game also includes a special taste challenge in which a fragment of the puzzle can be won. The goal of the game is to learn the importance of a varied diet by eating the 5 colored fruits and vegetables, understanding the nutritional benefits of each variety and the recommended daily portions and frequency. An educational adventure that combines fun and health.

MR. H2O AND THE MAGIC OF WATER

The educational game "*Mr. H2O and the Magic of Water*" offers an interactive approach to engage children in a process of discovering the importance of water for the human body, both the water we drink and the water contained in solid foods. To effectively convey this concept, a tool called "Mr. H2O" was created, a



puppet with two separate compartments: one for pictures representing food and the other for water. During the game, children win food items by correctly answering the MDG's questions and fill the dedicated compartment, while the MDG fills the water compartment with an amount corresponding to that contained in the foods they placed. The team that manages to fill the compartment with a greater amount of water and thus correctly answered the questions asked by MDG on the importance of water wins. In parallel, the game involves the use of a paper board depicting the five meals and thus the food day, to be completed with cards illustrating the various foods. To make the educational experience more complete and tangible, the game begins with the use of a press to crush different foods, such as fruit, raw and cooked pasta, to highlight the differences in water content between them. The primary goal of the game is to educate about the importance of water, both the water we drink and the water that composes the foods we eat, while promoting healthy eating habits. In fact, this approach aims to encourage a preference for water-rich foods, such as fruits and vegetables, to promote a healthy and conscious eating pattern.

Third grade games

For third and subsequent grades, there is an increase in the number of topics covered and thus games; third grades are administered 3 different games.

ENERGY BREAKFAST

The educational game called “*Energy Breakfast*” is designed as an engaging path for children to explore the concept of an ideal breakfast. This game makes use of two distinct tools: an “energy thermometer” and an “energy scale”. The first is used by the MDG to survey children's eating



habits at breakfast. The rulers, symbolising the Kcal introduced with breakfast, are inserted into the energy thermometer, which is divided into three different colours, each representing one of the three main food groups to be eaten at breakfast. Students who manage to complete the thermometer eat an ideal breakfast. The “energy scale” is a further tool that allows a more precise assessment of the ideal breakfast, taking into account both the food consumed and the school and extra-school activities that require energy expenditure. Loads represent breakfast food items or morning activities (e.g., 1 hour math class) and are won by correctly answering MDG questions

about breakfast. The weight of the loads is different and proportional to the energy expenditure (for the activities) or energy supply (from the foods). The winning team is the one that selects a balanced breakfast in relation to morning activities, including fruit as a mid-morning snack. The primary objective of the game is to educate participants on the importance of breakfast as the first meal of the day, emphasizing its fundamental role in providing the energy needed for daily activities. Not only is the importance of eating breakfast highlighted, but also the importance of choosing the right foods to obtain the proper amount of energy, avoiding excesses or deficiencies, to maximize performance in all daily activities.

MSS. MERENDERA AND THE HEALTHY CHOICE

The educational game "Mss. Merendera And The Healthy Choice" involves children in creating a healthy and balanced menu for the day, with focus on snacks, based on their daily activities, active or sedentary. The main tool of the game is a Lego character representing the 5 meals (5 drawers). The drawers are filled with cards representing the different foods eaten as snacks and the different activities that involve energy



consumption. Children answer the MDG questions to win foods and construct the food day based on the chosen profile of daily energy expenditure, sedentary or sporty. This game likewise begins with the food press experiment, which is used to explain the difference in water content between different types of fruit, the main component of the ideal snack. In fact, fresh, dried, and dehydrated fruits differ greatly in terms of water content and therefore recommended consumption portions. The purpose of the game is to teach the importance of the snack, which is not a main meal but is very important because it provides energy between main meals, a topic that will be better addressed in the fourth-grade game "5 Meals a Day." The ideal snack is varied and characterized by balanced food choices, also depending on daily activities.

THE WORLD OF CARBOHYDRATES

The educational laboratory on *“The World of Carbohydrates”* offers an immersive experience to explore the world of these nutrients. Using two wooden toy trains on a landscape setting, the difference between simple and complex carbohydrates is visualized. The short train, representing simple carbohydrates,



moves quickly, while the longer train, symbolizing complex carbohydrates, travels more slowly but covers a greater distance. By means of a crank handle, children experience in concrete terms how simple carbohydrates provide ready-to-use but short-lived energy, while complex carbohydrates provide a more gradual and prolonged release of energy. In addition, a *“Gioco dell’Oca”* game about carbohydrates is used, with a paper board illustrating carbohydrate source foods. Each picture corresponds to a question about the source of carbohydrates. The team that completes the board first wins, thus adding a playful element to the learning process. To enable the children to explore the diversity of carbohydrate sources in a tangible way, vials containing different varieties of cereals were also used. The overall goal of the game is to teach children about the importance of carbohydrates as a source of energy, enabling them to distinguish between simple and complex carbohydrates, and to acquire knowledge about the origin of these nutrients.

Fourth grade games

For the fourth grades, as well as for third grades, three different games are planned on three specific topics, increasingly more challenging.

DIETARY FIBER

The educational game on “*Dietary Fiber*” engages children in a hands-on experience to fully understand the benefits of this essential nutrient. A variety of tools are used in the game. Initially, using different types of foods (contained in specific vials) such as pasta, whole wheat pasta, rice, wheat germ, and bran, children explore the presence of fiber in these different foods. A demonstration with soap and water visually illustrates how fiber, unlike water, adheres to the walls, highlighting its role in intestinal cleansing. In addition, a paper board representing the human body and in particular the human digestive system is used to illustrate more generally the path that food takes in our bodies and thus also the dietary fiber we consume. Also in this Trivial® game, each step corresponds to a question about foods that contain dietary fiber or not. The team that completes the board first wins. The goal of the game is to teach children about fiber-rich foods and why they are essential to our health and well-being.



MR. BEAN AND PLANT BASED PROTEINS

Mr. Bean is the protagonist of the game that makes learning about plant proteins fun. After a brief explanation of what legumes are and what they contain, children play at assembling “proteins” with Lego bricks representing the different amino acids to learn the difference between animal and plant based proteins. In fact, through this experiment, they can clearly see that animal



proteins are complete, whereas vegetable proteins must be consumed with a cereal source to be complete like animal proteins. Children discover the world of legumes thanks to Mr. Bean, a giant legume that allows them to learn what legumes are composed of and how they are made in terms

of parts and structure. The aim of the game is to make children aware of why legumes are important in the diet and how they can be part of a healthy meal.

5 MEALS A DAY

The “5 Meals a day” educational game helps children in composing a complete daily menu. Using a paper board representing a placemat on which to eat the 5 daily meals, children choose food items to create their own menu for each meal. The goal is to choose the right foods to



ensure that the menu is varied, complete and balanced. Each team must complete the 5 daily meals taking into account what they have learnt in all previous classes. The MDG rewards the winning team, the one that elaborated the best food day from a nutritional point of view. The game encourages a review of all the previous lessons, allowing children to understand that a balanced menu must be a daily choice to ensure a complete, healthy and also sustainable diet.

Fifth grade games

For the fifth grades, four different games are scheduled to take up all the major topics covered, with greater complexity, to conclude the educational path.

THE FOOD PYRAMID

The food pyramid educational game engages children in practical experiments to better understand what foods constitute a balanced diet and their frequencies of consumption. By projecting the food pyramid on the board, attention is focused gradually on the foods we encounter on various steps.



Starting at the bottom, an experiment highlights that potatoes, often considered vegetables, are actually complex carbohydrates, showing the starch they contain with iodine dye. Moving on upwards, milk and cheese are found. Children participate in the production of cheese; it is explained how the proteins in the milk curdle, turning into cheese. This explains why the consumption of cheese is different from that of fresh milk, being more concentrated. The children also had the opportunity to actively participate in the production of butter: a bottle containing fresh cream was passed from hand to hand among all the children in the class, who enthusiastically worked by shaking it until an appropriate consistency was achieved. This activity gave them a practical understanding of how different products can be made from milk. A further experiment compares French fries with raw potatoes; rubbing them on a sheet of paper reveals the differences in preparation. In this case for the same food (potato) it is the method of preparation that determines a different frequency of consumption. The objective is to introduce children to MD through the food pyramid and guide them to “climb” it in order to educate and explain the correct consumption frequencies of each food in the context of a healthy and sustainable diet.

THE ENVIRONMENTAL PYRAMID

By means of the environmental pyramid educational game, children get deep into the topic of sustainability. By “climbing” the environmental pyramid, children are involved in the understanding of the different environmental impact of food supply chains (i.e. by examining



the difference between the tomato chain -short- and the ham chain -long-) in terms of water, carbon and ecological footprint. Large cards depicting the various stages of supply chains are used, highlighting the differences between long and short supply chains, with a focus on the different environmental impact they generate. A Trivial® game with illustrations of food products in the outer circular part and images of ecological products in the inner radial part, it engages children with questions about environmental sustainability and the ecological footprint of different foods. Children participate in the game by rolling dice and selecting a food to "stop" on. The MDG asks a specific question regarding that food and what level of the environmental pyramid it is in. If the child answers correctly, he or she earns a cube representing a step in the pyramid. The winner is the first to gain the 6 cubes, corresponding to the 6 steps of the environmental pyramid. Next, the game moves to the center of the board, introducing questions related to the environment and ecology. This playful approach engages children in the context of sustainability, emphasizing the concept that making conscious food choices not only benefits human health, but also contributes positively to the environment.

FOOD WASTE

The game dedicated to food waste begins with a carefully structured introductory lesson on the topic, supported by a specific presentation. The primary objective of this phase is to instil in fifth graders an accurate awareness of the amount of food wasted in our society. In addition,



this introduction includes a review of basic concepts relating to the food chain, the ecological footprint and the environmental pyramid, as well as an in-depth definition of the concept of Overshoot Day.

Subsequently, various food waste prevention strategies are presented, complemented by instructions on proper food storage practices in the refrigerator to ensure optimal food shelf life. The core of the game involves a competition with the class divided into two groups that must conquer four skills (i.e. shopping list; nice inside, recycling, doggy bag) on a game board. By rolling dice, the groups move along the squares and can conquer the skills by accurately answering the MDG's questions related to food waste. Wins the group that first conquers the four skills.

NUTRITIONAL LABEL

The educational game on food labels involves children in a practical experience of reading the nutritional facts of packaged food products. Each child in the class is asked to bring a label of a



packaged food product from home. During the game each student had to classify a packaged food nutritionally and ecologically by filling out the "Food Identity Card." The game allows each child to carefully analyse the packaging of a food to understand what a nutrition label is, why it is important, how it should be read and what information we can find. The main goal is to make the students aware that the most important aspect of a nutrition label are the ingredients, which are listed in

descending order, and the provenance, not just the nutrition label. What is new in this game is a digital component that amplifies the experience. Children explore digital information about their products, while understanding the importance of navigating the digital world critically. The lesson extends to the media component, educating children to discern online information; this approach aims to provide children with practical skills and digital awareness, integrating the reading of food labels into the modern era. The goal is for children to make informed and conscious decisions about food, developing a comprehensive understanding of what they buy and consume from a health and sustainability perspective.

Examples of the pedagogical worksheets

Educational Fact Sheet Let's Train The Five Senses - 1st Grade

SCHEDA A



Alleniamo i cinque sensi.

IN OGNI AZIONE O GIOCO CHE FACCIAMO UTILIZZIAMO I NOSTRI SENSI E, SPESSO, SENZA ACCORGERcene OGNI SENSO HA IL SUO ORGANICO COL QUALE FUNZIONA ED OGNUNO DI NOI PUÒ SENTIRE LE COSE IN MANIERA DIVERSA. NEGLI ANIMALI ALCUNI SENSI SONO MOLTO PIÙ SVILUPPATI, COME MAI? PERCHÉ LORO LI ALLENANO SIN DA PICCOLI E LI USANO PER CACCIARE LE PREDE ANCHE DA MOLTO LONTANO. MA ANCHE NOI POSSIAMO ALLENARLI.

QUANTI SONO I SENSI? 5 COME LE DITA DELLA NOSTRA MANO! QUALI SONO?

LA VISTA: ABBIAMO GLI OCCHI SEMPRE APERTI, TRANNE QUANDO DORMIAMO! SE STIAMO TROPPO DavANTI ALLA TV O AI VIDEOGIOCHI LA PERDIAMO PIÙ FACILMENTE!

IL GUSTO: TUTTE LE VOLTE CHE MANGIAMO PERCEPIAMO I VARI SAPORI CON LA LINGUA. RICONOSCIAMO IL DOLCE, IL SALATO, L'ACIDO, L'AMARO E L'UMAMI (CHE RICORDA IL GUSTO DEL PARMIGIANO-REGGIANO).

L'UDITO: CON LE NOSTRE ORECCHIE POSSIAMO ASCOLTARE LE CANZONI O L'INSEGNANTE CHE SPIEGA A SCUOLA. CI SONO PERÒ DEI RUMORI CHE NON SIAMO IN GRADO DI PERCEPIRE: QUELLI TROPPO FORTI, CHIAMATI ULTRASUONI, E QUELLI TROPPO BASSI, CHIAMATI INFRASUONI. I PIPISTRELLI COMUNICANO CON GLI INFRASUONI.

L'OLFATTO: QUANTI ODORI POSSIAMO SENTIRE CON IL NOSTRO NASO? TANTISSIMI! EPPURE LO ALLENIAMO TROPPO POCO E ALLA FINE CI SEMBRANO TUTTI SIMILI. I CANI, INVECE, HANNO UN OLFATTO 50 VOLTE PIÙ SVILUPPATO DELL'UOMO.

IL TATTO: LISCIO O RUVIDO? DURO O MORBIDO? CALDO O FREDDO? LE MANI CI PERMETTONO NON SOLO DI CONOSCERE GLI OGGETTI CHE CI CIRCONDANO MA SONO ANCHE LA PRIMA FORMA DI COMUNICAZIONE CHE IMPARIAMO!

Fallo anche con la tua famiglia!

OBIETTIVI:

- ALLENARE I CINQUE SENSI A RICONOSCERE I VARI ALIMENTI
- IMPARARE A CONOSCERE MEGLIO IL CIBO.
- STIMOLARE LA CONSCENZA E L'ASSAGGIO DI NUOVI ALIMENTI.

ATTIVITÀ: "ALLENIAMO L'OLFATTO"

PRENDI UN FOGLIO BIANCO E DIVIDILO IN DUE: FATTI AIUTARE DA MAMMA E PAPÀ E DISEGNA DA UNA PARTE LA FRUTTA E LA VERDURA CHE HANNO UN ODORE PARTICOLARE (PER ESEMPIO LE CIPOLLE) E DALL'ALTRA QUELLI CHE NON CE L'HANNO (LE ZUCCHINE). SE VUOI, APPENDILO SUL FRIGO E, OGNI GIORNO, ALLENATI AD ANNUSARE TUTTI GLI ALIMENTI CHE HAI SCRITTO. SEI SICURO CHE NON ABBIAMO NESSUN ODORE?

RICORDATI DI FARE ALMENO 30 MINUTI DI MOVIMENTO, GIOCO ALL'APERTO, UN GIRO IN BICI O UNA CORSA CON GLI AMICI NEL CORTILE O AL PARCO!

ATTIVITÀ: "BANANA CAMBIA COLOR"

PRENDI 3 BANANE E NON SBUCOCARLE:

- A. UNA LA METTI IN FREEZER
- B. UNA LA METTI IN FRIGO
- C. UNA IN CUCINA SUL TAVOLO

LASCIALLE PER 4 GIORNI DOVE LE HAI POSIZIONATE, AVENDO CURA CHE NESSUNO LE SPOSTI O LE MANGI CHE COSA È SUCCESSO DOPO 4 GIORNI? OSSERVA BENE LA BUCCIA E GUARDA:

1. IL COLORE: QUALE È DIVENTATA PIÙ SCURA?
2. L'ODORE: QUALE HA L'ODORE PIÙ FORTE?

ED ORA TOGLI LA BUCCIA E OSSERVA LA POLPA; CONTROLLA:

3. IL TATTO: QUALE È PIÙ MORBIDA E QUALE PIÙ DURA?
4. IL SAPORE: QUALE È PIÙ DOLCE?

LA BANANA IN FREEZER È DIVENTATA DURA COME IL CEMENTO E SI SONO FORMATI DEI PICCOLI CRISTALLI ALL'INTERNO. IL SUO COLORE PERÒ È RIMASTO GIALLO E IL SUO SAPORE NON È CAMBIATO. LA BANANA IN FRIGO È DIVENTATA PIÙ MARRONCINA. MA IL FREDDO HA CONSERVATO IL SUO SAPORE. ALL'ULTIMA IN CUCINA SONO SPUNTATE DELLE MACCHETTE MARRONI ED È DIVENTATA MOLLIACCIA E PIÙ ZUCCHERINA! A TEMPERATURA AMBIENTE È RIUSCITA A MATURARE.

Lo sapevi che...



Ascolta con gusto: l'orchestra vegetale.

QUANDO MASTICHIAMO, GLI ALIMENTI SOTTO I NOSTRI DENTI PRODUCONO DEI SUONI. PER ESEMPIO SE MANGIAMO UNA MELA O UNA CAROTA, SAPREMO DISTINGUERE BENE IL RUMORE CHE FANNO. ESISTE ANCHE UN GRUPPO DI MUSICISTI CHE UTILIZZA SOLO ORTAGGI PER SUONARE LA PROPRIA MUSICAI: PEPPERONI, ZUCCHINE, CAROTE, MELANZANE, CETRIOLI, PORRI, RADICCHIO, PREZZEMOLO, ZUCCHE E CARCIOFI... NON È L'ELENCO DEGLI INGREDIENTI PER UNA GUSTOSA RICETTA, MA È CIÒ CHE OCCORRE A QUESTA SPECIALE ORCHESTRA PER ESEGUIRE I SUOI CONCERTI. PRIMA DI OGNI ESIBIZIONE VANNO AL MERCATO E SCELGONO CON QUALI ORTAGGI SUONARE. HAI MAI PROVATO A COSTRUIRE UN FLAUTO CON UNA CAROTA? O UNA BATTERIA CON UNA ZUCCATA O DELLE NACCHERE CON LE MELANZANE?

NON DIMENTICARTELI!

INSERISCI I SENSI NELLE CASELLE E COLORA LE FIGURE:









I MIEI COMMENTI

COME ANDATA/COSA NE PENSO:

giocampus scuola

Tel. 0521 905568 - segreteria@giocampus.it - www.giocampus.it

Study 2

PROSPECTIVE STUDY: Assessment of the nutritional status, eating habits and lifestyle of children attending primary school in Parma

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Short Title: Weight Status and Life-Style of Children In Parma

Keywords: Paediatric Obesity, Children, Primary School, Weight Status, Lifestyle, Giocampus

ABSTRACT

Overweight and obesity remain significant public health challenges among Italian children, with 19.0% classified as overweight and 9.8% as obese. Poor dietary habits, diverging from the Mediterranean Diet (MD), are widespread. Nearly two out of five children skip breakfast, more than half consume a substantial mid-morning snack, a quarter drink sugary or carbonated beverages daily, and fruit and vegetable intake is notably low. Physical activity is also insufficient, with one in five children failing to engage in daily exercise and almost half spending more than two hours per day on electronic devices. Educational interventions in schools, such as the Giocampus project, along with awareness campaigns and policies that facilitate access to healthy food, hold potential to improve children's health by fostering the adoption of healthy and sustainable lifestyles. In collaboration with the Department of Human Nutrition at the University of Parma, the Giocampus project has initiated an observational study to monitor the nutritional status of primary school children in Parma and assess the effectiveness of its educational methods. The study involves anthropometric and bioimpedance measurements as well as a questionnaire designed to explore the dietary and behavioral habits of the students. In its first year (2023), data were collected from 1,975 children in first and fifth grades, and in the second year (2024), from 940 children in second grade. According to the IOTF parameters, most students fall within the normal weight category. The study's main findings reveal both positive and negative trends concerning children's habits in key areas such as nutrition, physical activity, sleep, and hygiene. In terms of nutrition, over 90% of children report eating breakfast; however, the majority opt for foods such as biscuits and cereals, with only 3.3% including fruit. This highlights a significant gap in healthy eating practices at the start of the day. While more than 90% of children have a mid-morning snack, most choose fresh fruit, which is a positive indicator. However, at lunch, fewer than half of the children consume fruits or vegetables. Additionally, around 32.3% of children eat before going to bed, which may disrupt proper digestion and sleep. At dinner, nearly half of the children skip fruits and vegetables, raising concerns about overall nutritional intake. Regarding physical activity, more than 50% of students engage in sports at least twice a week, indicating a positive trend. However, this may not be sufficient to ensure sustained active lifestyles, and there is room for improvement. Sleep patterns align with health recommendations, with children sleeping between 8:29 and 9:36 hours per night, suggesting adequate rest. However, sleep quality could be further improved with more consistent routines, particularly given the variability in school schedules. In terms of hygiene, 80% of children brush their teeth before school, reflecting good oral hygiene practices. A concerning aspect is the high

prevalence of television watching during breakfast, which may distract children from focusing on a healthy, mindful start to the day. Many children watch TV while eating, potentially detracting from their nutritional intake and overall morning routine. Finally, adherence to the MD is moderate, as indicated by an average score of 5.77 ± 2 on the KIDMED questionnaire. This score suggests that while some healthy habits are in place, such as fruit consumption during snacks, there is significant room for improvement, particularly regarding fruit and vegetable intake during meals. This study examined lifestyle habits across different grade levels in elementary school children using statistical analyses to compare first – second and first - fifth grade children. Significant differences were observed between first and fifth-grade children ($p < 0.001$) and between first and second-grade children ($p < 0.05$) for various behaviors. Specifically, fifth-grade children demonstrated better oral hygiene, including more frequent tooth brushing after breakfast and before bed. First-grade children were more likely to have mid-morning snacks and consume sugary drinks, while fifth-grade children had lower frequencies of afternoon snacking and higher consumption of fruits and vegetables at dinner. Additionally, the practice of sports outside of school was more common among fifth and second-grade children. These findings emphasize the importance of early health education and the role of both family and school environments in promoting healthier habits as children grow older. These findings underscore the importance of ongoing educational interventions to promote healthy eating habits and lifestyles during these school transitions. Fostering a Mediterranean lifestyle among children is a scientifically supported approach to improving public health by encouraging healthy eating habits and balanced lifestyles. The results of the Giocampus project suggest a positive impact on the nutritional status, dietary, and lifestyle habits of children in Parma. However, targeted interventions are still necessary to reduce rates of overweight and obesity, as well as to address the higher-than-average prevalence of underweight. Continued monitoring of fruit and vegetable consumption, the promotion of balanced breakfasts, and the encouragement of physical activity remain essential. The Giocampus Prospective Monitoring project, which has a five-year duration, will continue to monitor the situation of children in Parma, refining and enhancing the educational initiatives of the Giocampus Method. The aim is to ensure the well-being of children, aspiring to establish a model of excellence recognized nationally and internationally in the promotion of child health.

INTRODUCTION

Childhood obesity is a growing public health challenge worldwide and is also emerging in Italy, where one would expect a lower incidence due to the traditional culinary culture and Mediterranean lifestyle (131,132). However, the increase in childhood obesity is now a clear phenomenon that requires urgent and targeted interventions. According to the Istituto Superiore di Sanità (ISS), this phenomenon is steadily growing and threatens the well-being of younger generations with significant long-term implications for both health and the economy (133).

The causes of childhood obesity are complex and linked to genetic, biological, and environmental factors (134,135). In particular, a diet rich in calorie-dense and nutrient-poor foods, such as fast food, packaged snacks, and sugary drinks, contributes to weight gain in children. Excessive portions, lack of education on balanced diets, and a sedentary lifestyle worsen the problem(133,135). In addition to poor diet, the lack of safe spaces for physical activity, excessive screen time, and inadequate sleep are all factors that promote childhood obesity (136).

Childhood obesity has serious health consequences for children, increasing the risk of developing chronic diseases such as type 2 diabetes and cardiovascular diseases (137,138). These problems can arise early and continue into adulthood, worsening the quality of life and leading to significant healthcare costs (139,140). The impact is not only physical but also affects mental health, with obese children possibly experiencing social isolation, depression, and low self-esteem (140).

Childhood obesity represents a significant economic burden for society. The costs for the national healthcare system stem from the treatment of obesity-related diseases, in addition to long-term productivity losses due to chronic health problems. Socioeconomic and geographic disparities worsen the problem, with higher rates of overweight and obesity in children in southern Italy and disadvantaged contexts, making a targeted approach that considers these variables necessary (141).

Addressing childhood obesity requires integrated food education and the promotion of physical activity (142). An example of an intervention in this direction is Giocampus, an educational project aimed at promoting the well-being of future generations. Born from the collaboration of public and private institutions in the Parma region, the program integrates physical and food education based on the principles of the Mediterranean Diet (MD) and scientific evidence. Giocampus is structured in three main phases: Giocampus School, activities in schools that combine lessons on food

education and movement; Giocampus Snow, which offers winter camps to teach healthy eating and promote sports; and Giocampus Summer, summer camps that offer sports activities and educational workshops. A distinctive feature of the Giocampus method is the use of the “Maestro del Gusto” and the “Maestro del Movimento” educators specialized in nutrition and motor sciences, respectively, who make learning engaging and formative. This holistic approach, which combines food education and physical activity, represents a promising solution to counter childhood obesity, providing children with the tools to make healthy choices and build a balanced lifestyle from an early age (78,109,113).

AIM

The purpose is to report descriptive data relating to the first two years of the Giocampus five-year prospective study. These data, collected in the school years 2022/2023 and 2023/2024 respectively, describe the nutritional status and eating habits of children in the first, second and fifth classes of primary schools in Parma. The aim is to provide an accurate overview of the first two years of monitoring within the Giocampus Method educational context, thus contributing to understanding the initial impact of the programme on participating children.

MATERIALS AND METHODS

Population and Sample

Data were collected from children attending the first and fifth grade in the primary school year 2022/2023 and from children attending the second grade in the school year 2023/2024. In the school year 2022/2023 (time 1), first and fifth grade children were enrolled. At the end of the 2022/2023 school year, the study ended for the fifth-grade children, while it continued for the first-grade children who participated in the second measurement in the 2023/2024 school year and will continue until the end of their school term (time 5), scheduled for the 2026/2027 school year. In the school year 2026/2027, first grade children will be enrolled again to compare the new participants with those enrolled at time. So far, data have been collected from first and fifth graders in the first survey year (2022/2023) and from second graders in the second survey year (2023/2024) (**Figure 1**). After a detailed presentation of the study by the trained staff, the parents or legal guardians of the children were given the opportunity to consent to their children's participation. The privacy of the participants is ensured using an alphanumeric code to identify the subjects, instead of using their first name and surname. The project was approved by the Board for the Ethics of Non-Medical Research on the Person (REB - Research Ethics Board) of the University of Parma (prot. no. 0266536 of 28/10/2022).



SCHOOL YEAR 2022/2023	SCHOOL YEAR 2023/2024	SCHOOL YEAR 2024/2025	SCHOOL YEAR 2025/2026	SCHOOL YEAR 2026/2027
1st grade	2nd grade	3rd grade	4th grade	5th grade
Data collection: Sociodemographic (place of birth, age, gender); Anthropometric (weight, height, waist circumference); Bioimpedance (BMI, % fat mass)	Data collection: Sociodemographic (place of birth, age, gender); Anthropometric (weight, height, waist circumference); Bioimpedance (BMI, % fat mass)	Data collection: Sociodemographic (place of birth, age, gender); Anthropometric (weight, height, waist circumference); Bioimpedance (BMI, % fat mass)	Data collection: Sociodemographic (place of birth, age, gender); Anthropometric (weight, height, waist circumference); Bioimpedance (BMI, % fat mass)	Data collection: Sociodemographic (place of birth, age, gender); Anthropometric (weight, height, waist circumference); Bioimpedance (BMI, % fat mass)
Administration of questionnaires:	Administration of questionnaires:	Administration of questionnaires:	Administration of questionnaires:	Administration of questionnaires:
Eating habits;	Eating habits;	Eating habits;	Eating habits;	Eating habits, KIDMED ;
Lifestyle (sleep, physical activity)	Lifestyle (sleep, physical activity)	Lifestyle (sleep, physical activity)	Lifestyle (sleep, physical activity)	Lifestyle (sleep, physical activity)
5th grade				1st grade
Data collection: Sociodemographic (place of birth, age, gender); Anthropometric (weight, height, waist circumference); Bioimpedance (BMI, % fat mass)				Data collection: Sociodemographic (place of birth, age, gender); Anthropometric (weight, height, waist circumference); Bioimpedance (BMI, % fat mass)
Administration of questionnaires:				Administration of questionnaires:
Eating habits, KIDMED ; Lifestyle (sleep, physical activity)				Eating habits; Lifestyle (sleep, physical activity)

Figure 1 Study Design

Data Collection

Data collection is carried out annually for each child from time 1 to time 5, covering the period from the school year 2022/2023 to 2026/2027 (**Figure 1**). The data collected are anthropometric (height, weight, body mass index, waist circumference) and bioimpedance measurements to assess body composition. In addition, a detailed questionnaire (**Appendix 1**) is administered to investigate dietary habits, lifestyle, oral hygiene, levels of physical and sporting activity and sleep habits.

Anthropometric and Bioimpedance Measurements

Anthropometric measurements were collected using standardized and calibrated instruments, while body composition was assessed through bioimpedance analysis. In the context of the nutritional assessment conducted in the study, precise anthropometric measurements were employed to characterize the physical status of the participants. Variables considered included:

- **Height:** Measured in centimeters using a wall-mounted stadiometer with a movable horizontal arm, ensuring the Frankfurt plane (line between the tragus and the eye) was parallel to the floor, with participants standing upright with feet together after a deep breath.
- **Weight:** Measured in kilograms using a bioimpedance scale (Tanita, model MC-580MS).
- **Body Mass Index (BMI):** Calculated as weight (kg) divided by the square of height (m²), following the guidelines of the International Obesity Task Force (IOTF) to classify individuals into weight status categories (underweight, normal weight, overweight, obesity) (143).
- **Waist Circumference (WC):** Measured in centimeters using a body measuring tape, positioned at the midpoint between the lowest rib and the iliac crest of the pelvis.

To further assess body composition, the bioimpedance scale (Tanita, model MC-580MS) was used to calculate the **percentage of body fat**. This includes adiposity found in subcutaneous, intramuscular, and visceral areas. Visceral adiposity, concentrated around the abdomen, is considered highly detrimental to health. It is important to note that this data is scientifically validated for subjects under 18 years of age using the specified model of scale. These methodologies were selected to ensure an accurate evaluation of participants' body composition and nutritional status, providing essential data for the analysis and conclusions of this study.

Questionnaire

The questionnaire used in the study was developed based on reviewed scientific literature, including previous studies by Avery et al. (2017), Brecic et al. (2017), and the nutritional surveillance project in Puglia by Marcotrigiano et al. (2021), deemed particularly relevant for alignment with the current prospective study conducted in Parma (144–146). Administered to participating children, the questionnaire consisted of 22 structured questions aimed at obtaining a detailed understanding of the subjects' lifestyles (**Appendix 1**). Questions included both multiple-choice options and completion questions, covering various key areas of interest. Evaluated sections included general health conditions, dietary consumption throughout the day, eating behaviors, afternoon activities, levels of physical activity, sleep quality and duration, and oral hygiene. Questions related to dietary consumption specified details about breakfast, snacks, lunch, and dinner, using a standardized list of foods and beverages to facilitate accurate questionnaire completion. A question addressed to teachers gathered information on any special diets followed by children due to allergies, intolerances, or religious/ethical reasons. The reliability of responses was assessed by trained personnel responsible for questionnaire administration, categorized into four levels: reliable responses, mostly reliable, mostly unreliable, and unreliable. Prior to specific questions on dietary consumption, an initial question evaluated the child's general health status at the time of questionnaire completion, exploring any potential influence of health conditions on the validity of subsequent responses. The paper-based questionnaire was administered by qualified personnel, including researchers and student interns from the Department of Food and Drug Sciences at the University of Parma, to ensure completeness and reliability of the data collected during the study phase.

KIDMED Questionnaire

The KIDMED questionnaire is a reliable tool used to assess adherence to the MD in children and adolescents (**Appendix 1**). It consists of 16 questions that explore children's daily eating habits, with a particular focus on characteristic elements of the MD such as consumption of fruits, vegetables, fish, legumes, and olive oil, as well as the limitation of unhealthy foods like sweets and sugary drinks. The KIDMED score ranges from -4 to +12, where higher scores indicate greater adherence to the MD and potentially healthier dietary habits. This tool has been validated across different contexts and populations to assess diet quality and its impact on health. In this study, the KIDMED questionnaire was exclusively implemented to evaluate MD adherence in fifth-grade children (age

≥ 10 years), thus providing a specific measure of the nutritional quality of their diet according to the principles of the MD, without the need for parental/guardian presence (147).

Statistical Analysis

A descriptive statistical analysis was conducted on the collected data, using different methodologies to represent the variables. Quantitative variables were presented as mean ± standard deviation, while qualitative variables were expressed in numerical values and percentages. To compare categorical variables between first-year and fifth year classes, a Chi-square test was performed. This statistical test evaluates whether there is a significant association between two categorical variables, assuming the observations are independent. In contrast, for the comparison between first-year and second-year classes, where the measurements were repeated on the same subjects, the McNemar test was employed. The McNemar test is specifically designed for paired categorical data, assessing whether the proportions of two related conditions differ significantly. A value of $p < 0.05$ was considered significant. All analyses were performed using IBM SPSS software for Windows, version 28.0.1.1, developed by SPSS Inc., based in Chicago, Illinois, USA.

RESULTS AND DISCUSSION

Data collection for the first year (2022/2023) was conducted between February and May 2023 on a total sample of 1975 children, comprising 961 first-grade and 1014 fifth-grade primary school students. Data collection for the second year (2023/2024) took place between February and May 2024 with a total sample of 940 children attending second grade. At the conclusion of the recruitment phase in 2023, consent was obtained from 2089 students, including 1022 first-grade and 1067 fifth-grade students (**Table 1**). During the first year of data collection, 1995 students were interviewed and measured, including 979 first-graders and 1016 fifth-graders (**Table 1**). A total of 94 consented students were neither interviewed nor measured: 75 were absent (30 from first grade and 45 from fifth grade), while others did not participate due to disabilities or errors in consent form completion.

By the end of the second year of data collection in 2024, 959 second-grade students were interviewed and measured. After data cleaning, 940 students' data were included in the analysis (**Table 1**), excluding incomplete data from 19 students. Additionally, 19 students were absent, and 18 were unable to undergo bioimpedance measurement due to reasons such as disabilities or inappropriate clothing. Fifteen new students participated in the study in the second year through parental/legal guardian informed consent signature.

Table 1 Total participants 2023 and 2024

	2023	2024
	(1st and 5th grade)	(2nd grade)
TOTAL CONSENSUS COLLECTED	2089	2104
1ST GRADE STUDENTS PARTICIPATING	961	0
5TH GRADE STUDENTS PARTICIPATING	1014	0
2ND GRADE STUDENTS PARTICIPATING	0	940
TOTAL PARTICIPATING STUDENTS	1975	940
TOTAL NEW STUDENTS (from 2024)	0	15

Anthropometric Measurements

The population of primary school pupils in Parma presents anthropometric values that vary between classes, with specific data reflecting the physical development of children in different age groups. First graders have an average age of 6.8 ± 0.3 years, an average weight of 39.0 ± 9.3 kg, and an average height of 121.6 ± 5.6 cm. The average waist circumference is 55.0 ± 5.3 cm, and the average body fat percentage is $21.7 \pm 4.0\%$. The fifth graders, with an average age of 10.8 ± 0.4 years, had an average weight of 23.7 ± 4.5 kg, a height of 145.3 ± 7.5 cm, a waist circumference of 63.2 ± 8.3 cm, and a body fat percentage of $22.9 \pm 5.9\%$. Finally, the second graders, with an average age of 7.7 ± 0.4 years, had an average weight of 27.1 ± 5.6 kg, a height of 127.4 ± 5.8 cm, a waist circumference of 56.8 ± 6.5 cm, and a body fat percentage of $21.9 \pm 5.8\%$ (**Table 2**).

The majority of students fall into the normal weight category according to the IOTF thresholds, with 71.8% of first graders, 66.5% of fifth graders and 70.5% of second graders (143). The overweight rate in first- and second-year classes in Parma is lower than the national average of 19.0%, at 11.3% and 15.1% respectively, while in fifth year classes there is a slight increase in the overweight rate to 20.0%, slightly higher than the national average (**Table 2**) (94). This increase could be related to changes in lifestyle and a decrease in physical activity as school age progresses, suggesting the need for targeted interventions to promote physical activity in this age group. This trend is supported by data from the national OKkio alla SALUTE survey (Italian COSI), which indicates that 18.5% of children were not physically active the day before the survey. Additionally, at the national level, 39.3% of children engage in sports only twice a week, while only 21.8% do so three times a week, highlighting the need for strategies to encourage more frequent physical activity (21).

The obesity rate in Parma is consistently lower than the national average of 9.8%, reflecting the effectiveness of local policies to promote balanced diets and healthy lifestyles (**Table 2**) (94). Preventing childhood obesity is a public health priority, as this condition is associated with an increased risk of chronic diseases and mental disorders. The success of local initiatives suggests a good trend, but it is important to continue monitoring these data to ensure that the positive trend is maintained over time.

Another relevant aspect is the percentage of underweight children, which in Parma is higher than the national average of 1.7% in all the classes measured (**Table 2**) (148). This phenomenon could indicate nutritional problems or socio-economic influences that affect the nutritional status of

children. Underweight, like obesity, has negative health consequences, such as delays in physical and cognitive development. It is therefore a priority to identify the causes of this condition and implement effective strategies to ensure adequate nutrition and support for these children (149).

In general, the consistency between local and national data confirms the validity of the methods used and the representativeness of the sample (94). In addition, the results obtained show how educational initiatives and health promotion programmes, such as the Giocampus project, are fundamental to maintaining and improving children's health, highlighting the importance of promoting healthy lifestyles and preventing future weight-related diseases.

Table 2 Anthropometric measurements

	1st grade (n=961)	5th grade (n=1014)	2nd grade (n=940)
Age (years)	6.8 ± 0.3	10.8 ± 0.4	7.7 ± 0.4
Weight (kg)	23.7 ± 4.5	39.0 ± 9.3	27.1 ± 5.6
Height (cm)	121.6 ± 5.6	145.3 ± 7.5	127.4 ± 5.8
Waist circumference (cm)	55.0 ± 5.3	63.2 ± 8.3	56.8 ± 6.5
Fat mass (%)	21.7 ± 4.0	22.9 ± 5.9	21.9 ± 5.8
Weight status (%)*			
Underweight	106 (11.1)	82 (8.2)	82 (8.7)
Normal weight	684 (71.8)	669 (66.5)	663 (70.5)
Overweight	108 (11.3)	201 (20.0)	142 (15.1)
Obesity	55 (5.8)	54 (5.4)	53 (5.6)

Data are expressed as mean ± SD or absolute number (%).

* IOTF cut-off values were taken as reference.

Eating Habits and Behaviour

Breakfast

Almost all children in Parma, with over 90.0% in all observed classes, regularly consume breakfast before going to school (**Table 3**). This data is significant, as breakfast is considered an essential meal that provides the necessary energy to start the day. Several scientific studies have demonstrated

that breakfast is associated with improved attention, memory, and academic performance in children. Beginning the day with a nutritious meal helps stabilize blood glucose levels, which is essential for optimal brain function and overall well-being (150). National data indicates that 10.9% of Italian children do not consume breakfast (16), whereas in Parma this percentage is slightly lower, particularly among first graders, where only 7.3% skip breakfast. This comparison suggests greater awareness and adherence to the importance of breakfast in Parma. Breakfast is crucial not only for providing energy but also for preventing health issues such as obesity and malnutrition, which can result from irregular eating habits (150). Despite the high percentage of children consuming breakfast, dietary choices in Parma (**Chart 1**) reveal that most prefer cookies and cereals, while only 3.3% of children consume fruit. This is consistent with the national trend in 2023, where 36.5% of Italian children consume a nutritionally inadequate breakfast (16). The preference for foods rich in sugars and refined carbohydrates over fruit can have negative long-term health implications. Simple sugars can cause rapid spikes and drops in blood glucose levels, leading to fluctuations in energy and mood, and contributing to the risk of obesity and dental cavities (151).

The preferred beverage at breakfast for children in Parma (**Chart 2**) is milk, followed by water. Milk is an important source of protein, calcium, and essential vitamins, crucial for children's growth and bone development. However, it is important that milk consumption is balanced with other nutrients to ensure a varied and complete diet. Water as the second choice is positive, as it indicates a preference for non-sweetened beverages, contributing to better hydration and a reduction in the intake of added sugars (152). The consumption of breakfasts high in sugars and refined carbohydrates can lead to long-term metabolic and nutritional problems. The low presence of fruit in children's breakfast diets suggests the need for educational interventions to promote the importance of a balanced diet. Fruit provides essential fibers, vitamins, and antioxidants, aiding in the prevention of chronic diseases and supporting the immune system (150).

