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Food supply in school context in Portugal and Italy for children between 6 and 10 years old: a qualitative assessment and a study of the main associated factors

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Oferta alimentar em contexto escolar em Portugal e em Itália em crianças dos 6 aos 10 anos de idade: avaliação qualitativa e estudo dos principais fatores associados

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Abstract

Introduction: In recent years, the global prevalence of obesity and pre-obesity has been steadily rising, posing one of the most significant public health challenges in Europe. Italy and Portugal are among the European countries with the highest rates of overweight in the paediatric population. Poor dietary habits established during childhood, which are shaped and modified by various contexts, are major contributors to this issue. Schools play a critical role in fostering healthy eating behaviours. However, school meals often fail to meet the standards of a healthy diet. Moreover, in light of the escalating environmental crisis, it is essential to identify dietary patterns that are both health-promoting and sustainable for the environment.

Objective: To characterise the food offered at school to children aged 6 to 10 years in Portugal and Italy, focusing on criteria of healthiness and sustainability and to identify the factors associated with the food quality.

Methodology: A descriptive cross-sectional observational study was conducted in 17 public schools in Portugal and 15 public schools in Italy to evaluate school menus for children aged 6 to 10 years old. In Portugal, three monthly menus were collected from each municipality for the autumn, winter, and spring seasons, while in Italy, one spring/summer and one autumn/winter menu were collected from each school. The quality of the menus was analysed using the SPARE+ tool, the Pavia ATS self-assessment questionnaire and an adapted version of the SPARE+ tool for Italy, modified to accommodate the culinary culture difference between Italy and Portugal. In addition to the school menus, the characterisation of each institution was made through a questionnaire completed by the nutritionists or by the municipal manager.

Results: Using the SPARE+ tool, Portuguese menus demonstrated a mean compliance rate of 73.3% with dietary recommendations. In contrast, Italian menus, assessed with the Pavia ATS tool, exhibited a slightly higher mean compliance rate of 74.7%. For SPARE items applied to both countries, significant differences were observed in the average menu quality scores, with Italian menus displaying higher quality. Both countries excelled in offering fresh fruit, limiting sweets, and using local products, but lacked in the offer of whole grains in children's meals. Italy performed well with protein sources, maintaining recommended meat levels and

increased plant-based options, though still insufficient. Portugal performed well in the vegetable and fish categories, but the offer of meat was excessive when compared to the alternative protein foods.

In Portugal, no statistically significant correlations were identified between associated factors and the menu quality. However, in Italy, a generally positive association was found between the menu quality, analysed with the original Italian tool, and the number of canteens and meals served by the municipality. Also, in Italy, using the adapted SPARE+ tool, menu quality was found to be higher in urban settings compared to rural ones during the winter season.

Conclusion: This study found generally good compliance with health and environmental sustainability criteria in the analysed meals, with Italian menus performing better overall. Additionally, the study revealed that menu quality in Italy was generally positively associated with the number of canteens and meals provided by the municipality, a trend not observed in Portugal.

Keywords

Childhood, Food quality, Italy, Meals, Portugal, School, Sustainability.

Resumo

Introdução: Nos últimos anos, a prevalência global da obesidade e pré-obesidade tem vindo a aumentar de forma constante, constituindo um dos mais significativos desafios de saúde pública na Europa. Itália e Portugal estão entre os países europeus com as taxas mais elevadas de excesso de peso na população pediátrica. Os maus hábitos alimentares estabelecidos durante a infância, que são moldados e modificados por vários contextos, são factores importantes que contribuem para este problema. As escolas desempenham um papel fundamental na promoção de comportamentos alimentares saudáveis. No entanto, as refeições escolares muitas vezes não cumprem os padrões de uma alimentação saudável. Além disso, à luz da crescente crise ambiental, é essencial identificar padrões alimentares que sejam simultaneamente promotores da saúde e sustentáveis para o ambiente.

Objetivo: Caracterizar a alimentação oferecida na escola a crianças dos 6 aos 10 anos de idade em Portugal e em Itália, com base em critérios de salubridade e sustentabilidade, e identificar os factores associados à qualidade alimentar.

Metodologia: Foi realizado um estudo observacional transversal descritivo em 17 escolas públicas em Portugal e 15 escolas públicas em Itália para avaliar as ementas escolares para crianças dos 6 aos 10 anos de idade. Em Portugal, foram recolhidas três ementas mensais de cada município para as estações do outono, inverno e primavera, enquanto em Itália foram recolhidas uma ementa primavera/verão e uma ementa outono/inverno de cada escola. A qualidade das ementas foi analisada utilizando a ferramenta SPARE+, o questionário de autoavaliação da ATS (Agenzia di Tutela della Salute) de Pavia e uma versão da ferramenta SPARE+ adaptada para Itália, modificada para ter em conta a diferença de cultura culinária entre Itália e Portugal. Para além das ementas escolares, a caracterização de cada instituição foi feita através de um questionário preenchido pelos nutricionistas ou pelo gestor municipal.

Resultados: Utilizando a ferramenta SPARE+, as ementas portuguesas demonstraram uma taxa média de cumprimento das recomendações alimentares de 73,3%. Em contrapartida, as ementas italianas, avaliadas com a ferramenta da ATS de Pavia, apresentaram uma taxa média de cumprimento ligeiramente superior, de 74,7%. Relativamente aos itens SPARE aplicados a ambos os países, foram observadas diferenças significativas nas pontuações médias de qualidade dos menus, com os

menus italianos a apresentarem uma qualidade superior. Ambos os países se destacaram na oferta de fruta fresca, na limitação de sobremesas doces e na utilização de produtos locais, mas apresentaram uma baixa oferta de cereais integrais nas refeições das crianças. Itália teve um bom cumprimento no que respeita às fontes de proteína, atingindo os níveis recomendados de carne e apresentando mais opções vegetais que Portugal, embora ainda insuficientes. Portugal teve um bom cumprimento nos itens de hortícolas e pescado, mas a oferta de carne foi excessiva quando comparada com os alimentos proteicos alternativos.

Em Portugal, não foram identificadas correlações estatisticamente significativas entre os factores associados e a qualidade das ementas. No entanto, em Itália, foi encontrada uma associação positiva entre a qualidade da ementa, analisada com a ferramenta original italiana, e o número de cantinas e refeições servidas pelo município. Além disso, em Itália, utilizando a ferramenta SPARE+ adaptada, verificou-se que a qualidade dos menus era mais elevada nos meios urbanos do que nos meios rurais durante o inverno.

Conclusão: Este estudo constatou que, de um modo geral, as refeições analisadas cumprem bem os critérios de saúde e de sustentabilidade ambiental, com os menus italianos a apresentarem um melhor desempenho global. Adicionalmente, o estudo revelou que a qualidade das ementas em Itália estava geralmente associada de forma positiva ao número de cantinas e refeições fornecidas pelo município, uma associação não observada em Portugal.

Palavras-chave

Escola, Infância, Itália, Portugal, Qualidade alimentar, Refeições, Sustentabilidade.

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Acronyms List

ATS: Agenzia di Tutela della Salute

BMI: Body Mass Index

COSI: Childhood Obesity Surveillance Initiative

DGS: Direção Geral da Saude

EFSA: European Food Safety Authority

EIPAS: Integrated Strategy for Healthy Eating

EU: European Union

FAO: Food and Agriculture Organization of the United Nations

FBDG: Food-Based Dietary Guidelines

HELENA-CSS: Healthy Lifestyle in Europe by Nutrition in Adolescence Cross-Sectional Study

LARN: Reference Intake Levels of Nutrients and Energy

IAN-AF: Inquérito Alimentar Nacional de Alimentação e Atividade Física

ISTAT: Istituto Nazionale di Statistica

MIUR: Ministry of Education, Universities and Research

MDP: Mediterranean Dietary Pattern

SPARE: Sistema de Planeamento e Avaliação de Refeições Escolares

USA: United States of America

WHO: World Health Organization

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Background

Nutrition and Health: The Interconnected Dynamics

The World Health Organization's (WHO) definition of health as "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" (1) highlights the intricate nature of this concept and its interconnectedness with various aspects of our lives. Our health is indeed influenced by a myriad of factors within the context of our environment (2). Malnutrition in its various forms poses a significant threat to human health, manifesting as undernutrition, insufficient intake of essential vitamins or minerals, overweight, obesity, and the subsequent development of noncommunicable diseases, as highlighted by the WHO (3). The term "double burden of malnutrition" was coined to encapsulate the simultaneous occurrence of undernutrition and overnutrition (4). This phenomenon is not only observed globally but can coexist within the same regions, countries, and communities. Moreover, its repercussions extend beyond individual health, exerting significant consequences at the family and community levels (5,6).

In fact, one of the key elements that affects our health is our nutritional status. Nutrition plays a key role in determining the health of an individual of any age (7). An optimal nutritional status is associated with numerous health advantages, such as enhanced resistance to diseases, safer pregnancy and childbirth, and a diminished risk of noncommunicable diseases such as obesity, hypertension, diabetes mellitus and cancer (8). Furthermore, maintaining a good nutritional status also contributes to increased longevity (9,10). These interconnections demonstrate how nutrition is a crucial element in promoting health at all stages of life. Adopting a healthy diet is an effective means of defence against malnutrition in all its forms and noncommunicable diseases (11).

When it comes to the paediatric age group, it is paramount to underscore the significance of maintaining a healthy diet from the moment of conception. There is a particular emphasis on the initial 1,000 days of an individual's life. This period, spanning from conception to 24 months of age, constitutes a critical phase marked by rapid and pivotal brain growth and development (12). Research underscores the link between nutritional status and brain development, highlighting that childhood

deficiencies such as stunting, wasting, and micronutrient deficiencies can have profound effects (13). These nutritional gaps are linked to diminished developmental performance, resulting in lower academic achievement, psychological issues, and reduced economic prospects in adulthood. Thus, prioritizing adequate nutrition during the initial 1,000 days is not just a matter of immediate health but also an investment in the individual's long-term well-being and potential (13,14).

Considering childhood, besides the association found between nutrition and health outcomes mentioned previously, a moderate correlation has been identified between various aspects of dietary intake and academic performance. Indicators associated with higher performance included regular breakfast consumption, reduced intake of energy-dense and nutrient-deficient foods (commonly identified in research as 'junk/fast foods', including sugary drinks), as well as a better overall diet quality (15). Adopting a healthy diet during childhood is essential to ensure appropriate physical and cognitive development, as well as to contribute to the prevention of adverse health outcomes such as childhood obesity (16).

Towards Optimal Nutrition: Understanding and Applying Dietary Guidelines

In order to understand which dietary recommendations should be adopted and promoted, the WHO and the Food and Agriculture Organization of the United Nations (FAO) have promoted the development of national food-based dietary recommendations, considering the economic, cultural, social and environmental conditions of each country (17). Also, the European Food Safety Authority (EFSA) has encouraged European Union member states to establish food group-focused dietary recommendations based on Dietary Reference Values, in order to avoid nutritional deficiencies or excesses that may compromise health (18). The primary goal of these guidelines is to offer practical tools and clear information that assist individuals in comprehending the principles of a balanced and healthy diet. In doing so, they can effectively adopt a dietary pattern that aligns with their individual needs.

In this context, the food-based dietary guidelines are considered short messages expressed as dietary recommendations based on food groups, in accordance with general and accepted nutritional principles and current scientific evidence (19). Food-based dietary guidelines are focused on preventing malnutrition,

promoting human health, and reducing environmental impact by incorporating the concept of sustainability into the definition of healthy diet (19-21).

In general, all national and international dietary guidelines comply with a healthy eating model with a low environmental impact (22,23), including the following recommendations:

- a varied and balanced diet: consuming a wide range of foods from different food groups and maintaining an appropriate balance between the energy ingested and energy expended by individuals;
- a dietary pattern primarily centered on plant-derived foods including fruits, vegetables, minimally processed tubers, whole grains (preferably), unsalted seeds and nuts, as well as oils and fats with a favourable omega 3:6 ratio;
- diet should include a moderate consumption of fish and aquatic products and limited quantity of meat and meat products;
- very limited consumption of foods with high content of fat, simple sugars or salt, as well as low in micronutrients (e.g., french fries, sweets, sugary drinks, etc.);
- intake of water as the main beverage, limiting consumption of other beverages, especially sugary drinks.

However, the specific recommendations may vary slightly depending on the country, the institutions involved and local culinary traditions.

These recommendations are transversal and must also be adopted in the paediatric age group to avoid deficiencies and pathologies, with particular attention to certain micronutrients especially in the first stage of life. The American Academy of Paediatrics recommends vitamin K supplementation during the first six months of life and during breastfeeding (24) and particular importance is also emphasised for vitamin D, for which the WHO recommends supplementation especially in the case of exclusive breastfeeding (25).

During the food introduction process, it is important to be particularly vigilant in the selection of foods introduced in order to prevent possible nutritional gaps. The choice of foods initially supplemented with breast milk and/or formula must be made in accordance with the generic dietary guidelines for the population, with specific regard to variables such as consistency and potential risk of choking, amount of fibre

introduced, limitation of salt and sugar, as well as careful monitoring of the microbiological risk associated with the foods (26).

Several European countries have developed Food-Based Dietary Guidelines (FBDG) derived from the nutritional recommendations for infants and young children. These guidelines are designed to assist family and caregivers in selecting appropriate foods for different age groups to meet specific dietary needs (27).

Healthy Eating Habits in Childhood: Importance for Health and Development

The prevalence of paediatric obesity has increased worldwide over the past five decades. From 1975 to 2016, the age-standardised percentage of obesity among children and adolescents aged 5-19 years old increased from 0.7% to 5.6% for girls and from 0.9% to 7.8% for boys (28). In 2019, the World Obesity Federation projected that by 2025 there will be 206 million children and adolescents aged 5-19 years old with obesity, with an estimated 254 million children by 2030 (29). Among the 42 countries projected to reach over one million obese children by 2030, China takes the lead with India, the United States of America (USA), Indonesia, and Brazil following closely behind (29). The association between higher Body Mass Index (BMI) and chronic diseases is well established and epidemiological evidence shows that obesity is an independent risk factor for many diseases, including type 2 diabetes, cardiovascular disease, non-alcoholic fatty liver disease, sleep apnea, hypertension, stroke, and several cancers (30). For children and adolescents, obesity can also have a negative impact on the cognitive function, which may lead to a decrease in academic performance (31). The urgency of adopting preventive dietary habits against these diseases from childhood is growing, given that, at the European level, pre-obesity and obesity collectively impact nearly 60% of adults and approximately one in three children (29% of boys and 27% of girls) (32).

In relation to the prevalence of other cardiovascular diseases, approximately 41,600 new cases of type 2 diabetes were diagnosed among the paediatric and adolescent populations globally in 2021 (33). The three countries with the highest estimated number of diabetes cases are China, India, and the USA (34). Regarding hypertension, the prevalence of confirmed paediatric cases ranged from 2% to 4% in 2017 (35). Based on previous pathophysiological and epidemiological evidence, there is a growing hypothesis that the onset of hypertension in childhood is linked to the

development of hypertension in adulthood and the occurrence of adverse cardiovascular events throughout life (36). Hypertension as well as diabetes were previously related to consuming foods with high content of saturated fat, sugar, and sodium, while lacking in fresh vegetables and fruits (37).

An examination of the latest data on per capita food consumption from the Global Dietary Database spanning 2010 to 2018 (38) reveals persistent deficiencies in incorporating sufficient quantities of fruits, vegetables, legume grains, nuts, and whole grains into dietary patterns. Concurrently, there is an alarming, escalating trend in the consumption of red and processed meats, alongside an excessive intake of sugary beverages (39). In the paediatric domain, the results do not differ. Despite the crucial importance of instilling healthy dietary habits from an early age given their association with an increased likelihood of persistence into adulthood (40,41), the literature indicates that school-age children and adolescents exhibit a tendency toward excessive consumption of refined cereals, high-sugar products, and ultra-processed foods and beverages. Simultaneously, they tend to overlook foods that promote health, such as fruits, vegetables, and whole grains. Specifically, it is noteworthy that approximately one-third (30.3%) of school children do not incorporate fruits into their daily diets, while 43.7% consume soft drinks daily (39,42).

Regarding the meat and fish food categories, the HELENA-CSS cohort of European adolescents (12.5-17.5 years old) exhibited an average meat intake approximately 230% higher than the recommended values for boys and around 190% for girls. In contrast, the fruit and vegetable consumption among European boys averaged roughly 35% of the recommended values, while girls displayed slightly higher figures of about 40% for vegetables and approximately 50% for fruit (43).

The World Health Organization has concluded that, although some people may be genetically predisposed towards weight gain, the fundamental causes of the obesity epidemic are societal, resulting from an environment that promotes sedentary lifestyles and the adherence to unhealthy diets (44). Since the family is the base in which a person creates the habits and behaviour, including eating, it seems crucial that good eating practices are learned from childhood, as they will then be one of the main influences in shaping the individual (45).

The Dual Benefits of Having a Healthy and a Sustainable Diet during Childhood

Today, climate change is one of the major emergencies facing humanity. The repercussions of climate change are far-reaching and multifaceted, including shifts in temperature, altered precipitation patterns, rising sea levels, and an escalation in the frequency and intensity of extreme weather events. These changes not only disrupt ecosystems but also pose threats to human societies, affecting agriculture, water resources, health, and socio-economic stability (46).