Table 3 Breakfast (behaviour)

	1st grade (n=961)	5th grade (n=1014)	2nd grade (n= 940)
<i>^sDid you have breakfast this morning?</i>			
YES	890 (92.7)	923 (91.1)	859 (91.4)
NO	70 (7.3)	90 (8.9)	77 (8.2)
<i>What do you usually do for breakfast?</i>			
I just eat and drink	258 (26.9)	360 (35.5)	324 (34.5)
Talk to someone in the family	226 (23.5)	286 (28.2)	234 (24.9)
I play/ draw	46 (4.8)	8 (0.8)	13 (1.4)
I read/ study	7 (0.7)	16 (1.6)	4 (0.4)
Watching TV	346 (36.0)	230 (22.7)	306 (32.6)
I use my tablet/mobile phone	45 (4.7)	43 (4.2)	30 (3.2)
<i>^sDid you brush your teeth after breakfast?</i>			
YES	775 (80.7)*	901 (88.9)*	736 (78.3)
NO	185 (19.3)	112 (11.1)	204 (21.7)

Data are expressed as an absolute number (percentage).

^s questions for which statistical analysis was carried out; *significant differences between first and fifth grades (Chi-square test, $p < 0.05$);[†], significant differences between first and fifth classes (McNemar test, $p < 0.05$).

Many children in Parma watch TV during breakfast. Although common, this behavior can lead to increased food intake and preferences for less healthy foods. The distraction of TV and exposure to unhealthy food advertisements can negatively influence children's food choices. In contrast, talking with family members during breakfast is associated with various benefits. Family conversations improve diet quality and emotional well-being. Regular family meals promote higher self-esteem, better social skills, and a lower risk of eating disorders in children (153). Activities during breakfast influence children's eating habits and social development. Balancing passive activities, such as watching TV, with family interactions can foster a healthy and positive eating environment.

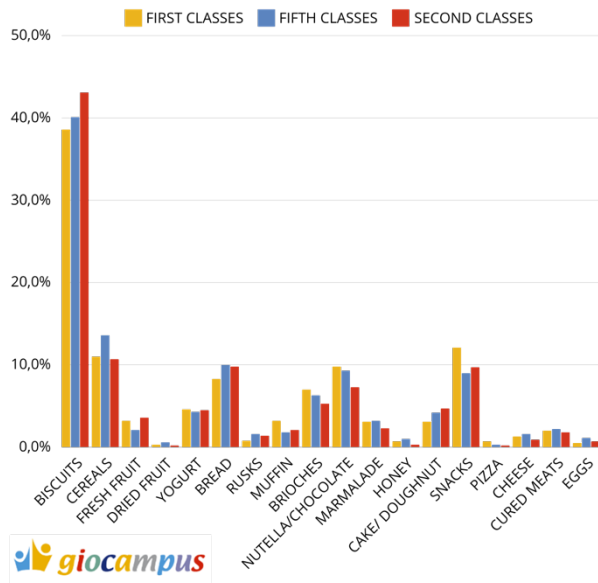


Chart 1 Food consumption at breakfast time

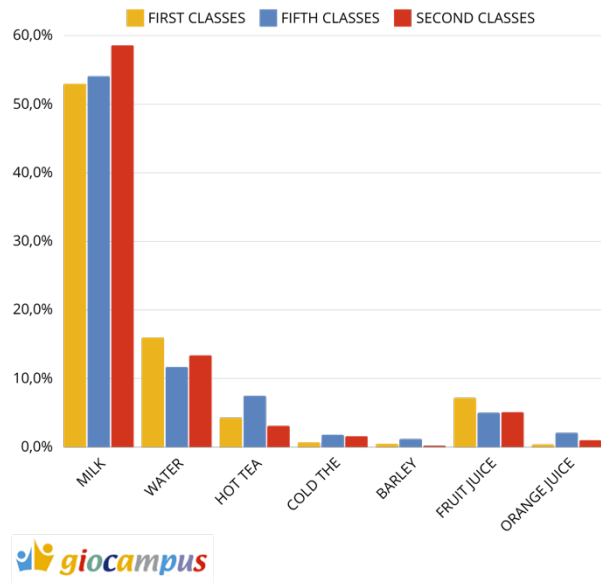


Chart 2 Drinks consumption at breakfast time

On average, 80.0% of children in Parma brush their teeth after breakfast before going to school, indicating a good awareness of oral hygiene. This practice is crucial for preventing cavities and gum disease, as it removes food residues and utilizes fluoride to strengthen tooth enamel (154). The high percentage can be attributed to effective educational programs and awareness campaigns. However, there is always room to further improve oral hygiene awareness and practices among children.

In the statistical analysis conducted to compare lifestyle habits across classes, significant differences were observed in oral hygiene after breakfast. Specifically, fifth-grade children demonstrated a higher frequency of brushing their teeth compared to first-grade children ($p < 0.001$). This result may reflect an age-related developmental process and cognitive maturation, leading to greater awareness of the importance of oral hygiene. Additionally, educational influences, both at school and at home, could play a crucial role in fostering healthier habits as children advance through school grades.

On the other hand, no statistically significant differences were observed between first-grade and second-grade children for any of the analyzed parameters, including those related to breakfast and morning oral hygiene. This finding suggests that behavioral habits in the early school years remain relatively stable, likely shaped primarily by the family environment and established routines. The absence of variations may indicate that the effects of educational interventions or the school environment require more time to result in noticeable behavioral changes. These results highlight

the importance of targeted and early health education, as well as the need for continuous monitoring and interventions to promote improvements in the medium to long term.

MIDMORNING SNACK - Eating habits and behaviour

In the context of the mid-morning snack, more than 90.0% of the students in all the classes examined participate in the consumption of a snack (**Table 4**). A particularly striking finding is that most of the children choose to consume fresh fruit (**Chart 3**). This positive eating behaviour can be attributed to the daily supply of fresh fruit by the school catering service, which facilitates access to healthy choices. Other foods most consumed at snack time include crackers and snacks, both sweet and savoury. In terms of drinks (**Chart 4**), water is the most consumed, followed by fruit juices. The predominance of water as the preferred beverage is a positive sign, as it promotes hydration without the calorie and sugar intake of fruit juices. This behaviour can reduce the risk of obesity and dental caries, problems frequently associated with excessive consumption of sugary drinks.

Table 4 Mid-morning snack (eating habits)

	1st grade (n=961)	5th grade (n=1014)	2nd grade 940	(n=)
⁵ Did you have a snack this morning? ¹				
YES	895 (93.4)*	913 (90.1)*	858 (91.3)	
NO	63 (6.6)	100 (9.9)	65 (6.9)	

Data are expressed as an absolute number (percentage).

¹The subjects who did not provide an affirmative or negative response to the question stated "I don't remember."

⁵ questions for which statistical analysis was carried out; *significant differences between first and fifth grades (Chi-square test, $p < 0.05$);[†], significant differences between first and fifth classes (McNemar test, $p < 0.05$).

According to the national OKkio alla Salute survey of 2023, 66.9 % of children consume an abundant and, consequently, inadequate mid-morning snack (16). However, in Parma, this problem seems to be less pronounced, as the consumption of fresh fruit is predominant. These national data underline a problematic dietary behaviour, where an abundant snack can lead to excessive calorie intake and

consumption of low-nutrient foods, contributing to the risk of childhood overweight and obesity. This type of snack often includes foods rich in sugar and saturated fat, which can have negative effects on children's physical health and cognitive abilities (16). In contrast, data from Parma show a healthier trend, with fresh fruit dominating children's food choices during the mid-morning snack. This behaviour can be attributed to local initiatives, such as the daily supply of fresh fruit by the school catering service, which encourages more nutritious food choices.

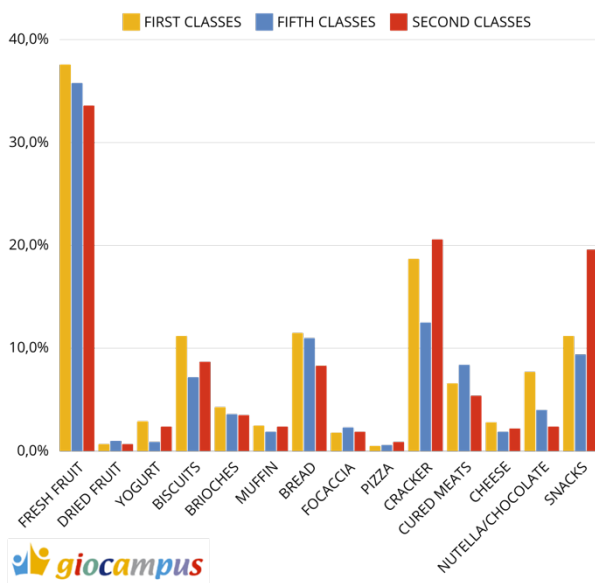


Chart 3 Foods consumed at morning snack

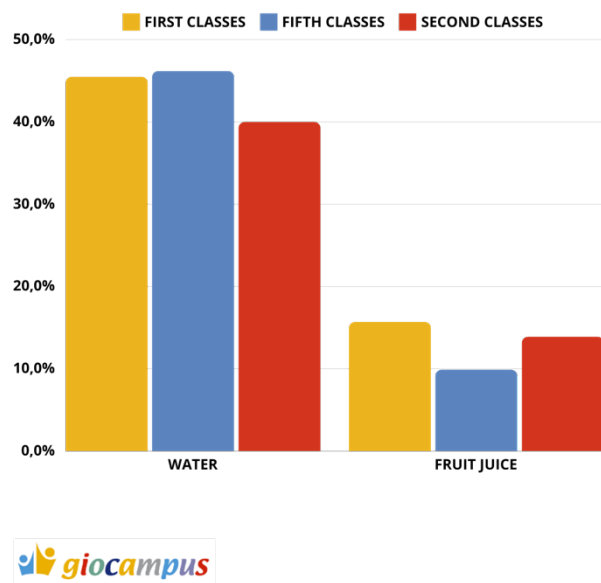


Chart 4 Drinks consumed at mid-morning snack

A significant difference was observed between first-grade and fifth-grade children in the habit of having a mid-morning snack. Specifically, a higher number of first-grade children reported having a mid-morning snack compared to fifth-grade children ($p = 0.008$). This finding may reflect a decreased perceived importance of snacks as children grow older, possibly due to changes in lifestyle, increased decision-making autonomy, or different management of hunger throughout the morning. In contrast, no significant differences were found between first-grade and second-grade children. This result suggests that snack-related habits remain stable during the early school years, likely influenced by well-established family routines. The lack of variation between these age groups may indicate that changes in dietary habits begin to emerge later, as individual and social maturity progress. These findings highlight the importance of monitoring and supporting healthy eating practices from an early age to ensure that established habits are both positive and nutritionally adequate for children's needs.

LUNCH - Eating habits and behaviour

Most children (an average of 82.1%) use the school canteen service for lunch, reflecting broad family support for this option (**Table 5**). However, slightly less than half of the children do not consume fruit or vegetables during lunch, an aspect that requires attention. It is important to note that while fruit is not included in the school canteen meals, vegetables are offered daily. This data is significant considering that, at the national level, 25.9% of children consume fruit and/or vegetables less than once a day (16). These findings highlight the need to promote greater consumption of fruits and vegetables among children during school meals, encouraging more balanced food policies and educating students on the importance of a nutrient-rich diet. Although not widespread, the consumption of sugary drinks during home lunches is present. This phenomenon deserves attention since sugary drinks are often associated with excessive added sugars, which can contribute to the risk of childhood obesity and related health problems and should only be consumed occasionally (151). During home lunches, most children typically interact with a family member as the primary activity, underscoring the importance of meals as a time for family sharing and socialization. This type of interaction can enhance children's emotional well-being and promote positive family bonds, creating a favorable environment for discussing eating habits and modeling healthy behaviors. Additionally, many children tend to watch television during home meals, an activity that can influence their attention to food and their eating behavior (153).

Table 5 Lunch (eating habits and behaviour)

	1st grade (n=961)	5th grade (n=1014)	2nd grade (n= 940)
⁵ Did you eat in the canteen today? ¹			
YES	773 (80.6)*, †	766 (75.6)*	848 (90.2) †
NO ²	186 (19.4)	247 (24.4)	92 (9.8)
⁵ Did you eat fruit and/or vegetables? ⁵			
YES	516 (53.8)*, †	581 (57.4)*	572 (58.9) †
NO ³	443 (46.2)	432 (42.6)	368 (41.1)
⁵ Consumption of sugary/carbonated drinks; ^{4,5}			
YES	16 (1.7) †	20 (2.0)	5 (0.5) †
NO	943 (98.3)	993 (98.0)	935 (99.5)
What do you usually do for lunch? ⁴			
I only eat and drink	25 (2.6)	28 (2.8)	10 (1.1)
I talk to someone in the family	95 (10.0)	142 (14.1)	45 (4.8)
I play/draw	7 (0.7)	3 (0.3)	1 (0.1)
I read/study	3 (0.3)	4 (0.4)	0 (0.0)
I watch TV	65 (6.8)	52 (5.2)	29 (3.1)
I use my tablet/mobile phone	6 (0.6)	8 (0.8)	6 (0.6)

Data are expressed as an absolute number (percentage).

¹ The question refers to the day of the interview or to the previous day if the questionnaire was carried out in the morning.

²This percentage also includes subjects for whom the interview was carried out in the morning after a public holiday.

³This refers to those who eat neither fruit nor vegetables.

⁴This question refers to when lunch is eaten at home.

⁵The subjects who did not provide an affirmative or negative response to the question stated, "I don't remember."

^s questions for which statistical analysis was carried out; *significant differences between first and fifth grades (Chi-square test, $p < 0.05$);[†], significant differences between first and fifth classes (McNemar test, $p < 0.05$).

Significant differences were observed in the habit of having lunch in the school canteen, both between first and fifth-grade children ($p = 0.007$) and between first and second-grade children ($p < 0.05$). Specifically, more first-grade children have lunch in the canteen compared to fifth-grade children. However, when comparing first and second grade, a higher number of second-grade children eat in the canteen compared to first-grade children. This trend might reflect an organizational transition or a shift in preferences and dietary needs as children advance in school. In the early years, the canteen may represent a more common logistical choice for families, whereas in later grades, greater autonomy among children and different family arrangements might reduce this frequency. Concerning the consumption of fruits and vegetables at lunch, significant differences were found in both comparisons. Between first and fifth grade, fruit and vegetable consumption is lower among first-grade children ($p = 0.007$). A similar trend was observed between first and second grade, where fruit and vegetable consumption is again lower among first-grade children ($p = 0.006$). These results suggest that in the early school years, there may be less inclination or education towards consuming healthy foods such as fruits and vegetables, which gradually increases over time. Additionally, a significant difference was found between first and second-grade children in the consumption of sugary and carbonated drinks at lunch, with a higher number of first-grade children consuming these drinks compared to second-grade children ($p = 0.031$). This finding may reflect an initial preference for sweetened beverages typical of younger children, which tends to decrease as they grow older. Educational influences, both at home and at school, may play a key role in gradually reducing the consumption of these unhealthy drinks. These findings emphasize the importance of targeted interventions starting in the early school years to encourage the consumption of healthy foods such as fruits and vegetables and to reduce the intake of sugary and carbonated beverages, fostering balanced dietary habits from a young age and ensuring they become well-established over time.

AFTERNOON ACTIVITIES - Eating habits and behaviour

In the context of afternoon snacking habits among students, it was found that on average over 77.6% of them regularly consume this meal (**Table 6**). Food preferences (**Chart 5**) show that bread, usually filled with cold cuts, is the most popular option (14.4%) among snacks consumed outside of school. Cookies (11.3%) and snack (11.2%) are also common choices. The presence of fresh fruit in children's diets is significant, with about 12.6% of them consuming fresh fruit as part of their afternoon snack. However, when compared to the consumption of fresh fruit during the morning snack, which averages 35.7% of children, there is clearly ample room for improvement in the afternoon snack. This data indicates a significant opportunity for parents to promote the consumption of fresh fruit during this time of day instead of alternatives like bread or snack. Regular inclusion of fresh fruit could not only increase the intake of essential nutrients in children but also establish healthier long-term eating habits (155). Water remains the preferred beverage during the afternoon snack, similar to the preference observed during the morning snack, followed by fruit juice (**Chart 6**). This indicates a conscious choice towards less caloric and sugary drinks compared to other available options. These results underline the importance of promoting a variety of healthy food choices among children during snack times, encouraging the inclusion of fresh fruit and low-calorie beverages as part of a balanced diet.

Table 6 Afternoon activities (eating habits)

	1st grade (n=961)	5th grade (n=1014)	2nd grade (n= 940)
^s Did you have a snack yesterday afternoon?			
YES	759 (79.2) ^{*, †}	796 (78.6) [*]	703 (74.9) [†]
NO	187 (19.5)	216 (21.3)	188 (20.0)

Data are expressed as an absolute number (percentage).

^s questions for which statistical analysis was carried out; ^{*} significant differences between first and fifth grades (Chi-square test, $p < 0.05$); [†], significant differences between first and fifth classes (McNemar test, $p < 0.05$).

Significant differences were observed in the habit of having an afternoon snack outside of school hours in both comparisons analyzed. Fifth-grade children who have a snack are significantly fewer compared to first-grade children ($p = 0.005$). Similarly, second-grade children who have a snack are

fewer than first-grade children ($p < 0.01$). These findings suggest a progressive change in afternoon snack habits as children advance through school grades. The reduced frequency of snacking may be attributed to several factors: on one hand, a possible shift in energy requirements and food preferences among older children; on the other, a different organizational context that might limit the time available for snacking or affect the regularity of meals. In the early school years, afternoon snacks are often encouraged by families or educators to ensure an adequate caloric intake for growth and activities. However, as children grow older, they may adopt habits more similar to those of adults, reducing the frequency of light meals or afternoon snacks, in line with increasing autonomy in managing their diet. This shift could also be influenced by a reduced desire for intermediate meals or a preference for more structured ones. These results highlight the importance of fostering nutritional education that supports balanced eating habits, teaching older children about the importance of a healthy afternoon snack, particularly in relation to school and sports activities.

After school, the most common activities among children in Parma (**Table 7**) include playing at home, which is more common than outdoor play, and watching films or videos on TV or devices such as tablets. This behaviour pattern is consistent with national data, where 45.1% of children spend more than two hours a day in front of the TV or devices such as video games, tablets or mobile phones (16). It is therefore crucial to encourage outdoor physical activities and other forms of entertainment that can contribute to the overall well-being of children by reducing the time spent inactively in front of electronic media (156).

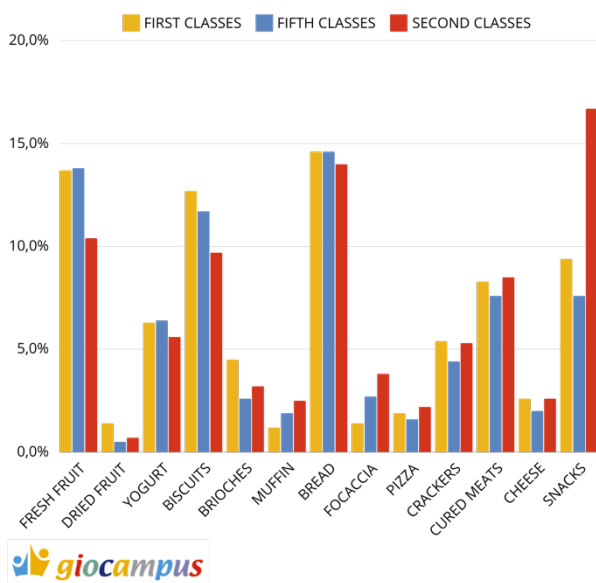


Chart 5 Afternoon snack food consumption

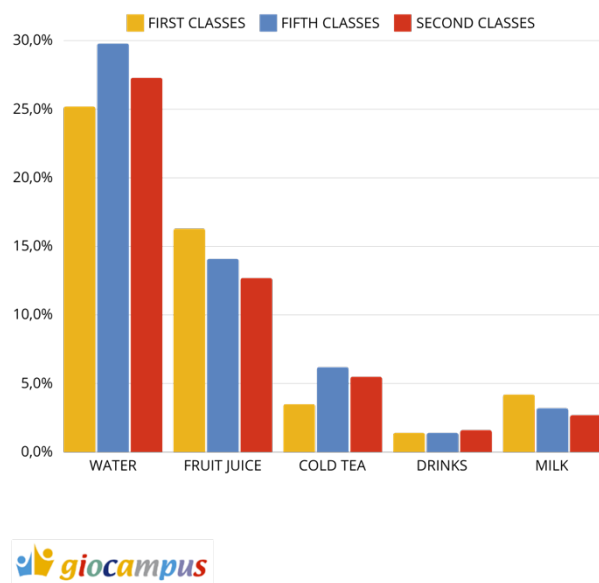


Chart 6 Afternoon drink consumption

Table 7 Afternoon activities (behaviour)

	1st grade (n=961)	5th grade (n=1014)	2nd grade (n= 940)
<i>What did you do yesterday afternoon?</i>			
I did my homework	171 (17.8)	393 (38.8)	145 (15.4)
I played at home	494 (51.5)	241 (23.8)	456 (48.5)
I played outdoors	203 (21.1)	149 (14.7)	149 (15.9)
I played sports	78 (8.1)	277 (27.3)	180 (19.1)
I played an instrument/sang	9 (0.9)	22 (2.2)	19 (2.0)
I watched movies/videos on TV or tablet	369 (38.4)	272 (26.9)	242 (25.7)
I played video games	64 (6.7)	97 (9.6)	75 (8.0)
Other	133 (13.8)	209 (20.6)	120 (12.8)

Data are expressed as an absolute number (percentage).

DINNER - Eating habits and behaviour

Approximately half of the children in Parma do not consume fruit and vegetables during dinner, a finding that deserves attention when compared to consumption during lunch at school, where the percentage of children consuming neither fruit nor vegetables is on average less than 20.0% (**Table 8**). This difference could be explained by the fact that the school canteen regularly offers a variety of vegetables, whereas at home the same offer may be lacking. Furthermore, although the consumption of sugary drinks during dinner is higher than during lunch at school, this cannot be considered alarming unless it reflects a daily habit. If this were the case, it would be cause for concern because of the potential negative impact on children's health. About dinnertime behaviour, most children reported talking to a family member, although a significant number watch TV, a trend similar to that observed when eating lunch at home. These data highlight the importance of encouraging family interactions during mealtimes and limiting exposure to electronic media, thus promoting a favourable environment for children's health and development (153).

Table 8 Dinner (eating habits and behaviour)

	1st grade (n=961)	5th grade (n=1014)	2nd grade (n= 940)
⁵ Did you consume fruit and/or vegetables? ¹			
YES	329 (41.3)*, †	481 (47.5)*	549 (58.4)†
NO²	557 (58.7)	531 (52.5)	391 (41.6)
⁵ Consumption of sugary/carbonated drinks ¹			
YES	49 (5.2)	46 (4.5)	35 (3.7)
NO	900 (94.8)	966 (95.5)	905 (96.3)
What do you usually do for dinner? ¹			
I only eat and drink	121 (12.7)	88 (8.7)	94 (10.0)
I talk to someone in the family	445 (46.6)	699 (69.3)	462 (49.0)
I play/draw	50 (5.2)	4 (0.4)	11 (1.2)
I read/study	5 (0.5)	2 (0.2)	3 (0.3)
I watch TV	374 (39.2)	321 (31.8)	396 (42.1)
I use my mobile phone/tablet	59 (6.2)	34 (3.4)	48 (5.1)

Data are expressed as an absolute number (percentage).

¹The questions refer to the previous day's dinner.

²It refers to those who eat neither fruit nor vegetables.

⁵ questions for which statistical analysis was carried out; *significant differences between first and fifth grades (Chi-square test, $p < 0.05$); †, significant differences between first and fifth classes (McNemar test, $p < 0.05$).

Significant differences were observed in the consumption of fruits and vegetables at dinner in both comparisons analyzed. Specifically, fifth-grade children consume a greater amount of fruits and vegetables compared to first-grade children ($p < 0.001$). Similarly, second-grade children also consume more fruits and vegetables at dinner compared to first-grade children ($p < 0.001$). However, unlike what was observed for lunch, no significant differences between grades were found in the consumption of sugary or carbonated drinks at dinner. This finding may indicate a certain uniformity in habits regarding this specific category of beverages during evening meals, suggesting

that the influence of family habits or educational choices might be more stable in this context compared to their impact on fruit and vegetable consumption. The overall results highlight a progressive improvement in evening dietary habits, with an increased intake of healthier foods like fruits and vegetables among older children. This positive trend could be attributed to various factors, including greater exposure to educational content on the importance of a balanced diet and a gradual refinement of taste that leads children to accept less preferred foods as they grow older. No significant differences were found in the consumption of sugary/carbonated drinks between the classes during dinner.

AFTER DINNER - Eating habits and behaviour

On average, 32.3% of children in Parma regularly consume food after dinner before going to bed (**Table 9**). This behavior can negatively impact sleep quality and metabolism, as eating right before bedtime can interfere with the digestive process and disturb nocturnal rest. Adopting healthier eating habits, such as avoiding food consumption right before sleep, could improve children's overall well-being by promoting more restful sleep and a balanced metabolism (157). Additionally, the preferred activity for children in Parma after dinner is watching movies or videos on TV or tablets (**Table 9**). This behavior can also negatively affect sleep quality if media exposure occurs too close to bedtime, as the blue light emitted by electronic devices can interfere with the production of melatonin, the sleep hormone. Promoting alternatives such as reading or engaging in relaxing activities before bed can help improve children's sleep quality (158,159). Regarding oral hygiene (**Table 9**), more than 80.0% of children regularly brush their teeth after dinner, reflecting adequate oral hygiene practices, although there is room for improvement. This aligns with the practice of brushing teeth after breakfast, indicating a good hygienic habit that contributes to children's overall dental health. This positive behavior is particularly frequent among fifth graders, suggesting greater awareness and habit of personal hygiene in this age group (160).

Table 9 After dinner (eating habits and behaviour)

	1st grade (n=961)	5th grade (n=1014)	2nd grade (n= 940)
<i>^sDid you eat or drink anything after dinner yesterday before going to bed?</i>			
YES	328 (34.2) [†]	384 (37.9)	234 (24.9) [†]
NO	631 (65.8)	629 (62.1)	706 (75.1)
<i>Did you do anything after dinner last night?</i>			
I watched films/videos on TV or tablet	385 (40.2)	483 (47.7)	447 (47.6)
I read a book	19 (2.0)	54 (5.3)	53 (5.6)
I have played video games	46 (4.8)	64 (6.3)	51 (5.4)
Other	318 (33.2)	275 (27.1)	157 (16.7)
<i>^sDid you brush your teeth after dinner?[°]</i>			
YES	793 (82.7) [*]	889 (87.8) [*]	763 (81.3)
NO	166 (17.3)	124 (12.2)	176 (18.7)

Data are expressed as an absolute number (percentage).

[°]Question referred to the previous evening.

^s questions for which statistical analysis was carried out; ^{*}significant differences between first and fifth grades (Chi-square test, $p < 0.05$);[†], significant differences between first and fifth classes (McNemar test, $p < 0.05$).

No significant differences were found in the eating habits after dinner when comparing first-grade and fifth-grade children. However, a significant difference was observed between children who ate or drank something after dinner in the first and second grades. Specifically, a significant reduction was noted among second-grade children who consumed food or drinks before going to bed compared to first-grade children ($p < 0.001$). Additionally, regarding oral hygiene, a significant difference was observed between first-grade and fifth-grade children regarding the habit of brushing teeth before going to bed. A greater number of fifth-grade children had this habit compared to first-grade children ($p = 0.001$). This may reflect greater awareness and responsibility among older children regarding the importance of oral hygiene, whereas younger children may not

have fully developed this habit yet. These results suggest that, as children grow older, they tend to establish more regular eating habits and become more mindful of personal hygiene behaviors. The reduction in food and drink consumption after dinner in second-grade children and the increased habit of brushing teeth before bed in fifth-grade children indicate maturation and growing attention to overall health. These changes are key to educating children to take care of their bodies and adopt a healthy lifestyle from a young age.

Physical Activity

In Parma, physical activity is a fundamental aspect of children's daily routine. The data (**Table 10**) indicate that most children (67.8% in first grade, 78.8% in second grade, and 82.9% in fifth grade) engage in physical activities after school hours. This increasing trend with age suggests a growing interest and participation in sports as children mature. This phenomenon can be viewed positively since regular physical activity is crucial for children's physical and mental health, contributing to their muscular and skeletal development, weight control, and enhancement of self-esteem and social skills (117). Another significant data concerns the weekly frequency of sports activities among children in Parma. The most common pattern is practicing sports twice a week, which aligns with the national average (39.3% of children engage in physical activity twice a week) (161). However, national data show that 30.0% of children practice sports at least three times a week, suggesting there is room to encourage an increase in the weekly frequency of sports activities among Parma's youth (161). Greater involvement in sports activities can lead to significant health benefits for children, including improvements in cardiorespiratory endurance, coordination, and balance, as well as a reduced risk of developing chronic conditions such as type 2 diabetes and heart disease (156).

Regarding transportation to school (**Table 10**), 26,0% of children in Parma walk or bike to school. This figure is similar to the 27.4% reported for Italian children (161). However, the most used mode of transportation to school in Parma is by car. The high dependence on private and motorised transport can be an obstacle to increasing daily physical activity among children. Walking or biking to school not only promotes an active lifestyle but also supports environmental sustainability by reducing greenhouse gas emissions and improving air quality in urban areas (162).

Table 10 Physical activity

	1st grade (n=961)	5th grade (n=1014)	2nd grade (n= 940)
^s Do you play sports?			
YES	651 (67.8) ^{*, †}	840 (82.9) [*]	740 (78.9) [†]
NO	309 (32.2)	173 (17.1)	198 (21.1)
How did you come to school this morning?			17 (2.3%)
On foot	211 (22.0)	233 (23.0)	17 (2.3%)
Bicycling	43 (4.5)	37 (3.7)	194 (20.6)
By motorbike	1 (0.1)	4 (0.4)	32 (3.4)
By car	554 (57.7)	572 (56.5)	551 (58.6)
By bus	151 (15.7)	167 (16.5)	162 (17.2)

Data are expressed as an absolute number (percentage).

^s questions for which statistical analysis was carried out; ^{*} significant differences between first and fifth grades (Chi-square test, $p < 0.05$); [†], significant differences between first and fifth classes (McNemar test, $p < 0.05$).

Significant differences were observed in the comparison between first and fifth-grade children, as well as between first and second-grade children, regarding the practice of sports outside of school. Specifically, more fifth-grade children engage in sports compared to first-grade children ($p < 0.001$), and more second-grade children practice sports compared to first-grade children ($p < 0.001$). These results indicate a trend toward increased involvement in physical activities as children advance in grade, suggesting growing awareness of the benefits of exercise and a greater willingness to participate. These differences may result from factors related to physical maturation, but also from the influence of school programs that more actively promote physical activity in higher grades.

Sleep Hygiene

In the context of elementary schools in Parma, a significant variation in sleep habits emerges across different grades. In first grade, a considerable percentage (60.2%) of children did not provide clear information regarding their wake-up time (**Table 11**). This may be attributed to their young age, as they are often not responsible for determining their bedtime and rely on their parents to establish and maintain their sleep routine. Consequently, they may not be fully aware of the exact times they

fall asleep or wake up. However, this data improves substantially in the higher grades. As children mature, they gain greater awareness and responsibility regarding their sleep habits. In second and fifth grades, most children can accurately report their wake-up time, reflecting increased autonomy and a more established sleep routine. This suggests that as children mature, they become more capable of understanding and reporting their sleep habits, underscoring the importance of progressive education on time management and daily routines. It is encouraging to note that the majority of children across all grades wake up between 7:00 and 7:29 AM, a time indicative of good adaptation to school start times. This demonstrates careful synchronization of sleep routines with daily schedules, contributing to a well-regulated sleep-wake cycle. Regarding bedtime, children across all grades, including first grade, exhibit a preference for going to bed between 9:00 and 9:59 PM. This timing aligns with recommendations for maintaining a healthy circadian rhythm for effective night-time rest. It is positive to observe that more than 90.0% of children reported having slept well the previous night, indicating good sleep quality among the participants. Before falling asleep, the majority of children in Parma engage in relaxing activities, with only a small percentage reading a book (13.5%) or watching films/videos on television or tablets (10.6%). It is imperative to monitor these behaviors, as they can influence overall sleep quality, ensuring that nighttime routines are relaxing and not overly stimulating (158). The data reveal that first-grade children sleep an average of $9:36 \pm 1:18$ hours per night, whereas fifth-grade children sleep an average of $9:07 \pm 0:51$ hours per night. These values are consistent with recommendations suggesting a range of 9-12 hours of sleep per night for children aged 6 to 12 years (163). However, second-grade children exhibit greater variability in sleep duration, with an average of $8:29 \pm 2:59$ hours, which may necessitate particular attention to ensure they receive adequate sleep to support their physical and mental health.

In summary, the analysis of sleep hygiene among children in Parma suggests good practices regarding sleep routines, appropriate wake-up and bedtime, and overall good sleep quality. Nonetheless, variations among grades may require continuous monitoring and targeted educational interventions to further improve the sleep habits of children. Educating parents and children about the importance of regular sleep and promoting relaxing nighttime routines are crucial steps in ensuring the physical, mental, and cognitive well-being of children in Parma.

Table 11 Sleep hygiene

	1st grade (n=961)	5th grade (n=1014)	2nd grade (n= 940)
<i>What time did you go to bed last night?*</i>			
19:00-19:59	7 (0.7)	2 (0.2)	8 (0.9)
20:00-20:59	70 (7.3)	53 (5.2)	62 (6.6)
21:00-21:59	184 (19.2)	420 (41.5)	328 (34.9)
22:00-22:59	95 (9.9)	371 (36.6)	152 (16.2)
23:00-23:59	19 (2.0)	72 (7.1)	31 (3.3)
00:00-00:59	6 (0.6)	9 (0.9)	5 (0.5)
01:00-01:59	1 (0.1)	6 (0.6)	5 (0.5)
I don't know	577 (60.2)	80 (7.9)	347 (37.0)
<i>What did you do last night after you went to bed?</i>			
Nothing	664 (69.2)	773 (76.3)	641 (68.2)
I watched films/videos on TV or tablet	112 (11.7)	87 (8.6)	107 (11.4)
I read a book	124 (12.9)	103 (10.2)	163 (17.3)
I played video games	6 (0.6)	6 (0.6)	7 (0.7)
Other	59 (6.1)	53 (5.2)	23 (2.4)
<i>Did you sleep well last night?</i>			
YES	928 (96.7)	968 (95.6)	864 (91.9)
NO	32 (3.3)	45 (4.4)	76 (8.1)
<i>What time did you wake up this morning?*</i>			
5:00-5:59	8 (0.8)	8 (0.8)	15 (1.6)
6:00-6:59	58 (6.0)	235 (23.2)	113 (13.1)
7:00-7:29	158 (16.5)	524 (51.7)	360 (38.3)
7:30-7:59	26 (2.7)	19 (1.9)	95 (10.1)
8:00-9:00	26 (2.7)	19 (1.9)	22 (2.3)
I don't know	684 (71.3)	58 (5.7)	323 (34.4)
Total hours of sleep at night (hh:mm)	09:36 ± 01:18	09:07 ± 00:51	08:29 ± 02:59

Data are expressed as mean ± SD or absolute number (percentage).

Mediterranean Diet Adherence_ Kidmed Questionnaire

In the first year of measurement (2023), the KIDMED questionnaire was administered exclusively to fifth-grade students in elementary schools in Parma to assess the adherence of their dietary habits to the MD (147). The data collected in Parma reveal that 73.5% of respondents report eating at least one fruit daily, and 36.7% consume at least two fruits each day. Regarding vegetable intake, 74.5% of students consume at least one portion, either raw or cooked, daily, while 37.7% report eating at least two portions daily. These figures surpass the national averages. According to the national surveillance system OKkio alla Salute, 25.9% of children in Italy consume fruits and/or vegetables less than once a day. Comparing the data from Parma with national figures highlights that the elementary school children in Parma adhere more closely to nutritional recommendations for fruit and vegetable consumption than the national average. Additionally, 48.7% of fifth-grade children eat fish less than 2-3 times per week, whereas 81.1% consume pasta or cereals at least five times per week, aligning with recommended frequencies. Furthermore, 82.3% use olive oil as a dressing, reflecting good adherence to the MD. However, only 35.1% consume nuts at least 2-3 times per week. Regarding legume consumption, 47.0% of children consume legumes more than once a week, while 53.0% eat them once a week or less. Notably, 46.0% of children either never eat legumes or consume them less than once a week. This figure is lower than the national data, where 63.0% consume legumes less than once a week. The data also show that 78.6% of children in Parma consume milk or dairy products for breakfast, and 32.0% consume portions of yogurt and/or cheese daily. This indicates good adherence to nutritional recommendations, as milk and dairy products are important sources of calcium and essential proteins for children's growth and development. Comparing these data with national figures from OKkio alla Salute 2023 reveals a similarity, as a significant percentage of children nationally also regularly consume dairy products(161). However, 5.1% of respondents frequent fast food restaurants more than once a week. Although this percentage may not seem high, it is concerning given the long-term negative health impacts of a diet high in fast food, which can contribute to obesity and related diseases. This trend is reflected nationally, as reported by OKkio alla Salute 2023 where the consumption of fast food and high-calorie foods is on the rise (161). Moreover, 19.5% of children consume sweets and candies multiple times a day. This dietary behavior is alarming, as excessive consumption of simple sugars is associated with an increased risk of obesity, dental caries, and other adverse health conditions. Nationally, OKkio alla Salute 2023 also reports that a significant percentage of children consume sweet snacks daily (52.9% consume sweet snacks more than three days a week) (161). The average

KIDMED score for children in Parma is 5.77 ± 2 , classifying them in the range of medium adherence to the MD (147).

Table 12 KIDMED questionnaire

	YES	NO
Do you consume one fruit or juice every day?	745 (73.5)	268 (26.5)
Do you eat a second fruit every day?	372 (36.7)	641 (63.3)
Do you eat raw or cooked vegetables regularly once a day?	755 (74.5)	258 (25.5)
Do you eat raw or cooked vegetables regularly more than once a day?	382 (37.7)	631 (62.3)
Do you eat fish regularly (2-3 or more times a week)?	493 (48.7)	520 (51.3)
Do you go to fast food (hamburgers) more than 1 time a week? ¹	52 (5.1)	961 (94.9)
Do you eat legumes (peas. beans. lentils. chickpeas. etc.) more than 1 time a week?	476 (47.0)	537 (53.0)
Do you eat pasta or rice almost every day (5 or more times a week)?	822 (81.1)	191 (18.9)
Do you eat cereals. bread or rusk for breakfast?	609 (60.1)	404 (39.9)
Do you consume nuts (walnuts. hazelnuts. almonds. etc.) regularly (at least 2-3 times a week)?	356 (35.1)	657 (64.9)
For seasoning do you use olive oil at home?	834 (82.3)	179 (17.7)
Do you usually have breakfast? ²	921 (90.9)	92 (9.1)
For breakfast do you eat milk or dairy products (yoghurt. etc.)?	796 (78.6)	217 (21.4)
At breakfast do you eat snacks or biscuits? ¹	785 (77.5)	228 (22.5)
Do you consume 2 yoghurts and/or cheese (40 g) every day?	324 (32.0)	689 (68.0)
Do you consume sweets and candies several times each day? ¹	198 (19.5)	815 (80.5)

Data are expressed as an absolute number (percentage).

¹ A yes answer is associated with a score of -1.

² a positive answer is associated with a null score.

CONCLUSIONS AND FUTURE PERSPECTIVES

In conclusion, the results of this research provide a significant overview of the weight conditions and dietary habits of children in Parma's schools, highlighting data that require further investigation and interventions. The analysis of weight parameters showed a significantly higher percentage of underweight children in Parma (9.3%) compared to the national average (1.7%), suggesting the need to explore the causes further, which could be linked to socio-economic, cultural, or educational factors (15). While normal weight is in line with the national average, the prevalence of overweight and obesity is lower in Parma (14.5% overweight, 5.6% obese) compared to the national average (19% and 9.9%, respectively), indicating the effectiveness of local health policies and educational programs such as Giocampus (15,16). However, it is essential to continue monitoring children's weight conditions, raising awareness among families, educators, and local authorities about the risks associated with unhealthy lifestyles. Regarding eating habits, the study highlighted the importance of breakfast, with over 90% of children in Parma consuming it regularly, a figure that reflects scientific evidence about the importance of this meal for cognitive and physical development (150). However, the presence of sugary foods and processed cereals at breakfast suggests the need for educational interventions to promote healthier, more balanced food choices. Similarly, while snacks show a positive eating behavior, with a predominant consumption of fresh fruit, there is still a need to reduce the intake of sweet and salty snacks, further improving diet quality. Data related to lunch highlight good adherence to the school meal service. However, one aspect that deserves attention is the low incidence of fruit and vegetable consumption during meals, despite the school canteen offering these foods daily. Many children do not consume fruit or vegetables during lunch, a behavior that underscores the need to promote greater inclusion of these foods in school meals. Fruits and vegetables are essential for a balanced diet and proper physical development, and their consumption should be encouraged through targeted educational activities (164). National data confirm this need, as a significant percentage of Italian children consume fruit and vegetables less than once a day, suggesting the need for continuous efforts to promote healthier eating habits (16). Furthermore, while the consumption of sugary drinks is not predominant during school lunches, their presence in meals consumed at home is still concerning. Sugary drinks are a significant source of added sugars and contribute to the increased risk of childhood obesity, as evidenced by national data (16,165). Regarding dinner, the data show a worrying lack of fruit and vegetables in evening meals, with about half of the children not consuming these foods. This behavior is particularly alarming when compared to lunch consumption, where less than 20% of children do not eat fruit or vegetables. The difference could be attributed to the

regular availability of fruit and vegetables in school canteens, which, in contrast, is not always guaranteed at home. The absence of these foods at dinner is concerning, especially considering their fundamental role in a balanced diet and in preventing diseases such as obesity (166). Although sugary drink consumption during dinner does not reach alarming levels, it is necessary to monitor its frequency to avoid it becoming a daily habit, compromising children's long-term health.

The KIDMED questionnaire revealed that fifth-grade children in Parma follow the MD quite well, with higher consumption of fruit, vegetables, and olive oil than the national average, although the consumption of sweets and fast food, while lower than the national average, warrants attention (147). An average score of 5.77 indicates good adherence to the diet, but there is room for improvement, especially regarding the intake of legumes, nuts, and fish. Regarding behaviors during meals, many children in Parma watch TV during breakfast, a common habit that can negatively influence food choices, leading to higher consumption of less healthy foods. Distraction from TV and exposure to advertising for unhealthy foods are factors that could explain this behavior. On the other hand, dialogue with family members during breakfast is associated with significant benefits, improving diet quality and children's emotional well-being. These moments of family interaction are also essential for children's social and psychological development (167). During main meals, many children interact with a family member, creating an environment conducive to discussing good eating habits. However, it is noteworthy that some children continue to watch TV during lunch and dinner, suggesting the need to promote more family interaction and limit exposure to electronic media during meals. Regarding physical activity, children's participation in extracurricular sports increases with age, with a good percentage of children practicing sports. However, the weekly frequency of physical activity, while in line with the national average, still has room for improvement, with 30% of children at the national level practicing sports at least three times a week (16). Additionally, the high use of motorized transport to get to school suggests the need to encourage active forms of transport, such as walking or cycling, to improve daily physical activity. In the afternoon, the most common activities among children in Parma include playing at home and watching movies or videos on TV or devices such as tablets, with a significant percentage of children spending more than two hours a day in front of a screen. This behavior reflects a national trend and underscores the importance of encouraging outdoor physical activities and forms of entertainment that contribute to children's overall well-being. Reducing the time spent in front of electronic devices may be key to promoting a more active and healthier lifestyle. The analysis of sleep hygiene showed that children in Parma follow good practices regarding wake-up and bedtimes, but

variations between classes suggest the need for continuous monitoring, particularly for younger children. Promoting relaxing routines before bed and raising awareness among parents and children about the importance of regular sleep are crucial steps for the overall well-being of children. A positive aspect that emerged was oral hygiene habits: over 80% of children in Parma regularly brush their teeth after breakfast and dinner. This behavior reflects a good awareness of the importance of oral hygiene, helping to prevent cavities and gum diseases (160). Regular tooth brushing seems well-established among children, especially among older children, such as fifth graders, who show greater awareness and habit in personal care. Despite good results, there is always room for improving oral hygiene awareness and practices among younger children. The statistical analysis showed significant differences between first- and fifth-grade children, with older children exhibiting more consolidated and healthy habits, both in terms of personal hygiene and food choices. This improvement can be attributed to greater cognitive maturity and the influence of educational interventions received over time. This analysis was conducted on independent samples collected in the same year (2022-2023), providing an immediate snapshot of the differences between age groups. In comparison between first and second grades, however, the differences observed are less pronounced, suggesting that the early school years are characterized by relative stability in habits, strongly influenced by the family context. This longitudinal analysis followed the same group of children over time, highlighting signs of evolution in behaviors that indicate the importance of early, targeted interventions to encourage positive changes from the early school years. In summary, the results highlight the need for continuous educational support to guide children through various stages of development, promoting conscious and healthy growth. In light of the findings, it is clear that the first two years of the five-year study already offer a useful overview for understanding the current situation of children in Parma and the effectiveness of the Giocampus educational program. However, for a complete evaluation, it will be necessary to monitor the subsequent years of the study to gather broader and more definitive data.

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Appendix 1 Questionnaire administered during the prospective study



Risposte affidabili? Sì Più sì che no Più no che sì No



Data: _____ Matt Pom Sogg. compilatore: _____ Sesso: M F Classe _____

Soggetto: _____ Dieta speciale? (all'insegnante) No Sì _____

Condizione di salute (per valutare se i consumi sono rappresentativi delle abitudini): Come al solito
 Indisposto: Ieri Oggi

1. Questa notte hai dormito bene? Sì No
2. Stamattina a che ora ti sei svegliato? _____ Non so/non mi ricordo
3. Quando non vai a scuola, ti svegli allo stesso orario? Sì No, prima No, più tardi Non so/non mi ricordo
4. Stamattina hai fatto colazione? Sì No, perché?

- Non ho avuto tempo
- Non mi piace fare colazione alla mattina
- La mia famiglia non è abituata a farla
- Non avevo fame

4.b Se hai detto di non aver fatto colazione, è un'abitudine? Sì No

5. Se sì, cos'hai mangiato e bevuto? (chiedere marca e in caso fare esempi)

- | | |
|---|--|
| <input type="checkbox"/> Biscotti semplici _____ | <input type="checkbox"/> Focaccia <input type="checkbox"/> Pizza |
| <input type="checkbox"/> Biscotti al cioccolato _____ | <input type="checkbox"/> Formaggio <input type="checkbox"/> Salume |
| <input type="checkbox"/> Cereali semplici (es. corn flakes) _____ | <input type="checkbox"/> Uova |
| <input type="checkbox"/> Cereali al cioccolato _____ | <input type="checkbox"/> Altro _____ |
| <input type="checkbox"/> Cereali alla frutta _____ | |
| Frutta: <input type="checkbox"/> fresca <input type="checkbox"/> secca | <input type="checkbox"/> Acqua |
| <input type="checkbox"/> Yogurt _____ | <input type="checkbox"/> Latte vaccino, zucch. agg.: <input type="checkbox"/> Sì <input type="checkbox"/> No <input type="checkbox"/> Non so |
| <input type="checkbox"/> Pane <input type="checkbox"/> Fette biscottate | <input type="checkbox"/> The, zucch. agg.: <input type="checkbox"/> Sì <input type="checkbox"/> No <input type="checkbox"/> Non so |
| <input type="checkbox"/> Muffin o plum-cake | <input type="checkbox"/> The freddo confezionato |
| <input type="checkbox"/> Brioches | <input type="checkbox"/> Cacao in polvere |
| <input type="checkbox"/> Marmellata <input type="checkbox"/> Miele <input type="checkbox"/> Nutella/cioccolato <input type="checkbox"/> Crema | <input type="checkbox"/> Orzo, zucch. agg.: <input type="checkbox"/> Sì <input type="checkbox"/> No <input type="checkbox"/> Non so |
| <input type="checkbox"/> Burro <input type="checkbox"/> Olio | <input type="checkbox"/> Succo di frutta |
| <input type="checkbox"/> Torta/ciambella _____ | <input type="checkbox"/> Spremuta, zucch. agg.: <input type="checkbox"/> Sì <input type="checkbox"/> No <input type="checkbox"/> Non so |
| <input type="checkbox"/> Merendine confezionate _____ | <input type="checkbox"/> Altro _____ |

5.a Indicare se il bambino/a ha mangiato almeno un frutto o un succo di frutta a colazione: Sì No

5.b Indicare se quella descritta è la colazione abituale No Sì Non fa colazione (fare dom. 16 su colazione)

6. Dopo colazione ti sei lavato i denti? No Sì

7. Oggi come sei andato a scuola? A piedi In bicicletta Scuolabus In macchina Altro _____

8. Oggi cos'hai mangiato e bevuto (o portato) per la merenda della mattina (focus su bevande zuccherate e frutta)? Niente, oggi non ho fatto merenda Non ricordo

- | | |
|--|---|
| <input type="checkbox"/> Frutta fresca <input type="checkbox"/> frutta secca <input type="checkbox"/> mousse di frutta | <input type="checkbox"/> Acqua |
| <input type="checkbox"/> Yogurt _____ | <input type="checkbox"/> Succo di frutta |
| <input type="checkbox"/> Biscotti _____ <input type="checkbox"/> Brioches _____ | <input type="checkbox"/> The freddo confezionato |
| <input type="checkbox"/> Muffin o plum-cake <input type="checkbox"/> torta _____ | <input type="checkbox"/> Bevande zuccherate/gassate |
| <input type="checkbox"/> Pane <input type="checkbox"/> focaccia <input type="checkbox"/> Pizza <input type="checkbox"/> cracker/grissini <input type="checkbox"/> fette biscottate | <input type="checkbox"/> Latte vaccino |
| con: <input type="checkbox"/> salume <input type="checkbox"/> formaggio <input type="checkbox"/> marmellata <input type="checkbox"/> cioccolato/nutella | <input type="checkbox"/> Latte e cioccolato, zucch. agg.: <input type="checkbox"/> Sì <input type="checkbox"/> No <input type="checkbox"/> Non so |
| <input type="checkbox"/> altro _____ | <input type="checkbox"/> Altro _____ |
| <input type="checkbox"/> Merendine confezionate _____ <input type="checkbox"/> dolci <input type="checkbox"/> salate | |
| <input type="checkbox"/> Altro _____ | |

8.a Indicare se il bambino/a ha mangiato/mangiato almeno un frutto o un succo di frutta a merenda: Sì No

9. Oggi (o ieri se intervista fatta prima di pranzo) hai mangiato in mensa? Sì No

10. Oggi (o ieri se intervista fatta prima di pranzo) cosa hai mangiato a pranzo (focus su F&V e bevande zuccherate/gassate)? Frutta Verdura No Frutta e no verdura Bevande zuccherate/gassate

Non ricordo (fare domanda 16 su pranzo, solo se consumato a casa)

11. Cos'hai mangiato e bevuto ieri pomeriggio per merenda quando sei tornato da scuola (focus su bevande zuccherate e frutta) Niente, non ho fatto merenda

- | | | | |
|---|---|---|---|
| <input type="checkbox"/> Frutta fresca | <input type="checkbox"/> frutta secca | <input type="checkbox"/> mousse di frutta | <input type="checkbox"/> Acqua |
| <input type="checkbox"/> Yogurt _____ | | | <input type="checkbox"/> Succo di frutta |
| <input type="checkbox"/> Biscotti _____ | | | <input type="checkbox"/> The freddo confezionato |
| <input type="checkbox"/> Brioches _____ | | | <input type="checkbox"/> Bevande zuccherate/gassate |
| <input type="checkbox"/> Muffin o plum-cake | <input type="checkbox"/> Torta _____ | <input type="checkbox"/> Gelato | <input type="checkbox"/> Latte vaccino |
| <input type="checkbox"/> Pane | <input type="checkbox"/> Focaccia | <input type="checkbox"/> Pizza | <input type="checkbox"/> Latte e cioccolato, zucch. agg.: <input type="checkbox"/> Sì <input type="checkbox"/> No <input type="checkbox"/> Non so |
| | <input type="checkbox"/> Cracker/grissini | <input type="checkbox"/> Fette biscott. | <input type="checkbox"/> Altro _____ |
| | con: <input type="checkbox"/> salume | <input type="checkbox"/> formaggio | |
| | <input type="checkbox"/> altro _____ | | |
| Altre merendine confezionate: _____ | <input type="checkbox"/> dolci | <input type="checkbox"/> salate | |
| Altro _____ | | | |

12. Cos'hai fatto ieri pomeriggio dopo la scuola?

- | | | |
|---|--|--|
| <input type="checkbox"/> Ho fatto i compiti | <input type="checkbox"/> Ho fatto att. sportiva | <input type="checkbox"/> Ho guardato film/video in TV o sul tablet |
| <input type="checkbox"/> Ho giocato a casa | <input type="checkbox"/> Ho suonato uno strumento/ | <input type="checkbox"/> Ho giocato ai videogiochi |
| <input type="checkbox"/> Ho giocato all'aperto (es parco) | ho cantato | <input type="checkbox"/> Altro _____ |

12.a Hai fatto anche un riposino? Sì No

12.b Indicare se le attività elencate sono quelle abituali: Sì No

13. Pratici qualche sport (fuori dall'orario scolastico)?

No Sì (includi att. sportive pomeridiane a scuola, es. nuoto): _____

14. Quante volte/quali giorni a settimana pratici sport fuori da scuola? _____

15. Cosa hai mangiato ieri sera a cena (focus su frutta e verdura e bevande zuccherate/gassate)?

Frutta Verdura No Frutta e no verdura Bevande zuccherate/gassate Non ricordo

16. Cosa hai fatto durante i pasti?

- | Colazione: | Pranzo (solo se il pranzo è a casa): | Cena: |
|--|--|--|
| <input type="checkbox"/> Mangio e bevo soltanto | <input type="checkbox"/> Mangio e bevo soltanto | <input type="checkbox"/> Mangio e bevo soltanto |
| <input type="checkbox"/> Parlo con qualcuno della famiglia | <input type="checkbox"/> Parlo con qualcuno della famiglia | <input type="checkbox"/> Parlo con qualcuno della famiglia |
| <input type="checkbox"/> Gioco/disegno | <input type="checkbox"/> Gioco/disegno | <input type="checkbox"/> Gioco/disegno |
| <input type="checkbox"/> Leggo/studio/ripasso | <input type="checkbox"/> Leggo/studio/ripasso | <input type="checkbox"/> Leggo/studio/ripasso |
| <input type="checkbox"/> Guardo la tv | <input type="checkbox"/> Guardo la tv | <input type="checkbox"/> Guardo la tv |
| <input type="checkbox"/> Uso il tablet/cellulare | <input type="checkbox"/> Uso il tablet/cellulare | <input type="checkbox"/> Uso il tablet/cellulare |

17. Ieri hai mangiato o bevuto qualcosa dopo cena, prima di andare a letto (oltre all'acqua)? No Sì: _____

18. Ieri sera hai fatto qualcosa dopo cena?

- | | |
|--|--|
| <input type="checkbox"/> Ho guardato film/video in TV o sul tablet | <input type="checkbox"/> Ho giocato ai videogiochi |
| <input type="checkbox"/> Ho letto (o mi hanno letto) un libro | <input type="checkbox"/> Altro _____ |

19. Ieri sera ti sei lavato i denti? Sì No

19.a Indicare se il bambino si lava i denti almeno due volte al giorno: Sì No

20. A che ora sei andato a letto? _____ Non so/non mi ricordo

21. Quando (non) vai a scuola, vai a letto allo stesso orario? Sì No, prima No, più tardi Non so/non mi ricordo

22. Ieri sera, dopo che ti sei coricato a letto, cos'hai fatto? Niente Sì:

- | | |
|--|--|
| <input type="checkbox"/> Ho guardato film/video in TV o sul tablet | <input type="checkbox"/> Ho giocato ai videogiochi |
| <input type="checkbox"/> Ho letto (o mi hanno letto) un libro | <input type="checkbox"/> Altro _____ |

DOMANDE AGGIUNTIVE SOLO PER CLASSI QUINTE
QUESTIONARIO KIDMED

22. Consumi un frutto o un succo di frutta ogni giorno?	Si	NO
23. Mangi un secondo frutto ogni giorno?	Si	NO
24. Mangi verdure crude o cotte regolarmente 1 volta al giorno?	Si	NO
25. Mangi verdure crude o cotte regolarmente più di 1 volta al giorno?	Si	NO
26. Consumi pesce regolarmente (2-3 o più volte a settimana)?	Si	NO
27. Vai più di 1 volta a settimana al fast food (hamburger)?	Si	NO
28. Mangi i legumi (piselli, fagioli, lenticchie, ceci, ecc.) più di 1 volta a settimana?	Si	NO
29. Consumi pasta o riso quasi ogni giorno (5 o più volte a settimana)?	Si	NO
30. A colazione, mangi cereali, pane o fette biscottate?	Si	NO
31. Consumi frutta a guscio (noci, nocciole, mandorle, ecc.) regolarmente (almeno 2-3 volte a settimana)?	Si	NO
32. Per condire, usi olio di oliva a casa?	Si	NO
33. Solitamente fai la colazione?	Si	NO
34. A colazione, mangi latte o latticini (yogurt, ecc.)?	Si	NO
35. A colazione, mangi merendine o biscotti?	Si	NO
36. Consumi 2 yogurt e/o formaggi (40 g) ogni giorno?	Si	NO
37. Consumi dolci e caramelle più volte ogni giorno?	Si	NO

DOMANDE SONNO

38.a Solitamente a che ora vai a letto nei giorni di scuola? _____

38.b Solitamente a che ora ti svegli nei giorni di scuola? _____

 38.c Fai un riposino pomeridiano nei giorni di scuola? NO Sì, durata: _____

39.a Solitamente a che ora vai a letto nel weekend? _____

39.b Solitamente a che ora ti svegli durante il weekend? _____

 39.c Fai un riposino pomeridiano nel weekend? NO Sì, durata: _____

Study 3

Nutrition education and detection of anthropometric and nutritional variables to determine the nutritional status, hydration level, eating habits and lifestyle of young soccer players: pilot study preliminary results and educational method

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Short Title: Improve Nutrition Education and Detection of Anthropometric, Nutritional, and Hydration Variables in Young Soccer Players

Keywords: Hydration, Sports Performance, Footballers, Children and Adolescents, Coaches

ABSTRACT

Deviations from the Mediterranean Diet (MD) and inadequate hydration have become significant issues among Italian children, contributing to increased rates of overweight, obesity, and metabolic disorders, as well as impairments in cognitive performance, physical health, and sports abilities. The AUDACE pilot project, conducted during the 2024 sports season, aimed to address these challenges by promoting healthier eating and hydration habits among young athletes of U.S. Audace and Camerino-Castelraimondo football teams. This initiative adopted a holistic approach, combining interactive education for athletes with digital resources tailored for parents and coaches, fostering a cohesive support network to encourage lasting behavior change. The project focused on athletes through a structured program, including baseline and follow-up assessments of anthropometric data, dietary habits, and hydration status. Dietary behaviors were evaluated using the KidMed questionnaire, while hydration was assessed with specialized questionnaires and a five-day urine color monitoring protocol. Educational interventions emphasized interactive methods, such as field games and informational materials, to teach the principles of MD and effective hydration strategies.

Coaches and parents participated in parallel programs to reinforce these concepts. Coaches received educational content through brief video lessons and informational brochures, while parents accessed similar digital resources to better support their children's nutritional and hydration practices. This integrated approach aimed to create an environment conducive to sustained improvements in health behaviors. Baseline findings highlighted moderate adherence to the MD among most participants, with some variation between teams. Hydration habits were generally suboptimal, characterized by insufficient fluid intake during training and meals, particularly breakfast, and reliance on thirst as the primary indicator for drinking water. Anthropometric data revealed differences between the teams, with variations in age, height, and waist circumference. Despite challenges such as small sample sizes and attendance rate, the AUDACE project demonstrated the potential of targeted educational interventions to improve dietary and hydration habits in young athletes. By engaging athletes, parents, and coaches in a collaborative effort, the program promoted health awareness and laid the foundation for enhanced sports performance and overall well-being. These findings provide valuable insights for future initiatives, emphasizing the importance of community-driven, evidence-based strategies to cultivate lifelong healthy behaviors.

INTRODUCTION

In recent decades, a concerning deviation from the principles of the Mediterranean Diet (MD) has been observed among Italian children, associated with inadequate fluid intake (15). Since 2008, there has been a deterioration in all indicators related to dietary habits (133). Specifically, the most recent national survey revealed that only 11.3% of children consume fruit 2-3 times per day, and 24.2% once per day (15). Fifteen percent of children eat fruit less than once a week or never. No differences were observed based on the child's sex, although differences were noted according to the mother's education level, with higher fruit consumption associated with higher educational attainment of the mother (15). Furthermore, parents reported that 6.5% of children consume vegetables 2-3 times per day and 12.4% once per day. Nineteen percent of children eat vegetables less than once a week or never. Thirty percent of children consume fruit and/or vegetables at least twice a day. Girls eat more vegetables compared to boys, and this percentage increases with the mother's educational level (15). Additionally, 13.3% of children never consume legumes or do so less than once a week, while the consumption of savory and sweet snacks "more than once a day, every day" is 2% and 8.2%, respectively, with a higher consumption of sweet snacks among boys. Daily intake of sugary beverages affects 9.5% of children (15). These changes in dietary and hydration lifestyles have significant implications for health, daily well-being, and sports performance in youth, highlighting the need for a reconsideration of nutritional strategies (168). Inadequate diet and poor hydration in children are associated with numerous negative health consequences. The deviation from the MD is linked to an increased risk of overweight, obesity, and metabolic diseases, conditions that are rising among Italian children (169). Childhood obesity not only represents a risk factor for the development of chronic diseases in adulthood, such as type 2 diabetes and cardiovascular diseases, but it can also have immediate effects on psychological well-being and quality of life in children (170). Moreover, poor hydration has been associated with reductions in cognitive capacity and academic performance in children (171). Dehydration can negatively affect mood, concentration, and short-term memory, which are crucial for academic performance and cognitive development (172). Therefore, adequate water intake is essential not only for maintaining body water balance but also for supporting cognitive functions and overall well-being (172,173). In addition to daily benefits, proper nutrition and hydration are crucial for sports performance in children and adolescents, especially those involved in organized sports(174,175). Studies have shown that adequate nutrient intake, in line with the MD, can significantly improve endurance, muscle strength, and post-exercise recovery (175). A balanced diet, rich in complex carbohydrates, lean proteins, and healthy fats, provides the necessary energy for intense physical activity and

supports muscle repair (176). Hydration plays an equally crucial role in sports performance. Proper hydration is essential for maintaining thermoregulation, preventing early fatigue, and enhancing endurance (177,178). Even mild dehydration can impair physical performance, reduce endurance, and increase the risk of injury (179). An observational study on young Italian athletes found that those who maintained adequate hydration during physical activity had better reaction times and greater endurance compared to their dehydrated peers (180). The deviation from the MD and poor hydration represent significant issues among Italian children, with potential detrimental effects on their health, development, and sports performance (133,181). To reverse this trend, a coordinated response is needed, including education, access to healthy foods, and public policies aimed at promoting a balanced lifestyle. Investing in children's health today will contribute to forming healthier and more resilient adults in the future (182).

The AUDACE project is a transformational sports nutrition education initiative designed to improve the overall health and performance of young athletes, while reducing the risk of injury through proper hydration. To achieve its goals, the programme uses an integrated approach that actively involves young athletes, their families and the wider sporting community. Effective nutrition education requires not only the transfer of theoretical knowledge, but also the creation of an environment that encourages practical application. This requires the involvement of all stakeholders in the athlete's life - parents, coaches and technical staff - through structured interventions that ensure the ongoing application of what has been learnt. A cornerstone of the program is its multimodal approach, which blends diverse learning methods to maximize accessibility and flexibility. While playful-educational activities are used to directly engage young athletes, the digital component is specifically designed for adults, such as parents and coaches. Online lessons, digital platforms, and mobile-accessible educational videos provide these stakeholders with tools to deepen their understanding of nutrition and apply it effectively in their supportive roles. By targeting adults, the digital resources ensure that the broader environment surrounding the young athlete is conducive to promoting healthy habits and optimal performance. Another innovative aspect of Progetto AUDACE is its emphasis on playful-educational activities for young athletes. By integrating learning and play, the program creates an engaging educational experience that fosters deeper understanding and retention. Interactive games, quizzes, and simulations transform theoretical knowledge into experiential learning, making complex nutrition concepts accessible and enjoyable for children and adolescents. The use of edutainment—combining education and

entertainment—further enhances engagement by situating learning in relatable, real-life scenarios. This method not only stimulates curiosity but also ensures that young athletes actively participate and apply the knowledge gained in their daily lives. Central to the program's success is the involvement of the entire sports community. Nutrition education is not an isolated process but a collective endeavor requiring active participation from all stakeholders. Coaches and technical staff are equipped to serve as role models, promoting healthy eating behaviors during training and beyond. Similarly, parents are integral to creating a home environment that supports and reinforces healthy habits, making them essential allies in achieving the program's goals.

In conclusion, Progetto AUDACE redefines nutrition education as a dynamic, continuous process that extends beyond the individual athlete to encompass families and the broader sports community. Through its multimodal delivery—tailored for both young athletes and their adult supporters—playful-educational strategies, and inclusive approach, it not only imparts knowledge but also instills lasting changes in behavior. By integrating these principles, young athletes gain the tools to improve their nutrition, enhance their performance, and maintain a foundation of health and well-being that will benefit them throughout their lives.

AIM

The aim of this study was to assess and monitor the nutritional status, hydration levels, eating habits, and lifestyle of children and adolescents involved in the U.S. Audace football teams of Parma and Camerino-Castelraimondo, both before and after a nutrition education intervention designed and implemented by our team. The primary goal was to evaluate the effectiveness of this educational intervention in improving the nutritional and lifestyle behaviors of the young athletes. This study sought to identify any changes in dietary patterns, hydration practices, and overall health, and to assess the impact of the intervention on their performance and well-being. By involving not only the athletes but also their families, coaches, and the wider sporting community, the project aimed to create a supportive and comprehensive educational environment. Through this intervention, we sought to promote long-term positive habits and enhance the athletes' overall health and sports performance, emphasizing the importance of proper nutrition and hydration in both daily life and athletic activities.

MATERIALS AND METHODS

Study design

The pilot study involved athletes, families, and technical staff from the U.S. Audace and Camerino-Castelraimondo teams, enrolled in the year 2024. Each group follows a specific pathway in several stages, including both data collection and targeted educational interventions **Figure 1**.

Athletes are the focus of the project, with a multi-stage structured programme to monitor progress over time. The study begins with the collection of anthropometric data (such as weight and height, waist circumference and arm circumference), an investigation into their eating habits through the KidMed questionnaire and an in-depth study of their hydration, measured both through a specific questionnaire and through daily monitoring of urine colour for five consecutive days (183). This data, obtained through guided self-observation, provides useful indications of the children's hydration level. Subsequently, the athletes participate in two separate educational interventions. The first, focused on nutrition, combines playful activities with educational sessions, making learning engaging and hands-on. During this intervention, educational brochures are provided to reinforce the concepts learned. The second intervention focuses on hydration, using a similar approach, where education is integrated with play. At the end of the course (after 4 weeks), the athletes repeat the anthropometric data collection, fill out questionnaires again and redo the self-assessment of urine colour. These measurements make it possible to assess any changes in their eating habits and hydration status.

Coaches, key figures in guiding and influencing young athletes, follow a parallel but simplified programme to that of the athletes. The course begins with a presentation of the project, introducing its objectives and methodologies. In this initial phase, nutrition data are collected via the MediLite tool, a validated questionnaire to assess eating habits in terms of adherence to MD (184). In addition, coaches complete a questionnaire on hydration and receive information brochures to further explore the topics. Subsequently, coaches participate in an educational intervention based on video 'micropills' of nutritional knowledge. These short online sessions are designed to be easily assimilated and applicable in the sports context. Finally, in the final phase of the project, coaches again complete the MediLite and hydration questionnaire, allowing for an evaluation of their improved skills and awareness after the intervention.

Parents, essential figures in supporting athletes in their daily lives, are also involved in the project. For them, the course focuses mainly on information and awareness-raising. The project is introduced with a presentation explaining the objectives and expected benefits, followed by the

delivery of information brochures. At a later stage, parents participate in an educational intervention similar to that of the coaches, based on video ‘micropills’ of nutritional knowledge. These short sessions are designed to fit their busy schedules and provide practical tools to support their children in improving their nutrition and hydration.

The project was approved by the Board for the Ethics of Non-Medical Research on the Person (REB - Research Ethics Board) of the University of Parma (prot. n. 0093737 del 02/04/2024).

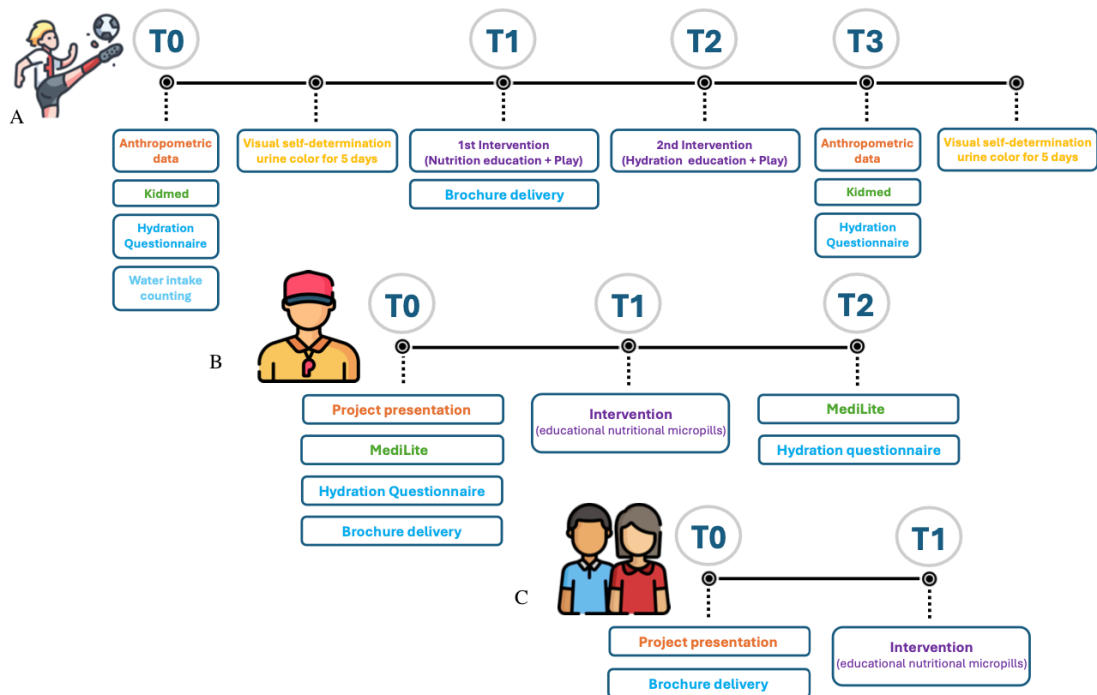


Figure 1 Study design footballers (A), coaches (B), parents (C)

Anthropometric Assessment of Athletes

Anthropometric measurements were performed exclusively on the athletes, following standardised protocols to ensure the accuracy and repeatability of the data collected. Weight was measured using a portable scale, the TANITA Body Composition Monitor Innerscan Compact Lightweight BC-730, which provides reliable and precise measurements. Height was assessed using a portable stadiometer, the SECA 213, ensuring consistency in the measurement of standing height. The circumference of the waist and hips was measured using the SECA Circumference Measuring Tape 201, a retractable tape measure with automatic rewind, designed to measure from 0 to 205 cm. This equipment ensured high accuracy and ease of use in capturing anthropometric dimensions specific to the athletic population.

Questionnaire

To analyze the dietary habits, lifestyle, and hydration status of young athletes, specific questionnaires were administered. The validated KidMed questionnaire was used to assess adherence to the MD in children and adolescents. This tool consists of 16 questions, some of which evaluate positive behaviors associated with the MD, such as the daily consumption of fruits, vegetables, legumes, fish, and extra virgin olive oil, while others identify unhealthy habits, such as the consumption of processed snacks, sweets, or sugary beverages. Each positive response to a beneficial habit scores +1 point, while positive responses to unhealthy habits score -1 point. The total score ranges from -4 to +12, classifying participants into three categories: low adherence to the MD (score ≤ 3), moderate adherence (score 4–7), and high adherence (score ≥ 8) (183). To assess hydration status, the Hydration Status Questionnaire for Adolescent and Youth Populations (HSQ-AY) was administered (185). This tool, designed for adolescents and young people, includes detailed questions about the frequency, quantity, and type of beverages consumed daily, the timing of fluid intake, and awareness of hydration status. The questionnaire also contains sections investigating symptoms related to poor hydration, such as fatigue, headaches, or difficulty concentrating, and provides a scale for self-assessment of thirst perception (185). Hydration status was further evaluated through a 5-day self-assessment of the first morning urine color using a color scale provided to participants (**Figure 2**). This self-assessment offered a simple and immediate method to detect potential dehydration (186). Additionally, participants were weighed before and after sports activities, and fluid intake during the activity was monitored by specialized professionals to obtain a more comprehensive understanding of hydration changes related to physical exercise and fluid consumption. These tools allowed for the collection of detailed information on the consumption of the five daily meals and hydration, with specific attention to the frequency and quality of food and beverage intake. To ensure proper understanding of the questions and minimize the risk of incomplete responses, the questionnaires were administered with the assistance of appropriately trained personnel, including researchers and student interns from the Department of Food and Drug Sciences for U.S. Audace and the School of Biosciences and Veterinary Medicine at the University of Camerino for the Associazione Sportiva Dilettantistica Camerino Castelraimondo. To evaluate the lifestyle of young athletes, the questionnaires also included questions about the weekly frequency of football activities and the time spent in sedentary activities, such as screen time on televisions, smartphones, or computers. Sociodemographic information, including age, sex, and place of birth, was also collected.



Figure2 Urine colour scale chart

Educational Intervention

Intervention for Young Athletes

For young athletes, the educational intervention was designed to be engaging, interactive, and seamlessly integrated into their training sessions, leveraging an edutainment approach. This method combined education and entertainment directly on the football field, turning learning into a dynamic and enjoyable experience that complemented their sports activities. Two field games, described in the **supplementary materials**, the "**Game of the Goose**" and the "**Water Drops Game**," were introduced. These activities aimed to educate the players on key nutrition and hydration concepts in an accessible and fun way, blending knowledge-building with the spirit of teamwork and competition.

- **The "Game of the Goose"** focused on introducing basic nutritional principles, including the importance of healthy eating habits, the foundations of the MD, and the role of different foods and nutrients in maintaining optimal health and performance.
- **The "Water Drops Game"** concentrated on hydration, teaching participants about the sources of water in food, the most suitable beverages for different phases of physical activity, and practical hydration guidelines for both active and rest days.

Both games were incorporated into training routines, aligning with the athletes' physical and cognitive engagement on the field. This on-the-field edutainment approach ensured that learning became an integral part of their practice sessions, enhancing retention and application of the knowledge in a context relevant to their daily lives as athletes. To reinforce the lessons from these games, an informational flyer on hydration was distributed. This flyer highlighted the importance of staying hydrated not only during football practice but also in everyday life. The combination of interactive games, printed materials, and on-field learning ensured that young athletes could easily understand and apply these concepts, promoting healthier habits both on and off the field.

Intervention for Adults: Parents and Coaches

The intervention for parents and coaches was tailored to their roles in supporting young athletes' nutrition and hydration. To accommodate different levels of availability and learning preferences, the educational content was provided in both print and digital formats. Printed materials included two dedicated leaflets: one focusing on the principles of proper nutrition for children, emphasizing balanced meals, and another on hydration, highlighting its critical role in sports and daily life. Digital resources featured three short educational video clips delivered via an online platform. These videos covered essential topics such as the five daily meals for healthy nutrition, the MD food pyramid, and hydration practices. For parents, the content emphasized meal planning at home, including strategies for encouraging healthy eating at family meals. For coaches, the focus was on practical guidance for snacks and hydration practices during training sessions and matches. This intervention aimed to engage adults as active participants in creating a supportive environment for young athletes. By educating both parents and coaches, the program sought to ensure that nutrition and hydration messages were reinforced consistently at home, during training, and in competition. The approach fostered collaboration among all stakeholders in the athletes' sports ecosystem, promoting sustainable and scientifically grounded habits that support both health and performance. Examples of the educational materials administered to adults are provided in the **supplementary materials**.

Statistical Analysis

A descriptive statistical analysis was conducted on the collected data. Quantitative variables were presented as mean \pm standard deviation. For comparisons between paired samples, the non-parametric Wilcoxon signed-rank test was applied as an alternative to the dependent samples T-test, particularly when normality assumptions were not satisfied. This approach allowed for a thorough examination of both parametric and non-parametric data distributions. All analyses were performed using IBM SPSS software for Windows, version 28.0.1.1, developed by SPSS Inc., based in Chicago, Illinois, USA.

RESULTS

Sixty-two volunteers, all male, were enrolled in the present study. Of these, 41 belonged to the U.S. Audace team, while 21 were part of the Camerino-Castelraimondo team. Four coaches were also recruited for the U.S. Audace team. All results were presented at baseline; before the educational intervention. The coaches joined the nutrition training but did not participate in the monitoring phase of the pilot project, so no data are available for this target population.

Results for Young Athletes

The mean age of the players of the U.S. Audace team was 11.4 ± 3.8 years, while that of the players of the Camerino-Castelraimondo team was 14.9 ± 1.6 years. The average BMI of the U.S. Audace players was 19.0 ± 3.2 , while that of the Camerino-Castelraimondo players was 20.89 ± 2.78 (**Table 1**).

Table 1 Anthropometric characteristics of the population at baseline

Anthropometric measurements		
Variables	Audace (n=41)	Camerino- Castelraimondo (n=21)
Age	11.4±3.8	14.9±1.6
Height (cm)	148.6±21.3	174.2±11.7
WC (cm)	65.8±8.3	75.3±7.2
AC (cm)	11.4±3.8	14.9±1.6
BMI (kg/m ²)	19.0±3.2	20.89±2.78

Data are expressed as mean \pm DS

The athletes' adherence to MD, assessed by means of the KidMed questionnaire, showed a prevalent average adherence in both sports clubs. In the U.S. Audace team, 56.1% of the athletes reported an average level of adherence to the MD, while in the Camerino-Castelraimondo team, this percentage was 67.0% (**Table 2**).

Table 2 KidMed

KidMed		
Adherence to MD	Audace (n=41)	Camerino- Castelraimondo (n=21)
LOW ADHERENCE n (%)	14 (34.0)	3 (14.0)
MEDIUM ADHERENCE n (%)	23 (56.1)	14 (67.0)
HIGH ADHERENCE n (%)	4 (9.8)	4 (19.0)
AVERAGE SCORE Mean ± DS	4.7±2.3	5.4±2.5

Data are expressed as mean ± DS or absolute number (percent)

The hydration status of the athletes was assessed by measuring body weight before and after training and by recording water intake during training. The results are presented in **Table 3**. In addition, the colour of the first morning urine was used as an indicator of hydration status. The mean values for urine colour were 3.0 ± 0.9 for the players of the U.S. Audace team and 3.9 ± 1.2 for the players of the Camerino-Castelraimondo team (**Table 3**).

Tabella 3 Hydration status

Hydration status		
Variables	Audace (n=41)	Camerino- Castelraimondo (n=21)
Pre-training weight (kg)	44.1±18.4	63.8±12.5
Post-training weight (kg)	44.2±18.2	63.7±12.5
Water intake during training (g)	324.0±264.8	521.7±526.4
Δ weight (considering water intakes) (kg)	0.2±0.6	0.7±0.6
Color of 5-day first urine	3.0±0.9	3.9±1.2

Data are expressed as mean ± DS

Hydration was further assessed using a specific questionnaire for children and adolescents, the results of which are shown in **Figure 3**. Data analysis showed that more than half of the children did

not have the habit of carrying a water bottle when they left home, although most brought one to school. Almost all children drank water between meals, throughout the day and during sports activities. Most athletes reported that they preferred water to other drinks when they were thirsty, with many expressing a particular preference for water. However, more than half of the volunteers reported drinking only in response to thirst, rather than proactively. About half of the footballers from both teams reported feeling full after drinking water. In terms of hydration during meals, almost none of the athletes drank water at breakfast, while a significantly higher number of athletes from the Camerino-Castelraimondo team tended to drink water during the main meals (lunch and dinner) compared to the US Audace team. Hydration was also assessed by the number of daily urinations, which was approximately 2-4 times per day for both teams. The frequency of defecation varied between the teams: players in the US Audace team reported a frequency of at least once a day, while those in the Camerino-Castelraimondo team reported about 5-6 defecations per week. Sweating was assessed using a questions in which participants rated their sweating on a scale of 1 to 10 at different times of the day. The results showed an average score of 5 ± 2.2 for the US Audace team and 5 ± 1.9 for the Camerino-Castelraimondo team during the day, rising to 7.7 ± 1.9 and 6.9 ± 2.3 respectively during exercise. In addition, the volunteers were asked if they knew their daily water requirements; more than half of the athletes from both teams answered in the affirmative. The soccer players from the US Audace team estimated a water requirement of 2.2 ± 1.3 litres per day, while reporting an actual intake of 1.5 ± 0.9 litres per day. The football players from the Camerino-Castelraimondo team reported a similar water requirement of 2.2 ± 0.3 litres per day, with an actual average intake of 2.1 ± 1.0 litres per day, which was in line with their knowledge.