The global food system and our dietary choices have a significant impact and are responsible for approximately 30% of global greenhouse gas emissions (47). Agriculture encompasses approximately 40% of the world's land and food production is accountable for up to 30% of global greenhouse gas emissions and 70% of freshwater use. Overall, emissions of the global food system averaged around 16 billion tonnes (Gt) of CO₂ equivalents per year from 2012 to 2017 (48). Importantly, 29% of the total water footprint linked to global agriculture is associated with the production of animal products. In the realm of animal production, red meat alone contributes to one-third of the global water footprint, highlighting their substantial impact on water resources (49). Among animal products, those with the largest ecological footprint were found to be the ones produced from ruminant animals, such as beef, milk and dairy products (50).

In general, studies consistently affirm that plant-based foods exhibit fewer adverse environmental impacts per unit weight, per serving, per unit of energy, or per unit of protein weight compared to animal source foods across various environmental indicators (51,52). In contrast to the growing awareness on the ecological footprint of animal-sourced foods, the consumption of these types of products by children and adolescents is steadily increasing. From 1990 to 2018 there has been an increase of about 0.5 servings per week of animal-source foods in all regions, with the largest increase in Southeast and East Asia (53).

This increase is not only a cause for concern from an environmental point of view but also from a health perspective of children and adolescents. High consumption of animal products, processed meat and cheese are associated with

worse health outcomes, including higher risks of cardiovascular diseases, obesity, and other metabolic disorders (54).

A sustainable diet is defined by the FAO as one “with low environmental impacts which contribute to food and nutrition security and to healthy life for present and future generations. Sustainable diets are protective and respectful of biodiversity and ecosystems, culturally acceptable, accessible, economically fair and affordable; nutritionally adequate, safe and healthy; while optimizing natural and human resources” (55). Already in the early 1990s, in response to mounting concerns about environmental sustainability, the Mediterranean diet, emphasizing a plant-centric approach, started to be investigated as a sustainable dietary pattern with a lower environmental impact (56). The Mediterranean diet is in fact based on a wide variety of seasonal vegetables and fruits, cereals and pulses, as well as fish, eggs, extra virgin olive oil and a small amount of meat. In 2009, an international conference titled 'The Mediterranean Diet as a Sustainable Diet Model' was convened to present the Mediterranean diet as a sustainable dietary pattern (57). The conference aimed to update the Mediterranean diet pyramid, considering contemporary lifestyle changes, with serving sizes reflecting frugality and local habits. It also introduced new elements such as biodiversity, seasonality, culinary activities, traditional and locally sourced eco-friendly food products, conviviality, adequate rest, and regular physical activity (58).

More recently, the Eat Lancet Commission created its specific dietary recommendations based on healthy and sustainable systems. These recommendations primarily include vegetables, fruits, whole grains, legumes, nuts, and unsaturated oils. It features a low to moderate amount of seafood and poultry, with little or no inclusion of red meat, processed meat, added sugar, refined grains, and starchy vegetables (59). Given that the consumption of red meat is not deemed essential and shows a linear correlation with overall mortality and risks of various health outcomes in populations with a long history of consumption, an optimal intake could be zero grams per day, particularly when substituted with plant-based protein sources (60).

The current dietary patterns in many Mediterranean countries have shifted away from the traditional Mediterranean Dietary Pattern (MDP). This trend is

particularly notable among younger populations (61). The increasing globalization of food products has played a role in diminishing the consumption of traditional food, being displaced by less healthy alternatives, mirroring global trends (62). The documented decline in fruit and vegetable consumption, coupled with an increasing intake of meat and high-density energy foods like snacks, sugar-laden items, fast food, and soft drinks is well-established and linked to lifestyle changes (63).

These dietary shifts contribute to a decline in diet quality and have been identified as a significant factor in the rising obesity rates, particularly concerning children, and the development of non-communicable diseases (64,65).

Promoting healthy and sustainable dietary patterns in childhood and identifying their primary modifiable determinants is critical. This is because dietary habits formed during this period often persist into adulthood and can anticipate diet-related diseases (41). Therefore, there is a widespread need for nutrition and health education to emphasise the double benefit of a sustainable diet, both from a health and an environmental point of view, especially starting in childhood.

The Main Determinants of Dietary Habits in Childhood

Childhood obesity is the result of a complex interaction between genetic and environmental factors, acknowledged as an outcome of the intricate interactions between genes and the environment (66,67). However, social and economic factors including advertising, the overall environment, economic status, family and education, school environment, transportation, and the food environment, significantly contribute to obesity (68).

The International Network for Food and Obesity non-communicable diseases Research, Monitoring and Action Support (INFORMAS) provides a comprehensive definition of the food environment as the "collective physical, economic, sociocultural, and policy surroundings and opportunities and conditions that influence people's food and beverage choices and nutritional status" (69). This broad framework definition serves as a valuable tool to identify the structural determinants of food acquisition, consumption, and nutrient profiles, incorporating measurable dimensions such as availability, accessibility, affordability, and desirability of foods, thereby guiding empirical research (70).

The food environment is recognized as a significant factor influencing health behaviours in children, although the underlying mechanisms remain not fully understood (71). Parents appear to exert a considerable degree of influence in shaping their children's eating habits. During the first year of life, children's dietary patterns undergo rapid development, with parents playing an essential role in selecting food and serving as role models. Moreover, children often mimic their parents' eating behaviours (72).

In addition, in this crucial developmental stage, peers emerge as significant sources of nutritional guidance, often influencing food choices. However, at this juncture, the capacity to discern the risks and benefits associated with different dietary options may be somewhat constrained (73). The impact of peers on eating habits can yield both positive and negative outcomes: often it involves the consumption of highly processed foods or the adoption of unhealthy behaviours such as unbalanced diets (74), but some studies have also found that the healthy diet encouragement of peers can reduce the intake of unhealthy foods such as snacks and beverages, thus encouraging children to make healthier dietary choices (75).

This influence of peers has taken on a new dimension with the proliferation of social networks (76). Social media exposure was associated with increased consumption frequency of unhealthy snacks, fast food and sugar-sweetened beverages, daily caffeine and sugar intake and higher odds of skipping breakfast. These associations were observed both in children and adolescents, with those living in rural and suburban areas being at higher risk (77).

Finally, also the school and community environment significantly shape young people's eating behaviours (78). Schools maintain a direct contact with students for approximately 6 hours each day, during critical years encompassing their social, psychological, physical, and intellectual development (79). The WHO advocates for interventions within school settings, recognizing schools as prime environments for instilling knowledge about healthy dietary habits and aiding children and adolescents in making informed and wholesome food selections (80). School lunches play a crucial educational role, including teaching children how to eat properly; exposing them to diverse food varieties and origins; and helping them understanding the emotional aspects associated with specific foods and beverages (81).

School catering serves as a privileged avenue for food education and plays a crucial role in enhancing access to healthier and more sustainable dietary habits, as highlighted by the FAO in their publication on Nutrition-Sensitive Agriculture and Food Systems in Practice: Options for Intervention (2017) (82). Simultaneously, in the current global movement towards more sustainable schools, administrators are actively seeking strategies and interventions to enhance the sustainability of all school operations. This trend aligns with the inclusion of sustainability issues in school curricula, reflecting a broader commitment to environmental consciousness (83). Repeated exposure to school catering may contribute to the acquisition of better dietary habits, making children more receptive to certain foods (e.g. fruits and vegetables) (67). Consequently, substantial changes in the quality and variety of foods offered at school could potentially influence children to adopt a healthier and more sustainable diet (84).

The Need to Ensure Quality Food Supply in Schools

The World Health Organisation's Global School Health Initiative was launched in 1995, with the mandate to use schools as a means of strengthening health promotion and education activities at local, national, regional and global levels - thereby improving the health of students, families and all members of the community (85).

Many schools globally face the challenge of an imbalanced food supply, often featuring high-calorie options. This circumstance perpetuates unhealthy eating habits during childhood, which individuals carry into their social or family settings upon leaving the school environment (86,87). Numerous studies have indicated that school lunches often provide an excess of certain nutrients, particularly fat and sodium, leading to an increased risk of obesity and cardiovascular diseases (88,89).

In the recent decades, there has been a growing interest in food environment research, driven by the recognition of its role in the global shift away from traditional dietary patterns rich in whole grains, fruits, vegetables, and legume grains toward diets dominated by highly palatable and nutrient-depleted ultra-processed foods (90). Recognizing the importance of addressing food environments, the WHO (91), the Institute of Medicine (92), and the Centers for Disease Control and Prevention (93) have identified interventions to influence the food environment as crucial

strategies for achieving widespread improvements in dietary patterns and weight status.

Implementing school nutrition programs, which include standards for the nutritional content of foods, meals, and beverages served on these places, can yield positive, long-term impacts on the nutritional status and health of children and adolescents (94). These benefits encompass improvements in BMI, a reduction in risk factors associated with metabolic diseases (95,96), and a decrease in micronutrient deficiencies (97). Therefore, food environment at schools plays a pivotal role in advocating and facilitating adequate dietary habits among students (98).

Knowing the importance of maintaining a dietary pattern that is not only healthy but also sustainable, as mentioned earlier in this work, and knowing the impact that the school food environment has on students' eating habits, it is imperative to consider the issue of sustainability at the school level. This shift is not only necessary but also feasible, as optimization studies have identified school meals that are both nutritionally adequate and environmentally friendly (99). A noteworthy example is seen in Barcelona, Spain, where the municipality introduced low-carbon meals in public schools during the 2020-2021 school year (100). The evaluation of this initiative demonstrated significant environmental benefits. In Bahia, Brazil, the Sustainable School Program implemented low-carbon meals twice a week in 155 schools across four municipalities and showed a 17% reduction in diet-related greenhouse gas emissions (GHGE) (101). In France, since 2018, national regulations require school canteens to serve a weekly vegetarian meal as part of efforts to reduce the environmental impact of school meals (102).

Portugal and Italy: The Two Countries Under Study

Italy and Portugal, both located in southern Europe, share a cultural background strongly influenced by Mediterranean traditions rooted in their history. However, distinctive geographic differences and similarities emerge between the two countries. Portugal stretches along the Atlantic coast, configuring a nation strongly linked to the sea and its resources, with a varied climate and landscape that changes from north to south, characterised by more mountainous and rainy regions in the north and more flat and arid territories in the south (103). Similarly, Italy has a rich geographical diversity, with regions bordering Switzerland, Austria and France

characterised by mountain ranges and a colder climate and southern areas facing the Mediterranean Sea, enjoying a mediterranean climate (104,105).

The historical evolution, culture and geographical location of both countries exert a significant imprint on their food traditions and the lifestyle adopted by each population.

The Dietary Patterns of Each Country: Similarities and Differences

Focusing on the European continent, with a specific emphasis on Italy and Portugal, dietary guidelines are grounded in the Mediterranean diet model, well-known for its health-promoting qualities.

The traditional MDP is typically based on several key features: a notable emphasis on high proportion of monounsaturated fats in comparison to saturated fats, largely attributed to the consumption of olive oil; substantial intake of vegetables, fruits, legume grains, nuts, and unrefined cereals; low consumption of meat and meat products and moderate intake of dairy and seafood products; incorporation of aromatic herbs into cooking practices; prioritization of water as the primary beverage; and a moderate consumption of alcohol, mostly wine, particularly during main meals (106).

In Portugal, the foundation of dietary guidelines aligns with the Mediterranean diet and also incorporates the concept of food sustainability, with typical and frequently consumed foods such as soup, fish, cereals and bread (107,108). It can be considered a Mediterranean cuisine with Atlantic characteristics, marked by a high consumption of fish and seafood, along with influences from diverse global sources (109). Undoubtedly, the culinary traditions of regions explored or colonized by the Portuguese have left an indelible impact on the country's cuisine. The widespread use of olive oil is a consistent culinary practice throughout the country (110). Despite all common characteristics, each region of Portugal is unique and presents its typical and traditional dishes within the framework of the Mediterranean diet.

In Italy, the dietary pattern encompasses a broad array of dishes centred around pasta, cheese, vegetables, and olive oil (111). The country exhibits a significant heterogeneity among its various regions and territories. The northern region reflects a fusion of Roman and Germanic influences, while the southern part

maintains a distinct Arab influence. Historical dominion by Spain, France and Austria over certain parts of Italy continues to exert influence on the culinary traditions of those regions, evident in many local dishes (111). In Alto Adige, a northern Alpine region with a substantial German-speaking population, traditional dietary practices diverge from those in southern Italian regions. Here, there is a lower traditional consumption of olive oil, pasta, and tomato sauce, with a preference for butter, rice, corn (for polenta), cheese, and cheese-based sauces (112). The South, being closer to the Mediterranean Sea, experiences higher fish consumption and a prevalent use of olive oil, pasta, tomatoes, and limited meat (113). The longer growing season in the South facilitates easier cultivation of vegetables, which are frequently integrated into regional dishes (114-116).

The main meal (lunch or dinner) setting itself is also different between these two countries. In Portugal, it is common to start the meal with a soup, made predominantly with vegetables, and a main dish with all the various components together (vegetables and the food source of protein and carbohydrates) (117). In Italy, this meal usually is composed by a first course, consisting of a cereal dish seasoned with different sauces (pasta, rice etc.) and a second course, consisting mainly of a food source of protein (as meat, fish, eggs, cheese, legume grains) and a side dish of vegetables or potatoes, with a lower frequency because of their carbohydrate content, already present in the first course (118) .

In order to guide their populations toward a healthy diet, Portugal and Italy present different food guides. Portugal advocates for healthy eating through a circular guide known as "A Nova Roda Dos Alimentos" (107). This guide is a segmented circle, with each section grouping foods of similar nutritional compositions. The circular format is designed to illustrate the principles of a balanced diet, offering a visual and structured approach to comprehend and embrace healthy eating habits, including those foods that should be consumed daily in order to achieve health and sustainability objectives (108). While these guidelines are oriented to the general population, the Italian guidelines (LARN) offer precise directives for organizing individual nutrition during childhood. The Italian Paediatric Society has also introduced the "Piramide Alimentare Transculturale" as an educational tool, harmonizing the principles of the Italian Mediterranean diet with the traditional foods of diverse childhood populations within the country (119).

It should be noted that the guidelines of both countries, in addition to the promotion of the consumption of fruits, vegetables, and legume grains, coupled with a decrease in the intake of free sugars, salt, and alcoholic beverages, also incorporate a segment on sustainability and advocate behaviours to minimize the overall nutritional impact (120).

In both countries, there is a shared emphasis on adhering to the Mediterranean diet to promote a healthy lifestyle and prevent chronic diseases, such as cardiovascular disease, with some structural differences (121-124). However, despite the growing awareness of the benefits of balanced nutrition and the existence of these guidelines, world food consumption is far from those designated as model.

Childhood Food Consumption Data from Portugal and Italy

According to the “Inquérito Alimentar Nacional e de Atividade Física” (IAN-AF) survey (125), Portuguese data reveal an inadequate consumption of food products like fruits and vegetables, particularly among children aged 3-9 years old (72%), falling below the WHO recommended levels of 400g/day (126). Moreover, more than 100g of red meat is consumed daily by 16.3% of children and 5.7% consume over 50g per day (125). Approximately 50% of the total Portuguese population exceeds the recommended intake for saturated fatty acids (>10% of total energy intake), with children having the highest prevalence at 73% (125,127).

In addition, the UPPER Project showed that about half of Portuguese children and adolescents were classified in the dietary pattern characterized by the lower consumption of fruits, vegetables and pulses, and with a higher consumption of sugar-sweetened beverages (127). This dietary pattern also presented the highest intake of ultra-processed foods and free sugars, and the lowest intake of dietary fibre, vitamins, and minerals. Regardless of the dietary pattern followed, over one third of the calories consumed by Portuguese children and adolescents came from ultra-processed foods (127).

Similarly, the “Okkio alla salute” survey in Italy, a representative study that is carried out by the Istituto Superiore di Sanità, analysed data from 50,000 Italian children aged 6-10 years old in 2019, revealing concerning dietary patterns among Italian children (128). These findings indicated that 24% of the considered population

do not include fruits and vegetables in their daily diet, while 26% consume soft drinks every day. Additionally, 48% of children indulge in sweet snacks for more than three days a week, and 38% never eat legumes or consume them less than once a week. Also, only 5.7% managed to incorporate fruits and vegetables into their daily meals at least five times. Concerning soft drinks, this same survey found that 25.4% of children consumed soft drinks at least once a day in 2019. Sweet snacks were consumed by 48.4% of children for more than three days a week, with 19.9% indulging in them daily. Regarding legumes, 23.4% of children reported consuming them less than once a week, and 15.0% did not consume them at all (128).

It's worth mentioning that the "Okkio alla salute" survey did not encompass the consumption of red meat by children. However, another study of 16,261 school-age children found out that 5.5% of them consume meat daily, 27.3% consume 2-3 times a week, 61.3% do it 1-2 times a week and 5.9% do not consume meat, with smaller percentages in female subjects (129).

The analysis of eating habits in Portugal and Italy reveals a significant disparity with respect to nutritional recommendations. Both countries have dietary patterns characterised by an excessive consumption of high-calorie foods, rich in saturated fats and added sugars, while the quantity of fruit, vegetables and whole grains is significantly lower than recommended (125,128). This gap between dietary habits and nutritional recommendations raises the urgency of promoting greater food literacy and implementing effective awareness-raising strategies to encourage a transition towards healthier and more sustainable dietary patterns.

Nutritional status and diseases prevalence in childhood

Cardiovascular disease continues to be the leading cause of death in Portugal, with approximately 35,000 deaths per year (130). The prevalence of several health determinants was assessed, including arterial hypertension (43.1%), diabetes mellitus (8.9%), and hypertriglyceridemia (≥ 200 mg/dL - 8.6%; >150 mg/dL - 18.6%) (131). In Italy, cardiovascular diseases are also the main cause of death among general population, being responsible for 34.8% of all deaths (132). Approximately 31% of Italians have hypertension and according to the Istituto Nazionale di Statistica (ISTAT) the prevalence of diagnosed diabetes in Italy was approximately 5.9% in 2020, over 3.5 million people, with a slowly increasing trend in recent years (133,134).