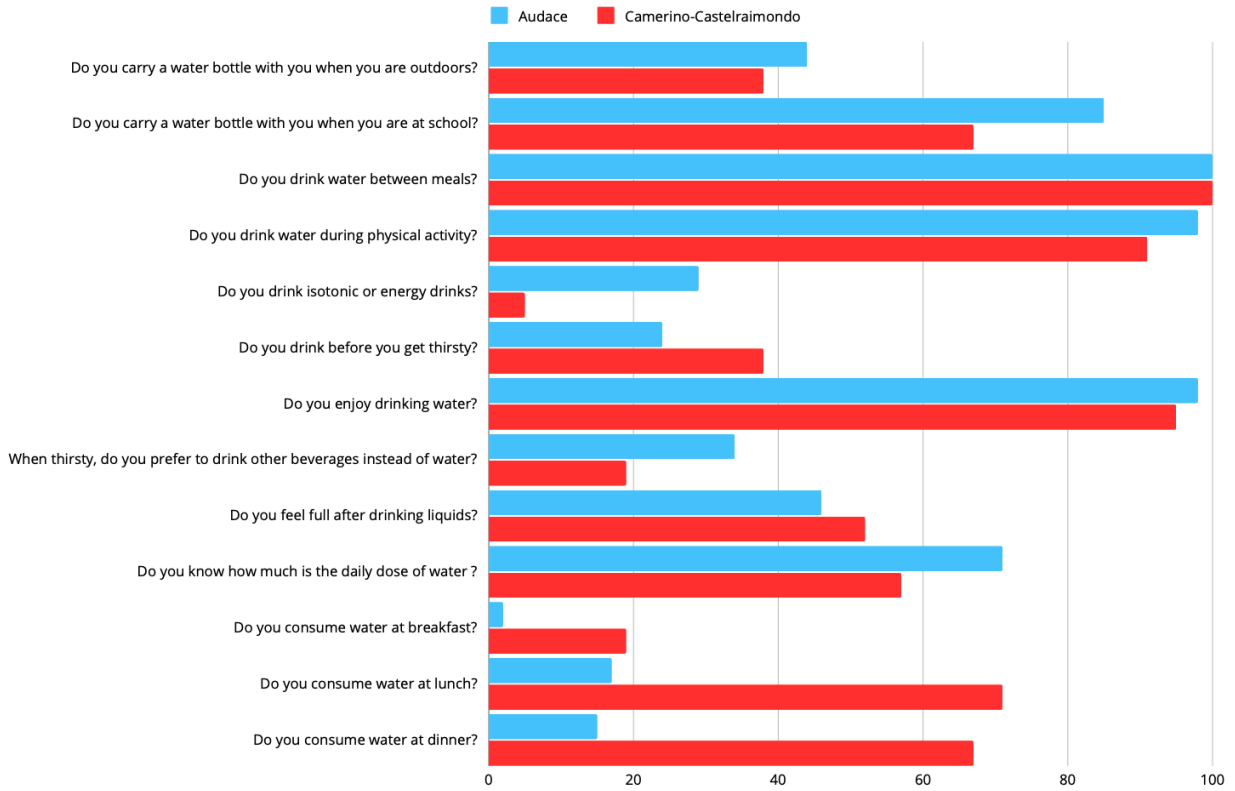


Figure 3 Percentage of positive answers to the hydration level questionnaire

DISCUSSION

The preliminary results of this pilot study did not reach statistical significance due to the small sample size, particularly for the Camerino-Castelraimondo team. Moreover, the present study played a fundamental role in outlining and refining the methodology for the prospective intervention study, planned for the period 2024-2025 and lasting three years, which will involve both sports clubs. The moderate adherence to the MD observed in this study highlights significant room for improvement among young Italians, consistent with findings from previous national surveys and studies on similar populations, such as elementary school children in Parma (133,187). These results underscore the importance of developing targeted educational interventions to promote the adoption of this dietary model, known for its well-documented health benefits and sustainability (188,189). Specific educational interventions could help increase adherence to the MD among young athletes, encouraging dietary habits that support both sports performance and overall well-being (190). Similarly, the results from the hydration questionnaire indicated the need to improve water consumption habits among participants. A critical area for intervention is promoting regular water intake during all main meals, a behavior currently uncommon in the studied sample. Although water was found to be the preferred beverage, in line with national data showing a decrease in the daily consumption of sugary and/or carbonated drinks (24.6%) compared to previous surveys, promoting proper hydration remains essential for optimizing sports performance and overall health in children and adolescents (133). In this regard, the Levels of Reference Intake of Nutrients and Energy for the Italian population (LARN) provide specific guidelines on water needs, which should be pursued through education and reinforcement of appropriate hydration behaviors in daily life (191). Despite the small sample size being a limitation, this pilot phase allowed for testing and evaluating the effectiveness of educational materials aimed at young athletes, their families, and coaches, including the administration of video capsules and printed leaflets. This provided valuable insights for optimizing these tools in future studies. Additionally, the proposed educational games for athletes, based on the “Learning through playing” approach—proven effective in previous studies on similar populations—were tested and refined (192). The pilot phase enabled the evaluation of both the game content and their timing on the field, identifying areas for improvement to enhance the educational effectiveness of the interventions. Nevertheless, it was not possible to obtain conclusive results on the effectiveness of the educational intervention due to a combination of an initially small sample size and a high drop-out rate. Specifically, study attrition was caused by illnesses among the younger participants and injuries among the older ones, which prevented the collection of sufficiently robust data to draw definitive conclusions about the intervention's impact.

These limitations highlight the need for more effective retention strategies and a larger sample size in future studies to improve the validity and generalizability of the findings.

CONCLUSIONS AND FUTURE PERSPECTIVES

The results of this pilot phase underline the importance of developing more effective retention strategies and significantly enlarging the sample size for the future prospective study. Involving sports clubs and parents more actively will be crucial for the success of educational interventions, especially for young athletes, and will also make the monitoring of coaches easier and more responsive. The aim will be to thoroughly evaluate the effectiveness of educational interventions on the health of athletes, with a specific focus on the adoption of correct dietary and hydration practices, in order to promote not only general well-being but also improved sports performance of young players. The future study will also aim to refine the 'Learning through playing' approach, adapting it to the specific context and maximising its potential in facilitating learning and behavioural habit change among participants. The increased sample size will allow for more robust and statistically significant data, providing scientifically valid answers on the effectiveness of educational interventions. Pre- and post-intervention monitoring, not only of the young sportsmen and sportswomen but also of the coaches, will allow a more comprehensive evaluation of the impact of the educational initiatives and the adaptation of strategies according to the results obtained, thus improving the quality and effectiveness of the intervention programme in the long term.

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SUPPLEMENTARY MATERIALS
Educational Games for Athletes

Game 1

<p><i>Game of the Goose</i></p>
<p>Materials:</p> <ul style="list-style-type: none">• Game cards: These cards contain questions and information on key nutrition concepts, such as healthy eating habits, principles of the MD, and the characteristics of various foods and nutrients.• Rings: Used to create the game pathway, simulating the spaces along which teams will advance.• Cones: Used as tokens to represent the teams on the game pathway.
<p>Game Play:</p> <ol style="list-style-type: none">1. Team Division: Participants are divided into multiple teams of equal size. Each team is represented by a cone that moves along the pathway created by the rings.2. Turns: In each round, one member from each team gets the chance to kick a ball towards the opposing team's goal. Each player has three attempts: Scoring on the first attempt allows the team to move forward by 3 spaces; scoring on the second attempt allows the team to move forward by 2 spaces; scoring on the third attempt allows the team to move forward by 1 space.3. Nutrition Questions: After scoring a goal, the team has the opportunity to advance by an additional space by correctly answering a nutrition-related question drawn from the game cards. The questions cover topics such as healthy eating habits, the benefits of the MD, food properties, and essential nutrients.
<p>Duration: The total duration of the game is approximately 1 hour, during which the teams compete to reach the finish line.</p>
<p>Objective: The main objective of the game is to reach the end of the pathway before the other teams, combining soccer skills with nutritional knowledge.</p>
<p>Knowledge Gained: Through the game, participants learn basic nutrition concepts, including healthy eating habits, the principles of the MD, and the roles of various nutrients. This gamified approach helps consolidate nutritional knowledge in an interactive and engaging way, while also promoting teamwork and healthy competition among young athletes.</p>

Game 2

Water Drops Game
Materials: <ul style="list-style-type: none">• Drops: Two types of drops are used: blue drops (dehydrated) and light blue drops (hydrated).• Belts: Belts are used to attach the drops to the players' waists.
Game Play: <ol style="list-style-type: none">1. Team Division: The group is divided into two teams. Each player is given a belt with six blue (dehydrated) drops attached and is assigned a number.2. Game Flow: A facilitator stands in the center between the two teams, holding a light blue (hydrated) drop. The facilitator calls out a number, for example, "Number 1!" At this point, the players with that number from each team race to grab the hydrated drop and return behind their team's line before their opponent can tag them.<ul style="list-style-type: none">○ If a player successfully retrieves the hydrated drop without being tagged, they must answer a question related to hydration. If they answer correctly, they get to keep the hydrated drop; if they answer incorrectly, the hydrated drop goes to the other team.○ If the opponent manages to tag the player before they cross their team's line, the opponent gets the chance to answer the question instead.○ After successfully obtaining the hydrated drop, the player must exchange one of their blue (dehydrated) drops with the facilitator.
Duration: The game lasts approximately 1 hour, allowing ample time for all players to participate and engage in multiple rounds.
Objective: The main objective of the game is to collect more hydrated drops than the opposing team by the end of the session.
Knowledge Gained: Participants learn fundamental hydration concepts, such as understanding where water is found in foods, identifying the most appropriate beverages for different stages of physical activity, and general guidelines for proper hydration during both active and inactive days. This interactive game aims to reinforce the importance of staying hydrated in an engaging and practical manner.



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La piramide alimentare



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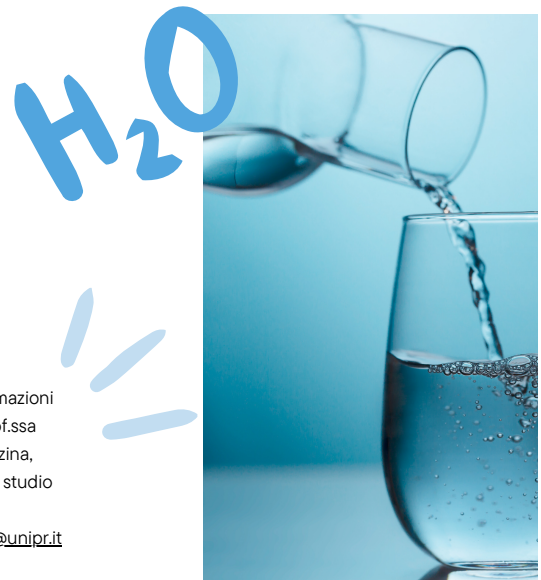
Massimizza la Performance con l'Idratazione Giusta!



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Consigli Alimentari per Giovani Sportivi

IL RUOLO DELL'ALLENATORE

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**Università Degli
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Consigli Alimentari per Giovani Sportivi

IL RUOLO DELLA FAMIGLIA

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Educational Content for Coaches

Consigli Pratici:

5 PASTI AL GIORNO

Insegna ai giocatori l'importanza di distribuire l'assunzione alimentare in cinque pasti equilibrati durante la giornata. Questo aiuta a mantenere costante il livello di energia e a supportare una migliore performance fisica.

MOMENTO CRUCIALE

Le merende sono fondamentali per massimizzare le prestazioni in campo. Assicurati che i tuoi ragazzi siano consapevoli dell'importanza di questo momento per ottenere il massimo dal loro allenamento e dalle partite.

SCELTE NUTRIENTI

Promuovi cibi che offrono una combinazione equilibrata di carboidrati, proteine e grassi sani. Questa combinazione garantisce un apporto energetico sostenuto e una migliore performance atletica.

PASTI DIVERSI PER ORARI DIVERSI

Invita ad adattare il tipo e le proporzioni di cibi consumati in base all'orario dell'allenamento. Se l'allenamento è vicino, favorisci cibi leggeri e facilmente digeribili per evitare sensazioni di pesantezza durante l'attività fisica.

Consigli Pratici:

BORRACCIA SEMPRE A PORTATA DI MANO

Assicurati che ogni giocatore abbia una borraccia d'acqua durante gli allenamenti e le partite.

IDRATARSI CON GLI ALIMENTI

Promuovi spuntini ricchi d'acqua come frutta e verdura.

SII UN ESEMPIO DA SEGUIRE

Assicurati di essere un modello di riferimento, bevendo acqua regolarmente durante gli allenamenti e le partite.

PAUSE

Introduci brevi pause durante le sessioni di allenamento per consentire ai ragazzi di bere. Questo non solo promuove l'idratazione ma offre anche un momento di recupero mentale.

Caro Allenatore,

Il successo di una squadra comincia con una base solida: una sana alimentazione.

Come allenatore, hai il potere di influenzare non solo le abilità calcistiche, ma anche le scelte alimentari dei tuoi giovani atleti.

Le merende sono un momento cruciale per ottimizzare le prestazioni in campo. Assicurati che i tuoi ragazzi carichino le batterie con cibi che danno loro l'energia necessaria per brillare durante l'allenamento e le partite.



Massimizza la Performance con l'Energia Giusta!



U.S. AUDACE PARMA

Il Goal dell'Alimentazione!



Caro Allenatore,

Sei pronto a portare i tuoi giovani campioni al livello successivo?

Sappiamo che l'allenamento e le partite sono fondamentali, ma c'è un elemento che spesso viene trascurato: **l'idratazione!** Aiuta a garantire che i giovani atleti siano sempre al massimo della forma aiutandoli ad avere le giuste abitudini per una corretta idratazione.



Massimizza la Performance con l'Idratazione Giusta!



U.S. AUDACE PARMA

Mantieni i Tuoi Campioni Idratati!



Educational Content for Parents

Consigli Pratici:

5 PASTI AL GIORNO

Insegna ai tuoi figli l'importanza di distribuire l'assunzione alimentare in cinque pasti equilibrati durante la giornata. Questo aiuta a mantenere costante il livello di energia e a supportare una migliore performance fisica.

MOMENTO CRUCIALE

Le merende sono fondamentali per massimizzare le prestazioni in campo ma non solo. Assicurati che i tuoi figli siano consapevoli dell'importanza di questo momento per ottenere il massimo dal loro allenamento e dalle partite.

SCELTE NUTRIENTI

Promuovi cibi che offrono una combinazione equilibrata di carboidrati, proteine e grassi sani. Questa combinazione garantisce un apporto energetico sostenuto e una migliore performance atletica.

PASTI DIVERSI PER ORARI DIVERSI

Invita ad adattare il tipo e le proporzioni di cibi consumati in base all'orario dell'allenamento. Se l'allenamento è vicino, favorisci cibi leggeri e facilmente digeribili per evitare sensazioni di pesantezza durante l'attività fisica.

Come Possiamo Aiutare i Nostri Figli a Bere di Più?

DARE L'ESEMPIO

I nostri bambini imparano da noi. Assicuriamoci di bere abbastanza acqua noi stessi per mostrare loro l'importanza di questo comportamento.

ACQUA LA PRIMA SCELTA

Limitiamo l'accesso a bevande zuccherate e rendiamo l'acqua la bevanda principale nelle nostre case.

ORARI PER BERE

Incoraggiamo i nostri figli a bere acqua al risveglio, ai pasti e durante l'attività fisica.

BORRACCIA SEMPRE A PORTATA DI MANO

Assicuriamoci che ogni bambino abbia una borraccia d'acqua durante gli allenamenti e le partite, ma anche a scuola e in tutti i momenti della vita quotidiana.

Cari Genitori,

Come genitori di giovani atleti impegnati nel mondo del calcio, sapete quanto sia importante fornire ai vostri figli il sostegno necessario per consentirgli di dare il meglio e divertirsi in campo.

Un aspetto fondamentale di questo supporto è rappresentato dalla corretta alimentazione, che gioca un ruolo cruciale nel fornire loro l'energia e i nutrienti necessari per affrontare le sfide dell'allenamento e delle partite.



Massimizza la Performance con l'Energia Giusta!



U.S. AUDACE PARMA

"Nutri la Tua Squadra per la Vittoria!"



Caro Genitore,

Siamo qui per ricordarti dell'importanza cruciale dell'idratazione per i nostri ragazzi.

L'acqua è essenziale per il loro benessere generale, influenzando non solo la salute fisica ma anche quella mentale e la performance sportiva. Ecco perché è fondamentale fare del consumo di acqua una priorità nella vita quotidiana dei nostri bambini.



Insieme, possiamo garantire che i nostri figli crescano sani e felici. L'idratazione è un passo cruciale su questa strada.



U.S. AUDACE PARMA

Mantieni i Tuoi Campioni Idratati!



Study 4

LOSTELLO Project, Communicating the OrtoBottega: Healthy, Social, Tasty

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Short Title: Nutrition Education Project at LOSTELLO Parma

Keywords: Mediterranean Diet; Nutrition Education; Seasonality; Fruits; Vegetables; Sustainability;
Local Food

ABSTRACT

The **LOSTELLO** project aims to promote healthier and sustainable lifestyles in the general population through an educational intervention that encourages the adoption of the Mediterranean Diet (MD), recognised for its proven health benefits and low environmental impact compared to other dietary habits. The MD, characterised by a high consumption of vegetables, legumes, fruit, whole grains, extra virgin olive oil, fish, and a moderate intake of dairy products and meat, has been shown to be effective in reducing the risk of chronic diseases such as cardiovascular disease, type 2 diabetes, and some cancers. However, its dissemination and adoption remain limited, often due to cultural and economic barriers or lack of information. The **LOSTELLO** project is developed in the **LOSTELLO** locations in Parma and includes an articulated education and awareness-raising programme, born from the collaboration with the social enterprise Madegus Srl. Through a series of educational activities and information tools, such as educational placemats, infographics, sustainable menus for the restaurant and bar, and show cooking open to the public, the project aims to make participants aware of the benefits of the MD not only for health, but also for the environment. Indeed, recent studies have shown how the adoption of a MD model can contribute to the reduction of greenhouse gas emissions, water consumption and overall ecological impact. A distinctive element of the project is the integration of modern technologies to maximise the dissemination of educational content and stimulate the interest of the local population. Using social media and QR codes linked to educational materials and menus, **LOSTELLO** intends to reach a heterogeneous audience and broaden the scope of the intervention. This technological approach, combined with the organisation of social events, facilitates direct interaction with the community, helping to promote a change in eating and living habits in an effective and sustainable way. The project also enhances the short supply chain and local seasonal products, with the collaboration of the Vigheffio Farm and the Ortobottega, promoting awareness of the importance of zero-kilometre products in the context of the MD. The long-term objective of **LOSTELLO** is to stimulate a positive and lasting change in the eating habits and lifestyle of the local community by disseminating knowledge and practices that integrate public health with environmental sustainability. The expected results of the project include increased adherence to the MD and increased awareness of the ecological impact of food choices, key elements in the promotion of a sustainable and resilient lifestyle.

INTRODUCTION

Proper nutrition is a cornerstone of modern society, crucial not only for individual health but also for environmental sustainability (193). In Europe, obesity has become a growing epidemic, with rates ranging from 15% to 35%, according to the World Health Organization (WHO) (194). In Italy, 21.7% of the adult population is classified as obese, a figure that has risen sharply over recent decades, as reported by the Istituto Superiore di Sanità (ISS) (195). These alarming statistics highlight the urgent need for interventions targeting unhealthy diets, a leading cause of obesity and noncommunicable diseases (NCDs) such as cardiovascular issues, diabetes, and certain cancers (196). Notably, poor dietary habits account for 58% of cardiovascular diseases and 21% of cancers, underscoring the profound impact of nutrition on public health. Obesity further exacerbates risks by contributing to hypertension, dyslipidemia, and insulin resistance, which reduce quality of life and increase healthcare costs (196). A shift toward healthier dietary patterns is essential for addressing these challenges. Diets rich in fruits, vegetables, whole grains, and healthy proteins are proven to lower the risks of obesity and chronic diseases while supporting overall physical and mental well-being. For instance, consuming abundant fruits and vegetables can reduce the risk of heart disease by 20% and stroke by 27%. Furthermore, a diet based on fresh, seasonal foods enhances nutrient intake, providing vital vitamins and minerals that support the body's functions and help prevent conditions like depression and anxiety (32,197).

The environmental implications of food systems are equally critical. Agriculture accounts for approximately 26% of global greenhouse gas emissions, with 31% attributed to animal production and 27% to crop cultivation for food and feed. Additionally, agricultural expansion is a leading driver of deforestation, responsible for 70–80% of tropical forest loss, primarily due to meat production and soy cultivation (198). This deforestation contributes significantly to biodiversity loss, with 60% of threatened animal and plant species directly impacted by agriculture. These figures illustrate how food production exacerbates climate change, deforestation, and ecosystem degradation (199).

Adopting sustainable dietary patterns, such as the Mediterranean Diet (MD), offers a solution to these interrelated challenges. Centered on local, seasonal, and environmentally friendly foods, the MD minimizes the environmental footprint of food production. By reducing reliance on long-distance transportation and excessive packaging, such diets cut greenhouse gas emissions and waste (200). The MD emphasizes fresh fruits and vegetables, whole grains, legumes, fish, and extra

virgin olive oil while recommending moderate consumption of red meat and dairy products (201). This approach not only promotes human health by reducing the risk of diseases like heart conditions and type 2 diabetes but also supports local agriculture, preserves biodiversity, and mitigates climate change (202).

Nutrition education plays a pivotal role in fostering healthier and more sustainable eating habits. Accessible and accurate information empowers individuals to make informed food choices, promoting balanced diets that benefit both personal health and the planet (87). Public health campaigns are instrumental in raising awareness of diet-related diseases, emphasizing the environmental impact of food production, and encouraging sustainable consumption patterns (203). These initiatives also highlight the value of local, seasonal foods in reducing waste and conserving resources. Promoting sustainable diets, exemplified by the MD, represents a powerful strategy to address the dual crises of public health and environmental degradation. By prioritizing nutrient-rich, locally sourced foods, society can achieve a healthier, more sustainable future that values the well-being of individuals and the planet alike (46,204).

In conclusion, proper nutrition is essential for both individual health and environmental sustainability. Addressing the growing obesity epidemic and its related diseases requires a shift toward healthier diets, such as the MD, which supports well-being and reduces environmental impact (205). Education and public awareness are key in promoting sustainable eating habits, ultimately benefiting both personal health and the planet (206).

In this context, the Social Enterprise Madegus Srl, also known as “Maestri del Gusto”, is at the forefront of this mission, bridging the gap between scientific research and practical application to enable people of all ages to make informed food choices (89). Founded with the support of the University of Parma and with over ten years of experience in the field of food education, Madegus is committed to providing the tools and knowledge necessary to make conscious food choices, with the aim of promoting healthier and more sustainable lifestyles. This commitment stems from a deep awareness of the interconnection between food, health, and the environment. At the heart of Madegus’s efforts is the desire to reduce health inequalities by making food education accessible and meaningful for all, regardless of age, background, or socioeconomic status. Madegus offers a wide range of personalized services to meet the needs of businesses, schools, and communities.

These include wellness programs, staff training, engaging educational content, and edutainment workshops. The Maestri del Gusto, professionals who are part of the Madegus team, bring a wealth of experience in nutrition and food science, using interactive tools to engage both children and adults in adopting a healthy lifestyle. Madegus recognizes the importance of continuously investing in research and development to adapt to market changes and emerging food trends. The company is committed to ensuring that its services remain cutting-edge, offering customized solutions for an increasingly health- and sustainability-conscious audience. Thanks to its ongoing commitment to research, Madegus is able to quickly respond to the needs of a changing market, providing innovative solutions that meet the growing demands of a population more aware of the importance of health and the environment. In addition to promoting individual health, Madegus also recognizes the crucial role of food choices in addressing global environmental challenges. The company advocates for diets based on local, seasonal, and minimally processed foods, such as the MD model, which not only promotes health but is also more sustainable for the environment. Through its educational programs, Madegus inspires communities and organizations to take an active role in conscious consumption, fostering changes that can contribute to a healthier and more sustainable future. In a period of urgent health and ecological challenges, Madegus Srl represents an example of how a social enterprise can be a driver of change, promoting a future where health, sustainability, and equity can walk together. Through education and awareness, Madegus provides individuals and institutions with the tools needed to build a healthier and fairer world (207).

A key initiative of Madegus is the LOSTELLO food education project, developed in collaboration with the Human Nutrition Science research group of the Department of Food Science and Pharmacy at the University of Parma. This innovative project is a concrete example of Madegus's commitment to spreading practical knowledge that promotes balanced and sustainable nutrition. LOSTELLO represents an urban regeneration project that has transformed a building previously used as a hostel, located in the scenic Parco Cittadella in Parma, into a multifunctional space serving the community. With the support of the Department of Welfare of the Municipality of Parma and in collaboration with the social cooperative Emc2 Onlus, LOSTELLO serves as a reference point for educational, training, and social inclusion activities. Within this initiative, the educational project of LOSTELLO focuses on promoting healthy, conscious, and sustainable nutrition through activities that involve both adults and children. Educational initiatives centered on health and food sustainability are among the many activities offered by the facility. To this end, the project

promotes the use of local and seasonal products, with a strong commitment to the valorization of short supply chains and sustainable agricultural practices. Additionally, LOSTELLO houses a bar-restaurant that primarily uses seasonal fruits and vegetables sourced directly from Ortobottega, a shop managed by members of the cooperative who grow fresh vegetables. This initiative not only offers healthy and sustainable food but also provides a social inclusion opportunity for those participating in the cooperative's workforce training programs. Beyond the bar-restaurant, LOSTELLO is involved in various agricultural projects, including those related to vegetable production and social beekeeping. Located at Vigheffio Farm, a fertile land where products are grown without pesticides, the project educates the community about the importance of sustainable agricultural practices, creating a direct link between the food we consume and the environment around us. In this context, LOSTELLO emerges as a learning center that not only promotes individual well-being but also educates the community on more responsible and conscious food choices. Through access to fresh, healthy, and local products, the project fosters the spread of a more sustainable food culture that not only meets health needs but also respects the environment, reducing the ecological impact of our eating habits. Ultimately, LOSTELLO embodies the essence of Madegus's approach to promoting healthy and sustainable food choices, combining education, urban regeneration, and social commitment into one meaningful initiative for the benefit of the community.

AIM

In this context, the aim of the LOSTELLO educational project, developed in collaboration with the social enterprise Madegus Srl, is to educate the community of Parma and beyond to adopt a healthier and more sustainable diet by promoting the consumption of fresh, local and seasonal fruit and vegetables from the Vigheffio Farm. As a social enterprise, Madegus Srl is deeply committed to providing people of all ages with the tools to make conscious food choices, contributing to a healthy and sustainable lifestyle. The main objective is to make participants aware of the health and environmental benefits of eating fresh, sustainably grown and local products. Through a variety of educational and dissemination activities, the project aims to provide information on MD and the importance of the consumption of fresh food, such as seasonal fruit and vegetables, in the context of a healthy and sustainable lifestyle. Furthermore, it intends to actively involve the local community, encouraging participation in events, workshops and tastings at LOSTELLO, where it is possible to experience and purchase the products of the Vigheffio farm through the l'Ortobottega

shop and learn practical ways of integrating them into the daily diet, through tasty recipes for everyday cooking. Ultimately, the project aims to create an inclusive and collaborative environment that promotes food awareness and encourages the transition to healthier and more sustainable eating habits. In this way, it aims to contribute not only to improving the individual health of participants, but also to promoting environmental sustainability and supporting the local economy through support for agricultural producers. Thus, the goal of the project is to inspire and motivate local people to make more conscious food choices, thus helping to create a healthier, resilient and environmentally conscious community.

MATERIALS AND METHODS

Storytelling

Madegus uses Storytelling as a key part of its educational approach to food, creating an engaging and informative experience for consumers. Through storytelling, Madegus reveals the true essence of the products it offers, acting as a "product identity card" that provides customers with a complete and transparent view of the product's journey, from farm to fork. This allows consumers to understand not only where their food comes from but also the people behind its production, from planting to harvesting and processing. By sharing these stories, Madegus helps build trust with consumers, offering them greater confidence in the provenance of their food. The goal is not only to highlight the nutritional benefits of the products but also to educate consumers on how these foods can contribute to their health and well-being. This way, consumers can make informed, conscious food choices that support their overall health. Additionally, Madegus encourages customers to experiment with their food by providing practical tips and cooking ideas. Through these suggestions, customers are inspired to create healthy, balanced dishes, contributing to the adoption of a healthier, more sustainable eating lifestyle.

Edutainment

Madegus uses **Edutainment** as an innovative methodology that combines learning and entertainment to make food education more engaging and effective. This approach aims to deliver knowledge in a fun and enjoyable way, stimulating interest and curiosity in both adults and children. Madegus's goal is to make food education accessible and interesting, creating practical experiences that encourage active participation. Through practical activities, games, and interactive workshops, Madegus guides participants in exploring topics related to nutrition, sustainability, and health. These playful and educational experiences allow for the combination of scientific information with hands-on experiments, promoting the adoption of healthier and more environmentally respectful eating behaviors. Additionally, the edutainment approach proposed by Madegus is designed to be inclusive, adapting to various age groups and contexts. Whether it's schools, businesses, families, or local communities, the approach aims to reach a wide audience by using tools that motivate and engage everyone. In this way, edutainment becomes a powerful means of raising awareness and driving change, helping to foster a more conscious and sustainable food culture.

Nudging

In the context of Madegus, **Nudging** is a behavioral strategy aimed at subtly influencing people's food choices in an effective way, without limiting their freedom of choice. The term "nudging" refers to a gentle "push" that encourages desired behaviors by using psychological and environmental elements to facilitate more conscious and sustainable decisions. Madegus applies nudging within the framework of food education, seeking to guide people toward healthier and more responsible food choices without imposing restrictions or obligations. This approach leverages the design of environments, communication, and the placement of food to make healthy and well-being-promoting choices easier and more natural. For example, placing healthy options at the forefront in cafeterias or making fresh, local foods more visible in stores can encourage the consumption of sustainable foods without forcing consumer behavior. Nudging is particularly useful for raising awareness and educating the public about more mindful eating behaviors, capitalizing on small environmental changes that have a large impact on everyday habits. In this way, Madegus uses nudging as a tool to promote a healthy and sustainable lifestyle, guiding people toward better food choices through subtle suggestions and effective psychological strategies.

LOSTELLO Project, Communicating the OrtoBottega: Healthy, Social, Tasty

The LOSTELLO educational project is founded on a number of fundamental assumptions derived from the importance of food service sites as educational tools for promoting proper nutrition and healthy lifestyles. These assumptions, supported by scientific evidence and educational theories, provide a sound basis for the design and implementation of the educational program. The approach of food services as educational spaces is supported by experiential learning theory, which emphasizes the importance of hands-on experience and active involvement in learning. Through the experience of eating food prepared with local and seasonal ingredients, participants can acquire knowledge about the origin, nutritional composition, and health effects of the food consumed. The project is based on the idea that food traditions are significant cultural expressions that can be used to promote greater awareness of the links between food, culture and identity. Enhancing food traditions makes it possible to preserve and promote cultural, social and ethnic diversity, as well as providing an opportunity to educate about environmental sustainability and food ethics. The project aims to educate people about healthy lifestyles by encouraging informed food choices that promote health and well-being. This approach is supported by scientific evidence demonstrating the link between diet and health, with a focus on the benefits of a balanced diet rich in local, seasonal and high-quality nutritional products. One of the key points on which the project is based is to make

nutrition education accessible to all groups of people, regardless of socioeconomic status, age or cultural background. This means creating inclusive and adaptable educational programs that account for the different needs and preferences of participants.

RESULTS

The LOSTELLO educational project is described in **Figure 1**.

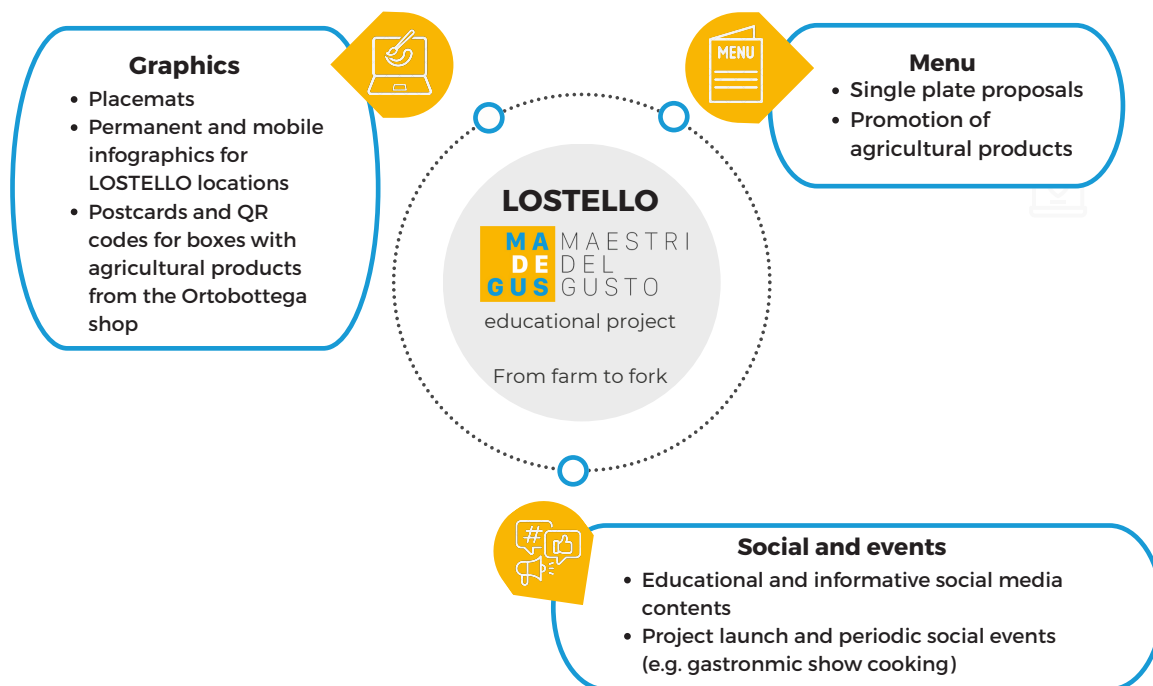


Figure 1 Outline of educational content

Graphic and Digital Educational Tools

Through storytelling, customers are offered not just a simple product, but a comprehensive and informative experience that helps them connect more deeply with the food they choose to consume. In detail, to make storytelling effective and ensure clear and engaging communication with the customer, several educational tools were designed.

Fixed and Mobile Posters

Posters are designed for both permanent and movable exposure within LOSTELLO's venue. These posters present the stories of the products in an attractive and informative way, illustrating the path they took from cultivation to the customer's table. Specifically, five posters/themes are installed, each with a specific purpose and distinctive message. One of them is a permanent infographic that tells the story of LOSTELLO, emphasizing the values of food awareness and sociality that drive the project's mission. This poster serves not only to provide an overview of the project's identity and purpose, but also to create a sense of connection and community among customers. The other four posters are mobile infographics that focus on the seasonality of products. Each infographic represents a season of the year: spring, summer, fall, and winter. Through colourful images and

informative text, these infographics give customers a detailed overview of the products offered in each season. They also include agricultural and cultural information, emphasizing the importance of eating according to the natural rhythm of the seasons and promoting awareness of traditional agricultural practices. Posters are more than just decorations: they are educational tools that aim to improve guests' food awareness. Providing consumers with accurate and relevant information about the foods they consume is key to help them make more informed and healthy choices. With visual tools, curiosity and interest in food and where it comes from can be inspired, thus helping to promote a healthier and more sustainable food lifestyle in our community. Examples of Fixed and Mobile Posters are included in the **supplementary materials A**.

Under-Dish Placemats

Under-dish placemats under the dish present informative and educational infographics, offering the customer an opportunity to learn more about the products during mealtime. These placemats not only enrich the dining experience but are also an opportunity for the customer to take home useful and interesting information. Four placemats were designed under the plate, each intended to provide an informative and engaging experience during the meal. These placemats were designed to meet the educational needs of adults and children by providing appropriate content on both sides. Specifically, the front side of the placemats is dedicated to educational information aimed at adults, offering a detailed overview of various topics related to healthy and conscious eating. One placemat features an illustration of a balanced meal, accompanied by a comprehensive explanation of the various essential nutrients found in the meal's different components. This helps adults better understand the importance of a balanced diet and provides practical guidance for meal planning. Another placemat offers a weekly menu suggestion, emphasizing the importance of food frequency, variety, and balance. On the back of the placemat is a empty weekly planning chart, allowing customers to fill out their own personalized menu at home, thus encouraging conscious food planning. Another placemat presents practical and useful tips for conscious shopping, including suggestions on how to read food labels, how to choose fresh and seasonal ingredients, and how to reduce food waste. Finally, the fourth placemat addresses food and environmental sustainability, focusing on food waste. Through charts, data and practical tips, the impact of food waste on the environment is illustrated while also providing strategies to reduce it, thus encouraging more environmentally responsible behavior.

Cards with QR code

Cards are included in the boxes of fruit and vegetables sold at the OrtoBottega. Each card lists the products in the box, with particular attention to their origin and seasonality. These cards are intended to provide detailed information on the products in the box, offering the customer a complete guide to the best use of the food purchased. Each postcard also includes a QR code that, when scanned with a smartphone, provides access to a range of additional content: by scanning the QR code with a smartphone, customers can get access to a range of educational content, including recipes, nutritional advice, cooking and storage methods, sustainability information and more. This interactive approach allows customers to further explore the world of our products and deepen their understanding and appreciation. For each product listed in the card, three recipes are proposed, for a total of 30 recipes including first and second courses and side dishes or desserts. This allows customers to experiment with new culinary preparations using fresh, seasonal ingredients purchased from LOSTELLO. The recipes aim to valorise the fruit and vegetable products of the Vigheffio farm, creating healthy, balanced and nutritionally sustainable dishes which are also tasty. These recipes are designed to be easily replicable and quick to prepare, also with the aim of including them in the LOSTELLO menu. Each product is also accompanied by detailed information on its origin, growth cycle and other relevant agronomic aspects. This enables customers to better appreciate the origin of their food and develop a greater awareness of the food chain. Information is also provided on the micronutrient content of various products, enabling customers to better understand the nutritional value of the food they buy and consume. Finally, by means of postcards and QR codes, each product is accompanied by practical advice on how best to cook and store it, as well as tips on how to reduce food waste. This helps customers maximise the use of the food they buy and reduce waste in the kitchen. Examples of QR code-accessible 'Cartoricette' are included in the **supplementary materials B**.

LOSTELLO's Menu

In addition to the recipes designed for the cards, an innovative culinary proposal has been introduced: each month a new recipe for a single dish, characterised by optimal nutritional balance and wholesomeness, is presented to enrich the LOSTELLO menu. This initiative aims to diversify the monthly gastronomic offer, giving customers a continuous opportunity to discover and enjoy dishes prepared with fresh, seasonal ingredients from the Vigheffio farm. Each new recipe is carefully designed to ensure proper nutritional balance and offer a satisfying and tasty dining experience. In addition, the monthly introduction of a new one-dish recipe promotes variety and dietary diversity,

encouraging customers to experiment with new flavours and combinations of ingredients. This contributes to raising customers' awareness of the importance of a balanced and nutrient-rich diet, consolidating LOSTELLO's identity as a place of refreshment committed to promoting health and well-being through conscious food choices.

Scientific Show Cooking

For the launch of the Lostello Project, an engaging and informative scientific cooking show is planned, during which chefs and nutritionists share a series of fundamental information with the public. First, the products of the Vigheffio Farm and Lostello philosophy are illustrated, offering the audience a complete overview of the origins and characteristics of the products used in the proposed dishes. Next, the nutritional and gastronomic properties of these products are explored, highlighting the health benefits of eating fresh, local and seasonal food. Finally, the importance of becoming ambassadors of a lifestyle that promotes a varied and sustainable diet is emphasised, highlighting LOSTELLO's approach of encouraging a direct connection between the land and the table. This is further emphasised using social media stories with hashtags such as #Lostello, to engage and inspire the public to make conscious and responsible food choices.

Social Media

A targeted social campaign is planned through a series of posts, reels and videos carefully designed to provide the public with a wide range of information on food education. Firstly, the seasonal products of the Vigheffio Farm are presented, also through social media, with the aim of raising public awareness of the value and importance of consuming fresh and local food. At the same time, food education content is delivered to provide detailed information on the nutritional properties of the products offered, as well as on best food practices to promote a healthy and balanced diet. In addition, practical advice and tips on food sustainability are shared online, emphasising the importance of making choices that take into account environmental impact and waste reduction. Finally, the social campaign includes the promotion of the culture of food and sociability, underlining the central role that food has in fostering moments of sharing and conviviality among people.

DISCUSSION

Nutrition education projects targeted at the community are crucial for promoting healthy and sustainable eating behaviors and improving public health and the health of the environment (208). However, most such initiatives in Italy have traditionally been concentrated in schools, as shown by the study conducted by Ministero dell'Istruzione, dell'Università e della Ricerca (MIUR) in 2018. This study found that 74.3% of the schools involved carried out nutrition education activities, with a higher prevalence in primary school than in secondary schools (209). In contrast, nutrition education in collective catering and food services, such as school, university and company canteens, and other food venues destined for the community such as bars and restaurants, got less attention (210). However, there are examples of effective interventions in this context as well. For example, the 2011 study conducted by Vitale et al. at Barilla company canteens showed that a nutrition intervention program based on promoting the MD is feasible and effective in changing workers' eating habits, even in the long term (211). Other studies, such as the one conducted by Rosi and colleagues in 2022 at the same company, have examined the impact of interventions based on "gentle pushes" (nudges), such as the use of the Double Food Pyramid logo combined with a web application promoting the MD (212). Although this intervention led to a significant improvement in food choices, the results suggest that additional strategies may be needed to maximize the effectiveness of such interventions (212). Food services provide a strategic framework in which to implement public health interventions to support citizens in this urgent food change towards healthy and sustainable ways of eating. Given the importance of connecting different actors in the food system and combining different skills and resources to drive the urgent transformation of the food system, the FAO has recognized food service venues as one of the main agents of change. Indeed, with the increasing consumption of meals out-of-home, food services play an increasingly important role in shaping people's food preferences, raising public awareness and building a new food culture (213). The importance of nutrition education to promote healthy and sustainable diets based on local and seasonal products is also widely supported by scientific research (214–218). The integration of environmental sustainability in dietary guidelines, both for individuals and groups, as well as in the definition of national dietary guidelines, is crucial (219). Improving the long-term nutritional health of the population requires a commitment to ensuring the long-term sustainability of the food system. Current environmental trends, such as climate change, biodiversity loss, land degradation, water scarcity and water pollution, threaten long-term food security and are, in part, a result of current agricultural and dietary practices (220). More specifically, nutrition education focusing on the importance of local products can increase people's awareness of the environmental

benefits of reduced transport and greenhouse gas emissions. Promoting the seasonality of food can increase the diversity of diets and promote the preservation of agricultural biodiversity. Nutrition education can also foster greater local community involvement and a sense of belonging. This highlights the potential of nutrition education not only to improve individual health and the environment, but also to strengthen social and community connections (221).

In conclusion, nutrition education is a crucial tool for promoting healthy and sustainable diets, offering tangible benefits for both human health and the environment. Targeted projects, such as the initiative developed by Madegus Srl at LOSTELLO in Parma, provide unique opportunities to raise community awareness about healthier and more sustainable food choices while fostering collaboration among different organizations to enhance population well-being. The intervention at LOSTELLO, inspired by the MD model, combines balanced meals, educational information, innovative digital tools, and engaging experiences to increase awareness of the connections between food, health, and the environment. Although the project lacks a system to monitor changes in consumers' lifestyles, its effectiveness can be assessed based on established scientific evidence and positive outcomes from similar campaigns. Modern technologies, such as QR codes and social media, play a pivotal role in expanding the educational impact. QR codes provide immediate access to digital content like recipes and nutritional tips, making the learning experience more dynamic. Social media platforms allow for broader outreach and two-way communication, engaging younger audiences and fostering active participation. This integrated approach aims to build a more aware and sustainable food culture, encouraging community involvement and the creation of a network dedicated to health and sustainability in eating habits.

CONCLUSIONS AND FUTURE PERSPECTIVES

The LOSTELLO educational project is based on the idea that food services can play a vital role in nutrition education, promoting healthy and sustainable lifestyles. Through an integrated approach that values culinary traditions and relies on scientific evidence, the project aims to transform food consumption venues into dynamic and engaging educational spaces. LOSTELLO seeks to become a benchmark for scientific communication by raising awareness of the connections between food, health, the environment, and society. This is achieved through innovative initiatives such as educational materials, QR codes, scientific show cooking, and dedicated social campaigns. To ensure the project's long-term success and sustainability, targeted monitoring activities would be beneficial. These could include quantifying the agricultural products sold at the OrtoBottega of Vigheffio Farm or tracking the number of consumers choosing the healthy single-dish option over traditional menu items. Additionally, gathering direct feedback through interviews, surveys, and analyzing social media interactions could provide valuable insights for evaluating and improving the proposed initiatives, inspiring positive lifestyle changes within the community.

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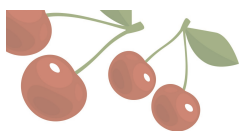
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SUPPLEMENTARY MATERIALS

A. Examples of Fixed and Mobile Posters

1. Introductory panel: From the soil to the plate. Social inclusion to be cultivated and cooked

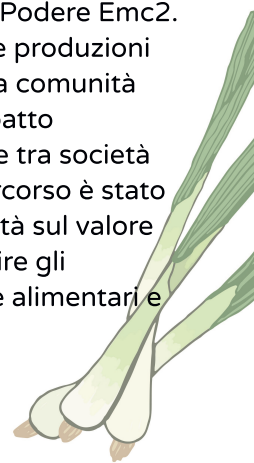
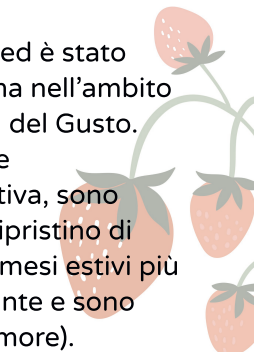


Dalla terra al piatto.

L'inclusione sociale da coltivare e cucinare

Il progetto nasce da un'idea della cooperativa sociale Emc2 ed è stato realizzato nel 2023 con il contributo di Fondazione Cariparma nell'ambito del bando Inclusione e in partnership con Madegus, Maestri del Gusto. Presso il podere Emc2 alla Fattoria di Vigheffio dove ha sede OrtoBottega, il progetto di agricoltura sociale della cooperativa, sono state apportate migliorie con il montaggio di coperture e il ripristino di tunnel prima scoperti e con l'installazione di ombreggi per i mesi estivi più caldi. Si è inoltre realizzato un nuovo fragoletto con 1000 piante e sono state messe a dimora 700 piante di frutti minori (lamponi e more). L'ampliamento produttivo ha aumentato le occasioni di inclusione lavorativa per persone fragili, favorendo le opportunità di inserimento per chi ha scarse autonomie fisiche e/o cognitive.

Nei luoghi della cooperativa dedicati alla ristorazione sociale ha preso vita e si è sviluppata la parte del progetto dedicata all'educazione alimentare con il sostegno di Madegus, con la proposta di fuori menu preparati con le verdure di OrtoBottega, la realizzazione di cartellonistica divulgativa dedicata alla stagionalità degli ortaggi, con la distribuzione di "cartoricette" con piatti nutrizionalmente equilibrati a base di verdura e frutta a km zero coltivata senza l'uso di pesticidi chimici del Podere Emc2. I due luoghi di ristorazione sociale e i due punti vendita delle produzioni della cooperativa hanno permesso un contatto diretto con la comunità chiudendo il cerchio della filiera agroalimentare a basso impatto ambientale e ad alto impatto sociale, e riducendo le distanze tra società civile e progetti di inclusione per persone fragili. L'intero percorso è stato pensato per migliorare la consapevolezza dell'intera comunità sul valore dell'inclusione lavorativa e sociale e per sensibilizzare e fornire gli strumenti necessari per fare nella propria quotidianità scelte alimentari e d'acquisto sostenibili.



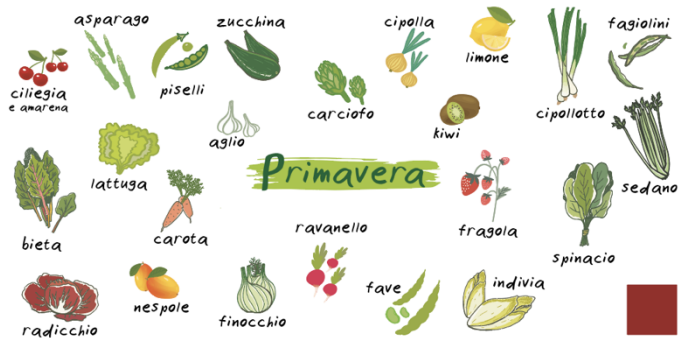
IN COLLABORAZIONE CON



CON IL CONTRIBUTO DI



2. Descriptive panels of the seasonality of fruits and vegetables



B. Examples of QR code-accessible 'Cartoricette'

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Zucchine

Le zucchine sono tra gli alimenti con il più alto valore di acqua, infatti, una porzione da 200 g a crudo, corrisponde a un bicchiere di acqua. Per conservarne il contenuto vitaminico, come la vitamina C e i folati, è meglio mangiarle crude, ad esempio finemente grattugiate in un'insalata.



Vuoi saperne di più?

Zucchine ripiene di ricotta e noci

per 4 persone

8 zucchine / 2 cipolle / 400 g di ricotta vaccina o di pecora / 40 g di noci / 4 cucchiaini di olio extravergine di oliva / menta, sale*, pepe q.b.

- Tagliate le zucchine a metà per il lato lungo, togliete la polpa e ponetela in una ciotola
- Unite la ricotta, metà delle noci, la cipolla, 2 cucchiaini di olio, la menta, tritate tutto con un mixer, salate e pepate
- Riempite le zucchine con l'impasto e infornate in forno preriscaldato a 200 °C per 20 minuti
- A fine cottura, tritate grossolanamente le noci rimaste, spolveratele sulle zucchine ripiene e servite

* Il sale è già naturalmente presente negli alimenti, l'apporto massimo è di 5 g al giorno per prevenire patologie.



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Melanzane

Questa ricetta rappresenta un piatto completo nutrizionalmente bilanciato, composto da una fonte di carboidrati (pasta), una di proteine (ricotta), una di grassi (olio) e verdura (melanzane).



Vuoi saperne di più?

Pasta con crema di melanzane e menta

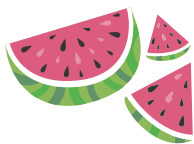
per 4 persone

4 melanzane / 320 g di pasta / 40 g di pinoli / 200 g di ricotta affumicata / 4 cucchiaini di olio extravergine di oliva / menta, aglio, sale*, pepe q.b.

- Lavate le melanzane, togliete il picciolo, tagliatele a metà per il lungo
- Mettetele sopra una teglia con carta da forno e bucherellate la polpa con una forchetta
- Infornate a 180 °C per 40 minuti o fino a quando la polpa non sarà morbida
- Con un cucchiaino rimuovete tutta la polpa, tagliatela e fatela ripassare in padella con 2 cucchiaini di olio e 1 spicchio di aglio
- Cuocete la pasta in acqua salata e in una padella tostate i pinoli
- Aggiungete alle melanzane la menta, quattro cucchiaini di acqua di cottura e aggiustate di sale e pepe
- Aggiungete la pasta e saltate, aggiungete quindi 2 cucchiaini di olio a crudo
- Servite la pasta aggiungendo ad ogni piatto i pinoli e la ricotta affumicata grattugiata

* Il sale è già naturalmente presente negli alimenti, l'apporto massimo è di 5 g al giorno per prevenire patologie.





Anguria

Questa ricetta rappresenta un piatto completo nutrizionalmente bilanciato, composto da una fonte di carboidrati (riso), una di proteine (primo sale), una di grassi (olio), verdura (cetrioli) e frutta (anguria).



Vuoi saperne di più?

Insalata di anguria

per 4 persone

2 fette di anguria / 400 g di feta / 25-30 olive taggiasche
320 g di lattuga / 440 g di pane / 4 cucchiaini di olio
extravergine d'oliva / menta, sale* e pepe q.b.

- Tagliate a cubetti l'anguria, mettetela in una ciotola insieme alla lattuga
- Unite la feta tagliata a cubetti, aggiungete le olive taggiasche, le foglioline di menta e aggiustate di sale e pepe nero
- Versate 4 cucchiaini di olio, mescolate e servite accompagnando con del pane

* Il sale è già naturalmente presente negli alimenti, l'apporto massimo è di 5 g al giorno per prevenire patologie.



Melone

Una porzione di melone da 150 g può coprire più di un terzo del fabbisogno giornaliero di vitamina A! Si tratta di una sostanza importante per il buon funzionamento della vista e per la salute della pelle, delle ossa e del sistema immunitario.



Vuoi saperne di più?

Pasta con gamberi, melone e menta

per 4 persone

600 g di gamberi / 400 g di pomodorini / 160 g di rucola
4 fette di melone / 320 g di pasta / 4 cucchiaini di olio
extravergine di oliva / aglio, menta fresca, brandy, sale* q.b.

- Cuocete la pasta al dente in acqua salata, scolatela, mescolatela con 2 cucchiaini d'olio
- Pulite e sguosciate i gamberi
- Appassite 1 spicchio d'aglio tritato in un padellino con acqua e 1 cucchiaino d'olio
- Aggiungete i gamberi, saltate velocemente a fuoco vivo e sfumate con il brandy (o vino bianco)
- Abbassate la fiamma e lasciate cuocere altri 5 minuti circa
- Tagliate il melone a cubetti e i pomodorini in 4; lavate ed asciugate la rucola
- Mettete tutti gli ingredienti in una ciotola, condite con 1 cucchiaino di olio, sale e della menta tritata
- Servite freddo

* Il sale è già naturalmente presente negli alimenti, l'apporto massimo è di 5 g al giorno per prevenire patologie.



Study 5

Impact of a Workplace Nutritional Intervention on Nutritional Knowledge and Mediterranean Diet Adherence: A Study at the University of Parma

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Keywords: Healthy Diet; Sustainable Diet; Nutrition Education; University Workers; Training Course; e-learning

ABSTRACT

Poor diet and unhealthy lifestyles are among the main factors affecting health status by increasing the risk of multimorbidity, negatively impacting people's quality of life and healthcare costs. Considering the considerable amount of time spent in the workplace, the work environment has been identified as a crucial setting for promoting correct lifestyles. This study aimed at assessing the level of nutritional knowledge (NK) and adherence to the Mediterranean Diet (MD) of the community of the University of Parma before and after a nutritional intervention in the framework of a mandatory training course in workplace health and safety. The research also sought to investigate factors associated with increased knowledge and adherence to the MD before the intervention. The intervention consisted of ten video pills and interactive games on the principles of a healthy and sustainable diet. A total of 1095 participants (57% F) completed baseline data collection (T0) showing a medium knowledge and adherence. Having a food-related background, being responsible of food purchasing and preparation, and preferring home-cooked meals strongly impacted the probability of having a good NK and healthy eating. Considering the study sample who completed T1 data collection (n=929) a significant increase in NK score was found immediately after the educational intervention. Despite the small number of participants attending follow-up (T2) (n=124), the NK score recorded 3 months after the end of the course was still significantly higher than the initial value (T0), but a significant decline compared with T1 was found. In contrast, no improvements in terms of adherence to the MD were evidenced, except for an increase in the consumption of fruit. The intervention findings confirmed the effectiveness of nutrition education lectures in rising theoretical understanding but without concretely improving participants' eating habits. Future initiatives should integrate various approaches that combine nutrition education with behavioural interventions, including practical tools and activities to enhance culinary skills and facilitate meal management, as well as the creation of a supportive food environment through university food services.

INTRODUCTION

The overall increase in non-communicable diseases (NCDs) is the result of a concomitance of complex factors that include demographic ageing, environmental influences and changes in lifestyle. Global estimates report that NCDs are currently responsible for 71% of deaths worldwide, with a particularly high prevalence in low- and middle-income countries (222). Obesity represents one of the leading causes of the global spread of NCDs, affecting over 650 million adults worldwide (223). Italy is not exempt from this pandemic (224). Unhealthy dietary patterns and sedentary lifestyles are increasingly widespread among Italian population ((225,226), contributing to the prevalence of obesity (21%) (224) and the incidence of death for cardiovascular diseases (32%), cancer (29%) and chronic respiratory disorders (10%) (95). The ever-growing process of urbanization, coupled with evolving models of transportation and technological advancement, has shaped modern societies, leading to a reduction in physical activity level among the population (226,227). For instance, work has become ever more reliant on technology over the past few years, with people spending a large part of their day in front of a computer screen (228). On the other hand, modern-era innovations have facilitated the food globalization process (229) by transforming dietary patterns and lifestyles across the globe (230), including Mediterranean countries such as Italy. The readily availability of energy-dense foods has negatively influenced the Italians' eating behaviors toward a reduced intake of plant foods, an improper daily distribution of meals and a lack of variability, seasonality and conviviality of the diet (225), causing a shift away from the traditional Mediterranean Diet (MD) (231–233), which has been widely recognized for its benefits to human and planetary health (234–238). Considering the prevalence of NCDs and the extended life expectancy in Italy (239), it is pivotal promoting healthy and sustainable lifestyles and proper dietary habits, in line with the key elements of the MD. This entails advocating for an increased intake of fruits and vegetables, whole grains, and legumes. Furthermore, the MD encourages the consumption of nuts and seeds, with olive oil being the preferred condiment. Fish, lean meats, eggs, and fresh dairy are also recommended, while red and processed meats should be consumed in moderation and less frequently (240). In addition, the MD promotes a healthy lifestyle, including regular exercise and convivial meals (240). There is a broad consensus in literature that rising people' food literacy is a promising public health strategy for encouraging healthy dietary habits and foster the communities' wellbeing (241). When defining food literacy, the interconnectedness of several factors needs to be considered (242). In this context, promoting individual knowledge is the primary factor for developing personal skills that are crucial to facilitate better food choices, such as confidence in decision-making, meal preparation and culinary ability (243,244). However, it is important to consider that food behaviors are related

to a multitude of factors including social and physical environment, such as social networks and living contexts (245). Considering the considerable amount of time spent in the workplace, the work environment has been identified as a crucial setting for promoting correct lifestyles, alongside school, community and health services (246). The workplace also enables the creation of a social network and a sense of belonging to a group, which may facilitate motivation and adherence to change due to the mutual influence among peers. Indeed, company welfare programs provide an innovative strategy for enhancing the social dimension and improving the well-being of the employees (14). As outlined by the World Health Organisation (WHO), to establish health-promoting work environments, it is essential to act on both physical and psychosocial dimensions, as well as to provide adequate resources for personal health (248). These resources may include regular cardiovascular screenings, hypertension management programs, healthy lifestyle education campaigns (249), seminars on balanced diet and physical activity, and access to company gyms, walking groups, and discounts on subscriptions to sports centres (250). One of the primary challenges to promoting a healthy lifestyle is achieving a lasting change in eating habits. This is not only attributable to inaccessibility to healthy meals but is mainly rooted in a lack of Nutrition Knowledge (NK) (251). In this context, numerous research studies have highlighted the crucial role of nutrition education in the workplace in promoting informed food choices and improving the overall health of employees (250). In this context, this study aimed at (1) assessing the level of nutritional knowledge and adherence to the MD of the employees of the University of Parma investigating the socio-demographic factors favouring the consciousness and the adoption of healthy and sustainable eating habits, and (2) evaluating the effect of a nutritional intervention in the framework of a mandatory training course in workplace health and safety.

MATERIAL AND METHODS

Participants and study design

This research project was promoted by the University of Parma within the mandatory training course in workplace health and safety, as required by Legislative Decree 81/08 and implementing agreements. The educational program was launched in February 2022 through the University Web Portal and is still accessible to new hires at the University of Parma, along with other modules related to the promotion of healthy lifestyles and occupational risk prevention. All members of the faculty and technical-administrative staff were invited to attend the e-learning training via institutional mail. After logging in, users had the option of either taking only the course or enrolling in a pre-post single-arm intervention study. Course details and expectations associated with participation in the study were disclosed in accordance with the ethical regulations and the principles of informed consent. All respondents signed the informed consent form and were thus enrolled in the intervention. Besides baseline data collection (T0) before the beginning of the course, participants were asked to complete other two further data collections, the second immediately following the conclusion of the digital course (intervention end data collection -T1) and the third after 3 months (follow up data collection - T2). Baseline data collection (T0) comprised three questionnaires on socio-demographic characteristics, NK, and adherence to the MD. NK questionnaire was also administered during the intervention end data collection (T1), singularly, and with the adherence to the MD questionnaire in the follow up data collection (T2) (Figure 1). At each time point questionnaires were administered through the same platform with which the e-learning course was delivered. This study was approved by the local Research Ethics Board (Prot. n. 9300/2022) and conducted in accordance with the Helsinki declaration.

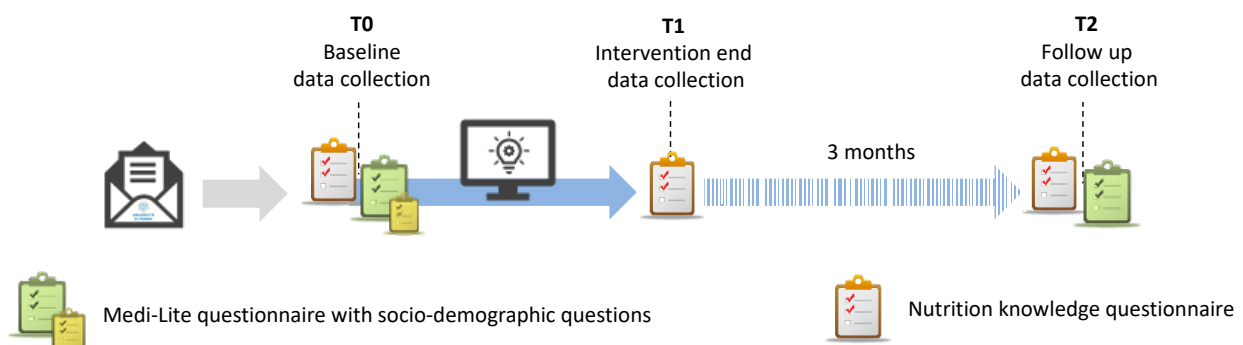


Figure 1. Study design

Intervention

The educational intervention consisted of ten videos, each lasting between 6 and 19 minutes, for a total of two hours. The videos addressed the principles of a healthy and sustainable diet. The main topics were related to (1) nutrients, (2) food groups, (3) salt, (4) sugars, (5) fiber, (6) hydration, (7) five meals a day, (8) eating out, (9) sustainable nutrition, (10) food allergies and intolerances. Concurrent with the video lectures, a “learning by doing” approach was implemented through the creation of interactive games associated with each lesson. This strategy aimed to enhance the participants' active involvement in the learning process by providing a dynamic and participative learning experience. At the end of the course, all teaching resources and supplementary documentation were made available to participants. The follow-up materials were designed to provide an ongoing and accessible reference to consolidate and deepen the knowledge acquired during the educational intervention.

Data collection

A general socio-demographic questionnaire was used to collect participants' information related to age range, gender, educational background and employment status, size of household and place of residence. In addition, other information was gathered, such as responsibility in food purchasing and preparation, as well as the frequency of eating out and consuming home-cooked lunches during the working days. The NK was evaluated by applying a 30-items questionnaire specifically developed according to the topics of the nutritional intervention. Each question offered four possible answers, with only one of each correct and one pertaining to the option 'I do not know'. One point was awarded for each correct answer, resulted in a total score that ranged between 0 and 30 points. Internal consistency was assessed via Cronbach's alpha reliability test, and item analyses were performed (i.e., item difficulty index and item discrimination index). The internal consistency of the questionnaire was good (Cronbach's $\alpha = 0.848$). Nine items had a difficulty index out of the advisable range (0.2-0.8) (252,253) while almost all items showed a good discrimination capability, except three for which a poor correlation index was found (<0.2) (252,254) (Table S1). However, their exclusion did not lead to an improvement in the internal consistency of the questionnaire. Given the relevance to the topics, all 30 items were retained in the final questionnaire. Adherence to the MD was assessed using the long version of the Medi-Lite questionnaire (255), already validated for the Italian adult population. Briefly, the questionnaire assesses the habitual intake of fruits, vegetables, legumes, cereals and cereal products, meat and meat products, fish, milk and dairy products, as well as the drinking of alcoholic beverages and the use of olive oil, providing a final

score ranging from 0 to 18 points. According to the literature-based scoring system elaborated by Sofi and colleagues (256) a score ranged 0 to 2 was assigned to each of category proportionally to the consumption level for foods characteristic of MD (i.e., fruit, vegetables, cereals, pulses, and fish) while for meat and dairy categories the score was reversed. For alcohol consumption an average consumption of 1-2 AU/day was considered the optimal intake. About olive oil, 2 points are awarded for regular consumption, 1 point for frequent consumption and 0 points for occasional consumption (255). Both the level of NK and the adherence to the MD were defined according to the tertile of belonging (i.e., 1st-low; 2nd-medium; 3rd-high).

Statistical Analysis

The IBM SPSS Statistics for Macintosh, version 29.0 (Armonk, NY: IBM Corp) was used to run all statistical analyses, keeping a p -value less than 0.05 as statistically significant. Descriptive and inferential statistics were carried out considering the sample at baseline (T0) and the subjects completed the second (T1) and follow up (T2) data collection separately. The normality of the data distribution was performed and rejected by applying the Kolmogorov-Smirnov test. Results were reported as median and interquartile ranges (IQRs) for continuous data and as absolute number and percentage for categorical variables. The non-parametric Kruskal-Wallis H test with Bonferroni post hoc test and Pearson Chi-square test (χ^2) were applied to investigate significant differences among subjects divided according to tertile of NK level and adherence to the MD at baseline, separately. Nonparametric statistics for independent samples were also used to explore differences in NK and MD score based on socio-demographic characteristics. Logistic regression analysis was carried out to explore the predictors of belong to the highest tertile of adherence to the MD. In addition, non-parametric Wilcoxon test and non-parametric Friedman test were used to compare subjects' NK score over time, considering separately the subjects who completed only T0 and T1 data collections, and those who finished also the follow-up phase (T2). Non-parametric Wilcoxon test was performed also to compare the food data between T0 and T2. Finally, Pearson's correlation test was used to assess the degree of association between the NK and MD scores.

RESULTS

Participants' characteristics, nutrition knowledge and eating habits at baseline data collection

Out of 1127 subjects enrolled in the research study, 32 were excluded for incomplete information and 1095 completed all the requests of baseline data collection. Characteristics of the participants before the intervention are shown in **Table 1**.

Table 1 Characteristics of the study sample at baseline reported as total and by gender.

Variables	Total (n=1095)	Females (n=622)	Males (n=415)	Non-binary gender (n=18)	p-value
Age range					<0.001
<30 years	270 (24.7)	156 (23.6)	111 (26.7)	3 (16.7)	
31–45 years	282 (25.8)	169 (25.5)	110 (26.5)	3 (17.7)	
46–60 years	468 (42.7)	294 (44.4)	166 (40.0)	8 (44.4)	
>60 years	70 (6.4)	42 (6.3)	27 (6.5)	1 (5.6)	
I prefer not to answer	5 (0.5)	1 (0.1)	1 (0.1)	3 (0.3)	
Education level					0.251
Secondary school	15 (1.4)	8 (1.2)	6 (1.4)	1 (5.6)	
High school	176 (16.1)	107 (16.2)	63 (15.2)	6 (33.3)	
Bachelor's degree	60 (5.5)	36 (5.4)	23 (5.5)	1 (5.6)	
Master's degree	437 (39.9)	277 (41.8)	155 (37.3)	5 (27.8)	
Postgraduate studies	407 (37.2)	234 (35.3)	168 (40.5)	5 (27.8)	
Employment status					<0.001
Full or Associate Professor	161 (14.7)	82 (12.4)	74 (17.8)	5 (27.8)	
Assistant Professor	99 (9.0)	52 (7.9)	47 (11.3)	0 (0.0)	
Research fellow or PhD student	294 (26.8)	160 (24.2)	132 (31.8)	2 (11.1)	
Technical-administrative staff	487 (44.5)	330 (49.8)	150 (36.1)	7 (38.9)	
Student	23 (2.1)	17 (2.6)	6 (1.4)	1 (5.6)	
I prefer not to answer	30 (2.7)	21 (3.2)	6 (1.4)	3 (16.7)	
Nationality					0.298
Italian	1080 (98.6)	653 (59.6)	410 (37.4)	17 (1.6)	
Other	15 (1.4)	9 (1.4)	5 (1.2)	1 (5.6)	
Size of residence (number of inhabitants)					0.645
<5000	177 (16.2)	110 (17.4)	63 (24.1)	4 (5.6)	
5000–49,999	262 (23.9)	165 (24.9)	95 (22.9)	2 (11.1)	
50,000–500,000	628 (57.4)	372 (56.2)	244 (58.8)	12 (66.7)	
>500,000	28 (2.6)	15 (2.3)	13 (3.1)	0 (0.6)	
N. household members					0.132
1	216 (19.7)	115 (19.7)	100 (19.7)	1 (19.7)	
2	269 (24.6)	174 (26.3)	90 (21.7)	5 (27.8)	
3	275 (25.1)	160 (24.2)	108 (26.0)	7 (38.9)	
4	286 (26.1)	187 (28.2)	94 (22.7)	5 (27.8)	
5	41 (3.7)	21 (3.2)	20 (4.8)	0 (0.0)	
6	5 (0.5)	3 (0.3)	2 (0.2)	0 (0.0)	
>6	3 (0.3)	2 (0.2)	1 (0.1)	0 (0.0)	
N. household members < 18 years					0.086
None	743 (67.9)	437 (66.0)	297 (71.6)	9 (50.0)	
1	210 (19.2)	135 (20.4)	70 (16.9)	5 (27.8)	
2	128 (11.7)	84 (12.7)	41 (9.9)	3 (16.7)	
3	12 (1.1)	4 (0.6)	7 (1.7)	1 (5.6)	

4	2 (0.2)	2 (0.3)	0 (0.0)	0 (0.0)	
Academic sector*					<0.001
Food	51 (9.2)	31 (10.5)	20 (7.9)	0 (0.0)	
Human-Social	68 (12.3)	38 (12.9)	30 (11.9)	0 (0.0)	
Scientific-Technological	349 (63.0)	164 (55.8)	181 (71.5)	4 (67.1)	
Medicine	86 (15.5)	61 (20.7)	22 (8.7)	3 (42.9)	
Nutritional background					0.136
Yes	254 (23.2)	164 (24.8)	84 (20.2)	6 (33.3)	
No	841 (76.8)	498 (75.2)	331 (79.8)	12 (66.7)	
Responsibility of food purchases					<0.001
Mainly responsible	510 (46.6)	363 (54.8)	141 (34.0)	6 (33.3)	
Co-responsible	497 (45.4)	273 (41.2)	214 (51.6)	10 (55.6)	
Little or not at all responsible	88 (8.0)	26 (3.9)	60 (14.5)	2 (11.1)	
Responsibility in meal preparation					<0.001
Mainly responsible	570 (52.1)	404 (61.0)	158 (38.1)	8 (44.4)	
Co-responsible	419 (38.3)	224 (33.8)	186 (44.8)	9 (50.0)	
Little or not at all responsible	106 (9.7)	34 (5.1)	71 (17.1)	1 (5.6)	
Frequency of eating out					<0.001
Never or seldom	226 (20.6)	155 (23.4)	67 (16.1)	4 (22.2)	
<1 time/week	155 (14.2)	102 (15.4)	49 (11.8)	4 (22.2)	
1 time/week	219 (20.0)	143 (21.6)	73 (17.6)	3 (17.7)	
2-4 times/week	328 (30.0)	182 (25.5)	141 (34.0)	5 (28.8)	
≥5 times/week	167 (15.3)	80 (12.1)	85 (20.5)	2 (11.1)	
Having lunch on working days					0.299
No	63 (5.8)	34 (5.1)	23 (6.3)	3 (16.7)	
Seldom	52 (4.7)	33 (5.0)	18 (4.3)	1 (5.6)	
Yes	980 (89.5)	595 (89.9)	371 (89.4)	14 (77.8)	
Home-cooked lunch					<0.001
Never or seldom	340 (31.4)	166 (25.4)	170 (41.4)	4 (22.2)	
<1 time/week	32 (3.0)	21 (3.2)	10 (2.4)	1 (5.6)	
1 time/week	59 (5.4)	35 (5.4)	21 (5.1)	3 (16.7)	
2-4 times/week	292 (27.0)	177 (27.1)	109 (10.1)	6 (33.3)	
≥5 times/week	360 (33.2)	255 (39.0)	101 (24.6)	4 (22.2)	
NK score	18.0 (16.0-21.0)	19.0 (16.0-21.0) ^a	18.0 (14.0-20.0) ^b	14.5 (11.0-19.0) ^b	<0.001
Medi-Lite score	12.0 (11.0-14.0)	12.0 (11.0-14.0)	12.0 (10.0-14.0)	13.0 (11.0-14.0)	0.135

NK: Nutrition Knowledge. Data are expressed as a number (%) or as the median (IQR). [†]Chi-square test.

§Nonparametric Kruskal-Wallis H test for independent sample with pairwise comparisons. Different letters in the same line highlight significant differences among adherence to MD groups. * Data reported only for faculty, research fellows and PhD students.

More than half of the respondents were female (57%), and about 40% aged between 46 and 60 years. As expected, most (77%) had a master's degree or postgraduate certification. However, almost half of the sample belonged to the technical-administrative staff. The majority of the subjects were Italian, and 60% resided in population centres with more than 50,000 inhabitants. Regarding family unit, a rather homogeneous distribution was observed among households of 1 to 4 members, most of them without minors. In addition, mostly of faculty, research fellow and PhD students

belonged to scientific-technological departments and 23% of the participants stated to have background in human nutrition (i.e., that they had covered nutrition-related topics during their education). In terms of food-related habits, almost all employees were mainly or co-responsible for purchasing food and preparing meals at home. In addition, the habit of having meals away from home was quite common, and 45% used to eat out at least 2 times a week. Ninety percent of enrolled employees regularly had lunch during working days, and of these, 60% most often consumed home-prepared meals. Lastly, the median NK score was 18.0 (16.0-21.0) and the median Medi-Lite score was 12.0 (11.0-14.0), by highlighting a moderate knowledge and a medium adherence to the MD before the intervention. Significant associations were found between participants' gender and several variables such as age group, employment status, academic sector, level of responsibility for food purchasing and meal preparation, frequency of eating out and having home-cooked lunches during the working days (all $p < 0.001$). When delving into the NK results (Table S1), generally the items related to experts' recommendations (e.g., sugars intake recommendation) recorded the lowest number of correct answers (<30%), whereas the questions about the health aspect of foods (e.g., salt and health risk) and proper food choices (e.g., strategy for healthy and sustainable nutrition) were those with the most correct answers (>70%). With regards to dietary habits, the percentages of scores obtained for each food group making up the Medi-Lite score were depicted graphically in **Figure S1**. Over two-thirds had an optimal consumption of cereals and regularly used olive oil. Between 40 and 50% of the entire population responding to consume the recommend amount of fruit, vegetables, and legumes, while less than 15% reported poor consumption of these plant-based foods. On the contrary, about half of the participants scored zero or one point, indicating excessive consumption of the meat category (47%) and milk and dairy products (50%). Some discrepancies between optimal consumption and selected choice were recorded for fish intake, with the sample splits into optimal or poor consumption with no intermediate consumption. Finally, according to the definition of adherence to the MD, 63% responding to have a sub-optimal daily intake of alcohol. In addition, the median dietary intakes by food categories are shown in Supplementary Table – S2.

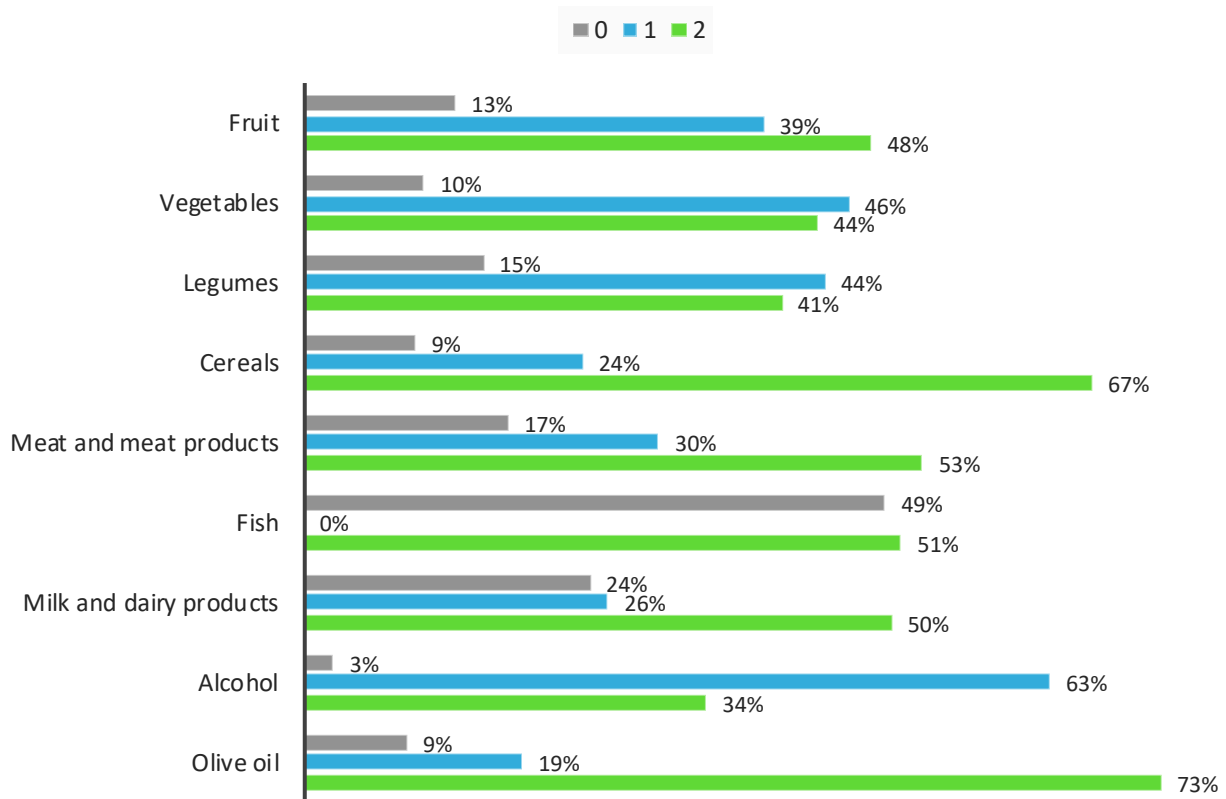


Figure S1 Answers to the questions relating single food component of the Medi-Lite score in the total sample at baseline data collection reported by level of consumption: poor (grey), average (blue), optimal (green).

Determinants of Nutrition Knowledge level and adherence to the Mediterranean Diet

The sample mostly belonged to the 1st tertile of NK (42%) and MD adherence (39%), showing a low to medium knowledge and adherence. Participants' characteristics were analysed according to their level of nutrition knowledge (**Table 2**) and adherence to the MD (**Table 3**) to highlight possible determinants of knowledge and adoption of healthy eating habits, respectively. Both analyses pointed out similar findings. Specifically, academic sector, nutritional background, responsibility in food purchasing and preparation, and consuming home-cooked lunches during the working days were found to be statistically significantly associated with the level of NK and MD adherence (all $p < 0.005$), emphasizing their possible role in the adoption of healthy eating habits. Notably, the MD score was significantly different among the three NK tertiles, with the 3rd one showing the highest scores (**Table 2**), vice versa considering the median NK score among the three MD adherence groups, the 3rd tertile had the highest score (**Table 3**).

As reported in **Table 3**, no significant associations were found between socio-demographic characteristics and level of adherence to the MD. On the contrary, gender, employment status, and educational level were significantly associated with the NK level (all $p < 0.001$). Considering the

distribution of the both scores among the categories of different socio-demographic data (Supplementary Table S3, Table S4), higher scores were observed in participants with higher educational level. In addition, significant differences were shown for age range ($p = 0.032$) and employment status ($p=0.019$) in term of NK.

Table 2 Socio-demographic characteristics, field of study, food-related habits, and nutritional knowledge reported for the baseline study sample by level of NK knowledge.