Considering children, from the latest published Childhood Obesity Surveillance Initiative (COSI) data that was collected in 33 countries in 2018-2020 about children aged 6-9 years old, Italy was found to be among the countries with the highest prevalence of overweight and obesity along with Cyprus, Greece, and Spain, while Northern European countries had lower prevalence (128,135). In Italy, the national percentage of obesity in children aged 5 to 9 years old was around 18% (128), while in Portugal it was 15% (125), placing these countries in first and sixth place, respectively, in the ranking of European countries with the highest prevalence of overweight in 2016 (32,125).

In Portugal, according to the IAN-AF 2015-2016, the prevalence of pre-obesity and obesity in the age group of children younger than 10 years was 17,3% and 7,7% respectively (125). In 2019, in Italy, the prevalence of pre-obesity in children aged 8 to 9 years old was 20.4%, with an additional 9.4% classified as obese (128).

Reports from China, Europe, and the USA have documented increased weight gain among children and adolescents during the COVID-19 pandemic when compared with the rate before the pandemic, as an apparent consequence of decreases in physical activity, increased screen time, changes in dietary intake, food insecurity, and increased family and individual stress (136-139).

Regarding paediatric diabetes and pre-diabetes, in Italy, a study conducted in 510 patients aged 3 to 18 years shows how glucose metabolism alterations were detected in 12.4% of patients. Impaired glucose tolerance was the most frequent alteration (11.2%), with a higher prevalence in adolescents than in children (14.8% vs. 4.1%, $p < 0.001$) (140). In a study conducted in Portugal on a sample of 237 adolescents aged between 10 and 12 years, 89% of whom were obese, showed that 19.4% suffered from hypertension, 2.5% had impaired fasting glucose values and 8.9% suffered from metabolic syndrome according to the 2005 International Diabetes Federation criteria (141). Another study conducted in Portugal in a sample of 82 children with obesity or pre-obesity between the ages of 7 and 9 years revealed that 18.5% showed the necessary criteria for the diagnosis of metabolic syndrome according to the National Cholesterol Education Program Adult Treatment Panel III criteria modified by Cook (142).

Worldwide it is estimated that there were approximately 41,600 new cases of diagnosed type 2 diabetes among children and adolescents in 2021 (143).

Dietary Supply in Primary Schools in Portugal and Italy: Diagnosis and Evaluation Methods

The improvement of children's lifestyle relies on actions carried out in school settings. This is widely acknowledged and has generated several successful initiatives throughout the WHO European Region. Nevertheless, additional commitment from both central and local governments is necessary to ensure all children in the European Region have access to adequate school environments (144). Due to significant variations among schooling systems across countries, it is unfeasible to formulate a single European school food and nutrition policy. Therefore, it is imperative for each country, authority or school to independently determine which suggestions for school nutrition and food policy are most relevant and feasible given their specific circumstances (85).

In 2014, the WHO together with the European Commission and the 27 EU Member States approved a declaration on 'Health in All Policies' to promote the development and implementation of health-promoting policies in various fields, such as nutrition, environment, trade, education, industry, labour and transport. In fact, the success of many health promotion interventions also depends on elements outside the 'health system' (145).

In Portugal, in 2018, the Ministry of Education published guidelines for menus and school canteens: the "Orientações sobre ementas e refeições escolares" (146). This work was carried out by the Directorate-General for Education, in collaboration with the National Program for the Promotion of Healthy Eating of the Directorate-General for Health (DGS), promoting a balanced diet based on the Mediterranean Diet and presenting qualitative guidelines for the practice of drawing up healthy school menus. This is a fundamental document that promotes a nutritionally balanced diet, a priority in all school policies and in line with the Integrated Strategy for Healthy Eating (EIPAS) (147). The document presents several essential nutritional and food principles as well as information on cooking, plating, meal composition and menu components (146).

The “School Meals Planning and Evaluation System” (SPARE+) is a Portuguese simple and practical informatic tool that was developed to facilitate effective and organized planning of school meals in line with current national and international food and nutrition standards. SPARE serves as a comprehensive tool for planning, evaluating, monitoring and reviewing meals, with the goal of continuously improving the quality of school meals (148,149). Subsequently, in 2022 a new version of this tool was created (SPARE+) (150), with the contemplation of criteria that allow for the qualitative evaluation of school menus that are based not only on aspects related to health but also to environmental sustainability, as well as updating and complementing the criteria expressed in Circular 3097/DGE/2018 (150).

In Italy, school catering has been identified as a priority tool for promoting health and educating on proper nutrition. In school catering, it is of fundamental importance to raise the quality level of meals, in terms of nutritional and sensory quality, while maintaining the principles of food safety (151). The correct management of catering can promote nutritionally correct food choices by assessing the suitability of menus and promoting certain dishes/recipes. Moreover, in order to produce and distribute meals that comply with the indications of the Daily Reference Intake Levels of Nutrients for the Italian population (LARN) (152), the involvement of children, families and teachers in nutrition education can play an important role.

The “Linee di Indirizzo Nazionale per la Ristorazione Scolastica” (151) were developed in 2010 by a technical group established within the General Directorate for Food Safety and Nutrition of the Ministry of Labour, Health, and Social Policies. These guidelines are directed towards all school catering providers and emphasize several significant aspects aimed at enhancing the quality of various elements, particularly focusing on nutrition. They include instructions for organizing and overseeing the catering service, establishing specifications, and offering meals tailored to the requirements of different age groups, with the objective of educating children to adopt healthy eating habits.

Research studies on the nutritional analysis of school canteens are limited in Portugal and Italy. Despite the growing importance of nutrition in education and public health, there is little specific research that examines in depth the nutritional

quality of meals served in school canteens, although both countries have regulations and guidelines to ensure minimum food quality standards.

A study carried out in 32 canteens in the northern region of Portugal in 2010 examined the nutritional content of meals provided in primary schools. It revealed that the average sodium chloride content per meal was 3.4g, significantly exceeding the maximum recommended value of 1.5g (153). Another Portuguese study showed that 88.9% of the menus alternate between meat and fish on a daily basis, with only 55.6% having the same or a higher proportion of fish than meat and white meats being preferred to red meats (154). The indication that eggs are the main protein source twice a month is not fulfilled in 77.8% of the menus (154). Other non-conformities are also mentioned in studies carried out in Coimbra and Águeda, such as the low availability of vegetables, inequitable distribution between carbohydrate suppliers and the prioritisation of meat dishes over fish and eggs (155).

In Italy, the Ministry of Health in collaboration with the Ministry of Education, Universities and Research (MIUR) launched in 2014 a survey on school canteens in order to promote the culture of continuous improvement of the quality of the service (156). A total of 7,733 kindergartens, primary and secondary schools across the country were involved, of which 1,168 responded, divided nationwide as 43.3% by northern region, 26.7% by central region and 30% by southern and isolated region. This research showed that only 73% of the institutions involved offered food with a reduced environmental impact, as organic and integrated cultivation foods, and a short supply chain (KM 0) (156).

In Italy, there is currently a lack of a specific tool to systematically assess the quality of school canteens, despite the existence of national guidelines. Although regulations and recommendations are established to ensure minimum standards of nutritional quality in meals served in schools, the lack of a formal evaluation tool makes it difficult to effectively monitor compliance with these guidelines and identify any areas for improvement. Without a standardized evaluation system, it becomes difficult for local authorities and educational institutions to objectively assess the nutritional quality of canteens and take corrective measures when necessary. For this reason, tools have been created at the local level, for example

by the Agenzie di Tutela della Salute (ATS), to assess the quality of the school food supply in an easy and effective way, such as checklists and questionnaires (157).

This poses a challenge for policymakers and practitioners in devising targeted interventions to enhance the nutritional quality of school meals and encourage healthier eating habits among students. Furthermore, within the current paradigm concerning the utilization of natural resources, numerous scientific studies advocate for dietary habits that prioritize environmental sustainability (23,47,59,83). Despite our understanding of the characterisation of school food offerings in certain regions of Portugal and Italy, there remains a gap in our knowledge regarding how these offerings address environmental sustainability. Consequently, this study represents a pioneering effort, as far as the research team is aware, to qualitatively assess school menus served to children aged 6 to 10 in Portugal and Italy, taking into consideration not only nutritional healthiness but also environmental sustainability. This serves as a foundational step towards implementing future measures in nutrition education and restructuring the school food service system to align with a more sustainable trajectory.

Objectives

Hypotheses and Objectives

The hypotheses to be answered in this dissertation are the following ones:

- What is, in qualitative terms, the supply of school meals in Portugal and Italy for children aged 6 to 10 years old?
- Which are the factors associated with the food quality of lunch menus in Portugal and Italy for children aged 6 to 10 years old?

To answer these hypotheses, the objective of this thesis is to qualitatively characterize the food offered at lunchtime to children aged 6 to 10 years old in Portugal and Italy and study the associated factors.

Methodology

Type of Study and Time Frame:

Cross-sectional descriptive observational study carried out between September 2023 and July 2024.

Sample selection:

In this project a convenience sample of 32 municipalities was selected, comprising 17 municipalities from Portugal and 15 municipalities from Italy, located in the North, Center, and South region of these countries (**Figure 1**). The invitation to participate in this study was sent by e-mail through the public contacts of 63 municipalities (36 from Portugal and 27 from Italy) and 32 accepted to participate (51% of proportion rate).

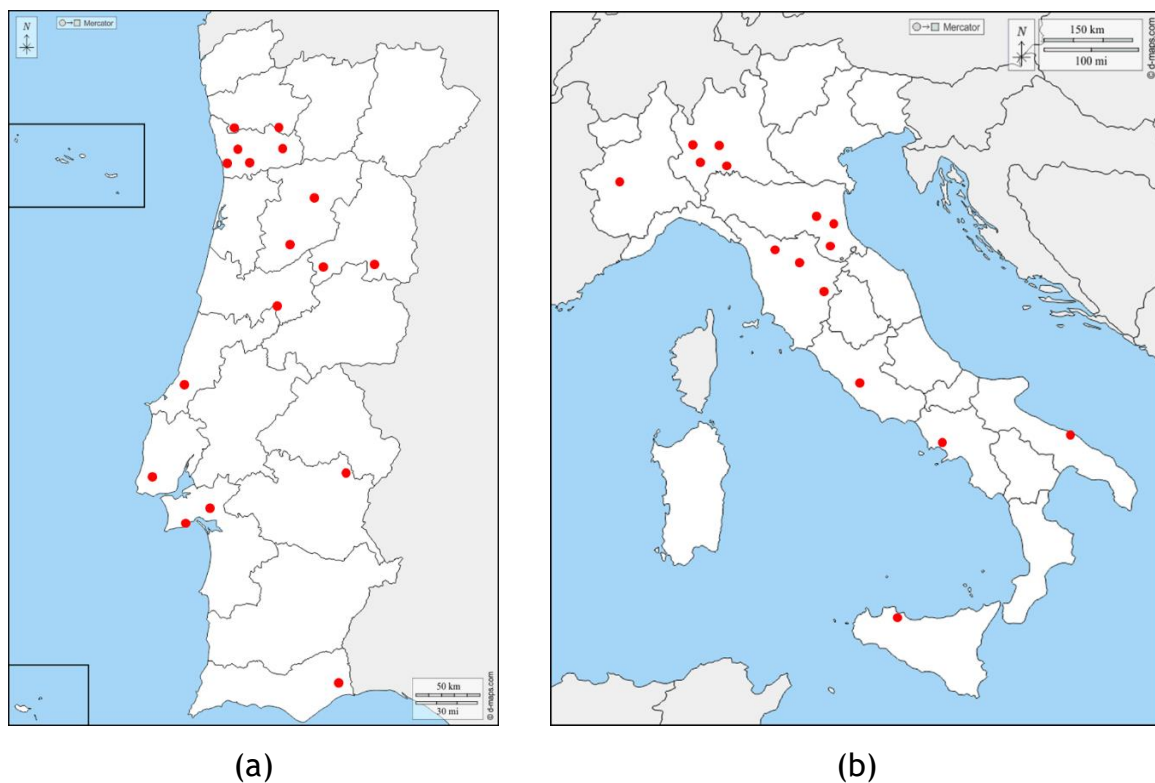


Figure 1 - Geographic location of the municipalities involved in the study in Portugal (a) and Italy (b)

Data collection

To meet the proposed objective, the lunch menus of children aged 6 to 10 years old were collected. It is important to note that public school meals in Portugal and Italy are organized differently, so, in order to obtain the menus for this age group, the menus for grades 1 to 4 in Portugal and grades 1 to 5 in Italy were used.

The municipal organization of school catering is also different: in Portugal, the municipal nutritionist develops a menu that is used in all the schools in the territory, with a self-managed kitchen or one contracted to an outside company. On the other hand, in Italy, school catering works almost totally through external companies. These companies usually have only one external kitchen and the meal is transported to the different municipal schools; the nutritionist is not associated with the municipality but with the company itself. To perform this function, the company must win a tender issued by the municipality, which sets the nutritional, economic, and logistical rules for the school's menu.

After the agreement of each institution to participate in this study, they were asked to provide their school lunch menus for three different months (12 weeks) in Portugal and two months (8 weeks) in Italy from the previous or current school year. This difference is due to Italy's typical practice of designing school menus for two macro seasons (winter-autumn and spring-summer) each over a period of four weeks. Additionally, to account for the seasonality of Portuguese menus, each month's menus were requested to correspond to a different school term (1st term - fall, 2nd term - winter, and 3rd term - spring). Vegetarian menus were also requested.

In addition to the school menus, in order to gather information on the characteristics of each institution and its meal management procedures, an online questionnaire was made by the investigation team and sent by e-mail to be completed by the nutritionists or by the municipal manager, which provided the following information:

- the regional area of Portugal or Italy where the institution is located (North, Center, or South);
- the environment in which the institution is located (rural or urban area);
- the type of existing food service (self-management or concessionary service);
- the type of unit (unit for cooking meals or receiving them);

- the number of nutritionists in the institution;
- the number of meals served daily;
- the number of vegetarian and vegan menus served daily;
- the cost of the meal unit;
- the presence (or not) of an active food education program in the institution;
- the rating of the perceived municipality's interest in healthy and sustainable diet on a scale of 1 to 5 (where 5 means the highest level of municipal interest in sustainable and healthy food and 1 means the lowest level of interest).

Contacts with the various institutions for data collection were always made through e-mail.

Qualitative lunch menu assessment

Two tools were applied to assess the menus of school lunches qualitatively, and a database was created.

For Portuguese menus, the tool SPARE+ was applied (149). This tool is an instrument designed, planned, and developed by the Faculty of Nutrition and Food Sciences of the University of Porto at the request of the Portuguese General Directorate of Health (*Direção Geral da Saúde - Programa Nacional para a Promoção da Alimentação Saudável*) to plan, evaluate, monitor and verify school meals in an effective and organized way, with the main national and international food and nutritional recommendations. The most recent version of SPARE+ has 88 items and it is divided into seven topics (General items, Soup, Source of Protein, Vegetarian options, Vegetables, Source of Carbohydrates, Dessert and Fruit) related to school lunch meals and compliance with criteria for healthy and environmentally sustainable diets (158). In this new version, new elements have been added to take into account not only health but also sustainability criteria. The original SPARE+ tool is shown in Annex A, in its original language (Portuguese) and in English.

Scores were assigned to each item based on compliance with each SPARE+ criteria. If the requirement was met, it was given 1 point; if it was not, no points (0) were given. The final rating of the menu was obtained by adding the scores of all evaluated items and dividing by the total number of items. Then, this value was multiplied by 100 to obtain the percentage value of compliance with the tool's guidelines (0-100%).

For Italian menus, the tool provided and created by the Agenzia di Tutela della Salute (ATS) of Pavia has been applied to evaluate the lunch menus (157). This tool is divided into two parts to identify the main shortcomings and points of improvement of the lunch offered from a nutritional point of view (Basic Nutritional Requirements and Nutritional Requirements for Improvement). The tool has 30 items of yes/no answers, if the requirement was met it was given 1 point; if it was not, no points (0) were given (157). The final rating of the menu was obtained by adding the scores of all evaluated items and dividing by the total number of items. Then, this value was multiplied by 100 to obtain the percentage value of compliance with the tool's guidelines (0-100%). The original Italian tool is shown in Annex B, in its original language (Italian) and in English.

To assess the Italian lunch menus using the SPARE+ questionnaire while considering cultural diversity, the research team conducted an analysis and selected specific questions from the tool. This selection process was done with the assistance of two Italian nutritionists who have expertise in this field.

For this adaptation, the following decisions were taken into account:

- 1) The SPARE+ criteria that didn't conflict with the Italian criteria or culture were included in this adapted version, such as the presence of whole grains in the menu.
- 2) Whenever the criteria in the SPARE+ tool conflicted with the criteria of the Italian tool, the question was not selected for this version.
- 3) When SPARE+ criteria conflicted with Italian culture and habits, even though they were not mentioned in the Italian tool, they were not included in the adaptation. One example of such criteria is the items about soup consumption, which is not regularly consumed in Italy, usually only present in the winter season, and, for this reason, they were not considered for this adaptation.