Variables	NK level			p-value
	1st tertile (n=359)	2nd tertile (n=310)	3rd tertile (n=426)	
Gender				<0.001
Females	176 (49.0)	200 (64.5)	286 (67.1)	
Males	171 (47.6)	107 (34.5)	137 (32.2)	
Non-binary	5 (1.4)	0 (0.0)	1 (0.2)	
I prefer not to answer	7 (1.9)	3 (1.0)	2 (0.5)	
Age range				0.059
<30 years	75 (20.9)	71 (22.9)	124 (29.1)	
31–45 years	100 (27.9)	83 (26.8)	99 (23.2)	
46–60 years	158 (44.0)	139 (44.8)	171 (40.1)	
>60 years	22 (6.1)	17 (5.5)	31 (7.3)	
I prefer not to answer	4 (1.1)	0 (0.0)	1 (0.2)	
Education level				<0.001
Secondary school	10 (2.8)	3 (1.0)	2 (0.5)	
High school	75 (20.9)	53 (17.1)	48 (11.3)	
Bachelor's degree	15 (4.2)	24 (7.7)	21 (4.9)	
Master's degree	133 (37.0)	125 (40.3)	179 (42.0)	
Postgraduate studies	126 (35.1)	105 (33.9)	176 (41.3)	
Employment status				0.034
Full or Associate Professor	50 (13.9)	39 (12.6)	72 (16.9)	
Assistant Professor	30 (8.4)	26 (8.4)	43 (10.1)	
Research fellow or PhD student	92 (25.6)	70 (22.6)	132 (31.0)	
Technical-administrative staff	167 (46.5)	160 (51.6)	160 (37.6)	
Student	7 (1.9)	6 (1.9)	11 (2.6)	
I prefer not to answer	13 (3.6)	9 (2.9)	8 (1.9)	
Nationality				0.569
Italian	356 (99.2)	305 (98.4)	419 (98.4)	
Other	3 (0.8)	5 (1.6)	7 (1.6)	
Size of residence (number of inhabitants)				0.397
<5000	56 (15.6)	45 (14.5)	76 (17.8)	
5000–49,999	80 (22.3)	85 (27.4)	97 (22.8)	
50,000–500,000	210 (58.5)	173 (55.8)	245 (57.5)	
>500000	13 (3.6)	7 (2.3)	8 (1.9)	
N. household members				0.578
1	77 (21.4)	61 (19.7)	78 (18.3)	
2	85 (23.7)	76 (24.5)	108 (25.4)	
3	99 (27.6)	72 (23.2)	104 (24.4)	
4	87 (24.2)	90 (29.0)	109 (25.6)	
5	10 (2.8)	9 (2.9)	22 (5.2)	

6	1 (0.3)	1 (0.3)	3 (0.7)	
>6	0 (0.0)	1 (0.3)	2 (0.5)	
N. household members				0.549
< 18 years				
None	242 (67.4)	207 (66.8)	294 (69.0)	
1	74 (20.6)	61 (19.7)	75 (17.6)	
2	37 (10.3)	39 (12.6)	52 (12.2)	
3	6 (1.7)	3 (1.0)	3 (0.7)	
4	0 (0.0)	0 (0.0)	2 (0.5)	
Academic sector*				<0.001
Food	7 (4.1)	9 (6.7)	35 (14.2)	
Human-Social	37 (21.5)	16 (11.9)	15 (6.1)	
Scientific-Technological	104 (60.5)	85 (63.0)	160 (64.8)	
Medicine	24 (14.0)	25 (18.5)	37 (15.0)	
Nutritional background				<0.001
Yes	57 (15.9)	62 (20.0)	135 (31.7)	
No	302 (84.1)	248 (80.0)	291 (68.3)	
Responsibility of food purchases				<0.001
Mainly responsible	133 (37.0)	157 (50.6)	220 (51.6)	
Co-responsible	182 (50.7)	130 (41.9)	185 (43.4)	
Little or not at all responsible	44 (12.3)	23 (7.4)	21 (4.9)	
Responsibility in meal preparation				<0.001
Mainly responsible	163 (45.4)	165 (53.2)	242 (56.8)	
Co-responsible	140 (39.0)	115 (37.1)	164 (38.5)	
Little or not at all responsible	56 (15.6)	30 (9.7)	20 (4.7)	
Frequency of eating out				0.117
Never or seldom	66 (18.4)	58 (18.7)	102 (23.9)	
<1 time/week	51 (14.2)	39 (12.6)	65 (15.3)	
1 time/week	63 (17.5)	64 (20.6)	92 (21.6)	
2–4 times/week	114 (31.8)	101 (32.6)	113 (26.5)	
≥5 times/week	65 (18.1)	48 (15.5)	54 (12.7)	
Having lunch on working days				0.005
No	33 (9.2)	11 (3.5)	19 (4.5)	
Seldom	21 (5.8)	16 (5.2)	15 (3.5)	
Yes	305 (85.0)	283 (91.3)	392 (92.0)	
Home-cooked lunch				<0.001
Never or seldom	136 (37.9)	99 (31.9)	105 (24.6)	
<1 time/week	12 (3.3)	7 (2.3)	13 (3.1)	
1 time/week	22 (6.1)	16 (5.2)	21 (4.9)	
2–4 times/week	94 (26.2)	87 (28.1)	111 (26.1)	
≥5 times/week	87 (24.2)	101 (32.6)	172 (40.4)	
Medi-Lite score	12.0 (10.0-13.0) ^b	12.0 (11.0-14.0) ^a	12.0 (11.0-14.0) ^a	<0.001

MD: Mediterranean Diet. NK: Nutrition Knowledge. Data are expressed as a number (%) or as the median (IQR). †Chi-square test. ^a 1st tertile ≤ 16; 2nd tertile 18–19; 3rd tertile > 20. §Nonparametric Kruskal-Wallis H test for independent sample with pairwise comparisons. Different letters in the same line highlight significant differences among adherence to MD groups. * Data reported only for faculty, research fellows and PhD students.

Table 3 Socio-demographic characteristics, field of study, food-related habits, and nutritional knowledge reported for the baseline study sample by level of MD adherence.

Variables	MD adherence			p-value
	1st tertile (n=422)	2nd tertile (n=358)	3rd tertile (n=315)	
Medi-Lite score	10.0 (9.0-11.0) ^c	12.0 (12.0-13.0) ^b	15.0 (14.0-15.0) ^a	<0.001 [§]
Gender				0.104 [†]
Females	252 (59.7)	207 (57.8)	203 (64.4)	
Males	165 (39.1)	145 (40.5)	105 (33.3)	
Non-binary	2 (0.5)	0 (0.0)	4 (1.3)	
I prefer not to answer	3 (0.7)	6 (1.7)	3 (1.0)	
Age range				0.621 [†]
<30 years	102 (24.2)	89 (24.9)	79 (25.1)	
31–45 years	119 (28.2)	80 (22.3)	83 (26.3)	
46–60 years	174 (41.2)	161 (45.0)	133 (42.2)	
>60 years	24 (5.7)	26 (7.3)	20 (6.3)	
I prefer not to answer	3 (0.7)	2 (0.6)	0 (0.0)	
Education level				0.170 [†]
Secondary school	8 (1.9)	4 (1.1)	3 (1.0)	
High school	80 (19.0)	55 (15.4)	41 (13.0)	
Bachelor's degree	28 (6.6)	20 (5.6)	12 (3.8)	
Master's degree	166 (39.3)	141 (39.4)	130 (41.3)	
Postgraduate studies	140 (33.2)	138 (38.5)	129 (41.0)	
Employment status				0.663 [†]
Full or Associate Professor	57 (13.5)	56 (15.6)	48 (15.2)	
Assistant Professor	37 (8.8)	32 (8.9)	30 (9.5)	
Research fellow or PhD student	109 (25.8)	95 (26.5)	90 (28.6)	
Technical-administrative staff	194 (46.0)	156 (43.6)	137 (43.5)	
Student	11 (2.6)	11 (3.1)	2 (0.6)	
I prefer not to answer	14 (3.3)	8 (2.2)	8 (2.5)	
Nationality				0.490 [†]
Italian	416 (98.6)	355 (99.2)	309 (98.1)	
Other	6 (1.4)	3 (0.8)	6 (1.9)	
Size of residence (number of inhabitants)				0.342 [†]
<5000	65 (15.4)	63 (17.6)	49 (15.6)	
5000–49,999	98 (23.2)	77 (21.5)	87 (27.6)	
50,000–500,000	247 (58.5)	206 (57.5)	175 (55.6)	
>500,000	12 (2.8)	12 (3.4)	4 (1.3)	
N. household members				0.768 [†]
1	86 (20.4)	69 (19.3)	61 (19.4)	
2	96 (22.7)	97 (27.1)	76 (24.1)	
3	103 (24.4)	86 (24.0)	86 (27.3)	
4	115 (27.3)	93 (26.0)	78 (24.8)	
5	20 (4.7)	9 (2.5)	12 (3.8)	
6	1 (0.2)	2 (0.6)	2 (0.6)	
>6	1 (0.2)	2 (0.6)	0 (0.0)	
N. household members < 18 years				0.079 [†]
None	284 (67.3)	250 (69.8)	209 (66.3)	
1	83 (19.7)	59 (16.5)	68 (21.6)	
2	46 (10.9)	45 (12.6)	37 (11.7)	
3	9 (2.1)	2 (0.6)	1 (0.3)	

4	0 (0.0)	2 (0.6)	0 (0.0)	
Academic sector*				0.024 [†]
Food	18 (8.9)	8 (4.4)	25 (14.9)	
Human-Social	26 (12.8)	22 (12.0)	20 (11.9)	
Scientific-Technological	134 (66.0)	118 (64.5)	97 (57.7)	
Medicine	25 (12.3)	35 (19.1)	26 (15.5)	
Nutritional background				0.003 [†]
Yes				
No	75 (17.8)	97 (27.1)	82 (26.0)	
	347 (82.2)	261 (72.9)	233 (74.0)	
Responsibility of food purchases				0.010 [†]
Mainly responsible	185 (43.8)	168 (46.9)	157 (49.8)	
Co-responsible	195 (46.2)	155 (43.3)	147 (46.7)	
Little or not at all responsible	42 (10.0)	35 (9.8)	11 (3.5)	
Responsibility in meal preparation				0.008 [†]
Mainly responsible	214 (50.7)	176 (49.2)	180 (57.1)	
Co-responsible	155 (36.7)	145 (40.5)	119 (37.8)	
Little or not at all responsible	53 (12.6)	37 (10.3)	16 (5.1)	
Frequency of eating out				0.001 [†]
Never or seldom	87 (20.6)	74 (20.7)	65 (20.6)	
<1 time/week	66 (15.6)	43 (12.0)	46 (14.6)	
1 time/week	59 (14.0)	78 (21.8)	82 (26.0)	
2–4 times/week	150 (35.5)	102 (28.5)	76 (24.1)	
≥5 times/week	60 (14.2)	61 (17.0)	46 (14.6)	
Having lunch on working days				0.006 [†]
No	33 (7.8)	17 (4.7)	13 (4.1)	
Seldom	29 (6.9)	9 (2.5)	14 (4.4)	
Yes	360 (85.3)	332 (92.7)	288 (91.4)	
Home-cooked lunch				0.011 [†]
Never or seldom	150 (36.0)	111 (31.4)	79 (25.2)	
<1 time/week	10 (2.4)	11 (3.1)	11 (3.5)	
1 time/week	31 (7.4)	11 (3.1)	17 (5.4)	
2–4 times/week	109 (26.1)	94 (26.6)	89 (28.4)	
≥5 times/week	117 (28.1)	126 (35.7)	117 (37.4)	
NK score	17.50 (15.0-20.0) ^c	19.00 (15.0-21.0) ^b	19.00 (17.0-21.0) ^a	<0.001 [§]

MD: Mediterranean Diet. NK: Nutrition Knowledge. Data are expressed as a number (%) or as the median (IQR). [†]Chi-square test. ^a 1st tertile ≤ 11; 2nd tertile 12–13; 3rd tertile > 13. [§]Nonparametric Kruskal-Wallis H test for independent sample with pairwise comparisons. Different letters in the same line highlight significant differences among adherence to MD groups. * Data reported only for faculty, research fellows and PhD students.

To better understand the influence of sample characteristics on NK level and MD adherence as well, logistic regression analyses were performed to determine the probability of having high NK (Table 4) and optimal adherence to the MD (Table 5), separately. According to both univariate analyses, affiliation with the Food Science Department increased the NK and the adherence to the MD compared with belonging to other research fields, including medicine. On the contrary, the poor

responsibility in food purchase and meal preparation reduced the likelihood of having high NK and MD score. As a matter of fact, a strong association was found between the frequency of consumption of home-cooked lunches and the knowledge and adoption of a healthy dietary pattern such as the MD. In addition, the nutrition background was found to be a major determinant of high NK but the impact on the level of MD adherence was not confirmed by these results. In addition, being female has been emphasized as a positive predictor of NK level. On the contrary, being part of the technical-administrative staff reduced the likelihood of having a high NK.

Table 4 Logistic regression analysis for being in the high tertile of NK considering a set of variables evaluated singularly.

Variables	OR (95% CI)	p-value
Medi-Lite score	1.120 (1.060-1.183)	<0.001
Gender		
Females	-1-	
Males	0.648 (0.502-0.837)	<0.001
Non-binary gender [†]	0.263 (0.263-0.917)	0.036
Employment status		
Full or Associate Professor	-1-	
Assistant Professor	0.949 (0.573-0.1.572)	0.839
Research fellow or PhD student	1.007 (0.684-1.482)	0.971
Technical-administrative staff	0.605 (0.420-0.870)	0.007
Educational level		
Secondary school	-1-	
High school	3.231 (0.410-25.444)	0.265
Bachelor's degree	4.667 (0.565-38.539)	0.076
Master's degree	5.799 (0.755-44.564)	0.091
Postgraduate studies	7.182 (0.935-55.186)	0.058
Academic sector*		
Food	-1-	
Human-Social	0.129 (0.057-0.295)	<0.001
Scientific-Technological	0.387 (0.207-0.725)	0.003
Medicine	0.345 (0.166-0.716)	0.004
Nutritional background		
Yes	-1-	
No	0.466 (0.351-0.620)	0.001
Responsibility of food purchases		
Mainly responsible	-1-	
Co-responsible	0.782 (0.607-1.106)	0.056
Little or not at all responsible	0.413 (0.245-0.695)	<0.001
Responsibility in meal preparation		
Mainly responsible	-1-	
Co-responsible	0.872 (0.674-1.127)	0.295
Little or not at all responsible	0.315 (0.188-0.527)	<0.001
Habit of having lunch on working days		
No	-1-	
Seldom	0.939 (0.419-2.102)	0.878
Yes	1.544 (0.888-2.684)	0.124
Frequency of consumed home-cooked lunch		
Never or seldom	-1-	
<1 time/week	1.531 (0.729-3.216)	0.260
1 time/week	1.237 (0.692-2.210)	0.473
2–4 times/week	1.373 (0.987-1.909)	0.0.60
≥5 times/week	2.048 (1.503-2.790)	<0.001

† Data also included the subjects answered “I prefer not to answer”.

* Data reported only for faculty, research fellows and PhD students.

Table 5 Logistic regression analysis for being in the high level of MD adherence considering a set of variables evaluated singularly.

Variables	OR (95% CI)	p-value
NK score	1.076 (1.041-1.112)	< 0.001
Academic sector*		
Food	-1-	
Human-Social	0.433 (0.203-0.924)	0.030
Scientific-Technological	0.400 (0.220-0.727)	0.003
Medicine	0.451 (0.220-0.923)	0.029
Nutritional background		
Yes	-1-	
No	0.804 (0.594-1.089)	0.158
Responsibility of food purchases		
Mainly responsible	-1-	
Co-responsible	0.944 (0.721-1.236)	0.677
Little or not at all responsible	0.321 (0.166-0.621)	< 0.001
Responsibility in meal preparation		
Mainly responsible	-1-	
Co-responsible	0.859 (0.652-1.133)	0.282
Little or not at all responsible	0.385 (0.220-0.675)	< 0.001
Frequency of eating out		
Never or seldom	-1-	
<1 time/week	1.045 (0.667-1.638)	0.847
1 time/week	1.483 (0.996-2.206)	0.052
2-4 times/week	0.747 (0.508-1.099)	0.138
≥5 times/week	0.942 (0.603-1.470)	0.791
Habit of having lunch on working days		
No	-1-	
Seldom	1.417 (0.597-3.365)	0.430
Yes	1.601 (0.856-2.992)	0.140
Frequency of consumed home-cooked lunch		
Never or seldom	-1-	
<1 time/week	1.731 (0.800-3.744)	0.164
1 time/week	1.337 (0.721-2.479)	0.356
2-4 times/week	1.448 (1.138-2.223)	0.040
≥5 times/week	1.591 (1.382-2.223)	0.007

NK: Nutrition Knowledge. * Data reported only for faculty, research fellows and PhD students.

Intervention effects on Nutrition Knowledge and dietary habits

Short-term impact of intervention in terms of Nutrition Knowledge

The effect of e-learning training on NK immediately after the intervention is graphically reported in **Figure 1**. Considering the study sample who completed T1 data collection (n=929) a significant increase in NK score was found right after the educational intervention from 18.0 (15.0-21.0) to 23.0 (21.0-25.0) ($p < 0.001$) (Fig 3).

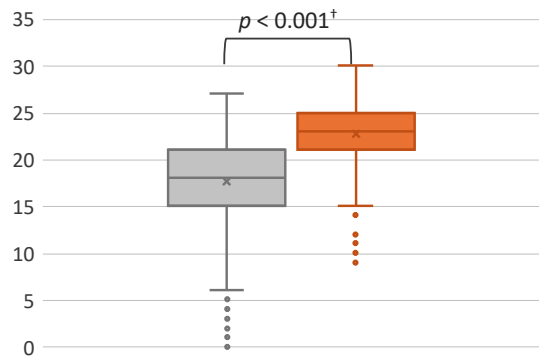


Fig 1 Effect of e-learning training on nutritional knowledge immediately after the end of the course. The analyses consider participants who completed T1 data collection (n=929). T0: grey; T1: orange. [†]Non-parametric Wilcoxon test.

Long-term impact of intervention in terms of Nutrition Knowledge and dietary changes

The impact of the education intervention after three months of follow up is graphically reported in **Figure 2** considering both knowledge and eating habits in terms of adherence to the MD.

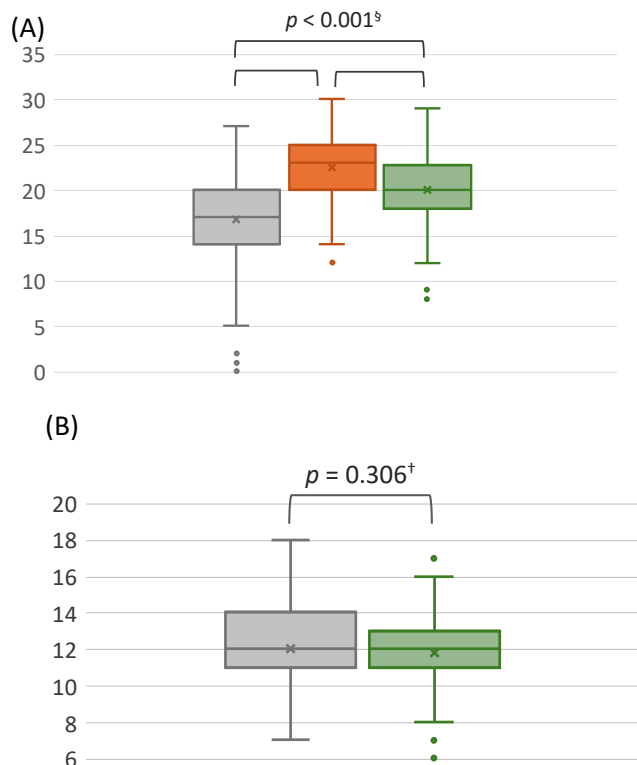


Fig 2. Effect of e-learning training on nutritional knowledge (A) and adherence to the MD (B) after 3 months (B). The analyses consider participants who completed the T2 follow-up phase (n=124). T0: grey; T1: orange; T2: green. [§]Non-parametric Friedman test. [†]Non-parametric Wilcoxon test.

Despite the small number of participants attending follow-up (T2) (n=124) 3 months after the end of the course, the NK score recorded at this final stage was still significantly higher than the initial

value (T0), confirming the effectiveness of the educational intervention (Fig 2-A). However, it is important to emphasize that despite the positivity of these results, there was a significant decrease in NK score between T1 and follow-up, indicating a loss of knowledge over time. With regards to dietary habits, no significant changes in terms of adherence to the MD were evidenced (Fig 2-B), except for an increase in the consumption of fruit ($p=0.005$) (data not shown). However, a significant correlation was shown between Medi-Lite score and NK score at T2 (Pearson's $\rho = 0.334, p < 0.001$). The degree of correlation was small but higher than at baseline (Pearson's $\rho = 0.178, p < 0.001$).

DISCUSSION

In this paper we analyzed the NK and the adherence to the MD in a large sample of employees attending an education intervention promoted within the University of Parma community. Consistent with our results, an Italian study explored the NK on a nationally representative sample of adults (257) showing a moderate level of knowledge. Also, the median level of adherence to the MD at baseline was in line with previous studies carried out at national (258–262) and regional level (263–266) reporting an overall medium compliance with MD principles and confirming a declining trend over time (267). Looking at the detailed analysis of the individual food categories included in the Medi-Lite scale, the eating habits of Parma University community were mostly in line with dietary intakes reported by Lotti and colleagues for a large sample of Italian adults between 2019 and 2022 (267). Cross-referring our results with more recent data for the Italian population (268) our sample had an intake of fruits, vegetables, cereals, dairy products, and olive oil more in line with the MD recommendations. Considering the latest Italian National Food Consumption Survey - SCAI 2017-2020 (269), the median dietary intakes of our community were in line with the national average for vegetables, cereals and dairy products. Whereas, our sample showed a higher consumption of fruits and legumes, and a lower intake of meat and fish. However, it is important to remark that not all the studies cited applied the same food recording methods, making accurate comparisons more difficult. Willing to consider a global benchmark as the recommended intakes for Planetary Health Diet outlined by Eat-Lancet Commission (270), our sample showed adequate median consumption of fish, poultry and fruits, sub-optimal median intake of legumes and dairy products, and excessive median intake of red meat. Sociodemographic characteristics highly impacted participants' NK. In line with previous studies, being females and having higher level of education were found to be associated with better knowledge (271). Otherwise, in contrast to existing literature that often reports higher MD adherence among women and elderly (272), no significant associations were highlighted by our findings. However, consistently with other studies (265,273), higher educational levels were positive predictors of higher MD score as well. More specifically, university staff of the Food Department were the most likely of having a high level of NK and to follow a MD regimen. These findings corroborated that good NK strongly influences people's eating behaviors, supporting the adoption of healthy dietary habits (274,275). It is also important to emphasize that participants in the medical field did not distinguish themselves as having a good level of NK. These results confirm the lack of adequate nutrition education in medical schools' curricula (276). In this context, future actions to improve the NK of health care professionals would be relevant to achieve a beneficial impact on communities' wellbeing. In addition, it is

noteworthy to underline that both NK and adherence to the MD were highly influenced by the extent of responsibility in food purchasing and preparation, as well as the frequency of consumed home-cooked lunch. This outcome highlights the concept of food involvement, such as the participation in the purchase and preparation of food, and confirmed its role in adopting healthy eating behaviors, as previously pointed out in the literature (277,278). In this regard, a recent systematic review (279) showed improved diet quality in European populations during 2019 Coronavirus (Covid-19) confinement, especially among Mediterranean countries. As pointed out by the authors (279), healthier eating habits might be due to more time devoted to food preparation, corroborating the role of food involvement and culinary skills in adopting healthy foodways. With regards to the effectiveness of the e-learning training, as previously reported in the literature (280), cognitive interventions in nutrition education (e.g., lectures or trainings) increased knowledge and consciousness about the effects of diet but have limited impact on behavioural change. In line with this, the lectures provided as intervention in our study have proven to be effective in increasing the NK, but not in determining a change in habits in the short-medium term. Therefore, given the complexity of factors that determine food choices at different levels (i.e., individual, social environment, physical environment, and macro-level environment), as a suggestion for future studies, it is advisable that nutrition training is not delivered singularly but be part of a multidimensional educational strategy (281). Combining e-learning with practical and interactive interventions could prove more effective. Several studies revealed the value of incorporating hands-on cooking activities into nutrition education projects (282). In this regard, various intervention studies performed corroborate the importance of imparting culinary skills to improve communities' eating habits (283–286), exploiting various environments including the workplaces and universities. Given this, is crucial to implement a comprehensive initiative to promote eating well on campus by enhancing NK and culinary skills, but also facilitating sustainable food choices providing healthy foods through canteens and vending machines (287). In this context, collaboration with university food services is crucial. Previous studies performed in similar settings, such as workplace canteen (288) and vending machines (289), highlighted the potential of these interventions in improving the choice of plant-based foods (290) and encouraging better food choices (291) at the lunchtime and during breaks. In the university setting, integrating these findings into food services might drive a shift toward healthier and more sustainable eating behaviors. For instance, introducing meal options aligned with the MD optimizing portion sizes, and providing clear information can directly influence diners' food preferences. Similarly, improving vending machine offerings by replacing

high-calorie snacks with healthier alternatives could further support these objectives. These joint efforts between academic institutions and catering services address immediate health and sustainability concerns while also laying the groundwork for the adoption of long-term healthy eating habits among university community. In addition, the use of Information and Communications Technology (ICT), such as mobile apps, would also enable to regularly monitor progress and adapt interventions based on participant feedback, as well as social networking among university community. Both these aspects are reported in the literature as crucial strategies for achieving lasting behavioral changes (290–295). This is the first study evaluating the NK and eating habits of the Parma University community while testing the efficacy of e-learning educational intervention. The involvement of the entire academic community and the large turnout provided a representative picture of the food behaviors of University of Parma employees while longitudinal approach made it possible to observe possible changes of the participants' nutritional knowledge and eating habits. Moreover, the use of a validated questionnaire to assess the adherence to the MD ensured a better accuracy and reliability of the data gathered. In addition, the NK questionnaire specifically developed for the study showed a good internal consistency. Although future validation on a larger sample is advisable, these preliminary results are promising to consider this short questionnaire a reliable tool for assessing nutritional knowledge in an Italian adult population. However, the study has some limitations. To begin with, since the intervention study was promoted within the mandatory training course in workplace health and safety for all university employees, the enrolment of a control group was not possible. In addition, the sample size decreased throughout the study due to the high dropout rate, especially during the follow-up phase. The limited number of participants completing all the study requests reduced the representativeness of the sample, making it difficult to draw a robust conclusion about the medium-long term effectiveness of the intervention. In conclusion, this study provides a picture of the eating habits of Parma University staff, showing low to medium adherence to the MD characterized by a suboptimal intake of fruits, vegetables, legumes and fish in about half of the sample. The intervention findings confirmed the effectiveness of nutrition education lectures in rising theoretical understanding but without concretely improving participants' eating habits. The difficulties in turning increased nutritional knowledge into dietary changes have emphasized the need for integrated approaches that combine nutrition education with behavioural interventions, such as optimising food services to encourage healthy food choices and practical activities to help in healthy food preparation and selection. It is also essential to bear in mind the factors emerged as predictors of high adherence to the MD, such

as responsibility in food purchasing and daily meal preparation. In this context, future initiatives should explore different types of action, including handy tools and activities to improve cooking skills and facilitate meal management. Finally, a long-term intervention with a large and consistent sample over time is crucial for monitoring the persistence of educational effects and their conversion into stable eating habits, therefore enhanced participant engagement and motivation will be paramount.

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SUPPLEMENTARY MATERIALS

Table S.1 Item analysis for the 30 questions of the nutrition knowledge questionnaire.

Item	Item Difficulty (% Correct Answers)	Item Discrimination (r Value)
1 - protein content of food	86%	0.431
2 - saturated fats content of food	26%	0.273
3 - carbohydrates intake recommendation	30%	0.294
4 - meat intake recommendation	37%	0.326
5 - cheese portion size	73%	0.440
6 - milk and yogurt intake recommendation	8%	0.137
7 - salt and health risk	95%	0.340
8 - salt intake recommendation	34%	0.315
9 - strategies to result salt intake	79%	0.468
10 - sugars intake recommendation	4%	0.067
11 - sugars content of food	90%	0.361
12 - strategies to reduce sugars intake	85%	0.410
13 - typology of fiber	49%	0.463
14 - health aspects of fiber	81%	0.460
15 - strategies to increase fiber intake	72%	0.412
16 - hydration recommendation	34%	0.245
17 - dehydration risk	73%	0.254
18 - strategy for an adequate hydration status	75%	0.270
19 - breakfast recommendation	35%	0.290
20 - lunch recommendation	74%	0.454
21 - snack recommendation	82%	0.414
22 - balanced meal at pizzeria	51%	0.375
23 - unbalanced meal	68%	0.348
24 - composition of a healthy sandwich	76%	0.428
25 - definition of sustainable diet	71%	0.358
26 - carbon footprint of foods	73%	0.439
27 - strategy for healthy and sustainable nutrition	88%	0.381
28 - lactose intolerance	47%	0.191
29 - food allergies and intolerances	34%	0.299
30 - gluten content of food	58%	0.503

Table S2. Dietary intakes reported by food categories included in the Medi-Lite scale for the baseline study sample.

Variables	Median (IQR)
Fruit (g/die)	300.0 (150.0 - 500.0)
Vegetables (g/die)	200.0 (150.0 - 350.0)
Legumes (g/die)	20.0 (10.0 - 40.0)
Pasta or grains (g/die)	80.0 (80.0 - 120.0)
Bread (g/die)	80.0 (40.0 - 80.0)
Biscuits (g/die)	15.0 (0.0 - 30.0)
Breakfast cereals (g/die)	0.0 (0.0 - 30.0)
Pizza (g/die)	42.9 (21.4 - 42.9)
Total Cereals (g/die)	232.9 (172.9 - 301.4)
White meat (g/die)	28.6 (21.4 - 57.1)
Red meat (g/die)	21.4 (14.3 - 42.9)
Processed meats/day (g/die)	11.4 (5.7 - 22.9)
Total meat (g/die)	75.7 (48.6 - 108.6)
Fish/week (g/die)	28.6 (14.3 - 57.1)
Milk (g/die)	50.0 (0.0 - 200.0)
Yogurt (g/die)	0.0 (0.0 - 125.0)
Fresh cheeses (g/die)	17.1 (8.6 - 34.3)
Seasoned cheeses (g/die)	14.3 (7.1 - 21.4)
Total dairy products (g/die)	180.7 (80.0 - 266.4)
Alcohol (ml/die)	0.0 (0.0 - 12.0)

Data are reported as median (IQR)

Table S3. Difference in Nutrition Knowledge score based on socio-demographic characteristics reported for the baseline study sample as total.

Variables	Nutrition Knowledge score (n=1095)	p-value
Gender		< 0.001
Females	19.0 (16.0-21.0) ^a	
Males	18.0 (14.0-20.0) ^b	
Non-binary	12.0 (11.0-15.0) ^c	
I prefer not to answer	16.0 (11.5-19.0) ^{bc}	
Age range		0.032
<30 years	19.0 (16.0-21.0) ^a	
31–45 years	18.0 (15.0-21.0) ^b	
46–60 years	18.0 (15.0-21.0) ^b	
>60 years	19.0 (16.0-21.0)	
I prefer not to answer	14.0 (12.0-16.0)	
Education level		< 0.001
Secondary school	16.0 (12.0-19.0) ^c	
High school	17.0 (14.0-20.0) ^{bc}	
Bachelor's degree	18.5 (16.5-20.5) ^{ab}	
Master's degree	19.0 (16.0-21.0) ^a	
Postgraduate studies	19.0 (16.0-21.0) ^a	
Employment status		0.019
Full or Associate Professor (0)	19.0 (15.0-21.0)	
Assistant Professor (1)	19.0 (16.0-21.0) ^a	
Research fellow or PhD student (2)	19.0 (16.0-21.0) ^{ab}	
Technical-administrative staff (3)	18.0 (15.0-20.0) ^c	
Student (4)	19.0 (16.0-21.0)	
I prefer not to answer (5)	17.0 (15.0-20.0) ^{bc}	
Nationality		0.222
Italian	18.0 (16.0-21.0)	
Other	19.0 (17.5-22.5)	
Size of residence (number of inhabitants)		0.277
<5000	19.0 (15.0-21.0)	
5000–49,999	19.0 (16.0-21.0)	
50,000–500,000	18.0 (16.0-21.0)	
>500,000	17.0 (13.5-20.0)	
N. household members		0.289
1	18.0 (16.0-21.0)	
2	18.0 (16.0-21.0)	
3	18.0 (15.0-21.0)	
4	18.0 (16.0-21.0)	
5	20.0 (17.0-22.0)	
6	20.0 (19.0-21.0)	
>6	24.0 (21.0-24.0)	
N. household members < 18 years		0.185
None	19.0 (16.0-21.0)	
1	18.0 (15.0-21.0)	
2	18.5 (16.0-21.0)	
3	11.5 (16.5-20.0)	
4	22.0 (20.0-24.0)	

Nonparametric Kruskal-Wallis H test for independent sample with pairwise comparisons. Different letters in the same line highlight significant differences.

Table S4. Difference in Medi-Lite score based on socio-demographic characteristics reported for the baseline study sample as total.

Variables	Medi-Lite score (n=1095)	p-value
Gender		0.242
Females	12.0 (11.0-14.0)	
Males	12.0 (10.0-14.0)	
Non-binary	14.0 (10.0-14.5)	
I prefer not to answer	13.0 (11.3-13.8)	
Age range		0.554
<30 years	12.0 (11.0-14.0)	
31–45 years	12.0 (10.0-14.0)	
46–60 years	11.0 (12.0-14.0)	
>60 years	12.5 (11.0-14.0)	
I prefer not to answer	11.0 (9.5-12.0)	
Education level		0.016
Secondary school	11.0 (8.0-13.0)	
High school	12.0 (10.0-13.0) ^b	
Bachelor's degree	12.0 (11.0-13.0) ^b	
Master's degree	12.0 (10.0-14.0)	
Postgraduate studies	12.0 (11.0-14.0) ^a	
Employment status		0.670
Full or Associate Professor	12.0 (11.0-14.0)	
Assistant Professor	12.0 (11.0-14.0)	
Research fellow or PhD student	12.0 (11.0-14.0)	
Technical-administrative staff	12.0 (10.0-14.0)	
Student	12.0 (10.3-13.0)	
I prefer not to answer	12.0 (10.8-14.0)	
Nationality		0.466
Italian	12.0 (11.0-14.0)	
Other	12.0 (11.0-15.0)	
Size of residence (number of inhabitants)		0.626
<5000	12.0 (10.0-14.0)	
5000–49,999	12.0 (11.0-14.0)	
50,000–500,000	10.0 (12.0-14.0)	
>500,000	11.0 (12.0-13.0)	
N. household members		0.942
1	12.0 (11.0-14.0)	
2	12.0 (11.0-14.0)	
3	12.0 (10.0-14.0)	
4	12.0 (11.0-14.0)	
5	12.0 (10.0-14.0)	
6	13.0 (10.5-14.5)	
>6	12.0 (11.0-12.0)	
N. household members < 18 years		0.489
None	12.0 (11.0-14.0)	
1	12.0 (10.0-14.0)	
2	12.0 (11.0-14.0)	
3	11.0 (10.3-11.8)	
4	12.0 (12.0-12.0)	

Nonparametric Kruskal-Wallis H test for independent sample with pairwise comparisons. Different letters in the same line highlight significant differences.

Study 6
INAIL Workclimate Project: Information Guide for Workers on Heat Management and
Nutrition

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ABSTRACT

The increasing importance of nutritional education and healthy lifestyle promotion in the workplace has significant implications for both employee well-being and business productivity. The workplace provides an ideal environment to influence lifestyle habits, helping prevent chronic diseases like obesity, type 2 diabetes, and cardiovascular conditions. A balanced diet, such as the Mediterranean Diet, not only improves physical health but also boosts cognitive abilities, stress resilience, and work efficiency. Integrating physical activity, stress management, and proper nutrition further enhances employee productivity. Information technology (IT), such as mobile apps and digital platforms, plays a pivotal role in delivering personalized health education, offering meal plans, exercise programs, and hydration reminders. The INAIL Workclimate project highlights the intersection of technology, nutrition education, and workplace well-being, focusing on mitigating the effects of heat stress through proper hydration, nutrition, and practical recommendations. This holistic approach fosters a healthier, more productive workforce while reducing absenteeism and healthcare costs.

BACKGROUND

The importance of nutritional education and a healthy lifestyle in the workplace

In recent decades, nutritional education and the promotion of a healthy lifestyle have gained increasing relevance, not only in private life but also in the workplace. This is because most people spend a significant portion of their day at work, making this context an ideal opportunity to positively influence employees' lifestyle habits. Promoting healthy behaviors at work not only improves individual health but also has tangible benefits for business productivity (296,297). Nutritional education is essential to prevent chronic diseases linked to poor eating habits, such as obesity, type 2 diabetes, cardiovascular diseases, and some forms of cancer (298). Similarly, appropriate education can be crucial in protecting the health of workers in specific work conditions, such as during extreme heat. In this sense, the workplace, as a social microcosm, offers a unique opportunity to raise employee awareness about the importance of a balanced diet and informed dietary choices (297).

Healthy diet and lifestyle: impacts on workplace well-being

Scientific studies show that a balanced diet, based on eating models like the Mediterranean Diet (MD), not only improves physical well-being but also enhances cognitive abilities, concentration, and stress resilience. An employee who follows a healthy and balanced diet is generally more efficient, less prone to errors, and better able to handle intensive workloads (299). Additionally, a correct diet reduces absenteeism due to illnesses related to an unbalanced lifestyle, such as metabolic and cardiovascular diseases (300). Besides nutrition, a healthy lifestyle should also include physical activity, stress management, the prevention of addictions like smoking, and maintaining an adequate work-life balance. Companies can facilitate positive changes in employee habits by promoting active breaks, offering corporate fitness programs, or encouraging the use of stairs instead of elevators. All these initiatives can have a significant impact on employees' overall health and well-being (218).

The use of IT devices to convey health education

Information technology (IT) plays a key role in promoting health in the workplace. Mobile applications, digital platforms, and dedicated software can be used to provide personalized content to employees, such as meal plans, exercise programs, and stress management techniques. For instance, apps can serve as reminders to encourage regular hydration, meal planning, and active breaks, contributing to a healthier lifestyle (301,302). The use of IT also allows for monitoring

individual well-being, providing real-time feedback and suggestions for improving daily habits. Push notifications, informational quizzes, and educational videos can serve as effective training tools without interfering with work activities. Moreover, the personalization aspect is particularly relevant, as workers can receive tailored advice based on their nutritional needs or specific health goals (303).

Informative materials and supporting graphics

Integrating IT devices with physical supports, such as informational flyers or posters, enhances the effectiveness of health education campaigns in the workplace. Neuromarketing studies have shown that combining engaging visual stimuli with clear informational content increases the likelihood that employees will remember the message and adopt new behaviors (304). Flyers and posters, placed in strategic areas such as cafeterias and locker rooms, can convey key information like tips for healthy lunches, the benefits of physical activity, or suggestions on how to avoid poor posture at the desk. Graphics, through clear diagrams and engaging images, are a powerful vehicle for normalizing and making healthy habits more desirable (305).

INAIL

INAIL, the National Institute for Insurance against Accidents at Work, is a public entity that manages compulsory insurance for work-related injuries and occupational diseases (306). It plays a crucial role in worker safety, with the primary goal of reducing accidents and ensuring the protection of workers in high-risk environments. In addition, the institute is responsible for the reintegration of injured workers into the workforce and promotes research in the field of prevention and workplace safety. The protection provided by INAIL is part of an integrated system that includes prevention, economic and healthcare support, and the reintegration of individuals who have suffered physical damage. The insurance, mandatory for employers with employees and parasubordinate workers, relieves them of civil liability for damages caused by workplace injuries or occupational diseases. To reduce workplace accidents, INAIL continuously monitors data related to incidents, offers training and consulting services to businesses, especially small and medium-sized enterprises, and provides financial incentives to improve safety. Furthermore, INAIL conducts research to develop more effective prevention methodologies. Recently, INAIL has sought collaboration with the University of Parma, particularly with the Department of Human Nutrition, to gather and provide scientifically accurate information to employees, based on accredited studies, to promote a more informed

prevention culture. This partnership strengthens INAIL's scientific and innovative approach to awareness and training, making the institute even more effective in its commitment to the health and safety of workers (307).

Workclimate Project

In this context, the Workclimate project, promoted by INAIL, in collaboration with the Human Nutrition Unit of the University of Parma, focuses on the effects of environmental heat stress on the health and productivity of workers, with particular attention to sectors most exposed, such as agriculture and construction, where workers spend most of their time outdoors and are subject to heatwaves (307,308). Extreme heat can significantly affect workers' health, increasing the risk of dehydration, heatstroke, and other ailments (309). Nutritional education and the promotion of a proper diet, therefore, become essential tools for mitigating the impact of heat stress. For example, the consumption of water-rich foods (fruits and vegetables, typical of MD) and minerals like potassium and magnesium is crucial for maintaining electrolyte balance, necessary for the body's proper functioning under intense heat conditions (201,310).

Technology and prevention in the Workclimate project

The Workclimate project also stands out for its innovative use of IT, such as a web-based forecasting platform and a web app that provide personalized predictions based on climatic conditions and the characteristics of individual workers. The integration of these technologies with health education initiatives, delivered via IT devices, represents a unique opportunity to promote healthy behaviors and prevent injuries related to heat stress. Technology also allows for the distribution of personalized educational content, including dietary advice, hydration tips, and strategies for coping with adverse climatic conditions. These technological solutions, enriched with digital flyers and clear graphics, make the message immediate and easily understandable, thus increasing workers' adherence to the recommended practices (307).

Informative brochure and practical recommendations

Complementing the technology, the Workclimate project developed the "Informative Guide for Workers on Heat and Nutrition", an informative brochure addressing the topics of heat-related illnesses, the factors contributing to their onset, and practical recommendations for

preventing microclimate-related risks (308). This brochure provides clear and practical guidance for managing extreme heat, in compliance with Art. 2, paragraph 2 of Legislative Decree 81/08, which emphasizes the importance of planning company interventions to prevent microclimatic risks (311).

The importance of each point in the educational brochure (Figure 1):

Adequate hydration: Drinking at least 2 litres of water a day, especially during hot days, is essential to prevent dehydration, one of the main consequences of heat stress. Heat causes high fluid loss through sweating, and if not compensated for can lead to heat stroke or fatigue. Consistently drinking fluids, even in the absence of thirst, helps maintain the body's water balance and prevent discomfort (310).

Water-rich foods: Incorporating fresh fruit and vegetables such as watermelon, melon, cucumber and lettuce into the diet not only helps to maintain hydration, but also provides important vitamins and minerals. Fruits and vegetables are cornerstones of the MD, famous for promoting the intake of essential nutrients such as potassium and magnesium, which support muscle function and help prevent heat-related cramps and fatigue (201).