Annex C presents a comparison between the items in the Italian and Portuguese tools, identifying which SPARE+ criteria have been taken into account in this adaptation and which have been removed, with the corresponding reason for removal. Finally, 64 items were considered when comparing the quality of the menus between the two countries. Annex D contains the total set of items that were applied to the Italian menus (Italia plus SPARE+ tools). To compare the two countries, only those questions from the SPARE+ questionnaire that met the Italian standards were used (Annex D).

Whenever necessary, the institutions were contacted to clarify doubts about the menus and to obtain a more detailed level of information, such as the type of fruit offered (if not specified on the menu), whether the products were locally sourced or if they were organic or not, or if the planned menu was usually respected.

After applying these tools, two variables were calculated:

The percentage (%) of compliance with each item: by adding the number of weeks in which a particular item in the tool was complied with, dividing this by the total number of weeks the item was evaluated (12 weeks in Portugal and 8 weeks in Italy), and then multiplying the result by 100.

The percentage (%) compliance of the overall quality of the menu at each place: by adding the number of compliant items each week, dividing this sum by the total number of items evaluated, and then multiplying the result by 100.

Finally, to account for seasonality, the same measures were calculated by season (fall, winter, and spring for Portuguese menus and fall/winter and spring/summer for Italian menus).

These variables were then categorized into 0%,]0-25[%, [25-50[%, [50-75[%, [75-100[% and 100% of compliance with the recommendations of each tool.

Data Treatment and Analysis:

Statistical analysis was carried out using the Software Package for Social Sciences (SPSS) for Windows V.27.0 and the results were considered statistically significant when $p < 0.05$.

The descriptive analysis of the variables used measures of central tendency and dispersion, including relative and absolute frequencies for nominal variables and mean (standard deviation - SD) for continuous variables. Median (25th and 75th percentiles) was used for continuous variables when the distribution did not meet the assumptions of normality, assessed by the Kolmogorov-Smirnov test.

To study the differences in municipal characteristics between countries, the Chi-square test or Fisher's exact test was used for categorical variables, and the Student's t-test or Mann-Whitney test was employed for continuous variables, depending on the normality of the variable distributions.

Pearson correlation was used to understand the association between the overall menu quality in both countries, based on the SPARE+ criteria that were applied to both Portugal and Italy. To assess seasonal differences in menu quality (globally and by item), the Mann-Whitney test was applied to the Italian menus, while the Friedman test was used for the Portuguese menus.

To examine the relationship between municipal characteristics and the overall quality of the menus in Portugal and Italy, Spearman's correlation coefficient was used for continuous variables and the Student's t-test was employed for categorical variables.

Results

Sample characterisation

This study included an analysis of school lunch menus from 32 municipalities, 17 in Portugal and 15 in Italy. Each Portuguese menu covered four weeks for three different seasons (winter, autumn, and spring), resulting in a total of 204 weeks analysed. In Italy, each menu corresponded to four weeks for two seasons (autumn/winter and spring/summer), in total 120 weeks of school menus were evaluated.

The majority of municipalities involved in the study were urban (62.5% urban vs. 37.5% rural) in both Portugal and Italy. Only 28.1% of the units (n=9) were self-managed, with 7 in Portugal and 2 in Italy. On average, each municipality had a median of 11 canteens, ranging from 1 to 128 canteens, with no significant difference between the two countries ($p=0.677$). Each municipality had a median of 6 reception units and 2 cooking units. The number of cooking units per municipality differed significantly between the countries (median [p25, p75]: Portugal = 6 [2, 21], Italy = 0 [0, 1], $p < 0.001$) (Table 1).

Regarding meals served, each municipality provided a median of 1,890 meals, with a range from 135 to 37,900 meals. These differences were not statistically significant between the countries. However, a significant difference was observed in the cost of a single meal. In Portugal, the median meal cost was €2.80, ranging from €1.50 to €5.00, while in Italy, the median cost was €5.50, with a range from €4.60 to €7.00 ($p < 0.001$) (Table 1).

Another statistically significant difference was observed in the presence of nutritionists at the municipal level ($p = 0.002$). In Portugal, the maximum number of nutritionists per municipality was 11, while in Italy, the maximum was 3. Both countries implement nutrition education programs in schools, with these programs being more frequently conducted in Italy than in Portugal. The level of interest in healthy and sustainable eating was similar between the municipalities, with 41.2% of Portuguese and 80% of Italian municipalities rating their interest at 5 points (very interested) (Table 1). Only two municipalities, one in Italy and one in Portugal, did not provide the vegetarian menu, because it did not exist due to the fact that no family had requested it.

Table 1 - Characterisation of the municipalities in the sample by country

	TOTAL	PORTUGAL	ITALY	P-VALUE
SAMPLE	n=32	n=17 (53.1%)	n=15 (46.9%)	
Environment, n (%)				
Rural	12 (37.5)	7 (41.2)	5 (33.3)	0.710*
Urban	20 (62.5)	10 (58.8)	10 (66.7)	
Type of service, n (%)				
Self-management	9 (28.1)	7 (41.2)	2 (13.3)	0.122**
Sub-contracted service	23 (71.9)	10 (58.8)	13 (86.7)	
Number of canteens				
Median (percentile 25, percentile 75)	11 (4, 33)	17 (2, 38)	9 (2, 28)	0.677***
Maximum	182	108	182	
Minimum	1	2	1	
Number of cooking units				
Median (percentile 25, percentile 75)	2 (1, 20)	6 (2, 21)	0 (0, 1)	<0.001***
Maximum	95	94	27	
Minimum	0	1	0	
Number of reception units				
Median (percentile 25, percentile 75)	6 (1, 20)	3 (2, 14)	6 (1, 28)	0.471***
Maximum	182	44	182	
Minimum	0	0	0	
Number of meals				
Median (percentile 25, percentile 75)	1890 (450, 3750)	1940 (575, 3700)	1840 (330, 6751)	0.821***
Maximum	37900	15000	37900	
Minimum	135	300	135	
Meal cost [€]				
Median (percentile 25, percentile 75)	4.2 (2.7, 5.4)	2.8 (1.5, 3.2)	5.5 (5.1, 5.8)	<0.001***
Maximum	7.0	5.0	7.0	
Minimum	1.5	1.5	4.6	
Number of municipal nutritionists				
Median (percentile 25, percentile 75)	1 (1, 1)	1 (1, 3)	1 (0, 1)	0.002***
Maximum	11	11	3	
Minimum	0	1	0	
Presence of nutrition education programmes, n (%)				
No	7 (21.9)	6 (35.3)	1 (6.7)	0.088**
Yes	25 (78.1)	11 (64.7)	14 (93.3)	
Municipality's interest in healthy and sustainable nutrition [1-5], n (%)				
Score of 5 (very interested)	19 (59.4)	7 (41.2)	12 (80.0)	0.076**
Score of 4	11 (34.4)	8 (47.1)	3 (20.0)	
Score of 2-3	2 (6.2)	2 (11.7)	0	
Score of 1 (nothing interested)	0	0	0	

*x² test, **Fisher test, ***Man-Whitney test

Lunch menus evaluation | Globally and by season

According to the application of the original SPARE tool, the Portuguese menus had a mean (standard deviation, SD) compliance rate of 73.3% (3.9%) with the recommendations, ranging from 67.4% to 80.1%. The Italian menus, evaluated using the original Italian tool, had a mean (SD) compliance rate of 74.7% (8.2%), ranging from 63.8% to 87.7%. For the SPARE items applied to both countries, significant differences were found between the average menu quality scores, with Italy showing

better quality results than Portugal (mean (SD): 75.5% (3.5%) for Portugal and 83.1% (5.4%) for Italy, p-value = 0.015) (Table 2).

Table 2 - Characterisation of the average menu quality score for the lunch meal, according to country

Note: The average quality score for lunch menus can range from 0 to 100%

	Totality of institutions (n=32)	Portugal (n=17)	Italy (n=15)		Portugal (n=17)	Italy (n=15)
	SPARE+ (only items comparable between Italy and Portugal)			p-value	Original SPARE+ tool	Original Italian tool
Mean (%)	79,1	75.5	83.1	0.015*	73.3	74.7
Standard deviation (%)	6.0	3.5	5.6		3.9	8.2
Minimum (%)	70.5	70.5	75.6		67.4	63.8
Maximum (%)	91.1	83.7	91.1		80.1	87.5

*Pearson Correlation

An evaluation of the menus from a seasonal perspective was conducted, using the original tool for each country, as shown in Table 3. In Portugal, no statistically significant difference was found between the winter, spring, and autumn menus (p-value = 0.729). However, in Italy, a statistically significant difference was observed in the total percentage of compliance using the original tool (p-value = 0.005). Compliance was greater during the winter/autumn period (mean (SD): 76.4% (8.2%)) compared to the spring/summer period (mean (SD): 73.1% (8.7%)).

Table 3 - Characterisation of the average menu quality score for the lunch meal in Portugal and Italy, according to the season, using the original country tool

Note: The average quality score for lunch menus can range from 0 to 100%

	Original Portuguese tool (n=17)				Original Italian tool (n=15)		
	Winter	Spring	Autumn	p-value	Winter/ Autumn	Spring/ Summer	p-value
Average overall compliance (%)	74.0	73.0	73.0	*0.729	76.4	73.1	*0.005
Standard deviation (%)	4.2	4.7	3.9		8.2	8.7	
Minimum (%)	67.4	66.1	68.0		63.4	63.4	
Maximum (%)	81.0	81.0	80.2		90.2	84.8	

*Friedman Test, **Mann-Whitney test

Portuguese lunch menus evaluation | By items and by season

Regarding the results for the parameters evaluated with the SPARE+ tool, **Figure 2** shows the main items that have been assessed on the compliance of school canteens in Portuguese municipalities. A colour scale was used to represent different levels of conformity, ranging from dark red (0% conformity) to dark green (100% conformity). Appendix B provides a comprehensive overview of these items, categorizing them by season and offering detailed descriptions.

Five items demonstrate 100% compliance across all municipalities. These items include the presence of vegetables at each meal, adherence to the planned versus executed menu, the availability of technical sheets indicating allergen information, the provision of meat and fish free of visible fat and skin and offering fruit with added sugar no more than twice per month. Conversely, two parameters showed 0% compliance across all municipalities: the preference for the use of whole grains and the requirement for plant foods to constitute at least 3/4 of the plate, as illustrated in **Figure 2**. Furthermore, the majority of the municipalities did not meet the criterion of offering tofu, seitan, tempeh, or soy more than once a month, and many lacked the use of utensils to standardise the portion sizes.

The evaluation of school lunch menus in Portuguese municipalities reveals significant variability in compliance with several criteria. For example, the requirement that sweet desserts be offered no more than twice a month shows notable heterogeneity, with some municipalities exhibiting complete non-compliance while others fully adhere to or exceed the standard (7 municipalities with 0% compliance and 6 with 100% compliance). Similarly, the criteria for including eggs as the main protein source and for incorporating sustainable fish at least once a week show a wide range of adherence, from non-compliance to full compliance across different municipalities (5 municipalities with 0% compliance and 1 with 100% compliance for eggs, and 1 municipality with 0% compliance and 6 with 100% compliance for sustainable fish). Furthermore, the criteria of limiting red meat to no more than once a week and serving an unfractionated fish dish at least once a week also demonstrate significant variability (1 municipality with 25-50% compliance and 5 with 100% compliance for red meat, and 3 municipalities with 25-50% compliance and 4 with 100% compliance for unfractionated fish). While there is variability in the use of seasonal products (at least 50%), a significant number of municipalities show high levels of compliance with this criterion (1 municipality with 0% compliance and 14 with 100% compliance) (**Figure 2**).

Examining each parameter individually to assess seasonal differences in compliance, it was found that two items exhibited statistically significant differences using the SPARE+ tool. The presence of unfractionated fish at least once a week was observed more frequently in spring and winter (median [p25-p75] for both: 100%, [50-100%]) compared to autumn (median [p25-p75]: 50% [0-75%]) (p-value = 0.017).

Conversely, for the presence of sustainable fish, spring consistently showed higher values (median [p25-p75]: 100% [100-100%]) compared to winter and autumn (median [p25-p75] for both: 100% [0-100%]) (p-value = 0.018) (Appendix B).

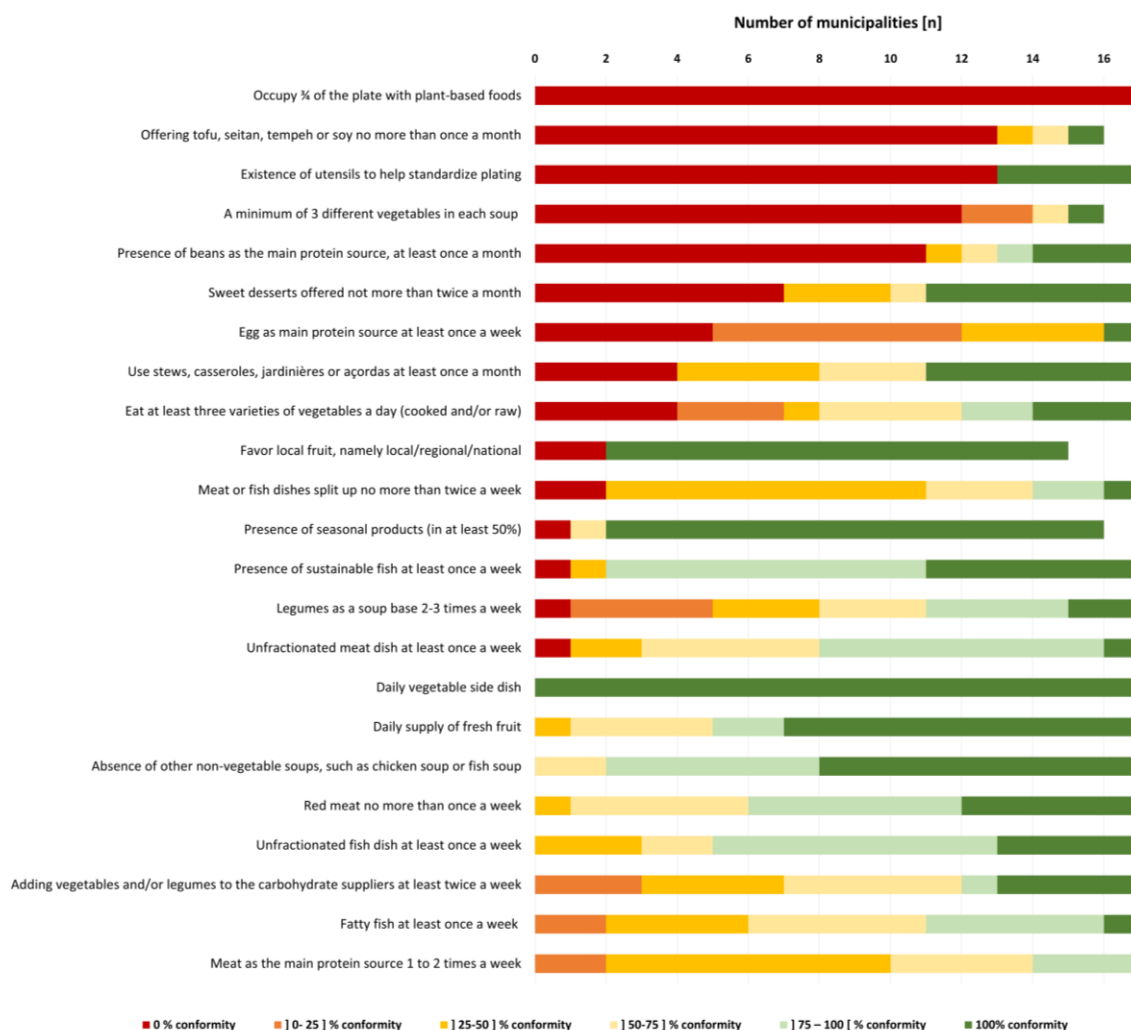


Figure 2 - Percentage of compliance considering the parameters of the SPARE+ tool for the Portuguese school lunch menus

Italian lunch menus evaluation | By items and by season

As for the Italian menus, they were evaluated through the Italian evaluation scale, which provides a compliance rate ranging from 0% to 100%. A colour scale was used to represent different levels of conformity, ranging from dark red (0% conformity) to dark green (100% conformity) (Figure 3). Appendix C provides a comprehensive overview of these items, categorizing them by season and offering detailed descriptions.

Several dietary practices demonstrated complete conformity, meaning they were fully adhered to in all municipalities. These practices included ensuring that

menus are spread over at least four weeks, serving grain-based dishes such as pasta, rice, spelt, barley, or polenta at each meal, and limiting meat dishes to no more than 1-2 times per week while varying the type of meat served. Conversely, there was no adherence (0% conformity) to the practice of offering pulse-based dishes more than once a week as a second course in place of meat (**Figure 3**).

For the criteria of serving fish dishes at least once a week, with canned fish no more than twice a month, compliance is generally high, with one municipality nearly achieving full compliance and most municipalities meeting these criteria completely (14 having a 75-99% of compliance). Additionally, more than half of the municipalities demonstrated complete compliance with the requirements for including whole grains at least once a week, offering at least four different vegetable varieties per week, and excluding preserved meats (cold cuts, cured meats, etc.) from the menu. In contrast, items with complete compliance in fewer than half of the municipalities included the provision of cheese dishes no more than once per week, the offer of a vegetable side dish daily, and the offering of a variety of other grains besides pasta and rice at least three times per month (**Figure 3**).