Avoid sugary drinks and alcohol: Sugary drinks and alcohol, although they may seem refreshing, have diuretic effects and can promote dehydration, worsening the body's ability to handle heat. Alcohol in particular increases diuresis, reducing fluid levels and enhancing the effects of dehydration, as well as impairing mental clarity. These drinks not only counteract the benefits of water, but also alter the electrolyte balance, increasing the risk of illness (312).

Light and frequent meals: During days of intense heat, it is advisable to eat light and frequent rather than large meals, so as not to overload the digestive system and to maintain a constant energy level. Digesting large meals increases body temperature, worsening the feeling of heat. Preferring small, frequent meals helps maintain an active metabolism and adequate energy distribution (313).

Whole grains and legumes: The MD places great emphasis on the consumption of whole grains and legumes, which provide complex carbohydrates and fibre. These foods contribute to regular digestion and prolong the feeling of satiety, reducing the need for unhealthy snacking. In addition, they are an excellent source of sustainable energy, particularly useful during hot working hours

(201).

Avoid salty and fatty foods: Foods high in salt and fat not only increase thirst, but also worsen the feeling of heaviness and can contribute to digestive problems. On hot days, reducing the consumption of fatty and salty foods improves digestive comfort and helps keep energy levels stable. Here again, the MD provides important guidance, as it promotes the moderate use of salt and fat, preferring extra virgin olive oil and natural spices (201,314).

Careful storage of food: Proper food storage is crucial to prevent food poisoning, especially in hot weather, when the risk of microbial contamination increases. Maintaining the cold chain ensures food safety, avoiding illnesses that could compromise workers' health and productivity (315).

Reusable bottles and continuous hydration: The brochure recommends carrying a water bottle with you at all times and preferring reusable containers over plastic bottles exposed to the sun. This tip is especially relevant for those working outdoors, as exposure of plastic to sunlight can encourage the release of harmful chemicals. Using safe bottles and drinking regularly throughout the day helps to keep the body hydrated effectively and continuously (316).

DISCUSSION AND CONCLUSION

In conclusion, nutrition education and the promotion of a healthy lifestyle in the workplace is not only an opportunity to improve the well-being and health of employees, but also an effective corporate strategy to increase productivity, reduce absenteeism and prevent work-related illnesses (317,318). The use of IT devices, integrated with visual information materials such as leaflets and posters, enables companies to deliver educational content in an effective and personalised manner, encouraging the adoption of healthy habits (319,320). INAIL's Workclimate project offers a concrete example of how technology can be used to prevent illnesses related to extreme working conditions, such as heat stress, through a multidisciplinary approach that combines prevention, nutrition education and advanced technological tools (307). The practical recommendations contained in the Workers' Guide on Heat and Nutrition (**Figure 1**) provide precise indications to protect workers' health and reduce the incidence of heat-related injuries and illnesses (311). By taking a holistic view of occupational well-being, encompassing nutrition, hydration, physical activity and stress management, companies can create a safer and healthier environment, helping to improve workers' quality of life and, at the same time, their efficiency and productivity. This integrated approach not only promotes health and safety, but also has a positive impact on business economics and social costs, making the workplace a fertile ground for the development of healthy and sustainable practices (307).

FUTURE DEVELOPMENTS

INAIL, traditionally committed to the health and safety of workers, has expanded its mission to include not only the prevention of physical injuries but also the overall well-being of employees. In a constantly evolving work environment, where challenges related to unhealthy lifestyles, stress, and varying work conditions are increasingly evident, nutritional education emerges as a crucial tool to improve the quality of working life and prevent occupational diseases (306). In recent years, awareness of the role that nutrition plays in the health of workers has grown significantly. From an increase in injuries linked to suboptimal physical conditions to the management of stress and fatigue, nutrition can make a significant difference. Not only in high-risk sectors but in many other working contexts, nutritional education can contribute to improving the safety and health of employees (318). In this regard, INAIL could further integrate its activities by promoting awareness of the importance of a balanced diet, tailored to the specific needs of each sector.

- Healthcare and assistance sector: healthcare workers, such as nurses and doctors, are often subjected to stressful, night, and long-term shifts. In these professions, proper nutrition could reduce the risk of fatigue, improve cognitive performance, and strengthen the immune system. Nutritional education programs could, for example, teach how to balance meals during shifts or how to manage a diet to avoid health issues related to stress.
- Construction sector: construction workers, who engage in physically demanding tasks, could benefit from nutritional education to improve their physical endurance, prevent musculoskeletal injuries, and enhance recovery. Proper nutrition, rich in nutrients that support muscle strength and stamina, could be essential in reducing workplace injuries.
- Agricultural and food industry sector: workers in agricultural environments or in the food industry who operate under challenging conditions could benefit from proper nutritional education to prevent gastrointestinal diseases, skin health issues, and improve fatigue management. Healthy eating practices could also be promoted to avoid risks related to exposure to chemicals.
- Transport and logistics sector: truck drivers, public transport workers, and staff who spend long hours sitting may suffer from issues linked to poor nutrition, such as obesity, diabetes, or cardiovascular diseases. Educating workers on healthier, balanced food choices, even while traveling, could contribute to improving their overall health and reduce the risk of occupational diseases.
- Catering and restaurant sector: in environments like kitchens and restaurants, where the work pace is high, nutritional education could help improve workers' energy and

concentration levels, as well as prevent eating disorders related to irregular hours and stress. For example, teaching the importance of a balanced diet during intense work shifts could reduce the risk of postural problems or digestive issues.

- Educational and school sector: teachers and school staff, often engaged in long and stressful working hours, could benefit from nutritional education programs that help maintain energy and focus throughout the workday. These programs could also raise awareness about healthy eating habits, which are essential for preventing stress-related diseases and obesity.

In all these fields, integrating nutritional education into health and safety strategies could lead to an overall improvement in the quality of working life, reducing absenteeism, and increasing productivity.

Figure 1 Information Guide For Workers On Heat And Nutrition



ALIMENTAZIONE CORRETTA: GUIDA INFORMATIVA PER I LAVORATORI

ONDATE DI CALORE E LAVORO





IL CAMBIAMENTO CLIMATICO, CON IL CONSEGUENTE AUMENTO DELLE TEMPERATURE, È UN TEMA IMPORTANTE PER LA TUTELA DELLA SALUTE E SICUREZZA DEI LAVORATORI. LE ONDATE DI CALORE SONO, INFATTI, ASSOCIATE AD UN AUMENTO DEL RISCHIO DI INFORTUNI LAVORATIVI. TUTTI I SETTORI POSSONO ESSERE COLPITI, SPECIALMENTE CHI LAVORA ALL'APERTO O IN AMBIENTI CHIUSI CON FONTI DI CALORE AGGIUNTIVE O DOVE SONO NECESSARI INDUMENTI CHE LIMITANO LA TRASPIRAZIONE. ANCHE LE ATTIVITÀ FISICAMENTE IMPEGNATIVE FANNO CRESCERE IL CALORE CORPOREO, INCREMENTANDO IL RISCHIO DI DISTURBI LEGATI AL CALDO.

PROTEGGERE LA SALUTE DURANTE LE ONDATE DI CALORE SI PUÒ MANTENENDO UNA BUONA IDRATAZIONE E ADOTTANDO COMPORTAMENTI ALIMENTARI CORRETTI, ISPIRATI AL MODELLO MEDITERRANEO. BASTANO PICCOLI ACCORGIMENTI PER MIGLIORARE LA SALUTE E RENDERE L'AMBIENTE DI LAVORO PIÙ SANO, SICURO ED EFFICIENTE.

CALDO ESTREMO, COME COMPORTARSI?



1 Bere abbondante acqua
Assumere almeno 2 litri di acqua al giorno, aumentando la quantità durante le giornate particolarmente calde, anche in assenza di sensazione di sete.



2 Consumare frutta e verdura fresche
Integrare nella dieta frutti ricchi di acqua come anguria, melone, arance, e verdure come cetrioli, pomodori e lattuga.



3 Evitare bevande zuccherate e succhi di frutta
Limitare l'assunzione di bibite gassate e succhi di frutta confezionati, poiché possono favorire la disidratazione.



4 Evitare le bevande alcoliche
L'alcol aumenta la diuresi e la possibile disidratazione, inoltre contribuisce ad aumentare la confusione mentale provocata dal caldo intenso.



5 Preferire alimenti ricchi di elettroliti
Consumare alimenti come banane, spinaci, noci e semi, che contengono potassio e magnesio, utili per mantenere l'equilibrio elettrolitico.



6 Mangiare pasti leggeri e frequenti
Preferire pasti piccoli e frequenti anziché pasti abbondanti, per facilitare la digestione e mantenere un livello di energia costante.



7 Preferire alimenti ricchi di fibre
Consumare cereali integrali, legumi e ortaggi per migliorare la digestione e mantenere l'idratazione.



8 Evitare cibi salati e grassi
Ridurre il consumo di cibi ad alto contenuto di sale e grassi, poiché possono aumentare la sete e la sensazione di pesantezza.



9 Attenzione alla conservazione degli alimenti
Mantenere inalterata la catena del freddo, i cibi conservati male rischiano una contaminazione da microrganismi.



10 Portare con sé una bottiglia d'acqua
A lavoro bere regolarmente; evitando bottiglie di plastica, soprattutto se esposte alla radiazione solare, e preferire una camel bag.

Adottare queste semplici abitudini alimentari e di idratazione può fare una grande differenza nel migliorare la salute e sicurezza durante le calde giornate estive.

RICORDATE, IL BENESSERE INIZIA DA PICCOLI GESTI QUOTIDIANI.

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La vostra salute è il bene più prezioso: investite in essa ogni giorno!

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Study 7

Effect of Nutritional and Educational Intervention with a Mediterranean Diet on Chronic Insomnia: The SONMED Pilot Study (Preliminary Results)

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ABSTRACT

Chronic insomnia represents a prevalent condition in the general population, leading to the risk of developing various medical/psychiatric comorbidities, including obesity, diabetes, cardiovascular diseases and depression, with consequent decline in overall quality of life. Traditional treatment for insomnia includes a combination of pharmacological and behavioural/psychological approaches. Dietary habits have shown a significant impact on sleep patterns. Despite the positive association between the Mediterranean Diet (MD) and sleep hygiene, its specific impact on chronic insomnia remains underexplored. This study aims to evaluate the impact of a nutritional and educational intervention based on the MD compared with conventional therapy alone in adult patients with chronic insomnia. To this end, clinical response and benefits on sleep hygiene and general health were measured through the administration of validated questionnaires, along with objective measures of body composition. Forty-five volunteers between 20 and 60 years old, 61.4% women, completed a 3-months randomized, controlled intervention study: 23 subjects were randomly assigned to the MD intervention group (I), while 22 subjects to the control group (C). Anthropometric and cardiac parameters, food intake (3-day food diary), MD adherence (MediLite questionnaire), physical activity level (IPAQ questionnaire), and sleep quality (PSQI, ESS, ISI questionnaires) were assessed at baseline and after the intervention. The food diaries and questionnaires were completed by the volunteers via a web application, through which the educational intervention was also administered. No significant differences were observed between the I and C groups in sleep quality and insomnia symptoms. Despite, the I group had a higher proportion of individuals with high adherence to the MD at the end of the intervention compared to the C group (65% vs. 41%), no differences were found between groups for adherence to the MD. In addition, the I group showed a greater increase in vegetable consumption, as well as a reduction in cholesterol and saturated fat intake and an increase in fibre consumption. The dietary and educational intervention did not result in significant changes in insomnia and sleep quality parameters, suggesting that dietary and educational interventions alone may not be sufficient to significantly affect sleep disturbance in pharmacologically treated patients. Future studies may benefit from more integrated approaches that combine behavioural and dietary interventions to more effectively address complex sleep disorders.

INTRODUCTION

Insomnia is defined as the difficulty in initiating, maintaining sleep continuity and/or poor sleep quality, despite the presence of adequate opportunity and circumstance for sleep, resulting in negative effects on daytime functioning, fatigue, irritability, anxiety and decreased ability to concentrate (ICSD-3)(321). Chronic insomnia is an extremely common condition in the general population, involving approximately 6% of adults, and with increasing prevalence rate in the latest year (322) . Epidemiological data indicate that chronic insomnia is a widespread and growing problem globally, with a clear-cut preponderance among women (323). At symptom level, its distribution is extremely diffuse, as it is estimated that around 30 to 48% of the worldwide population complain about some form of insomnia. More specifically, at syndrome level, the real prevalence of the disorder is estimated between 6-20% of the general population, depending on the nosologic criteria adopted for the definition (324,325). Epidemiological studies involving the Italian population attested that insomnia symptoms are reported by 27.6% of people, sleep dissatisfaction by 10.1% and proper insomnia disorder was diagnosed in 7% of cases, with 5.7% of Italian affected reporting the use of sleep-enhancing medication, mostly anxiolytics (326). A recent study conducted by the Sleep Research Institute in Italy revealed that insomnia affected up to 55.3% of patients aged over 50 years, and its strongly associated with numerous comorbidities such as anxiety-depressive disorder, cardiovascular diseases and dementia (327). These findings underline the importance of the problem and the need for a deeper understanding of the causes and consequences associated with chronic insomnia. The disorder is burdened by the risk of developing many medical and psychiatric consequences (including obesity, diabetes, cardiovascular diseases, depression) and it is associated with a general decline in quality of life, academic performance, increased risk for car accidents and lower productivity at work (328). Factors such as stressful situations, anxiety, depression, psychiatric disorders, chronic pain, various comorbid medical issues, changes in circadian rhythms, and the use and abuse of substances such as caffeine and alcohol have been identified as significant risk factors (329). Some research also suggests a genetic link in the onset of insomnia, and various genes such as Apolipoprotein (Apo) E4, *PER3* 4/4, *HLA-DQB1*0602*, homozygous *Clock* gene 3111C/C *Clock* and short (s-) allele of the *5-HTTLPR* has been implicated in the development of the disorder, overall suggesting significant heritability of the condition and multigene involvement in its pathophysiology (330). Increasing evidence points to a significant link between unhealthy lifestyles, such as poor eating habits and low physical activity, and susceptibility to this sleep disorder. Imbalanced meals and a diet high in saturated fats and simple sugars may contribute to the onset of insomnia (331,332). Research conducted by St-Onge

and colleagues (2016) revealed that a diet high in saturated fats can impair sleep quality by negatively affecting the duration of slow wave sleep (SWS) and REM sleep (333). Low physical activity is another key factor related to insomnia: there is an inverse relationship between physical activity and the severity of insomnia symptoms. Regular exercise can improve sleep quality through several mechanisms, including stress reduction, increasing body temperature and regulating circadian rhythms (331). Chronic insomnia not only impairs individual quality of life but also has significant public health impacts. People suffering from chronic insomnia have an increased risk of developing metabolic and cardiovascular disorders, and other chronic diseases(334).This underscores the importance of considering chronic insomnia as a public health priority and implementing interventions that reduce its impact on society. Therapeutic approaches for chronic insomnia frequently combined cognitive-behavioral therapy (CBT-I) to pharmacological treatment, but prevention and psychoeducational interventions play a crucial role. The promotion of a healthy lifestyle including sleep hygiene, stress management and awareness on the importance of sleep are crucial to prevent the onset and consolidation of chronic insomnia (335). The use of hypnotic drugs, such as benzodiazepines and non-benzodiazepine drugs, is common for short-term treatment, and, according to European guidelines, some sedating antidepressants too may be used (336). Although not easily available, CBT-I remains the first-line treatment for chronic insomnia, as it has been proved to be highly effective and well-tolerated (337). Other non-pharmacological approaches include light exposure and physical exercise, which are listed among the adjuvant therapies. So far, international guidelines, neglected the contribution of diet in the clinical management of the condition (336). However, the correlation between diet and sleep outcomes is a growing area of research, with increasingly evidence showing that food choices can significantly influence sleep hygiene (338). Recent studies have shown that a poor diet, overweight and some deficiencies in essential nutrientsincrease the risk of developing sleep disorders, including insomnia (339). It particularly emerges that a diet rich in unsaturated fatty acids, simple sugars and characterized by daily caloric excess correlates with poor subjective sleep quality. In contrast, a diet high in fiber and low in simple sugars is found to be associated with higher quality and deeper sleep (340,341). A recently published systematic review attested that Mediterranean Diet (MD), a high-quality diet and an empirically derived healthy dietary pattern are associated with a decreased risk of insomnia symptoms (342). Moreover, the dietary glycemic index and the dietary glycemic load are linked with a higher risk of insomnia symptoms. However, most of the available studies provide a very low

certainty of evidence and thus objective confirmation of these important findings are desirable (343).

The MD is a dietary pattern known for its benefits on cardiovascular health and reducing the risk of chronic diseases (39). Characterized by a high consumption of fruit, vegetables, whole grains, fish, olive oil and nuts, this diet has been the subject of numerous studies highlighting its positive effects on mental health and sleep quality (204,344). Certain nutrients typical in the MD may play a crucial role in the management of chronic insomnia. For example, tryptophan, a precursor of serotonin, is abundant in foods characteristic of the MD, as it is primarily found in legumes, nuts, seeds, fish, eggs, dairy products (such as yogurt and cheese), and whole grains. These staples of the MD may also contribute to improved sleep quality (345). Furthermore, omega-3 fatty acids, found in fish, have been associated with improvements in sleep quality. In fact, scientific evidence suggests that the MD can exert a beneficial impact on sleep quality and quantity through various mechanisms, including regulating circadian rhythm, reducing oxidative stress, and the intake of nutrients such as omega-3 and antioxidants (204). Despite proven benefits, increased adherence to the MD is still a public health challenge today. Factors such as globalization of eating habits, availability of processed foods, and lack of cultural awareness may compromise the adoption of this dietary pattern (55).

Scientific literature has shown that nutrition education can positively influence eating behavior. In fact, a higher level of information about the health benefits of the MD can result in more aware and sustainable food choices in the long term (346,347). Nowadays, the transmission of nutrition education through digital tools specifically designed to encourage healthy behavior, such as increased adherence to the MD, is becoming relevant. Indeed, nutrition education, especially when adapted and customized to the needs of the target population, is particularly important in terms of public health (348) Nutrition education programmes must be adapted and disseminated to different target population groups with different needs, to improve eating habits and thus promote health in both healthy people and patients. New technologies prove to be an important aspect for the success and wider implementation of nutrition education programmes in the population (349).

The SONMED study aimed to evaluate the effectiveness of a nutritional and educational intervention based on the MD as an adjunct to standard therapy, compared to standard therapy alone, in adult patients with chronic insomnia. The study explored whether integrating a structured

dietary approach with conventional treatments could improve clinical outcomes, enhance sleep hygiene, and provide broader health benefits. To achieve these objectives, the study assessed the impact of the intervention on various dimensions of health and well-being using validated questionnaires. Sleep quality was evaluated with tools designed to measure key aspects such as sleep duration, latency, disturbances, and overall restfulness. The adherence to the MD was assessed to determine if the intervention promoted meaningful improvements in dietary habits. Additionally, the overall quality of life was analyzed through comprehensive instruments that examined physical health, mental well-being, and the interaction between lifestyle choices and general health. The SONMED study sought to capture both subjective experiences and objective improvements, offering a holistic perspective on the effects of the intervention. By integrating dietary modifications into standard insomnia therapy, the research aimed to uncover new insights into how lifestyle changes, particularly those rooted in the MD, could complement conventional approaches to managing this complex and challenging condition.

METHODS

Participants

Participants were retrospectively recruited among adult outpatients attending the Sleep Disorders Center of the University Hospital of Parma, Italy and suffering from chronic insomnia. Eligible volunteers were adults (25 – 60 y) diagnosed with chronic insomnia according to the International Classification of Sleep Disorders (ICSD3), with a Pittsburgh Scale (PSQI) score greater than or equal to 5 and with no other co-existing sleep disorders. In confirmation of this, all the enrolled patients should have performed a cardio-respiratory monitoring (CRM) to rule out the co-existence of any respiratory or motor disturbances (AHI < 5 phases/h PLM index < 15 phases/h). Volunteers were not eligible if they were not within the age range, affected by severe psychiatric disorders (major depression, schizophrenia, personality disorder) or suffering from any neurological comorbidities (e.g., dementia, epilepsy, multiple sclerosis, Parkinson's disease). In addition, subjects with celiac disease, food allergies or intolerances (diagnosed) were excluded, as well as patients with symptomatic gastrointestinal diseases due to dyspepsia, major intestinal or gastric disorders, systemic inflammatory diseases (e.g. rheumatological diseases, rheumatoid arthritis, vasculitis). Finally, we excluded patients with coexistent sleep disorders such as sleep-disordered breathing, nocturnal myoclonus, restless leg syndrome, nocturnal epilepsy, NREM or REM parasomnia.

Study design and dietary/educational intervention

This study was an experimental randomized controlled 3-months intervention trial, which lasted from September 2022 to May 2023 (**Figure 1**). Inclusion/exclusion criteria were assessed by sleep specialists of the Sleep Medicine Department of the Ospedale Maggiore of Parma, about sleep disorders, related medical history and clinical variables, and by expert nutritionists from the Human Nutrition Unit of the University of Parma, about anthropometric and nutritional variables. All the eligible patients were enrolled in the study after obtaining their written informed consent.

Within the 3 months of intervention, all participants underwent two detailed visits with a nutritionist and a sleep specialist (respectively at time point 0 – baseline, and time point 3 – after 3 months, see **Figure 1**). During the visits, comprehensive data were gathered, including dietary intake, adherence to the MD, physical activity levels, and sleep quality, evaluated using food diaries and standardized questionnaires. In addition, anthropometric measurements (weight, height, waist and hip circumference) and cardiac parameters were recorded. At time point 1 (month 1) and time point 2 (month 2), two motivational phone interviews were conducted exclusively with volunteers

in the I group to assess compliance with the diet, provide support, and reinforce adherence to the study protocol.

The study included a sample size of 50 subjects, divided randomly into 2 groups: 25 patients treated with nutritional and educational intervention (I) and 25 controls (C) that did not receive the nutritional approach. The estimation of the sample size derived from the exploratory nature of the study (pilot project). Both groups (I and C) received behavioral advice for managing insomnia (sleep hygiene tips to enhance sleep quality and duration) and if clinically necessary, therapeutic indications, as prescribed in the normal course of treatment for chronic insomnia. This represents the normal care management pathway for chronic insomnia. The I group, in addition to the above-listed approaches, also received personalized nutritional counseling and educational content in line with the MD recommendations. In particular, patients enrolled in the I group were instructed, during the first visit with the nutritionist, about the basic principles of healthy eating and were provided with weekly examples of food plans based on the consumption frequencies of the food groups, based on the Italian Dietary Guidelines for Healthy Eating (350), and were invited to use a free in-home web-application where they were able to get educational content and healthy Mediterranean recipes aimed at encouraging MD adherence and study compliance. In the C group, in contrast, eating habits were not influenced in any way, as no dietary intervention or nutritional education was introduced. Patients in both groups were asked not to change their usual level of daily physical activity.

The trial was performed in compliance with the Helsinki declaration, approved by the Hospital of Parma Ethical Committee (846/2021/SPER/UNIPR).

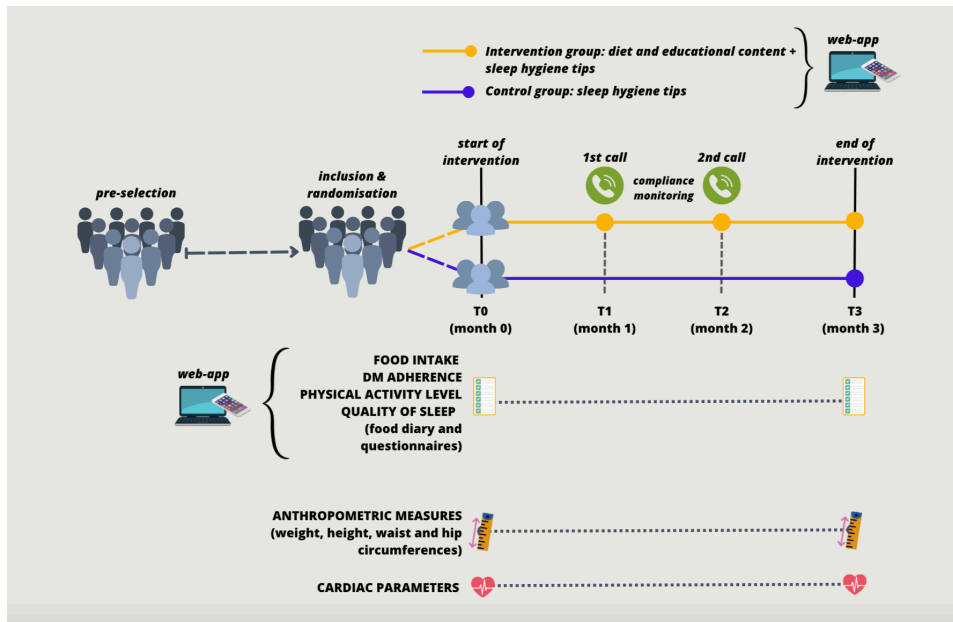


Figure 1 Study design and procedure

Nutritional Intervention

Volunteers in the I group were subjected to an individualized nutritional protocol based on the principles of the MD (47). The assignment of food plans with varying energy intakes (1500, 2000, 2500 Kcal) was carefully tailored to match the caloric requirements of each participant. These requirements were assessed during the nutritional consultation by evaluating key parameters such as Body Mass Index (BMI) and Total Energy Expenditure (TEE), which consider both basal metabolic rate and activity levels. The caloric ranges used for the food plans were selected based on their relevance and prevalence in the population of interest. These energy levels represent standard benchmarks commonly applied in dietary interventions for individuals with similar demographic and health characteristics. By using these well-established calorie categories, the food plans ensure accessibility and practicality, making them relatable and easy to implement within the target population. This approach also facilitates comparisons across studies and aligns with dietary practices that are already familiar to participants. For participants with a normal weight, no caloric restriction was applied, allowing their energy intake to align with their calculated needs for weight maintenance. Conversely, for participants classified as overweight or obese, a caloric restriction was applied to create an energy deficit aimed at promoting gradual and sustainable weight loss. This distinction ensured that the dietary intervention was appropriately individualized to meet the specific health and weight management goals of each participant. The food plans, designed to cover individual nutritional needs, included specific indications on what to consume at breakfast, snacks, lunch, and dinner for all days of the week, Monday through Sunday. Each main meal consisted of a

source of carbohydrates, a source of protein, fruits and vegetables, and healthy fats, with special emphasis on the use of extra virgin olive oil. Snacks, an integral part of the food plan, included mainly fresh seasonal fruits, thus promoting the consumption of nutritious foods in line with the MD principles. Importantly, the food plan did not specify individual foods (e.g., chicken meat) but rather food categories (e.g., white meat), providing flexibility in adapting the plan to individual preferences. The frequency of consumption and recommended portions were established in accordance with the Food Based Dietary Guidelines for the Italian population (43) and the Dietary Reference Values of Nutrients and Energy for the Italian population (LARN) (116,117), thus ensuring a culturally appropriate adaptation of the nutrition protocol (48,49). This customized dietary approach, based on the MD principles and adapted to the specific caloric needs of everyone, was administered via the Web Application, together with a series of nutritional tips giving more general guidelines on optimal ways to follow the dietary plan (e.g. how much water to drink, limiting sugar and salt consumption, preferring plain yoghurt or whole-grain cereals).

Web-Application

The web application used in this study was developed by the Human Nutrition group of the Department of Food and Drug Sciences in collaboration with the Artificial Intelligence Laboratory of the Department of Mathematical, Physical, and Computer Sciences at the University of Parma (RicercaAlimentare - <http://www.ailab.unipr.it/diario-sonno>), and was hosted on the University of Parma servers. Access to the application was granted to volunteers from both study groups using individual credentials (username and password) provided during the initial visit. During the three-months intervention, participants accessed specific educational content designed to support proper sleep hygiene. In addition, Volunteers in the I group received the same information discussed during the visit with the nutritionist, along with additional text-based educational content and Mediterranean-based recipes. The educational contents were organized weekly, with a specific topic for each week of the intervention. Additionally, the application provided daily tips and a recipe aimed at promoting healthy eating habits and supporting proper sleep hygiene. The I group also had access to their personalized dietary plan, developed during the consultation with the nutritionist. A detailed description of the educational content delivered through the web application is available in the **supplementary material**. The web application was also used to collect data from participants, regardless of enrolment group, using validated questionnaires on diet, sleep, physical activity and quality of life.

Sleep Assessment

ISI (Assessment Of Insomnia)

The Insomnia Severity Index (ISI) is a standardized instrument used to measure the severity of insomnia. It was developed by Bastien et al. in 2001 and has established itself as a reliable and valid tool for assessing the severity of sleep disorders. The ISI questionnaire consists of seven questions covering various aspects of insomnia, including the time it takes to fall asleep, sleep quality, sleep duration, and the impact of sleep on daily life. Each question is rated on a scale of 0 to 4, where 0 indicates no problem and 4 indicates maximum severity. The total sum of the responses to the seven questions provides a total ISI score, which can range from 0 to 28. Higher scores indicate greater insomnia severity (351).

PSQI (Sleep Quality Assessment)

The Pittsburgh Sleep Quality Index (PSQI) is a widely used instrument to assess sleep quality in various clinical and research settings. The questionnaire was developed by Buysse et al. in 1989 and since then has been the subject of numerous studies that have confirmed its reliability and validity. The PSQI is organized into components that assess various aspects of sleep. The questionnaire, administered via web-application, consists of 19 questions with seven components: sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbance, sleep medication use and diurnal dysfunction. Each component is scored from 0 to 3 (0, not in the last month; 1, less than once a week; 2, once or twice a week; 3, three or more times a week). The total score ranges from 0 to 21, with higher scores indicating worse sleep quality. Total scores greater than 5 indicate poor sleep quality, while scores ≤ 5 are indicative of normal sleep quality(36–38).

ESS (Assessment Of Daytime Sleepiness)

The Epworth Sleepiness Scale (ESS) was developed by Murray W. Johns in 1991 and is a self-report measure of daytime sleepiness (352). The questionnaire consists of eight questions, each rated on a scale of 0 to 3, in which participants indicate the likelihood of falling asleep in everyday situations. Total scores can range from 0 to 24, with higher scores indicating greater daytime sleepiness. Higher scores indicate more excessive daytime sleepiness. The severity of sleepiness was considered normal (score ≤ 10) and mild or moderate (score > 10).

Anthropometric And Body Composition

Body weight (BW) was measured using a TANITA BC-730 scale, while height was measured using the SECA 217 mobile stadiometer. BMI was calculated as weight in kilograms divided by the square of height in metres. Waist circumference (WC) and hip circumference (HC) were measured at the midpoint between the lower rib and the upper edge of the iliac crest and at the level of the greater trochanters, respectively, using a SECA 201 non-elastic tape measure, with the participants in standing position.

Cardiac Measurements

Systolic and diastolic blood pressure, as well as heart rate were measured with subjects in a prone position on a table under resting conditions. Blood pressure was measured using an Omron electronic sphygmomanometer.

Physical activity assessment

IPAQ (Level Of Physical Activity)

The International Physical Activity Questionnaire (IPAQ) is a widely used self-assessment tool to measure physical activity in adults aged 15-69 years (353,354). The questionnaire, developed by an international consortium of researchers, provides a detailed assessment of different dimensions of physical activity, including intensity, duration and frequency of activities performed in various settings. The short version questionnaire consists of 7 open-ended questions on physical activity during the last 7 days. Respondents were asked to recall and describe activities performed in the following categories: work, transportation, household activities and free time. The IPAQ classifies physical activity into three intensity categories: low, moderate and high. Analysis of the collected data allows for estimations of the total volume of physical activity expressed in Metabolic Equivalent of Task (MET)-a unit representing energy expenditure during physical activity, compared with energy expenditure at rest. (42,43)

Dietary Assessment

Dietary data were used as confirmation of dietary compliance to the intervention and to assess the consumption of specific food groups (e.g coffee) related to sleep. Dietary data were collected using a semi-quantitative 3-day food diary administered via the web-based application. Participants recorded their food intake during three consecutive days, specifying the exact weight of food or estimating it with household measurements, dividing the entries by meal and including details such

as date, time and place of consumption. Specific instructions were provided to minimize errors, and the food diaries were reviewed with a nutritionist to ensure data accuracy. Adherence to the MD was assessed using the Medi-Lite adherence score, a validated tool that measures the intake of specific food groups characteristic of the MD (355). The Medi-Lite assesses daily consumption of fruit, vegetables, cereals, meat, dairy products, alcohol, and olive oil, as well as weekly consumption of legumes and fish. The scoring system assigns 2 points for high consumption of typical MD foods, 1 point for moderate consumption, and 0 points for low consumption. Specifically, olive oil use is scored with 2 points for regular use, 1 point for frequent use, and 0 points for occasional use. For foods not typical of the MD, such as red meat and sweets, the scoring is reversed, with 0 points for high consumption and 2 points for low consumption. Alcohol consumption is scored with 2 points for an intake of 1-2 units per day, 1 point for 1 unit per day, and 0 points for consumption of more than 2 units per day. The total Medi-Lite score ranges from 0 to 18, with a score of 0 indicating low adherence to the MD, and a score of 18 indicating high adherence. This approach allows for a quantitative assessment of adherence to the MD, facilitating the analysis of the impact of the intervention on participants' dietary habits (355).

Statistical Analysis

The statistical analyses were performed considering both the initial sample (ITT, n=55) and the per protocol group (PP, n=45), thus just the subjects who completed the entire intervention. Data normal distribution was assessed using the Kolmogorov-Smirnov test. Continuous variables (anthropometric and cardiac data, questionnaire scores, food intake data) were then expressed as median (interquartile range). A descriptive analysis was conducted for the initial sample at T0. Mann-Whitney test for independent samples was used to assess statistically significant differences between groups at each time point (T0 and T3). The Wilcoxon test for paired sample was employed to explore within-group differences over time. Categorical variables (questionnaire scores) were presented as frequency and percentage and analyzed using the Chi-Square test. A p-value < 0.05 was considered statistically significant. All statistical analyses were performed using IBM SPSS Statistics version 28.0 (IBM SPSS, Inc., Chicago, IL, USA).

RESULTS

Baseline Characteristics

Of the 79 volunteers assessed for eligibility, 57 were enrolled in the study and randomised to the I group (n=28) or C group (n=29). Two subjects withdrew from the study prior to the start of the actual intervention, so data at baseline refers to only 55 subjects, 27 in the I group and 28 in the C group. Of these, a total of 45 (23 I and 22 C group) completed the 3-month study period (**Figure 2**). Dropout included subjects who developed health problems during the study, subjects who decided to discontinue the diet (in the case of the subjects in the I group) and subjects who were unable to meet the protocol appointments.

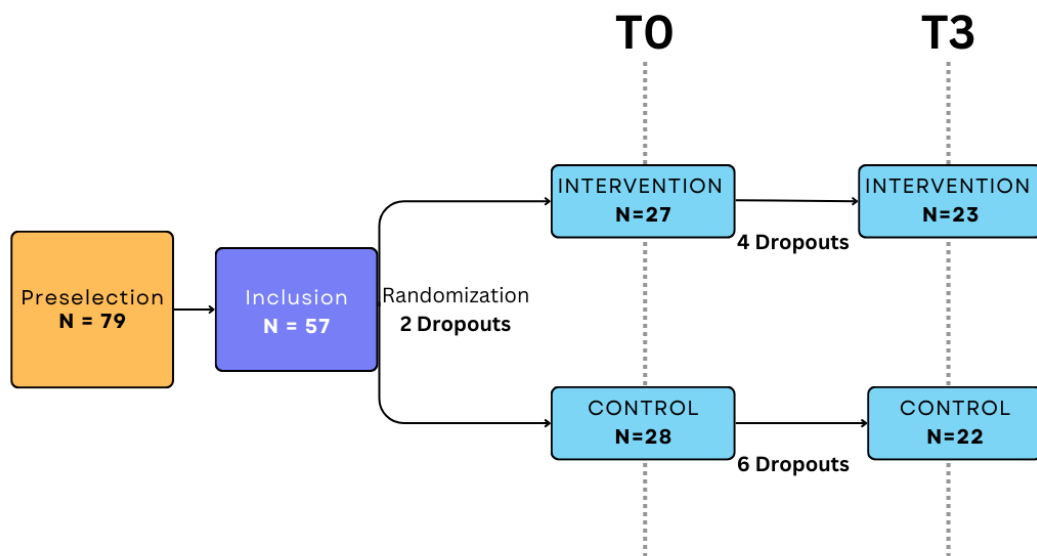


Figure 2 Summary flowchart of volunteer recruitment

The participants were mainly women (61.4%), aged between 26 and 60 years, with a mean BMI of 24.53 kg/m² (22.22-28.08). At baseline, the two groups (I and C) were balanced in terms of age, sex, BMI and the other anthropometric and cardiac parameters studied (**Table 1**).

Table 1 Baseline characteristics for the total population and for each treatment group (ITT analysis)

Anthropometrics	Total (n=55)	Intervention (n=27)	Control (n=28)	p value
Weight (kg)	67.20 (58.80 – 81.00)	67.30 (58.80 – 81.00)	66.25 (58.80 – 81.28)	0.973
Height (cm)	1.65 (1.60 – 1.72)	1.66 (1.60 – 1.78)	1.63 (1.60 – 1.71)	0.289
BMI (kg/m ²)	24.53 (22.22 – 28.08)	24.21 (22.35 – 26.19)	25.39 (21.80 – 30.02)	0.522
WC (cm)	87.00 (77.00 – 98.00)	89.00 (77.00 – 95.00)	86.50 (76.88 – 99.75)	0.762
HC (cm)	98.00 (93.00 – 103.00)	98.00 (92.00 – 99.00)	99.00 (93.00 – 107.88)	0.474
WHR	0.89 (0.79 – 0.94)	0.92 (0.84 – 0.94)	0.88 (0.79 – 0.95)	0.359
P. Max (mmHg)	117.00 (107.00 – 130.00)	111.00 (110.00 – 130.00)	118.50 (105.50 – 128.75)	0.819
P. Min (mmHg)	80.00 (70.00 – 81.00)	80.00 (70.00 – 80.00)	79.50 (70.00 – 84.00)	0.750
HR (bpm)	72.00 (66.00 – 80.00)	72.00 (66.00 – 75.00)	72.00 (66.50 – 85.50)	0.355

Data are expressed as median and interquartile range. P-values refer to between-group comparisons (C, I). Numbers in bold are significant p values.

Presented below are the results derived exclusively from the per-protocol (PP) analysis.

Sleep Parameters

At baseline, I and C were comparable in terms of insomnia severity, as expressed by ISI (mean score 13.8 +/- 5.40, indicative of a mild insomnia phenotype), subjectively-perceived sleep quality (mean PSQI 10.8 +/- 3.76) and daytime sleepiness (mean ESS 4.65 +/- 3.26). By the end of the study, there were no significant differences between the two groups with respect to any of the three questionnaires (**Table 2**).

Table 2 Sleep parameters measured using ISI, PSQI and ESS questionnaires for each group at baseline and after 3 months of intervention (PP analysis)

Sleep parameters	Time	Total (n= 45)	Intervention (n= 23)	Control (n= 22)	p value
ISI	T0	13.8 ± 5.40	12.95 ± 5.29	14.87 ± 5.80	0.195
	T3	12.2 ± 5.13	12.05 ± 5.07	12.35 ± 4.92	0.900
PSQI	T0	10.8 ± 3.76	10.18 ± 3.43	11.17 ± 3.80	0.331
	T3	11 ± 3.90	10.18 ± 4.08	11.78 ± 4.10	0.142
ESS	T0	4.65 ± 3.26	5.09 ± 3.44	4.57 ± 3.51	0.545
	T3	4.79 ± 3.30	4.09 ± 2.86	5.17 ± 3.23	0.225

Data are expressed as median ± standard deviation. The p-values refer to comparisons between groups.

Anthropometric Measurements and Cardiac Parameters

Data on anthropometric and cardiac parameters are presented in **Table 3**. Body weight remained approximately constant before and after the dietary and educational intervention in group I, whereas a tendency to increase in weight was observed in group C (from 64.65 kg (57.3-79.2) at T0 to 65.45 kg (57.7-80.1) at T3). No significant difference was observed between group I and group C regarding body weight at any of the time points considered. A decreasing trend in BMI and both circumferences was observed in group I. For all the parameters considered, presented in **Table 3**, no significant differences were observed between the groups at either T0 or T3.