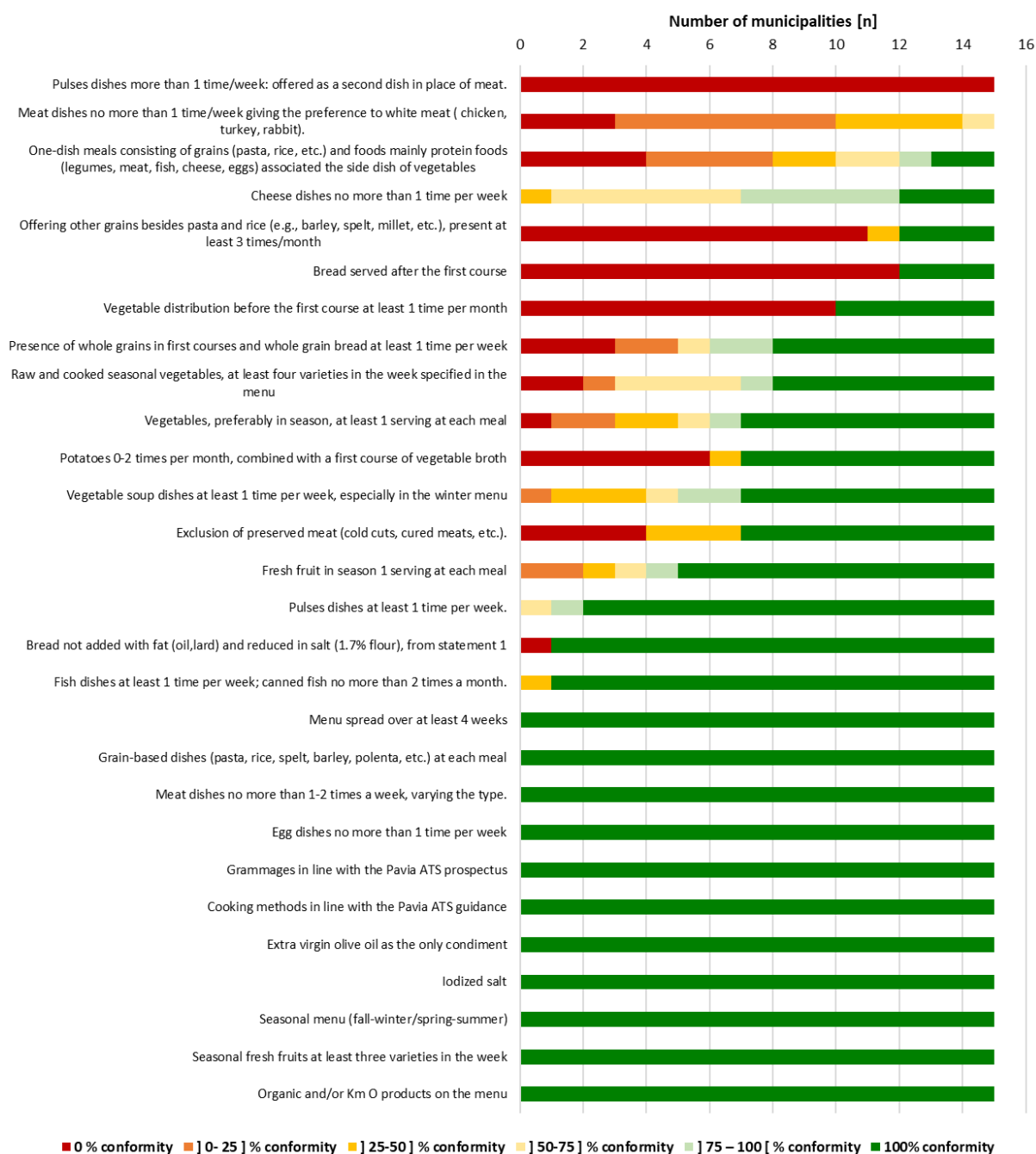


Figure 3 - Percentage of compliance considering the parameters of the Italian tool

The Italian data reveal a statistically significant seasonal difference in compliance with the practice of offering vegetable soup dishes at least once a week. When comparing compliance across the two seasons, winter and spring, a notable difference was observed, with higher adherence during the winter/autumn period (median [p25-p75]: 100% [94-100%]) compared to spring (median [p25-p75]: 88% [25-100%]) (p-value = 0.016) (Appendix C).

Comparison of Portuguese and Italian school lunch menus by item

When comparing the results obtained through the adapted SPARE tool for Portuguese and Italian menus, 17 items showed statistically significant differences. **Figure 4** provides a detailed comparison of these items across Portugal and Italy. Appendix D gives a detailed description of all the items used to compare Portugal and Italy.

Among these items, it should be highlighted that Portuguese menus demonstrated better results in terms of the presence of fatty fish (Portuguese median [p25-p75]: 90% [66-95%]; Italian median [p25-p75]: 75% [64-93%]) and the addition of vegetables to cereal side dishes (Portuguese median [p25-p75]: 100% [83-100%]; Italian median [p25-p75]: 83% [63-100%]). Conversely, Italian menus showed greater compliance with the criteria for limiting meat to no more than twice per week (Portuguese median [p25-p75]: 60% [59-80%]; Italian median [p25-p75]: 72% [54-100%]) and for including beans as the main protein source at least once a month (Portuguese median [p25-p75]: 0% [0-0%]; Italian median [p25-p75]: 0% [0-25%]) (Appendix D).

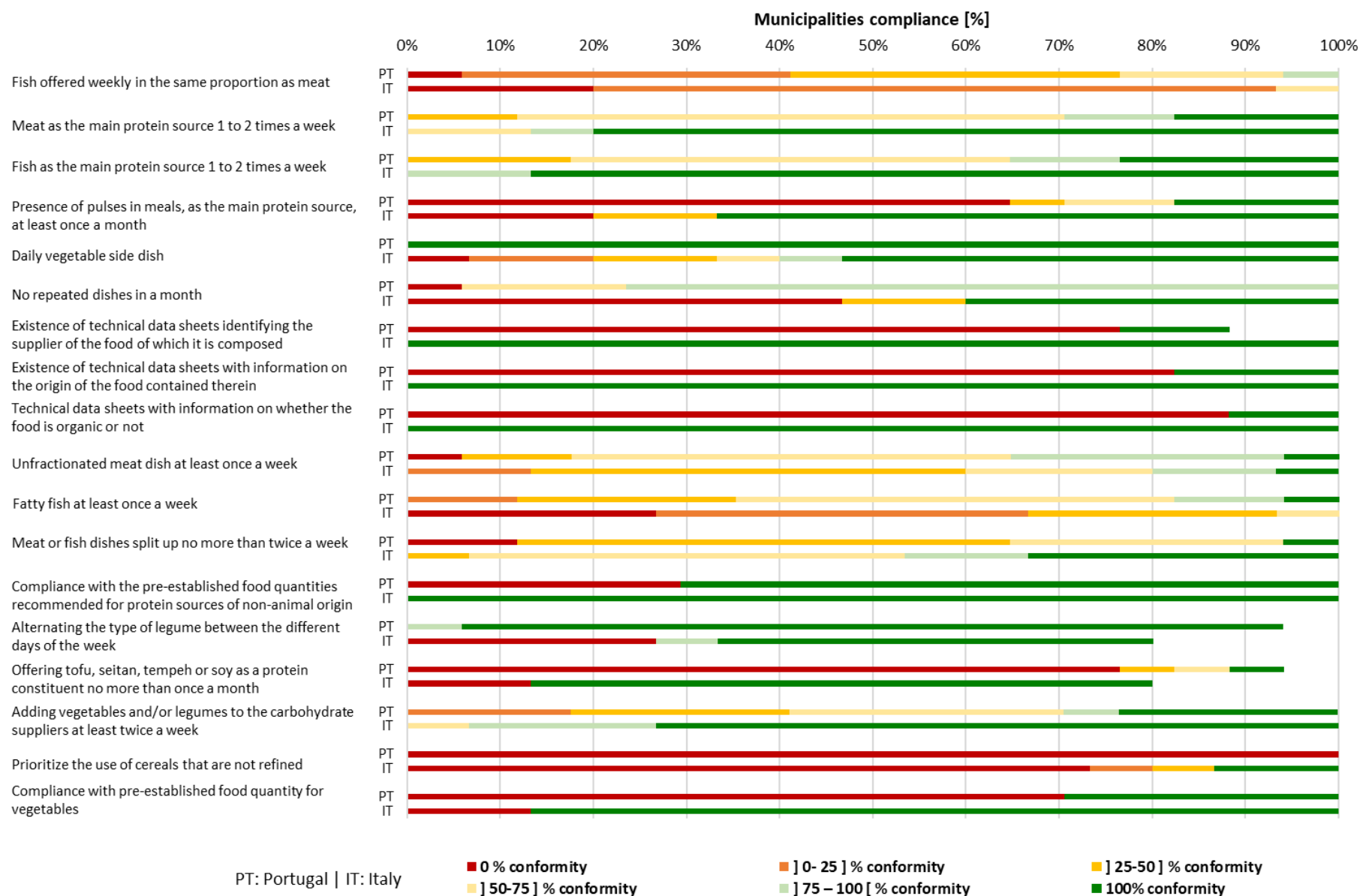


Figure 4 - Percentage of compliance considering the SPARE+ items with significant differences between Italy (IT) and Portugal (PT)

Factors associated with the quality of the menus evaluated | General and by season

In Portugal, no statistically significant correlations were detected between the number of canteens, cooking units, reception units, meals served, meal cost, the number of nutritionist or the municipality's interest in healthy and sustainable nutrition, and the overall quality score of the lunch menus. Nevertheless, the highest correlation observed in Portugal was between the municipality's interest in nutrition education programs and the quality of the menus, suggesting that a greater interest in nutrition education was associated with a higher menu quality both overall and across different seasons, although these correlations were not statistically significant (**Table 4**).

Table 4 - Spearman correlations between the number of canteens, cooking units, reception units, meals, meal cost, nutritionists, municipality's interest in healthy and sustainable nutrition and the menu quality score for the lunch meal in Portugal, using the original SPARE+ tool

	General		Winter		Spring		Autumn	
	Correlation	P-value	Correlation	P-value	Correlation	P-value	Correlation	P-value
Number of canteens	0.033	0.911	0.101	0.731	0.189	0.517	0.121	0.680
Number of cooking units	0.107	0.716	0.020	0.946	0.033	0.910	0.220	0.449
Number of reception units	0.138	0.637	0.143	0.626	0.319	0.266	0.054	0.856
Number of meals	0.040	0.893	0.191	0.512	0.088	0.765	0.136	0.642
Meal cost	0.038	0.898	0.220	0.450	0.018	0.952	0.131	0.655
Number of nutritionists	0.217	0.456	0.028	0.926	0.125	0.669	0.284	0.324
Municipality's interest in healthy and sustainable nutrition	0.256	0.378	0.241	0.406	0.217	0.455	0.346	0.225

In Italy, a positive association was found between the number of canteens and the menu quality in every season except spring, using both the original and the adapted SPARE+ tool. The same association was also identified in the spring season, but only when using the original tool ($p = 0.658$, $p = 0.008$). Additionally, the number of meals provided by the municipality was positively correlated with menu quality. This correlation was not observed in the winter season using the original tool or in the spring season using the adapted SPARE+ tool. Furthermore, the factor "number of cooking units" demonstrated a positive association with the menu quality in the general category when using the

original tool ($p = 0.514$, $p = 0.05$). No significant associations were found between the number of reception units, meal cost, number of nutritionists, the municipality's interest in healthy and sustainable nutrition, and the menu quality score for lunch in Italy (**Table 5**).

Table 5 - Spearman correlations between the number of canteens, cooking units, reception units, meals, meal cost, nutritionists, municipality's interest in healthy and sustainable nutrition and the menu quality score for the lunch meal in Italy, using the SPARE+ tool adapted and the original tool

	General of the adapted SPARE+		Winter of the adapted SPARE+		Spring of the adapted SPARE+		General of the original tool		Winter of the original tool		Spring of the original tool	
	Correlation	p-value	Correlation	p-value	Correlation	p-value	Correlation	p-value	Correlation	p-value	Correlation	p-value
Number of canteens	0.558	0.031	0.571	0.026	0.508	0.053	0.592	0.020	0.518	0.048	0.658	0.008
Number of cooking units	0.257	0.356	0.359	0.189	0.267	0.336	0.514	0.050	0.298	0.280	0.467	0.079
Number of reception units	0.458	0.086	0.471	0.076	0.332	0.226	0.457	0.087	0.510	0.052	0.489	0.064
Number of meals	0.521	0.046	0.558	0.031	0.452	0.091	0.542	0.037	0.467	0.079	0.612	0.015
Meal cost	0.171	0.541	0.143	0.610	0.104	0.712	0.193	0.491	0.249	0.372	0.140	0.619
Number of nutritionists	0.236	0.398	0.195	0.487	0.204	0.465	0.250	0.369	0.368	0.177	0.277	0.318
Municipality's interest in healthy and sustainable nutrition	0.116	0.681	0.039	0.891	0.077	0.784	0.212	0.447	0.155	0.582	0.097	0.731

In Portugal, no statistically significant correlations were detected between the environment (rural or urban), type of service (self-managed or sub-contracted), presence of nutrition education programs, and the lunch meal quality score. In Italy, using the adapted SPARE+ tool, menu quality was found to be higher in urban settings compared to rural ones during the winter season (Urban Mean (SD): 81.7 (5.3); Rural Mean (SD): 87.4 (2.9); $p = 0.044$). Conversely, during the spring season, the original tool revealed that municipalities with a sub-contracted service had better menu quality compared to those with self-managed services (Self-managed Mean (SD): 67.9 (1.3); Sub-contracted Mean (SD): 73.9 (9.1); $p = 0.042$) (Table 6).

Table 6 - Association between environment, type of service, presence of nutrition educational programmes and the lunch meal quality in Portugal and in Italy, using the original SPARE+ tool, the adapted one and the original Italian tool, according to the season and in general

	Environment, mean (SD)			Type of service, mean (SD)			Presence of nutrition education programmes, mean (SD)		
	Rural	Urban	p-value*	Self-management	Sub-contracted service	p-value*	No	Yes	p-value*
PORTUGAL									
General, SPARE+	71.4 (4.5)	74.2 (3.0)	0.207	73.9 (5.2)	72.9 (3.2)	0.663	75.5 (4.8)	72.1 (3.2)	0.125
Winter, SPARE+	71.5 (4.1)	74.9 (3.4)	0.128	74.4 (4.9)	73.6 (4.1)	0.746	76.7 (4.6)	72.3 (3.5)	0.067
Autumn, SPARE+	72.2 (5.1)	73.2 (3.0)	0.659	74.2 (5.6)	71.9 (2.0)	0.368	74.9 (5.1)	71.8 (2.7)	0.165
Spring, SPARE+	70.7 (4.6)	74.6 (4.3)	0.140	73.3 (5.6)	73.0 (4.4)	0.925	75.0 (5.1)	72.1 (4.5)	0.287
ITALY									
General, SPARE+ adapted	86.9 (3.2)	81.2 (5.7)	0.061	82.3 (2.0)	83.3 (6.0)	0.675	85.9 (0)	82.9 (5.8)	0.626
Winter, SPARE+ adapted	87.4 (2.9)	81.7 (5.3)	0.044	84.3 (0.6)	83.4 (5.7)	0.596	86.1 (0)	83.4 (5.5)	0.639
Spring, SPARE+ adapted	86.3 (4.0)	80.9 (6.3)	0.112	79.7 (2.6)	83.2 (6.4)	0.253	85.8 (0)	82.5 (6.3)	0.622
General, original tool	78.3 (5.8)	72.0 (8.8)	0.173	72.3 (0.6)	74.3 (8.9)	0.438	77.2 (0)	73.8 (8.5)	0.707
Winter, original tool	82.8 (5.7)	74.1 (8.7)	0.099	76.8 (2.5)	76.7 (9.1)	0.985	0.77.7 (0)	76.6 (8.8)	0.908
Spring, original tool	77.8 (8.0)	70.7 (8.4)	0.139	67.9 (1.3)	73.9 (9.1)	0.042	76.8 (0)	72.8 (8.9)	0.675

*t-student test

Discussion

This study analysed and compared school lunch menus from 32 municipalities—17 in Portugal and 15 in Italy—using 64 of 88 SPARE+ criteria. Portuguese menus scored lower than Italian ones, averaging 75.5 versus 83.1. In Italy, menu quality was positively correlated with the number of daily meals, canteens, and the use of concessionaires. Additionally, rural Italian municipalities showed better menu quality in winter compared to urban areas. No similar associations were found in Portugal.

Overall menu quality in Portugal and Italy

The average quality of Portuguese menus, assessed using the SPARE tool, was 73.3%, with no significant seasonal variation. This finding is consistent with a 2018 study reporting 74% compliance for elementary school menus in Lisbon, Oeiras, Cascais, and Sintra (159). Another 2018 study found scores ranging from 65.6% in September/October to 79.9% in February/March of the 2015/2016 academic year (155). The overall average quality of Italian menus, assessed with the original Italian tool, was 74.7%. Compliance was higher in autumn/winter menus compared to spring/summer, likely due to the ease of offering soups and other seasonal dishes that improve adherence to whole grain and plant-based protein requirements. These findings are not directly comparable to other studies, as no existing research on the seasonal nutritional quality of Italian school menus is known. Further investigation is needed to confirm these results.

It is noteworthy that although the SPARE+ tool was designed and validated to evaluate Portuguese menus, Italy showed generally better results in this study, with average scores of 75.5% for Portugal and 83.1% for Italy. This difference may be attributed to several factors. Firstly, Italy demonstrates a lower frequency of meat and animal product consumption, adhering more closely to various criteria regarding protein sources. Secondly, although to a lesser extent, Italy exhibits a higher consumption of whole grains and plant-based protein sources. Additionally, some technical data sheets that are optional in Portugal are mandatory in Italy, such as those detailing the origin and supplier of the food.

Menu quality by item in Portugal and Italy

In Portugal, although rice, pasta, and potatoes are evenly distributed in school menus, compliance with whole grain preferences was 0% across all municipalities. Italy also showed low adherence to whole grain offerings, with four municipalities having 0% compliance, though this was slightly better than in Portugal. Similar findings have been reported in other Portuguese studies (155). The low use of whole grains may be due to their higher cost and lower acceptance among children, who are more familiar with refined grains. Addressing this issue may involve introducing whole grain cereals from early school grades and integrating them into school menus and specifications. Early exposure can help children adapt to and appreciate these healthier options. (45).

In Portugal, all municipalities provide a daily vegetable side dish with good variety and seasonality, reflecting an improvement in compliance with dietary recommendations. This evolution may be attributed to the various Portuguese campaigns to improve and increase the supply of vegetables in schools (160, 161). This contrasts with a 2009 study in Pombal, which found that only 83.3% of menus included vegetables, and 20.3% featured only lettuce (160). In Italy, results were less favourable, with only 8 municipalities fully complying with the daily vegetable side dish requirement, often due to the prevalent use of potatoes.

In Portugal, 12 municipalities achieved over 75% compliance with daily fruit provision, but dessert offerings were less satisfactory, with 7 out of 17 municipalities serving desserts or sweetened yogurts more than once a month. This is consistent with a 2009 study in Pombal, which reported yogurt being offered more than once a month in 5.3% of menus (162). In Italy, 11 out of 15 municipalities also provided fruit daily (over 75% compliance), resulting in a lower frequency of sweets and yogurt. Recent improvements have reduced dessert and sweet consumption in schools. Notably, yogurt's high calcium content can inhibit iron absorption, which is important given the risk of iron deficiency in childhood (163).

In 75% of Portuguese municipalities, red meat was offered less than once per week, with excellent results in 15 out of 17 municipalities. This contrasts with another Portuguese study (159), which found red meat, particularly pork, to be more prevalent than poultry. In the current study, compliance with offering white meat at least once a week was above 75% in all municipalities, likely reflecting increased nutritional and environmental awareness (162). Given that beef production is resource-intensive (59,154), its inclusion has been decreased. Italian menus also showed strong results, with 100% of municipalities offering meat less than twice a week. However, compliance with offering white meat over red meat was lower, with 14 out of 15 municipalities having less than 50% compliance. This lower compliance may be due to traditional recipes, such as “ragù alla Bolognese,” which are commonly used in school menus.

Cultural differences are evident in fish offerings between Italy and Portugal. In Portugal, fish is offered more frequently than in Italy, although its provision remains low and below that of meat. This may be attributed to Portugal's higher traditional fish consumption, which makes it more acceptable to children. Economic factors also play a role, as fatty fish like salmon or mackerel are more expensive than leaner fish, with the average meal cost in Portugal being €2.80. Additionally, canned fatty fish, such as tuna, are rarely used due to their processed nature and recommendations against frequent use. Methylmercury content in fish is another concern, as exposure can pose a public health risk, particularly to children. A 2022 study found that 36.1% of the 113 Portuguese school menus analysed contained fish with high methylmercury levels (154). This factor was not assessed in the current study as it is not included in the SPARE+ tool.

More than half of Portuguese municipalities exhibited less than 50% compliance in offering eggs as a protein source at least once a week. This aligns with previous studies (155,159), indicating that Portuguese school meals rarely feature eggs as the sole protein source, likely due to cultural preferences for dishes that combine eggs with meat or fish. In contrast, in Italy, eggs are commonly offered as the main protein source once a week, with 100% compliance in all municipalities, following Italian school catering guidelines

(151). However, Italian menus often exceed recommendations for cheese-based dishes, due to the prevalence of traditional recipes that use cheese, such as béchamel and Parmesan. To improve nutritional quality, it is advisable to reduce the use of these cheeses, which contribute to higher salt and saturated fat intake, and to increase the inclusion of legumes and other plant-based proteins in school menus.

The importance of environmental sustainability in school meals

As awareness of the environmental impact of food choices grows, municipalities are increasingly integrating sustainability into their meal programs to reduce their environmental footprint and educate children (164, 165). The updated SPARE+ tool was developed to align with national and international sustainability recommendations for school catering, including criteria for menu planning (158). A key consideration is the choice of protein sources, with plant-based proteins offering a significantly lower environmental impact compared to animal-based options (59).

In this study, only two municipalities, one in Italy and one in Portugal did not provide a vegetarian menu, because no family requested, but still the provision of plant-based protein sources was very low in Portuguese schools, with 65% of municipalities not offering these products at all. In Italy, 20% of municipalities had no compliance in this area, reflecting the challenges of incorporating plant-based options despite their benefits over animal products (59). In Portugal, meals without meat or fish often face resistance from children and parents, who may view them as nutritionally inadequate (166). Similarly, pulses and their derivatives are frequently rejected by children unfamiliar with these foods (167). Parental influence and home food environments play a crucial role in shaping children's eating habits and preferences, as early exposure to parental dietary choices significantly affects children's food preferences and consumption (45).

Factors associated with menu quality in Portugal and Italy

Three statistically significant differences were observed between Italy and Portugal at the municipal level: a higher presence of municipal nutritionists

in Portugal, a higher cost of meals in Italy and a larger presence of cooking units in Portugal. The first factor is possibly due to the fact that in Italy nutritionists are scarcely present at the municipal level, often only in large cities, and normally hired directly by the contracted catering company. While the contrasting cost can be explained by differences in funding policies from the state and/or in the prices on food supply. Also, in Italy, there are fewer schools with cooking units, with most relying on meals provided by external catering companies, which are more prevalent when compared to Portugal.

In Portugal, no significant relationship was found between menu quality and various factors. In contrast, Italy showed a correlation between nutritional quality and the number of school canteens within a municipality. Municipalities with more canteens likely benefit from better organizations, more nutritionists, and stricter nutritional controls. This pattern is more common in larger cities compared to smaller towns. However, due to the small sample size, this finding may be coincidental, and further research is needed to confirm this correlation.

Limitations and strengths

The primary limitation of this study is its small, non-representative sample size. Additionally, the description of menu items, especially in Italy, lacks detail, such as culinary methods and specific fruits, potentially leading to misinterpretations. Although local nutritionists were consulted for clarification, the assumption that planned meals match those served and the use of an adapted but not specifically validated SPARE+ tool are limitations. However, the study's strengths include being the first to compare the nutritional quality of public school canteens in two countries and evaluating all menus by a single assessor, minimizing interpretation discrepancies. The SPARE+ tool and the Italian questionnaire are valid and widely recognized, and this study is the first to explore seasonal differences in menu quality. Further research is needed for a more comprehensive understanding.

Conclusion

In this qualitative study, menus generally adhered well to health and environmental sustainability criteria, with Italian menus outperforming Portuguese ones. In Portugal, no significant associations were found between menu quality and various factors, whereas in Italy, nutritional quality was positively associated with the number of canteens and meals provided by the municipality.

Both countries excelled in offering daily fresh fruit, limiting sweets, using iodized salt, and prioritizing local and seasonal products. However, both showed limited availability of whole grains in children's menus.

Italy showed better results in protein sources, with meat offerings generally within the recommended range of 1-2 times per week and increased availability of plant-based proteins, though still insufficient. Portugal performed well in the vegetable category, offering a greater variety and quantity, and had a higher supply of fatty fish. Conversely, Italy had lower compliance in fish offerings, particularly fatty fish, while Portugal had a higher supply of meat compared to alternative protein sources.

Further research is needed to understand the mechanisms behind these differences and to develop strategies for improving menu quality. This study's findings can help identify weaknesses in municipal food supply and inform interventions and nutrition education to enhance meal quality and child nutrition.

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Annex A: SPARE+ checklist (Portuguese) (148) and English translation

n	Check-list SPARE+ (Portuguese)	English Translation
General items		
1	Oferta de sopa com hortícolas diariamente	Daily soup with vegetables
2	Oferta semanal de pescado em proporção idêntica à de carne	Fish offered weekly in the same proportion as meat
3	Carne como principal fonte proteica 1 a 2 vezes por semana	Meat as the main protein source 1 to 2 times a week
4	Pescado como principal fonte proteica 1 a 2 vezes por semana	Fish as the main protein source 1 to 2 times a week
5	Ovo como principal fonte proteica, no mínimo, 1 vez por semana	Egg as the main protein source at least once a week
6	Presença de leguminosas no prato, pelo menos, 1 vez por semana	Presence of legumes on the plate at least once a week
7	Presença de leguminosas nas refeições, como fonte proteica principal, pelo menos, 1 vez por mês	Presence of legumes in meals, as the main protein source, at least once a month
8	Presença diária de acompanhamento fornecedor de hidratos de carbono	Daily presence of a carbohydrate-supplying side dish
9	Presença diária de pão, privilegiando a variedade	Daily presence of bread, favouring variety
10	O pão não contém mais de 1g de sal por 100g de pão	Bread contains no more than 1g of salt per 100g of bread
11	Acompanhamento diário de hortícolas	Daily vegetable side dish
12	Fruta em natureza diariamente	Fresh fruit daily
13	Oferta equitativa de técnicas de confeção (excluindo a fritura)	Equal offer of cooking techniques (excluding frying)
14	Alimento frito no prato até 1 vez por mês	Fried food on the plate up to once a month
15	Pratos com alimentos fornecedores de gorduras trans, no máximo, 2 vezes por mês	Dishes with foods containing trans fats no more than twice a month
16	Disponibilização de água da rede pública à refeição como única bebida	Public water available at mealtimes as the only drink
17	Ausência de pratos repetidos num mês	No repeated dishes in a month
18	Ausência de pratos com textura semelhante dos seus componentes	No dishes with a similar texture
19	Ausência de pratos monocromáticos	No monochrome dishes
20	Existência de fichas técnicas com a composição da refeição, matérias-primas utilizadas, com respetivas captações, e descrição de métodos de confeção	Existence of technical sheets with the composition of the meal, the raw materials used, with the corresponding headings and description of the cooking methods.
21	Existência de Fichas técnicas com indicação de substâncias ou produtos suscetíveis de provocar alergias ou intolerâncias (descritas no Anexo II do Regulamento (UE) nº1169/2011)	Existence of technical data sheets indicating substances or products that may cause allergies or intolerances (described in Annex II of Regulation (EU) No 1169/2011)
22	Existência de fichas técnicas com informação nutricional por 100g da refeição	Existence of technical sheets with nutritional information per 100g of the meal

23	Existência de fichas técnicas com informação nutricional por dose/porção de refeição	Existence of technical sheets with nutritional information per portion of the meal
24	Existência de fichas técnicas com identificação do fornecedor dos alimentos que a compõe	Existence of technical data sheets identifying the supplier of the food of which it is composed
25	Existência de fichas técnicas com informação da origem dos alimentos que a compõe	Existence of technical data sheets with information on the origin of the food contained therein
26	Existência de fichas técnicas com informação se os alimentos que a compõe são ou não biológicos	Technical data sheets with information on whether the food is organic or not
27	Cumprimento da ementa (planeada igual à executada)	Compliance with the menu (planned as executed)
28	Cumprimento da ficha técnica (planeada igual à executada)	Compliance with the technical data sheet (planned equal to executed)
29	Privilegiar a utilização de alimentos de produção local/regional/nacional (em pelo menos 30% dos alimentos da ementa mensal)	Prioritize the use of locally/regionally/nationally produced food (at least 30% of the food on the monthly menu).
30	Privilegiar a Presença de produtos atendendo à sua sazonalidade (em pelo menos 50% da globalidade dos produtos presentes na ementa mensal, nomeadamente, hortícolas, frutos e pescado)	Give priority to the presence of seasonal products (at least 50% of all products on the monthly menu, namely vegetables, fruit and fish).
31	Preferência por produtos in natura e produtos minimamente processados (maior proporção de uso destes em relação aos ultraprocessados)	Preference for natural and minimally processed products (higher consumption of these compared to highly processed products)
32	Utilização de alimentos transgênicos, no máximo, 1 vez por quinzena	Use of transgenic food no more than once every two weeks
33	O óleo utilizado não é derivado de produtos geneticamente modificados	The oil used is not derived from genetically modified products.
34	Azeite virgem como fonte de gordura de confeção (exceto na fritura)	Virgin olive oil as a source of cooking fat (except for frying)
35	Ocupação de $\frac{3}{4}$ do prato com alimentos de origem vegetal	Occupy $\frac{3}{4}$ of the plate with plant-based foods
36	Na preparação e confeção das refeições, utilização do alimento na sua forma integral, sempre que possível	When preparing and cooking meals, use foods in their whole form whenever possible.
37	Existência de utensílios que auxiliam à padronização do empratamento	Existence of utensils to help standardize plating
38	Reaproveitamento das sobras, de acordo com o Despacho n.º 5296/2017	Reuse of leftovers, in accordance with Order no. 5296/2017
39	Elaboração e disponibilização do plano de ementas mensal, pelos menos, com 15 dias de antecedência	Create and provide monthly menu plan at least 15 days in advance
40	Cumprimento das captações gerais dos ingredientes que integram a refeição do almoço (conduto, acompanhamento e hortícolas/saladas) (descritas no	Adherence to the general limits of the ingredients that make up the lunch meal (main course, side dish, and vegetables/salads) (described in Annex 2 of Circular 3097/DGE/2018)

	Anexo 2 da Circular nº3097/DGE/2018)	
41	Recurso a ensopados, caldeiras, jardineiras ou açordas, pelo menos, 1 vez por mês	Use stews, casseroles, jardinières or açordas at least once a month.
42	Utilização de sal iodado, com um teor de iodização de 30-60mg/kg de sal	Use of iodized salt, with an iodization content of 30-60mg/kg of salt
43	O sal adicionado não ultrapassa 0,2g por constituinte da ementa (sopa e prato)	The salt added does not exceed 0.2g per component of the menu (soup and dish)
44	Existência de opção vegetariana	Existence of a vegetarian option
45	Avaliação regular da satisfação da oferta alimentar, monitorizando o desperdício e/ou aplicando inquéritos	Regularly assess food service satisfaction, monitor waste and/or conduct surveys
46	Estraégias de minimização do desperdício alimentar	Strategies for minimizing food waste
Soup items		
47	Diariamente, um mínimo de 3 hortícolas diferentes em cada sopa	A minimum of 3 different vegetables in each soup every day
48	Hortícolas aos pedaços na sopa, pelo menos, 3 vezes por semana	Chopped vegetables in soup at least 3 times a week
49	Leguminosas, como base, 2 a 3 vezes por semana	Legumes, as a base, 2-3 times a week
50	Ausência de outras sopas sem base de hortícolas, como, canja ou sopa de peixe	Absence of other non-vegetable soups, such as chicken soup or fish soup
51	Privilegiar hortícolas, atendendo à sua sazonalidade (em pelo menos 50% dos hortícolas presentes na ementa mensal)	Give priority to vegetables, taking into account their seasonality (at least 50% of vegetables in the monthly menu).
Animal protein source items		
52	Carne branca, no mínimo, 1 vez por semana	White meat at least once a week
53	Carne vermelha, no máximo, 1 vez por semana	Red meat no more than once a week
54	Prato de carne não fracionado, pelo menos, 1 vez por semana	Unfractionated meat dish at least once a week
55	Peixe gordo, no mínimo, 1 vez por semana	Fatty fish at least once a week
56	Prato de pescado não fracionado, pelo menos, 1 vez por semana	Unfractionated fish dish at least once a week
57	Pratos com carne ou peixe fracionados, no máximo, 2 vezes por semana	Meat or fish dishes split up no more than twice a week
58	Ovo, no mínimo, 1 vez por semana (como principal fonte proteica)	Egg at least once a week (as the main source of protein)
59	Pratos que incluam produtos de salsicharia, no máximo, 1 vez por mês	Dishes that include sausage products no more than once a month
60	Carne e peixe livre de peles e gorduras visíveis	Meat and fish free of visible skin and fat
61	Cumprimento das captações pré-estabelecidas	Compliance with pre-established food quantities recommended
62	Presença de pescado sustentável, pelo menos, 1 vez por semana	Presence of sustainable fish at least once a week (listed in Annex 5 of Circular 3097/DGE/2018)