Table 3 Anthropometry, blood pressure, heart rate for each group at baseline and after 3-months of intervention (PP analysis)

Anthropometrics	Time	Total (n= 45)	Intervention (n= 23)	Control (n= 22)	p value
Weight (kg)	T0	65.3 (59.0-80.3)	67.3 (59.2-81)	64.65 (57.3-79.2)	0.570
	T3	66.5 (58.3-79.3)	67.2 (59.1-79.2)	65.45 (57.7-80.1)	0.658
BMI (kg/m ²)	T0	23.66 (21.56-26.81)	24.14 (21.94-25.58)	23.52 (20.31-28.46)	1.000
	T3	23.69 (21.72-26.98)	23.69 (22.09-26.58)	23.65 (20.57-28.97)	0.982
WC (cm)	T0	87.0 (76.75-95.5)	89.0 (77.0-95.0)	83.0 (73.8-99.0)	0.474
	T3	85.5 (77.0-94.5)	87.5 (78.0-94.0)	82 (75.6-96.9)	0.525
HC (cm)	T0	98.0 (92.0-101.3)	98.0 (92.0-99.0)	97.5 (91.9-107.6)	0.909
	T3	97.0 (92.5-102.8)	97.5 (91.0-101.0)	97.0 (92.5-107.4)	0.883
WHR	T0	0.88 (0.79-0.94)	0.92 (0.84-0.94)	0.88 (0.78-0.92)	0.224
	T3	0.88 (0.79-0.94)	0.91 (0.82-0.94)	0.84 (0.78-0.93)	0.296
P. Max (mmHg)	T0	117 (108-130)	111 (110-130)	118 (104-130)	0.982
	T3	120 (110-125)	115 (110-135)	120 (115-125)	0.661
P. Min (mmHg)	T0	80 (70-81)	80 (70-80)	78.5 (70-82)	0.660
	T3	75 (70-80)	80 (70-80)	72.5 (70-80)	0.287
HR (bpm)	T0	72 (66-80) ^b	72 (66-75)	71 (66-85) ^b	0.591
	T3	70 (63-78) ^a	72 (64-78)	66.5 (60-76) ^a	0.279

Data are expressed as median and interquartile range. The p-values refer to comparisons between groups (Mann-Whitney I vs. C test). Different letters in the same column indicate significant differences between visits in the same group (Wilcoxon test, p<0.05).

Level of Physical Activity

Analysis of the data collected made it possible to estimate the total amount of physical activity, expressed in MET (**Table 4**). Considering the PAL, an increasing trend in the level of physical activity can be observed in group I; the percentage of inactive subjects decreased, while the percentage of sufficiently active and active subjects increased. In group C, there was a parallel increase in inactive and vigorously active subjects, with a corresponding decrease in moderately active subjects.

Table 4 Level of physical activity (IPAQ questionnaire) for each group at baseline and after 3-months of intervention (PP analysis)

Physical Activity	Time	Total (n= 45)	Intervention (n= 23)	Control (n= 22)	p value
MET SCORE	T0	1250 (681-3060)	1170 (660-2945)	1433 (838- 3500)	0.946
	T3	1638 (1035-3225)	1620 (1080-2826)	2025 (563- 3518)	0.980
PAL					
Inactive	T0	24%	26%	23%	0.657*
	Sufficiently Active	44%	48%	41%	
Active		31%	26%	36%	
Inactive	T3	18%	9%	27%	0.657*
	Sufficiently Active	47%	61%	32%	
Active		36%	30%	41%	

Data are expressed as median and interquartile range. The p-values refer to comparisons between groups (Mann-Whitney I vs. C test).

Different letters in the same column indicate significant differences between visits in the same group (Wilcoxon test, $p < 0.05$). * Chi-square test.

Adherence to the Mediterranean Diet and Dietary Intake

Adherence to the MD, as measured by the validated MediLite questionnaire, is shown in **Table 5**. Adherence to the MD was similar between the treatment groups at baseline and at month 3. An increasing trend in adherence was observed in the I group, although not statistically significant. In terms of categorical adherence, the majority of subjects had a high level of adherence to the MD at both time points.

Table 5 Adherence to MD for each group at baseline and after 3-months of intervention (PP analysis)

Adherence to MD	Time	Total (n= 45)	Intervention (n= 23)	Control (n= 22)	p value
MEDILITE SCORE	T0	11.0 (9-13)	11.0 (8-13)	11.5 (10-13)	0.402
	T3	12.0 (9-13)	12.0 (10-13)	11.0 (8-13)	0.359
Adherence to the MD					
Low		4%	9%	0%	0.363*
Medium	T0	47%	43%	50%	
High		49%	48%	50%	
Low		11%	9%	14%	0.262*
Medium	T3	36%	26%	45%	
High		53%	65%	41%	

Data are expressed as median and interquartile range. The p-values refer to comparisons between groups (Mann-Whitney I vs. C test).

Different letters in the same column indicate differences a between visits in the same group (Wilcoxon test, $p < 0.05$). * Chi-square test.

Self-reported dietary intake, as assessed by food questionnaires, was similar between the C group and the I group about the daily intake of the main food groups, both at baseline (T0) and at 3 months (T3), as shown in **Table 6**. However, there was a significant difference between the groups in the daily consumption of vegetables, both at T0 and T3. At baseline, group C reported a significantly higher consumption of vegetables than group I, whereas at T3 an increase in vegetable consumption was observed in group I that exceeded that of group C. Specifically, group I showed a significant increase in daily vegetable consumption over time, from 144.76 g/day at T0 to 203.33 g/day at T3. In contrast, group C showed a significant decrease in vegetable intake from 227.84 g/day to 135.50 g/day over the same period. Furthermore, another significant difference was observed for egg consumption in group C, which increased from T0 to T3, with an average increase from 0 g/day to 15.50 g/day.

Table 6 Daily Food Groups intakes for each group at baseline and after 3-month of intervention (PP analysis)

Food Groups	Time	Total (n= 45)	Intervention (n= 23)	Control (n= 22)	p value
Cereals and derivatives (g/day)	T0	71.67 (42.50-100.50)	81.67 (46.67-116.67)	69.17 (32.67-83.33)	0.125
	T3	83.33 (47.50-113.34)	93.33 (53.33-126.67)	72.50 (42.67-90.00)	0.102
Bread and substitutes (g/day)	T0	78.33 (31.67-134.34)	72.67 (33.33-155.33)	84.17 (26.63-133.42)	0.674
	T3	82.67 (27.50-162.00)	76.67 (30.00-148.67)	96.34 (15.00-168.50)	0.691
Fruit (g/day)	T0	176.67 (107.17-270.83)	173.33 (123.33-273.33)	205.50 (102.17-261.58)	0.937
	T3	200.00 (92.50-343.08)	245.00 (100.00-393.33)	169.17 (79.17-340.71)	0.239
Vegetables (g/day)	T0	176.67 (117.17-284.17)	144.67 (113.33-201) ^a	227.84 (125.42-362.34) ^b	0.042
	T3	166.67 (111-270.84)	203.33 (135-321.67) ^b	135.50 (100.00-233.58) ^a	0.040
Legumes (g/day)	T0	25.00 (2.00-68.34)	23.33 (13.33-66.67)	30.84 (0.00-84.58)	0.757
	T3	43.33 (0.00-78.34)	36.67 (0.00-76.67)	58.34 (0.00-85.00)	0.704
Milk (g/day)	T0	66.67 (0.00-150.00)	53.33 (0.00-133.33)	75.00 (0.00-223.33)	0.450
	T3	3.33 (0.00-168.34)	3.33 (0.00-150.00)	30.00 (0.00-250.00)	0.522
Yogurt (g/day)	T0	20.00 (0.00-125.00)	0.00 (0.00-116.67)	41.67 (0.00-125.00)	0.390
	T3	41.67 (0.00-83.33)	83.33 (0.00-83.33)	41.67 (0.00-87.50)	0.387
Cheese (g/day)	T0	38.33 (12.00-54.50)	50.00 (13.33-60.00)	32.33 (9.17-50.00)	0.191
	T3	25.00 (8.34-46.50)	36.00 (10.00-55.00)	21.00 (6.17-34.17)	0.236
White and red meat (g/day)	T0	65.00 (43.33-115.00)	65.00 (46.67-116.67)	70.67 (34.17-110.83)	0.547
	T3	66.67 (37.50-89.17)	61.67 (33.33-83.33)	66.67 (42.30-93.33)	0.847
Sausages and cured meats (g/day)	T0	10.00 (0.00-23.33)	10.00 (0.00-20.00)	10.00 (0.00-27.50)	0.694
	T3	13.33 (0.00-27.5)	16.67 (0.00-33.33)	0.00 (0.00-27.09)	0.213
Fish and shellfish (g/day)	T0	25.00 (0.00-63.34)	23.33 (0.00-100.00)	28.84 (0.00-61.67)	0.807
	T3	26.67 (0.00-61.67)	26.67 (0.00-83.33)	30.00 (0.00-60.83)	0.898
Eggs (g/day)	T0	0.00 (0.00-15.67)	0.00 (0.00-14.67)	0.00 (0.00-26.00) ^a	0.863
	T3	0.00 (0.00-29.33)	0.00 (0.00-12.33)	14.50 (0.00-41.00) ^b	0.054
Sweets (g/day)	T0	37.33 (15.84-70.17)	40.00 (15.00-90.00)	33.50 (19.00-50.67) ^a	0.555
	T3	36.67 (16.00-60.50)	23.33 (10.67-57.33)	56.00 (27.50-84.59) ^b	0.035
Sugar and candy (g/day)	T0	16.67 (6.5-29.50)	13.33 (3.33-26.67)	17.83 (8.75-35.46)	0.290
	T3	13.67 (2.67-22.37)	12.67 (3.33-24.67)	15.50 (1.50-22.05)	0.640
Water (g/day)	T0	1367 (1000-1683)	1367 (1000-1667)	1367 (1000-1875)	0.811
	T3	1467 (1000-2000)	14000 (1000-2000)	1483 (958-1841)	0.593
Alcoholic drinks (g/day)	T0	0.00 (0.00-133.33)	10.00 (0.00-133.33)	0.00 (0.00-133.33)	0.651
	T3	0.00 (0.00-145.84)	66.67 (0.00-256.67)	0.00 (0.00-50.00)	0.040
Soft drinks (g/day)	T0	0 (0-0)	0 (0-0)	0 (0-0)	0.151
	T3	0 (0-0)	0 (0-0)	0 (0-0)	0.982
Coffee, tea, herbal teas (g/day)	T0	150.00 (66.67-241.67) ^b	150.00 (100.00-250.00) ^b	138.34 (63.34-237.92)	0.742
	T3	83.33 (50.00-158.34) ^a	66.67 (46.67-183.33) ^a	91.67 (50.00-154.17)	0.699

Data are expressed as median and interquartile range. The p-values refer to comparisons between groups (Mann-Whitney I vs. C test).

Different letters in the same column indicate significant differences between visits in the same group (Wilcoxon test, $p < 0.05$).

A significant difference in the consumption of sweets emerged between group I and group C at the end of the intervention (T3). Specifically, daily consumption of sweets was significantly higher in group C, with a median of 56.00 g/day, compared with group I, which reported a median of 23.33 g/day. In addition, group C showed a significant increase in sweet consumption between baseline (T0) and T3. Regarding alcohol consumption, significantly higher consumption was observed in group I compared to group C at the end of the intervention. Finally, there was a significant decrease in coffee and tea consumption between T0 and T3 in group I.

Self-reported dietary intakes of energy and nutrients, shown in **Table 7**, were similar between the I and C groups at both baseline and 3 months. However, there was a significant difference in daily cholesterol intake at baseline, with a higher median in group C (236.63 mg/day) than in group I (156.27 mg/day). During the study period, there were significant differences in cholesterol intake between the groups: in group I, cholesterol intake decreased between T0 and T3, whereas it increased in group C. A significant reduction in saturated fatty acid intake was also observed in group I, from a median of 24.11 g/day to 17.52 g/day after 3 months of intervention. In parallel, daily fibre intake increased significantly in group I, reaching a median value of 71.02 g/day at T3. However, alcohol intake increased significantly in group I, reaching a median of 6.33 g/day at T3.

Table 7 Daily energy and nutrient intakes for each group at baseline and after 3-month of intervention (PP analysis)

Nutrients	Time	Total (n= 45)	Intervention (n= 23)	Control (n= 22)	p value
Energy (kcal/day)	T0	1749 (1401-1996)	1821 (1401-2102)	1656.62 (1433.67-1943.68)	0.238
	T3	1670 (1334-2112)	1649 (1416-2091)	1742.03 (1151.31-2166.12)	0.440
Proteins (g/day)	T0	69.05 (56.52-81.06)	71.79 (59.61-89.81)	67.56 (51.60-80.99)	0.286
	T3	65.56 (55.84-76.77)	66.29 (59.91-74.93)	62.46 (52.87-87.29)	0.633
Fats (g/day)	T0	66.79 (48.88-84.83)	74.92 (54.15-88.69)	61.91 (46.75-81.06)	0.212
	T3	61.17 (47.05-80.30)	61.17 (54.45-67.27)	60.85 (43.09-85.27)	0.716
Saturated fatty acids (g/day)	T0	22.37 (14.05-28.80)	24.11 (18.17-29.48) ^b	16.90 (12.55-28.71)	0.073
	T3	17.52 (13.59-27.10)	17.52 (15.11-24.15) ^a	17.81 (11.85-28.81)	0.751
Mono-unsaturated fatty acids (g/day)	T0	31.21 (24.85-38.92)	33.46 (25.55-41.79)	28.53 (21.86-33.10)	0.200
	T3	29.82 (20.98-36.84)	30.85 (25.68-37.50)	29.45 (18.44-36.58)	0.482
Poly-unsaturated fatty acids (g/day)	T0	8.69 (6.02-12.35)	9.18 (5.99-12.32)	8.34 (5.87-12.97)	0.910
	T3	8.48 (6.26-11.32)	7.62 (5.92-10.79)	8.94 (6.36-11.64)	0.570
Cholesterol (mg/day)	T0	190.13 (127.48-283.50)	236.63 (155.30-320.09) ^b	156.27 (94.95-205.77) ^a	0.006
	T3	185.31 (113.83-259.74)	164.66 (109.29-243.19) ^a	213.05 (142.77-281.45) ^b	0.089
Carbohydrates (g/day)	T0	192.74 (151.19-239.90)	206.46 (167.20-249.92)	183.84 (145.83-230.72)	0.188
	T3	197.51 (161.54-266.07)	197.51 (170.81-274.49)	208.03 (149.61-263.38)	0.496
Sugars (g/day)	T0	61.84 (49.58-91.87)	67.85 (49.51-95.08)	60.60 (48.97-87.99)	0.633
	T3	70.06 (43.28-91.42)	67.97 (45.08-86.73)	80.08 (41.97-94.08)	0.525
Fiber (g/day)	T0	19.48 (14.19-25.09)	18.66 (14.27-24.17) ^a	19.81 (13.9-27.61)	0.54
	T3	20.71 (15.46-27.78)	21.02 (15.94-28.35) ^b	19.99 (14.93-23.01)	0.838
Alcohol (g/day)	T0	0.00 (0.00-9.71)	0.44 (0.00-10.40) ^a	0.00 (0.00-9.20)	0.845
	T3	0.00 (0.00-12.48)	6.33 (0.00-20.60) ^b	0.00 (0.00-6.09)	0.069
Water (mL/day)	T0	2358 (1965-2892)	2303 (1937-2846)	2377 (1998-2961)	0.768
	T3	2334 (2054-2858)	2472 (2168-3097)	2167 (1957-2698)	0.128

Data are expressed as median and interquartile range. The p-values refer to comparisons between groups (Mann-Whitney I vs. C test).

Different letters in the same column indicate significant differences between visits in the same group (Wilcoxon test, $p < 0.05$).

DISCUSSION

The analysis of the data collected in this study highlighted key aspects regarding the effectiveness of the dietary-educational intervention, sleep quality, physical activity, and the overall health of the participants. While the results did not reveal significant differences between the I and C groups in certain areas, they provide valuable insights for future investigations and targeted interventions.

The initial analysis indicated that the groups were comparable in terms of insomnia severity, perceived sleep quality, and daytime sleepiness, with mean scores reflecting suboptimal sleep quality. At the end of the study, the lack of significant differences in insomnia severity, subjectively-perceived sleep quality, and daytime sleepiness between intervention groups suggests that dietary modifications during three months may not be sufficient to produce significant improvements in sleep hygiene without more targeted interventions in subjects already treated pharmacologically. This finding aligns with existing literature; previous studies have shown that dietary interventions can have a limited impact on sleep quality when not accompanied by an integrated approach. For example, Lo Martire et al. (2020) demonstrated that the benefits of diet on sleep are often mediated by other factors, such as lifestyle and stress management (356). Similarly, Markwald et al. (2018) emphasized that while sleep education is a useful component, it is more effective when combined with specific behavioral strategies for treating insomnia (357). Kline et al. (2021) suggested that physical activity and proper sleep hygiene could enhance the positive effects of diet, but these interventions must be tailored to meet individual needs (358). Moreover, St-Onge et al. (2016) noted that although certain nutrients are associated with better sleep quality, the cumulative effect of dietary habits may be insufficient without interventions addressing the physiological and behavioral mechanisms of sleep directly (359). In summary, the absence of significant improvements in insomnia, sleep quality and daytime sleepiness underscores the importance of a multidimensional approach that combines diet, behavioral management, and personalized interventions, rather than relying solely on dietary or educational modifications.

The results also indicate that the intervention did not produce significant changes in anthropometric parameters, such as weight, BMI, or waist circumference, either over time or between groups. This may be attributed to the fact that most participants had a normal BMI at the beginning of the study, so the implemented diet was not primarily aimed at weight reduction but was designed to promote healthy food choices.

The increase in physical activity observed in both groups, particularly in the I group, suggests that the intervention, although not directly targeting improvements in physical activity, may have had an indirect effect by fostering greater awareness of a healthy and active lifestyle. This finding is supported by studies showing that health-focused educational interventions can enhance motivation to engage in physical activity (360–362).

The data on adherence to the MD revealed a positive trend over time in the I group, although it did not reach statistical significance. While not confirmed by statistical significance, this finding suggests that the intervention may have had a positive yet limited effect, with potential long-term benefits. Although there was a slight improvement, this shows that the participants did not fully follow the dietary recommendations they were given and therefore did not comply with the intervention. This, together with the fact that the patients were being treated pharmacologically, could be one of the main reasons for the lack of improvement over time and the significant differences between the two groups. However, it is important to consider that changing eating habits takes a lot of effort and time, and perhaps a longer treatment period would have improved adherence to the dietary prescription. Previous studies confirm that educational interventions targeting the MD tend to improve adherence gradually, with outcomes varying based on the program's duration and methodology. For instance, an analysis by Pant et al. (2024) demonstrated that significant improvements in MD adherence were observed only after prolonged periods of nutritional education and sustained behavioral changes (363). Similarly, a systematic review of López-Gil (2023) highlighted that MD interventions are more effective in younger populations, although improvements can still be observed in older adults, albeit with a less immediate adoption (364).

A notable finding from this study was the change in vegetable consumption. The I group exhibited a significant increase, whereas the C group reported a decrease in vegetable consumption over time. This result is particularly relevant given the MD's emphasis on fresh vegetables as a cornerstone of daily nutrition. Previous research supports the notion that educational interventions can enhance vegetable intake, contributing to healthier dietary patterns (365).

Another significant observation concerned the consumption of sweets. The C group showed a marked increase in sweet consumption compared to the I group. This suggests that the educational intervention in the I group effectively promoted healthier eating habits, aligning with findings from similar studies examining the impact of educational interventions on sugar and sweet consumption.

For example, a study by Chiang et al. (2020) demonstrated that nutritional education significantly reduces the intake of high-sugar foods (366).

The observed increase in alcohol consumption within the I group may reflect a misinterpretation of recommendations regarding "moderation" in wine consumption, as advocated by the MD. Such as the study by Hrelia et al. (2022), indicate that moderate alcohol intake, particularly red wine, is associated with cardiovascular health benefits (367). However, it is crucial to clarify the limits of moderation to avoid misinterpretations. Despite the results of conventional observational epidemiological studies supporting a potential beneficial role of wine in the context of a healthy Mediterranean diet, the issue remains highly controversial (368).

A positive outcome was the reduction in coffee and tea consumption in the I group, which could be linked to improved sleep quality. Caffeine and theine are known stimulants that interfere with sleep, and educational interventions aiming to reduce their intake have been associated with better sleep quality and overall well-being (369). The trend observed in the C group, though not significant, suggests that even general recommendations on sleep-related behaviors may have positive effects.

The analysis of nutrient intakes revealed significant differences between groups, particularly in the reduction of cholesterol and saturated fat intake in the I group. This result underscores the effectiveness of the educational intervention in improving participants' dietary choices, aligning with findings in the literature. For instance, interventions promoting the MD have been shown to reduce saturated fat and cholesterol intake, improving lipid profiles and lowering cardiovascular disease risk (370). Additionally, while the increased fiber intake remained below the recommended 25 g/day, it signals an improvement in dietary habits, though there remains room for further progress, as highlighted by prior studies(371).

In summary, while some observed changes were significant, the overall findings suggest that targeted educational interventions, particularly those focused on the MD, can positively influence dietary habits. However, the long-term effectiveness of such interventions will depend on the ability to sustain and reinforce these changes. Unfortunately, the dietary changes observed were not sufficient to have a significant impact on sleep quality and symptoms associated with chronic

insomnia. The need for more targeted and continuous interventions may be critical to ensuring lasting results.

CONCLUSIONS AND FUTURE PERSPECTIVES

The preliminary results of the SONMED pilot study indicate that, although the educational and nutritional intervention based on the MD led to some changes, no statistically significant differences were observed between the I and C groups regarding sleep disturbances. The current sample size limits the statistical power of the study, preventing the identification of potentially significant effects that may emerge in larger samples. Expanding the sample size would improve the precision of the estimates and allow for the exploration of variations within specific subgroups (e.g., age, sex, metabolic status, adherence to lifestyle or dietary regimens). Such analyses could reveal effects that did not emerge due to the limited sample size. The difficulty in detecting significant improvements in insomnia parameters may also be attributed to the relatively low baseline insomnia levels of the participants, limiting the potential for observing marked changes. Moreover, more severe sleep disturbances are often associated with physical and mental comorbidities, which may have influenced the recruitment and involvement of the participants. The results of the study show that the dietary-educational intervention had positive effects in food choices, such as increased vegetable consumption, but had a limited impact on sleep quality and body composition. To improve the effectiveness of future interventions, it is essential to develop educational and dietary models specifically tailored to the participants' needs. This includes clear communication regarding the risks associated with substances like wine, which is often mistakenly perceived as part of a healthy lifestyle. Improving the understanding and application of dietary recommendations could be crucial in achieving more pronounced effects. Furthermore, future studies should include larger samples, more specific interventions, and detailed monitoring through advanced technologies to obtain a more comprehensive and accurate view. This would allow for better identification of the mechanisms through which dietary-educational interventions influence overall health, thereby improving the effectiveness and implementation of preventive and therapeutic strategies. In conclusion, although the intervention did not produce significant changes in insomnia and sleep quality parameters, this may suggest that educational and nutritional interventions alone may not be sufficient to significantly impact sleep disturbances in pharmacologically treated patients. Future studies could benefit from more integrated approaches, combining behavioral and dietary interventions, to more effectively address complex sleep disorders. The lack of such data represents a limitation of the study but simultaneously highlights the importance of using multifactorial tools to deepen the relationship between sleep, nutrition, and lifestyle.

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SUPPLEMENTARY MATERIALS

Educational Content of the SONMED Study

Topics (12 topics, 1 per week for 12 weeks):

The educational topics were selected based on the CREA guidelines to enhance participants' adherence to a healthy lifestyle inspired by the MD model (117). Each weekly topic was designed to improve nutritional literacy and promote healthy habits, focusing on key aspects of nutrition and well-being.

1. The "Diet" of Good Sleep:

This topic introduces the principles of a diet that promotes sleep, highlighting the relationship between nutrition and sleep quality. It emphasized foods and habits that can improve sleep.

2. The Mediterranean Diet:

This topic provided an in-depth look at the MD, known for its benefits on cardiovascular health and longevity. The focus was on incorporating characteristic foods such as fruits, vegetables, whole grains, legumes, fish, and olive oil.

3. Nutrients:

This topic explored macronutrients (carbohydrates, proteins, fats) and micronutrients (vitamins and minerals), explaining their essential roles in the human body and how a balanced diet can contribute to overall health.

4. Foods:

This topic covered the nutritional properties of foods, including tips on selecting high-quality foods and incorporating a variety of foods to meet nutritional needs.

5. Seasonality of Foods:

The advantages of consuming seasonal foods were discussed, such as improved nutritional value, reduced environmental impact, and support for local agriculture.

6. Beverages and Hydration:

This topic emphasized the importance of proper hydration and the selection of healthy beverages, such as water, herbal teas, and other unsweetened drinks, to maintain optimal fluid balance.

7. Meals:

Guidance was provided on how to plan and structure the main meals of the day to ensure adequate nutritional intake, with particular attention to meal composition according to the principles of the MD.

8. The Healthy Plate:

Participants learned about the concept of the "healthy plate," a visual guide for balancing portions of vegetables, lean proteins, whole grains, and healthy fats in each meal.

9. Breakfast:

The importance of breakfast as a fundamental meal to start the day was emphasized, with advice on food choices that provide energy and essential nutrients.

10. Portions and Frequencies of Food Consumption:

This topic covered the importance of appropriate portions and consumption frequencies to prevent overweight and ensure nutritional balance.

11. Eating Out:

Tips were provided on how to make healthy food choices when eating out, such as selecting vegetable-based dishes, avoiding fried foods, and managing portion sizes.

12. Grocery Shopping and Food Preparation:

This topic provided practical advice on mindful grocery shopping and healthy food preparation, including reading food labels and using healthy cooking techniques.

Daily Tips (84 tips, 1 per day for 12 weeks):

Daily short messages were provided to reinforce the weekly topic, aimed at improving nutritional literacy and offering practical tips for daily implementation of the learned information.

Daily Recipes (1 per day for 12 weeks):

Participants received one recipe per day that followed the seasonality of foods. Each recipe was accompanied by tables with commonly used household measurements to facilitate preparation and encourage the adoption of healthy eating habits based on MD principles.

Sleep Hygiene Guidelines

Sleep hygiene guidelines were provided to both groups, following the standard recommendations for chronic insomnia management by the Department of Sleep Medicine at the Parma Hospital. These guidelines include a set of behaviors and habits that naturally and physiologically contribute to improved sleep quality, such as maintaining regular sleep schedules, creating a sleep-friendly environment, and limiting stimulating substances like caffeine.

Chapter 4 Overall conclusions

In today's context, where malnutrition and the environmental impact of diets are becoming increasingly urgent issues, the doctoral thesis *"Development of Innovative Tools for Nutrition Education: A Promising Strategy to Tackle and Prevent Malnutrition and to Reduce the Environmental Impact of Food through the Adoption of Healthier and More Sustainable Diets"* presents a critical analysis of the importance of nutrition education in promoting healthy and sustainable lifestyles. The central goal is to combat both undernutrition and overnutrition, as well as chronic non-communicable diseases (NCDs), while also addressing the environmental impact of food systems, highlighting how diet and food choices affect both health and the environment (372). The research consists of seven projects that explore a variety of educational, innovative, and digital strategies targeting different population groups. These include children, adolescents, and adults, across diverse contexts such as workplaces, community services, schools, and sports organizations. One project specifically focuses on a population with pathological conditions, such as patients suffering from chronic insomnia. The MD, recognized as a complete, healthy, and sustainable model, forms the foundation of the educational approach in these projects, offering an ideal solution for a balanced and environmentally respectful lifestyle (201). Central to the educational model proposed in the studies are nudging and edutainment, particularly for younger audiences. These approaches leverage subtle, non-coercive techniques and engaging, playful learning methods to shape behaviour and enhance educational experiences (373,374). Nudging encourages positive decisions by gently guiding food choices without restricting freedom, while edutainment combines education with entertainment to capture the attention of young people, making the learning process enjoyable and effective (373,374). These strategies are particularly effective in promoting long-term eating habits and behaviour, as they create a pleasant and supportive learning environment that resonates with children, helping them absorb information in a more natural and engaging way (216).

The first project, the GIOCAMPUS METHOD, demonstrates the effectiveness of food education in schools, engaging children, families, and teachers in a playful and educational context through a learning-through-playing approach. This model integrates edutainment, combining education and entertainment to make learning both enjoyable and impactful for younger audiences. The project was developed in collaboration with the business component Madegus, ensuring a strong connection between educational content and practical, real-world applications. The digitalization and creation of a virtual Giocampus could represent an evolution, expanding access to these

educational programs and making nutrition education available remotely. The initiative has shown positive results in promoting healthy eating habits, while the parallel monitoring project, GIOCAMBUS PERSPECTIVE, highlighted issues in children's diets, such as low fruit and vegetable intake and a high incidence of overweight and obesity, in line with the Italian scenario. This suggests that prolonged monitoring and active family involvement could further improve outcomes. The project benefited from the collaboration with Madegus, which played a key role in supporting the initiative and ensuring its practical impact, strengthening the link between education and real-world applications. The AUDACE project, involving young athletes, showed that a playful educational approach can encourage healthier hydration and eating habits both on and off the field. In this case, the learning took place not in the classroom, but on the football field, highlighting the importance of learning through play in an active setting. Additionally, the integration of *edutainment* played a key role in engaging the participants. However, the project also revealed the need for a larger sample size and a more prolonged intervention. These studies highlight how nutrition education for young people can be effectively integrated into the sports context, positively influencing both health and performance. The LOSTELLO project emphasized the importance of promoting the MD and the consumption of seasonal and locally sourced products to raise awareness about the environmental impact of food choices. Through innovative tools like QR codes and infographics, LOSTELLO effectively highlighted the environmental impact of food choices. The project was developed in close collaboration with Madegus, which contributed significantly to its implementation and outreach. However, the initiative encountered cultural and economic barriers that still hinder the adoption of sustainable eating habits. In this context, promoting public policies and initiatives that make these foods more accessible and inclusive will be crucial. The WELLNESS PROJECT highlights how workplace interventions can promote healthy eating habits among adults, especially in sedentary environments with limited time. The intervention, which includes video pills on the MD and interactive tools, improved participants' nutritional knowledge. However, actual adherence to the diet showed only slight improvements, particularly in fruit consumption. This suggests that nutritional awareness alone is not sufficient to change established habits. Multidimensional interventions, including culinary skills and supportive food environments, are necessary. The INAIL Workclimate study demonstrated how the work environment can be strategically used to promote health through nutrition education, even in specific work contexts such as thermal stress. Promoting the MD and stress management practices, coupled with the use of mobile apps to monitor hydration and nutritional well-being, proved to improve employees' health and productivity, confirming the

importance of integrating nutrition education programs into corporate settings. Finally, the SONMED study, which involved adults with chronic conditions, particularly chronic insomnia, is once again based on the adoption of the MD. While it did not show significant short-term changes in patients' health related to insomnia, it suggests that extended monitoring could demonstrate tangible benefits for patients' overall health, beyond just treating insomnia. This indicates the importance of structured and prolonged educational interventions to positively influence diet and, consequently, population health.

The analyzed projects highlight how nutritional education is a crucial tool for improving public health, especially when supported by digital technologies and a collaborative network involving schools, families, businesses, and institutions. However, an in-depth analysis of existing initiatives reveals critical issues that require targeted actions to ensure long-term sustainability and broader scalability. In this context, European projects such as **SWITCHtoHEALTHY**, **ProMedLife**, and **MED4Youth** offer innovative models (122,124,375). **SWITCHtoHEALTHY** focuses on transitioning to healthier eating habits by implementing strategies that engage families through digital awareness campaigns and improving access to nutritious foods. However, a major challenge lies in maintaining family engagement over time, particularly in socio-economically disadvantaged contexts (122). **ProMedLife**, on the other hand, promotes the Mediterranean diet as a sustainable nutritional model to reduce the risk of chronic diseases (124). This project combines nutritional education with scientific research, demonstrating the health benefits of the Mediterranean diet, while emphasizing the need for policies that ensure the economic accessibility of its key components (124). Similarly, **MED4Youth** targets young people with interventions that merge nutritional education and active lifestyle promotion, using interactive digital tools to increase awareness of a balanced diet. Despite encouraging results, this project highlights the challenges of integrating these approaches into traditional educational systems (375). At the national level, initiatives like *Fruit and Vegetables in Schools* and *Health@Work* reflect the potential of these interventions (376,377). *Fruit and Vegetables in Schools*, funded by the European Union, has positively impacted the consumption of fresh produce among children, but it has also revealed limitations related to long-term sustainability and the difficulty of aligning educational messages with the daily realities of families (376). Similarly, the *Health@Work* project, aimed at improving health in workplaces, has shown that prevention programs can reduce absenteeism and enhance overall well-being, but logistical and cultural barriers often hinder worker participation (377). Another innovative element is the

application of behavioral strategies such as nudging and edutainment. Nudging, based on the model proposed by Thaler and Sunstein (2008), involves modifying decision-making environments to encourage healthier choices, such as strategically placing healthy foods in school cafeterias (373). While effective, the implementation of this technique must consider the cultural and socio-economic characteristics of target communities to avoid being perceived as paternalistic or ineffective. Edutainment, which combines education and entertainment, offers a creative solution to engage young audiences, but its effectiveness depends on equitable access to technologies and recipients' digital skills (216). Projects like *Giocampus* have demonstrated that playful approaches improve understanding of nutritional topics, though they require significant investment in teacher and educator training (378). The adoption of digital technologies has significantly expanded the impact of many initiatives, as seen in platforms developed by companies like Madegus (89). Digital applications and wearable devices offer unprecedented opportunities for personalized monitoring and awareness, but they also raise significant challenges regarding digital equity and ethical data management (379). Their widespread adoption must be accompanied by regulations that protect privacy and ensure inclusive access. In this context, public policies play a pivotal role in consolidating and expanding the benefits of nutritional education initiatives. Studies show that measures such as mandatory nutritional guidelines, fiscal incentives for healthy foods, and awareness campaigns can significantly reduce the prevalence of chronic diseases like obesity and diabetes (380–382). These initiatives should not be limited to schools alone but must also extend to workplaces, communities, hospitals, care homes, and other collective settings. In these contexts, tailored approaches are essential to address the specific needs and challenges of different populations, ensuring the promotion of healthy lifestyles is inclusive and impactful (380,383,384). However, implementing these policies on a large scale requires synergistic collaboration among public institutions, the private sector, and local communities (380). Considering these aspects, maximizing the impact of interventions requires a holistic and multidimensional approach. This includes not only widespread nutritional education but also improved access to healthy foods, integrated prevention policies, and active involvement from all social actors (380,385). By addressing socio-economic and cultural disparities and integrating innovative technologies with robust public policies, it will be possible to promote healthy and sustainable lifestyles on a large scale, ultimately improving the health and well-being of future generations (380,386,387).

Chapter 5 Future perspectives

Based on the results obtained from this doctoral thesis, it is evident that the future prospects for nutritional education and food sustainability are closely linked to the need to address global challenges such as health, the environment, and food security. Concerns about chronic diseases related to poor dietary habits and the negative impact of the food system on the environment necessitate a rethinking of policies, educational practices, and dietary habits. It is urgent to develop strategies that promote both individual health and environmental sustainability, supporting balanced diets with low environmental impact integrated into public policies. Nutritional education must become a crucial aspect of food policy, as it can shape long-term food systems, improving public health and environmental outcomes. Including nutritional education in public policies helps individuals make informed choices, contributing to more sustainable food systems. Future developments in nutritional education, based on the conclusions of this thesis, could include the following directions:

Expansion of Digital and Remote Educational Tools: The growing integration of digital technologies in nutritional education provides the opportunity to reach a wider and more diverse audience. The development of virtual platforms, mobile apps, and interactive tools can make educational programs accessible to individuals in different geographical locations and socio-economic conditions. Future initiatives should focus on improving the digital infrastructure for nutritional education, enabling remote participation and providing personalized feedback to users.

Integration of Sustainable Diets into Public Policies: Governments need to incorporate sustainable eating practices, such as the MD, into public health policies. Policymakers should prioritize initiatives that promote the accessibility and affordability of healthy and environmentally sustainable foods, such as seasonal and local products. Public policies should also encourage the inclusion of nutrition education in schools, workplaces, and healthcare settings to foster a shared culture of health and sustainability.

Long-Term and Multidimensional Educational Interventions: Short-term interventions may not be sufficient to achieve lasting changes in eating habits. Future programs should adopt a multidimensional approach, which includes not only nutritional education but also teaching culinary skills, strategies for behavioral change, and the creation of supportive food environments. This holistic approach should target various settings, such as schools, workplaces, and communities, and provide continuous support to maintain long-term change.

Greater Focus on the Environmental Impact of Food Choices: As climate change and environmental degradation become increasingly urgent issues, future nutritional education initiatives should place more emphasis on the environmental impact of food choices. Educating people about the ecological consequences of their eating habits—such as the carbon footprint of food production and the benefits of a plant-based and seasonal diet—will be key to promoting more sustainable eating behaviors. Programs like LOSTELLO demonstrate how innovative tools, such as QR codes and infographics, can effectively communicate these environmental messages.

Promotion of Intergenerational Education: Nutritional education should engage families and communities to create a supportive environment for healthy eating habits. Programs that involve children, parents, and grandparents together can help reinforce positive eating behaviors across generations. Family-oriented initiatives can have a profound impact on long-term health outcomes, especially in the prevention and management of chronic diseases and obesity.

Collaboration between Public and Private Sectors: Successful nutritional education programs will require collaboration between governments, businesses, non-profits, and educational institutions. Businesses can promote healthy food choices in workplaces through initiatives like healthy catering, wellness programs, and partnerships with local farmers to offer sustainable products. An example of successful collaboration is the Giocampus Method, which exemplifies a highly efficient and virtuous partnership between the public and private sectors. This initiative demonstrates how combined efforts can effectively foster healthier lifestyles and promote sustainable food practices within communities.

Increased Awareness of Food Sovereignty and Local Food Systems: Future educational programs should also raise awareness about food sovereignty—enabling communities to take control of their food production and consumption practices. Promoting local food systems can foster greater self-sufficiency, reduce reliance on industrial agriculture, and protect local biodiversity. By emphasizing the importance of sourcing food locally and supporting small-scale producers, educational initiatives can contribute to the creation of more resilient and sustainable food systems. This shift could significantly reduce the environmental impact associated with long supply chains and promote healthier and culturally appropriate food choices.

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Curriculum Vitae

WORK EXPERIENCE

Ph.D. Student

Jan 2022-
Dec 2024

- Dept. of Food and Drug, University of Parma
- Parma, Italy
- Research Project: Development of innovative tools for nutrition education: a promising strategy to address and prevent malnutrition and reduce the environmental impact of food through the adoption of healthier and sustainable diets
- Project supervisors: Prof. Francesca Scazzina

Oct 2020-
Dec 2021

Post-graduate Research Fellow

- Dept. of Food and Drug, University of Parma, Italy
- Project: MED4Youth, Nutrition as a tool to improve health
- Project supervisor: Prof. Daniele Del Rio, Prof. Francesca Scazzina

Feb 2020-
Oct 2020

Post-graduate intern

- Dept. of Food and Drug, University of Parma, Italy
- Project: Nutrition as a tool to improve health
- Project supervisor: Prof. Francesca Scazzina

Oct 2018-
Oct 2019

Pre-graduate intern

- Dept. of Science and Technology University of Milan, Italy
- Project: Study of the role of the transcription factor nfix in macrophages during the process of fibrosis in muscular dystrophy
- Project supervisor: Prof. Graziella Messina

Sept 2016-
Dec 2016

Pre-Bachelor' degree intern

- Dept. of Biosciences, University of Parma, Italy
- Project: The yeast model for studying potentially pathological mutations in the ACO2 gene encoding mitochondrial aconitase
- Project supervisor: Prof. Paola Goffirni

**PARTICIPATION IN EU
PROJECTS**

2021 MED4Youth study, registered at ClinicalTrials.gov (NCT04719052)

**OTHER
EXPERIENCE**

2022-2023 Thesis co-supervisor for Bachelor and Master students

2021-2024 Social Media Manager for the official profiles of SINU (Italian Society of Human Nutrition).

2022-2024 Active member of the SINU Giovani group of SINU (Italian Society of Human Nutrition).

Nutrition education consultant on behalf of Madegus – University of Parma Spin-Off focused on nutrition education for children – www.madegus.com

PUBLICATIONS

2022 Marchini M, Rosi A, Raia F, Bertolotti E, Scazzino F, Carini E. Acceptability of alternative ready-to-use therapeutic foods in acute malnutrition management-a systematic review. Int J Food Sci Nutr. 2022 Dec;73(8):993-1004. doi: 10.1080/09637486.2022.2119213. Epub 2022 Sep 5. PMID: 36064197

**ORAL
COMMUNICATIONS**

2022 PhD day at University of Parma – title: “Development of innovative tools for nutrition education: a promising strategy to tackle and prevent malnutrition and to reduce the environmental impact of food through the adoption of healthier and more sustainable diets”

2022 XLII National SINU Conference in Naples – title: “Differences between measured and self-perceived body size and lifestyle habits in a sample of children and adolescents: the GiocaMed21 cross-sectional study”

2023 Congress: Pastaria FESTIVAL 2023, Hotel Parma & Congressi, Parma 29/09/2022 “Pasta: verità scientifica versus fake news”

2023 Workshop: NOTTE DEI RICERCATORI 2023, Parma 29/09/2023 “Le sfide della comunicazione scientifica oggi”

2024 XLII National SINU Conference in Piacenza: The Giocampus Prospective Project

**POSTER
COMMUNICATIONS**

2022 26th Workshop on the Developments in the Italian PhD Research on Food Science, Technology and Biotechnology in Asti – title:
“Development of innovative tools for nutrition education: a promising strategy to tackle and prevent malnutrition and to reduce the environmental impact of food through the adoption of healthier and more sustainable diets”



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