	(elencados no Anexo 5 da Circular nº3097/DGE/2018)	
63	Privilegiar pescado, atendendo à sua sazonalidade	Prioritize fish, taking into account its seasonality
Non-animal protein source items		
64	Oferta de leguminosas como principal constituinte proteico, preferencialmente ou, em alternativa, tofu, seitan, tempeh ou soja	Offer legumes as the main protein constituent, preferably or alternatively tofu, seitan, tempeh or soybeans
65	Alternância do tipo de leguminosa entre os diferentes dias da semana	Alternating the type of legume between the different days of the week
66	Oferta de tofu, seitan, tempeh ou soja como constituinte proteico, no máximo, 1 vez por mês	Offering tofu, seitan, tempeh or soy as a protein constituent no more than once a month
67	Leguminosas na sopa, caso não estejam presentes no prato/conduto	Legumes in the soup, if they are not present in the dish/conduct
68	Cumprimento das captações pré-estabelecidas para as fontes proteicas de origem não animal	Compliance with the pre-established food quantities recommended for protein sources of non-animal origin
Carbohydrate source items		
69	Cumprimento das captações pré-estabelecidas	Compliance with pre-established food quantities recommended
70	Distribuição equitativa entre arroz, massa, batata ou outros fornecedores de hidratos de carbono	Equal distribution between rice, pasta, potatoes or other carbohydrate suppliers
71	Adição de hortícolas e/ou leguminosas ao acompanhamento, no mínimo, 2 vezes por semana	Adding vegetables and/or legumes to the carbohydrate suppliers at least twice a week
72	Privilégio na utilização de cereais transformados pouco refinados	Prioritize the use of processed cereals that are not too refined
73	Leguminosas como acompanhamento no prato/conduto, no mínimo, 1 vez por semana	Legumes as a side dish at least once a week
Vegetables side dish items		
74	Cumprimento das captações pré-estabelecidas	Compliance with pre-established food quantities recommended
75	Acompanhamento diário de, no mínimo, três variedades de hortícolas (cozinhados e/ou crus)	Eat at least three varieties of vegetables a day (cooked and/or raw)
76	Variedade entre os diversos hortícolas	Variety of different vegetables
77	Variedade entre a oferta de hortícolas crus e confecionados	Variety between raw and cooked vegetables
78	Privilegiar hortícolas, atendendo à sua sazonalidade (em pelos menos 50% dos hortícolas presentes na ementa mensal)	Give priority to seasonal vegetables (at least 50% of the vegetables on the monthly menu)
79	Azeite virgem extra como fonte de gordura para o tempero em cru de saladas e/ou hortícolas	Extra virgin olive oil as a source of fat for seasoning raw salads and/or vegetables
Fruit and dessert items		
80	Oferta diária de fruta em natureza	Daily supply of fresh fruit
81	Existência de, pelo menos, 3 variedades de fruta diferentes semanalmente	At least 3 different varieties of fruit available every week

82	Oferta de fruta confeccionada sem adição de açúcar, no máximo, 2 vezes por mês	Offering fruit made without added sugar no more than twice a month
83	Oferta de sobremesas doces, no máximo, 2 vezes por mês	Sweet desserts offered no more than twice a month
84	Oferta semanal de fruta rica em vitamina C	Offer vitamin C-rich fruit every week
85	Privilegiar fruta, atendendo à sua sazonalidade (em pelo menos 50% da fruta presentes na ementa mensal)	Give priority to seasonal fruit (at least 50% of the fruit on the monthly menu)
86	Privilegiar fruta de proximidade, nomeadamente, local/regional/nacional	Favor local fruit, namely local/regional/national
87	Na opção vegetariana, oferta de sobremesas doces sem laticínios ou alternativas vegetais	In the vegetarian option, offer sweet desserts without dairy products or vegetable alternatives
88	Cumprimento das captações pré-estabelecidas	Compliance with pre-established food quantities recommended

Translated from tool SPARE+ (148)

Annex B: Italian checklist (157) and English translation

n	Italian Check-list	English Translation
BASIC NUTRITIONAL REQUIREMENTS		
1	Menu articolato su almeno 4 settimane	Menu spread over at least 4 weeks
2	Verdura, preferibilmente di stagione, almeno 1 porzione ad ogni pasto	Vegetables, preferably in season, at least 1 serving at each meal
3	Patate 0-2 volte al mese, associate ad un primo piatto in brodo di verdura	Potatoes 0-2 times per month, combined with a first course of vegetable broth
4	Frutta fresca di stagione 1 porzione ad ogni pasto	Fresh fruit in season 1 serving at each meal
5	Piatti a base di cereali (pasta, riso, farro, orzo, polenta, etc) ad ogni pasto	Grain-based dishes (pasta, rice, spelt, barley, polenta, etc.) at each meal
6	Primi piatti in brodo di verdure almeno 1 volta a settimana, in particolare nel menù invernale	Vegetable soup dishes at least 1 time per week, especially in the winter menu
7	Presenza di cereali integrali nei primi piatti e pane integrale almeno 1 volta a settimana	Presence of whole grains in first courses and whole grain bread at least 1 time per week
8	Pane NON addizionato con grassi (olio, strutto) e a ridotto contenuto di sale (1,7% farina)	Bread NOT added with fat (oil, lard) and reduced in salt (1.7% flour)
9	Piatti a base di pesce almeno 1 volta a settimana; pesce in scatola non più di 2 volte al mese.	Fish dishes at least 1 time per week; canned fish no more than twice a month
10	Piatti a base di legumi almeno 1 volta alla settimana.	Legume dishes at least 1 time per week.
11	Piatti a base di carne non oltre 1-2 volte alla settimana, variandone la tipologia.	Meat dishes no more than 1-2 times a week, varying the type.
12	Esclusione di carne conservata (affettati, salumi, ecc.)	Exclusion of preserved meat (cold cuts, cured meats, etc.).
13	Piatti a base di formaggio non oltre 1 volta alla settimana	Cheese dishes no more than 1 time per week
14	Piatti a base di uova non oltre 1 volta alla settimana	Egg dishes no more than 1 time per week
15	Grammature in linea con il prospetto ATS di Pavia	Grammages in line with the Pavia ATS prospectus
16	Metodi di cottura in linea con le indicazioni dell'ATS di Pavia	Cooking methods in line with the Pavia ATS guidance
17	Olio di oliva extravergine come unico condimento	Extra virgin olive oil as the only condiment
18	Sale iodato	Iodized salt
NUTRITIONAL REQUIREMENTS FOR IMPROVEMENT		
19	Menu stagionale (autunno-inverno/primavera-estate)	Seasonal menu (fall-winter/spring-summer)
20	Offerta di altri cereali, oltre a pasta e riso (es. orzo, farro, miglio ecc.), presenti almeno 3 volte/mese	Offering of other grains besides pasta and rice (e.g. barley, spelt, millet, etc.), present at least 3 times/month
21	Piatti a base di legumi più di 1 volta a settimana: proposti come secondo piatto in sostituzione della carne.	Legume dishes more than 1 time/week: offered as a second dish in place of meat.
22	Piatti a base di carne non oltre 1 volta alla settimana dando la preferenza alla carne bianca (pollo, tacchino, coniglio).	Meat dishes no more than 1 time/week giving the preference to white meat (chicken, turkey, rabbit).
23	Piatti unici composti da cereali (pasta, riso, ecc) e alimenti prevalentemente proteici (legumi, carne, pesce, formaggi, uova) associati al contorno di verdura	One-dish meals consisting of grains (pasta, rice, etc.) and mainly protein foods (legumes, meat, fish, cheese, eggs) associated to the side dish of vegetables
24	Verdura di stagione cruda e cotta, almeno quattro varietà nella settimana specificate nel menu	Raw and cooked seasonal vegetables, at least four varieties in the week specified in the menu

25	Frutta fresca di stagione almeno tre varietà nella settimana	Seasonal fresh fruits at least three varieties in the week
26	Prodotti biologici e/o a Km 0 presenti nel menù	Organic and/or Km 0 products on the menu
27	Frutta fresca e di stagione proposta come spuntino di metà mattina	Fresh, seasonal fruit offered as a mid-morning snack
28	Merende pomeridiane, se presenti, in linea con il documento ATS	Afternoon snacks, if any, in line with the ATS document
29	Pane servito dopo il primo piatto	Bread served after the first course
30	Distribuzione di verdure prima del primo piatto almeno 1 volta al mese	Vegetable distribution before the first course at least 1 time per month

Translated from tool Italian questionnaire (157)

Annex C: Final version of the total tool applied to Italian lunch menus

n	SPARE+ adapted for Italy
General items	
1	Fish offered weekly in the same proportion as meat
2	Meat as the main protein source 1 to 2 times a week
3	Fish as the main protein source 1 to 2 times a week
4	Presence of legumes on the plate at least once a week
5	Presence of legumes in meals, as the main protein source, at least once a month
6	Daily presence of a carbohydrate-supplying side dish
7	Daily presence of bread, favouring variety
8	Daily vegetable side dish
9	Fresh fruit daily
10	Equal offer of cooking techniques (excluding frying)
11	Fried food on the plate up to once a month
12	Public water available at mealtimes as the only drink
13	No repeated dishes in a month
14	No monochrome dishes
15	Existence of technical sheets with the composition of the meal, the raw materials used, with the corresponding headings and description of the cooking methods
16	Existence of technical data sheets indicating substances or products that may cause allergies or intolerances (described in Annex II of Regulation (EU) No 1169/2011)
17	Existence of technical data sheets identifying the supplier of the food of which it is composed
18	Existence of technical data sheets with information on the origin of the food contained therein
19	Technical data sheets with information on whether the food is organic or not
20	Compliance with the technical data sheet (planned equal to executed)
21	Prioritize the use of locally/regionally/nationally produced food (at least 30% of the food on the monthly menu)
22	Give priority to the presence of seasonal products (at least 50% of all products on the monthly menu, namely vegetables, fruit and fish)
23	Preference for natural and minimally processed products (higher consumption of these compared to highly processed products)
24	The oil used is not derived from genetically modified products
25	Virgin olive oil as a source of cooking fat (except for frying)
26	Occupy $\frac{3}{4}$ of the plate with plant-based foods

27	When preparing and cooking meals, use foods in their whole form whenever possible
28	Create and provide monthly menu plan at least 15 days in advance
29	Use of iodized salt, with an iodization content of 30-60mg/kg of salt
30	Existence of a vegetarian option
31	Regularly assess food service satisfaction, monitor waste and/or conduct surveys
32	Strategies for minimizing food waste
Animal protein source items	
33	White meat at least once a week
34	Red meat no more than once a week
35	Unfractionated meat dish at least once a week
36	Fatty fish at least once a week
37	Unfractionated fish dish at least once a week
38	Meat or fish dishes split up no more than twice a week
39	Dishes that include sausage products no more than once a month
40	Meat and fish free of visible skin and fat
41	Compliance with pre-established food quantities recommended
42	Prioritize fish, taking into account its seasonality
Non-animal protein source items	
43	Offer legumes as the main protein constituent, preferably or alternatively tofu, seitan, tempeh or soybeans
44	Alternating the type of legume between the different days of the week
45	Offering tofu, seitan, tempeh or soy as a protein constituent no more than once a month
46	Compliance with the pre-established food quantity recommended for protein sources of non-animal origin
Carbohydrate source items	
47	Compliance with pre-established food quantity recommended of cereals
48	Adding vegetables and/or legumes to the carbohydrate suppliers side dish at least twice a week
49	Prioritize the use of cereals that are not too refined
50	Legumes as a side dish at least once a week
Vegetable side dish items	
51	Compliance with pre-established food quantity recommended for vegetables
52	Variety of different vegetables
53	Variety between raw and cooked vegetables

54	Give priority to seasonal vegetables (at least 50% of the vegetables on the monthly menu)
55	Extra virgin olive oil as a source of fat for seasoning raw salads and/or vegetables
Fruit and dessert items	
56	Daily supply of fresh fruit
57	At least 3 different varieties of fruit available every week
58	Offering fruit made without added sugar no more than twice a month
59	Sweet desserts offered at least twice a month
60	Offer vitamin C-rich fruit every week
61	Give priority to seasonal fruit (at least 50% of the fruit on the monthly menu)
62	Favor local fruit, namely local/regional/national
63	In the vegetarian option, offer sweet desserts without dairy products or vegetable alternatives
64	Compliance with pre-established food quantity recommended for fruits

Appendix

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Appendix A: Comparison between SPARE+ and Italian checklist, with justifications provided for the rejection of specific items for the adapted SPARE+ for Italy

n	Check-list SPARE+	Comparable Italian Check-list	Result	Justification for accepting or rejecting the SPARE+ item
General items				
1	Daily soup with vegetables	Vegetable soup dishes at least 1 time per week, especially in the winter menu	Rejected	No soup offered daily in Italy
2	Fish offered weekly in the same proportion as meat	Fish dishes at least 1 time per week; canned fish no more than twice a month	Accepted	Comparable item
3	Meat as main protein source 1 to 2 times a week	Meat dishes no more than 1-2 times a week, varying the type.	Accepted	Comparable item
4	Fish as main protein source 1 to 2 times a week	Fish dishes at least 1 time per week; canned fish no more than twice a month	Accepted	Comparable item
5	Egg as main protein source at least once a week	Egg dishes no more than 1 time per week	Rejected	In Italy, the recommended frequency of eggs is a maximum of once a week
6	Pulses in the plate at least once a week		Accepted	Comparable item
7	Presence of pulses in meals, as the main protein source, at least once a month	Pulses dishes more than 1 time/week: offered as a second dish in place of meat.	Accepted	Comparable item
8	Daily presence of a carbohydrate-supplying side dish	Grain-based dishes (pasta, rice, spelt, barley, polenta, etc.) at each meal	Accepted	Comparable item
9	Daily presence of bread, favouring variety		Accepted	Comparable item
10	Bread contains no more than 1g of salt per 100g of bread	Bread not added with fat (oil, lard) and reduced in salt (1.7% flour)	Rejected	The criteria in Italy are different (salt 1.7% of flour)
11	Daily vegetable side dish	Vegetables, preferably in season, at least 1 serving at each meal	Accepted	Comparable item
12	Fresh fruit daily	Fresh fruit in season 1 serving at each meal	Accepted	Comparable item
13	Equal offer of cooking techniques (excluding frying)	Cooking methods in line with the Pavia ATS guidance	Accepted	Comparable item

14	Fried food on the plate up to once a month		Accepted	Comparable item
15	Dishes with foods containing trans fats no more than twice a month		Rejected	It is not possible to evaluate the trans fat content because it is not present in the nutritional table, since it is not mandatory
16	Public water available at mealtimes as the only drink		Accepted	Comparable item
17	No repeated dishes in a month		Accepted	Comparable item
18	No dishes with a similar texture		Rejected	Difficult to assess, texture not specified in Italian menu
19	No monochrome dishes		Accepted	Comparable item
20	Existence of technical sheets with the composition of the meal, raw materials used, with their respective amounts, and description of cooking methods		Accepted	Comparable item
21	Existence of technical sheets indicating substances or products that may cause allergies or intolerances (described in Annex II of Regulation (EU) No 1169/2011)		Accepted	Comparable item
22	Existence of technical sheets with nutritional information per 100g of the meal		Rejected	This specific technical sheet does not exist
23	Existence of technical sheets with nutritional information per portion of the meal		Rejected	This specific technical sheet does not exist
24	Existence of technical data sheets with identification of the supplier of the food		Accepted	Comparable item
25	Existence of technical sheets with information on the origin of the food that makes up the meal		Accepted	Comparable item
26	Existence of technical sheets with information on whether the food is organic or not		Accepted	Comparable item
27	Compliance with the menu (planned the same as executed)		Accepted	Comparable item

28	Compliance with the technical sheet (planned the same as implemented)		Rejected	Difficult to assess, it depends on the canteen service, leaving it to the discretion of each establishment
29	Prioritize the use of locally/regionally/nationally produced food (in at least 30% of the food on the monthly menu)	Organic and/or Km 0 products on the menu	Accepted	Comparable item
30	Prioritize the presence of seasonal products (in at least 50% of all the products on the monthly menu, namely vegetables, fruit and fish)	Seasonal fresh fruits at least three varieties in the week	Accepted	Comparable item
31	Preference for in natura and minimally processed products (a greater proportion of these are used in relation to ultra-processed products)		Accepted	Comparable item
32	Use of transgenic foods no more than once a fortnight		Rejected	It is not possible to evaluate if a food is transgenic, not specified in general but only for some category of food (e.g. oil)
33	The oil used is not derived from genetically modified products		Accepted	Comparable item
34	Virgin olive oil as a source of cooking fat (except for frying)	Extra virgin olive oil as the only condiment	Accepted	Comparable item
35	$\frac{3}{4}$ of the plate should be filled with foods of plant origin		Accepted	Comparable item
36	When preparing and cooking meals, use food in its whole form whenever possible		Accepted	Comparable item
37	Existence of utensils that help standardize plating		Rejected	Difficult to assess, it depends on the canteen service, leaving it to the discretion of each establishment
38	Reuse of leftovers, in accordance with Order no. 5296/2017		Rejected	Portuguese law not applicable in Italy
39	Preparation and availability of the monthly menu plan at least 15 days in advance		Accepted	Comparable item
40	Complying with the general capitations for the ingredients that make up the lunch meal (mains,		Rejected	Portuguese law not applicable in Italy

	side dishes and vegetables/salads) (described in Annex 2 of Circular 3097/DGE/2018)			
41	Use of stews, casseroles, jardinières or açordas at least once a month		Rejected	Dishes that do not exist in the Italian culinary tradition
42	Use of iodized salt, with an iodization content of 30-60mg/kg of salt	Iodized salt	Accepted	Comparable item
43	The salt added does not exceed 0.2g per component of the menu (soup and dish)		Rejected	The salt content of the menu is not analysed
44	Existence of a vegetarian option		Accepted	Comparable item
45	Regular assessment of the satisfaction of the food on offer, monitoring waste and/or applying surveys		Accepted	Comparable item
46	Strategies for minimizing food waste		Accepted	Comparable item
Soup items				
47	A minimum of 3 different vegetables in each soup every day		Rejected	No soup offered daily in Italy
48	Chopped vegetables in soup at least 3 times a week		Rejected	No soup offered daily in Italy
49	Pulses as a soup base 2-3 times a week		Rejected	No soup offered daily in Italy
50	No other soups without a vegetable base, such as chicken soup or fish soup		Rejected	No soup offered daily in Italy
51	Give priority to vegetables, taking into account their seasonality (at least 50% of the vegetables on the monthly menu for soup)		Rejected	No soup offered daily in Italy

Animal protein source items				
52	White meat at least once a week		Accepted	Comparable item
53	Red meat no more than once a week		Accepted	Comparable item
54	Unfractionated meat dish at least once a week		Accepted	Comparable item
55	Fatty fish at least once a week		Accepted	Comparable item
56	Unfractionated fish dish at least once a week		Accepted	Comparable item
57	Meat or fish fractional dishes no more than twice a week		Accepted	Comparable item
58	Egg at least once a week (as the main source of protein)		Rejected	In Italy, the recommended frequency of eggs is a maximum of once a week
59	Dishes that include sausage products no more than once a month	Exclusion of preserved meat (cold cuts, cured meats, etc.).	Accepted	Comparable item
60	Meat and fish free of visible skin and fat		Accepted	Comparable item
61	Compliance with pre-established catch quotas for animal protein		Accepted	Comparable item
62	Presence of sustainable fish at least once a week (listed in Annex 5 of Circular 3097/DGE/2018)		Rejected	Portuguese law not applicable in Italy
63	Prioritize fish, taking into account its seasonality		Accepted	Comparable item
Non-animal protein source items				
64	Offering legumes as the main protein constituent, preferably or alternatively tofu, seitan, tempeh or soybeans		Accepted	Comparable item

65	Alternating the type of pulses between the different days of the week		Accepted	Comparable item
66	Offering tofu, seitan, tempeh or soy as a protein constituent no more than once a month		Accepted	Comparable item
67	Legumes in the soup, if they are not present in the dish/conduct		Rejected	No soup offered daily in Italy
68	Compliance with the pre-established allowances for protein sources of non-animal origin		Accepted	Comparable item
Carbohydrate source items				
69	Compliance with pre-established capitations of cereals		Accepted	Comparable item
70	Equal distribution between rice, pasta, potatoes or other carbohydrate suppliers	Potatoes 0-2 times per month, combined with a first course of vegetable broth	Rejected	In Italy, the recommended frequency of potatoes is a maximum of 2 times a month
71	Adding vegetables and/or legumes to the side dish at least twice a week		Accepted	Comparable item
72	Prioritize the use of processed cereals that are not too refined	Offering of other grains besides pasta and rice (e.g., barley, spelt, millet, etc.), present at least 3 times/month	Accepted	Comparable item
73	Legume as a side dish at least once a week		Accepted	Comparable item
Vegetable side dish items				
74	Compliance with pre-established allowances for vegetables		Accepted	Comparable item
75	A minimum of three varieties of vegetables (cooked and/or raw) are served daily	Raw and cooked seasonal vegetables, at least four varieties in the week specified in the menu	Rejected	Difficult to assess since Italian menus often do not specify the type of vegetables.
76	Variety of different vegetables	Raw and cooked seasonal vegetables, at least four varieties in the week specified in the menu	Accepted	Comparable item
77	Variety between raw and cooked vegetables	Raw and cooked seasonal vegetables, at least four varieties in the week specified in the menu	Accepted	Comparable item

78	Give priority to seasonal vegetables (at least 50% of the vegetables on the monthly menu)		Accepted	Comparable item
79	Extra virgin olive oil as a source of fat for seasoning raw salads and/or vegetables	Extra virgin olive oil as the only condiment	Accepted	Comparable item
Fruit and dessert items				
80	Daily supply of fresh fruit	Fresh fruit in season 1 serving at each meal	Accepted	Comparable item
81	At least 3 different varieties of fruit available every week	Seasonal fresh fruits at least three varieties in the week	Accepted	Comparable item
82	Offering fruit made without added sugar no more than twice a month		Accepted	Comparable item
83	Sweet desserts offered at least twice a month		Accepted	Comparable item
84	Offer vitamin C-rich fruit every week		Accepted	Comparable item
85	Give priority to seasonal fruit (at least 50% of the fruit on the monthly menu)	Seasonal fresh fruits at least three varieties in the week	Accepted	Comparable item
86	Favor local fruit, namely local/regional/national		Accepted	Comparable item
87	In the vegetarian option, offer sweet desserts without dairy products or vegetable alternatives		Accepted	Comparable item
88	Compliance with pre-established capitations for fruits		Accepted	Comparable item

Appendix B: Characterisation of the compliance (%) of the Portuguese menu quality for each item, considering the original SPARE+ tool

P: Percentile

	ITEM	TOTAL					WINTER					AUTUMN					SPRING					P-value*
n		Min	P25	P50	P75	Max	Min	P25	P50	P75	Max	Min	P25	P50	P75	Max	Min	P25	P50	P75	Max	
General items																						
1	Daily soup with vegetables	91	96	100	100	100	75	75	100	100	100	0	0	100	100	100	100	100	100	100	100	0.206
2	Fish offered weekly in the same proportion as meat	0	83	17	18	20	20	0	20	60	100	20	20	25	63	100	0	0	20	23	25	0.828
3	Meat as the main protein source 1 to 2 times a week	58	59	60	80	100	60	50	60	80	100	60	60	75	88	100	0	0	50	55	60	0.846
4	Fish as the main protein source 1 to 2 times a week	58	59	60	80	100	50	50	60	80	100	50	50	60	80	100	60	60	75	88	100	0.166
5	Egg as the main protein source at least once a week	0	10	20	60	100	0	0	20	60	100	0	0	0	10	20	0	0	0	10	20	0.867
6	Presence of legumes on the plate at least once a week	90	95	100	100	100	90	90	100	100	100	90	90	100	100	100	90	90	100	100	100	0.819
7	Presence of legumes in meals, as the main protein source, at least once a month	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.180
8	Daily presence of a carbohydrate-supplying side dish	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	0.867
9	Daily presence of bread, favouring variety	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	1
10	Bread contains no more than 1g of salt per 100g of bread	0	50	100	100	100	0	0	100	100	100	0	0	100	100	100	0	0	100	100	100	1
11	Daily vegetable side dish	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	1
12	Fresh fruit daily	67	83	100	100	100	0	100	100	100	100	0	0	100	100	100	100	100	100	100	100	0.186
13	Equal offer of cooking techniques (excluding frying)	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	1
14	Fried food on the plate up to once a month	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	0.264
15	Dishes with foods containing trans fats no more than twice a month	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	1
16	Public water available at mealtimes as the only drink	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	1
17	No repeated dishes in a month	0	50	100	100	100	0	100	100	100	100	0	0	100	100	100	0	0	100	100	100	0.174

	ITEM	TOTAL					WINTER					AUTUMN					SPRING					P-value*
n		Min	P25	P50	P75	Max	Min	P25	P50	P75	Max	Min	P25	P50	P75	Max	Min	P25	P50	P75	Max	
18	No dishes with a similar texture	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	1
19	No monochrome dishes	0	45	90	95	100	90	0	90	95	100	90	90	100	100	100	90	90	100	100	100	0.949
20	Existence of technical sheets with the composition of the meal, the raw materials used, with the corresponding headings and description of the cooking methods.	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	1
21	Existence of technical data sheets indicating substances or products that may cause allergies or intolerances (described in Annex II of Regulation (EU) No 1169/2011)	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	1
22	Existence of technical sheets with nutritional information per 100g of the meal	0	50	100	100	100	0	0	100	100	100	0	0	100	100	100	0	0	100	100	100	1
23	Existence of technical sheets with nutritional information per portion of the meal	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	1
24	Existence of technical data sheets identifying the supplier of the food of which it is composed	0	0	0	50	100	0	0	0	50	100	0	0	0	50	100	0	0	0	50	100	1
25	Existence of technical data sheets with information on the origin of the food contained therein	0	0	0	0	100	0	0	0	50	100	0	0	0	50	100	0	0	0	50	100	1
26	Technical data sheets with information on whether the food is organic or not	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
27	Compliance with the menu (planned as executed)	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	1
28	Compliance with the technical data sheet (planned equal to executed)	0	0	0	50	100	0	0	0	50	100	0	0	0	100	100	0	0	0	0	100	1

[illegible]

	ITEM	TOTAL					WINTER					AUTUMN					SPRING					P-value*
n		Min	P25	P50	P75	Max	Min	P25	P50	P75	Max	Min	P25	P50	P75	Max	Min	P25	P50	P75	Max	
40	Adherence to the general limits of the ingredients that make up the lunch meal (main course, side dish, and vegetables/salads). (described in Annex 2 of Circular 3097/DGE/2018)	0	50	100	100	100	0	0	100	100	100	0	0	100	100	100	0	0	100	100	100	1
41	Use stews, casseroles, jardinières or açordas at least once a month.	67	83	100	100	100	100	100	100	100	100	0	0	100	100	100	100	0	100	100	100	0.895
42	Use of iodized salt, with an iodization content of 30-60mg/kg of salt	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	1
43	The salt added does not exceed 0.2g per component of the menu (soup and dish)	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	1
44	Existence of a vegetarian option	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	1
45	Regularly assess food service satisfaction, monitor waste and/or conduct surveys	0	0	0	0	100	0	0	0	50	100	0	0	0	50	100	0	100	100	100	100	1
46	Strategies for minimizing food waste	0	50	100	100	100	0	0	100	100	100	0	0	100	100	100	0	0	0	100	100	1
Soup items																						
47	A minimum of 3 different vegetables in each soup every day	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.670
48	Chopped vegetables in soup at least 3 times a week	0	0	0	50	100	0	0	0	50	100	0	0	0	50	100	0	0	0	50	100	1
49	Legumes, as a base, 2-3 times a week	0	29	58	69	80	75	75	80	90	100	0	0	25	53	80	75	75	80	90	100	0.424
50	Absence of other non-vegetable soups, such as chicken soup or fish soup	92	96	100	100	100	75	75	100	100	100	0	0	100	100	100	100	100	100	100	100	0.368
51	Give priority to vegetables, taking into account their seasonality (at least 50% of vegetables in the monthly menu).	0	50	100	100	100	0	0	100	100	100	0	0	100	100	100	0	0	100	100	100	1

	ITEM	TOTAL					WINTER					AUTUMN					SPRING					P-value*
n		Min	P25	P50	P75	Max	Min	P25	P50	P75	Max	Min	P25	P50	P75	Max	Min	P25	P50	P75	Max	
Animal protein source items																						
52	White meat at least once a week	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	1
53	Red meat no more than once a week	75	83	90	95	100	75	75	90	95	100	75	75	90	95	100	75	75	90	95	100	0.879
54	Unfractionated meat dish at least once a week	0	35	70	73	75	70	70	75	88	100	50	50	70	85	100	70	70	100	100	100	0.423
55	Fatty fish at least once a week	42	66	90	95	100	50	50	90	95	100	25	25	90	95	100	50	50	90	95	100	255
56	Unfractionated fish dish at least once a week	50	75	100	100	100	50	50	100	100	100	0	0	50	75	100	50	50	100	100	100	0.017
57	Meat or fish dishes split up no more than twice a week	0	15	30	32	33	25	25	30	65	100	25	25	30	65	100	30	30	50	75	100	0.773
58	Egg at least once a week (as the main source of protein)	20	23	25	63	100	0	0	20	60	100	0	0	0	10	20	0	0	20	48	75	0.707
59	Dishes that include sausage products no more than once a month	100	100	100	100	100	0	0	100	100	100	0	0	100	100	100	100	100	100	100	100	0.779
60	Meat and fish free of visible skin and fat	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	1
61	Compliance with pre-established food quantities recommended	0	50	100	100	100	0	0	100	100	100	0	0	100	100	100	0	0	100	100	100	1
62	Presence of sustainable fish at least once a week (listed in Annex 5 of Circular 3097/DGE/2018)	0	46	92	96	100	0	0	100	100	100	0	0	100	100	100	0	100	100	100	100	0.018
63	Prioritize fish, taking into account its seasonality	0	50	100	100	100	0	0	100	100	100	0	0	100	100	100	0	0	0	100	100	0.655
Non-animal protein source items																						
64	Offer legumes as the main protein constituent, preferably or alternatively tofu, seitan, tempeh or soybeans	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	0	100	100	100	1
65	Alternating the type of legume between the different days of the week	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	80	100	100	100	1
66	Offering tofu, seitan, tempeh or soy as a protein constituent no more than once a month	0	0	0	20	40	0	0	0	20	40	0	0	0	20	40	0	0	100	20	40	0.368

[illegible]

	ITEM	TOTAL					WINTER					AUTUMN					SPRING					P-value*
n		Min	P25	P50	P75	Max	Min	P25	P50	P75	Max	Min	P25	P50	P75	Max	Min	P25	P50	P75	Max	
Fruit and dessert items																						
80	Daily supply of fresh fruit	67	83	100	100	100	100	100	100	100	100	0	0	100	100	100	100	100	100	100	100	0.422
81	At least 3 different varieties of fruit available every week	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	1
82	Offering fruit made without added sugar no more than twice a month	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	1
83	Sweet desserts offered no more than twice a month	0	33	67	83	100	0	0	100	100	100	0	0	0	83	100	0	0	100	100	100	0.779
84	Offer of vitamin C-rich fruit every week	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	1
85	Give priority to seasonal fruit (at least 50% of the fruit on the monthly menu)	0	50	100	100	100	0	0	100	100	100	0	0	100	100	100	0	100	100	100	100	1
86	Favor local fruit, namely local/regional/national	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	0	100	100	100	1
87	In the vegetarian option, offer sweet desserts without dairy products or vegetable alternatives	0	50	100	100	100	0	0	100	100	100	0	0	100	100	100	0	0	100	100	100	1
88	Compliance with pre-established food quantities recommended	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	1

*Mann-Whitney test

Appendix C: Characterisation of the compliance (%) of the Italian menu quality by percentiles for each item of the original Italian tool

P: Percentile

[illegible]

ITALY																	
	ITEM	TOTAL					WINTER					SPRING					P-Value*
	n	Min	P25	P50	P75	Max	Min	P25	P50	P75	Max	Min	P25	P50	P75	Max	
17	Extra virgin olive oil as the only condiment	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	1
18	Iodized salt	0	100	100	100	100	100	100	100	100	100	0	100	100	100	100	1
	NUTRITIONAL REQUIREMENTS FOR IMPROVEMENT																
19	Seasonal menu (fall-winter/spring-summer)	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	1
20	Offering of other grains besides pasta and rice (e.g. barley, spelt, millet, etc.). present at least 3 times/month	0	0	0	25	100	0	0	0	25	100	0	100	100	100	100	0.317
21	Pulses dishes more than one time/week: offered as a second dish in place of meat.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
22	Meat dishes no more than 1 time/week giving the preference to white meat (chicken, turkey, rabbit).	0	0	25	50	75	0	25	25	75	100	0	0	25	50	100	0.314
23	One-dish meals consisting of grains (pasta, rice, etc.) and foods mainly protein foods (legumes, meat, fish, cheese, eggs) associated the side dish of vegetables	0	0	13	81	100	0	38	75	100	100	0	0	13	81	100	0.096
24	Raw and cooked seasonal vegetables, at least four varieties in the week specified in the menu	0	63	94	100	100	0	100	100	100	100	0	50	100	100	100	0.783
25	Seasonal fresh fruits at least three varieties in the week	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	1
26	Organic and/or Km 0 products on the menu	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	1
27	Bread served after the first course	0	0	0	25	100	0	0	0	25	100	0	0	0	25	100	1
28	Vegetable distribution before the first course at least 100 time per month	0	0	0	100	100	0	0	0	100	100	0	0	0	0	100	1

*Mann-Whitney test

Appendix D: Characterisation of the compliance (%) of menus quality by percentiles for each item (1-64) of the adapted SPARE+ tool, divided by country (Portugal and Italy)

P: Percentile

		PORTUGAL					ITALY					
		TOTAL										
n		Min	P25	P50	P75	Max	Min	P25	P50	P75	Max	P-value*
General items												
1	Fish offered weekly in the same proportion as meat	0	8	17	18	20	0	13	18	62	75	0.018
2	Meat as main protein source 1 to 2 times a week	58	59	60	80	100	42	54	72	100	100	<0.001
3	Fish as main protein source 1 to 2 times a week	58	59	60	80	100	33	52	68	100	100	<0.001
4	Presence of legumes in the meal at least once a week	90	95	100	100	100	75	86	96	100	100	0.76
5	Presence of beans in meals, as the main protein source, at least once a month	0	0	0	0	0		0	0	25		0.005
6	Daily presence of a carbohydrate-based foods	100	100	100	100	100	0	98	100	100	100	0.93
7	Daily presence of bread, favouring variety	100	100	100	100	100	92	75	100	100	100	0.348
8	Daily vegetable side dish	100	100	100	100	100	0	100	100	100	100	0.002
9	Fresh fruit daily	67	83	100	100	100	100	65	100	100	100	0.828
10	Equal offer of cooking techniques (excluding frying)	100	100	100	100	100	58	100	100	100	100	0.893
11	Fried food in the meal up to once a month	100	100	100	100	100	100	100	100	100	100	0.177
12	Public water available at mealtimes as the only drink	100	100	100	100	100	100	100	1,00	1,00	100	0.302
13	No repeated dishes in a month	0	50	100	100	100	100	75	100	100	100	0.011
14	No monochrome dishes	0	45	90	95	100	0	56	95	100	100	0.067
15	Existence of technical sheets with the composition of the meal, raw materials used, with their respective amounts, and description of cooking methods	100	100	100	100	100	0	100	100	1,00	100	0.348
16	Existence of technical sheets indicating substances or products that may cause allergies or intolerances (described in Annex II of Regulation (EU) No 1169/2011)	100	100	100	100	100	100	100	100	100	100	1
17	Existence of technical data sheets with identification of the supplier of the food	0	0	0	50	100	0	0	0	100	100	<0.001
18	Existence of technical sheets with information on the origin of the food that compose the meal	0	0	0	0	100	0	0	0	25	100	<0.001

		PORTUGAL					ITALY					
		TOTAL										
n		Min	P25	P50	P75	Max	Min	P25	P50	P75	Max	P-value*
19	Existence of technical sheets with information on whether the food is organic or not	0	0	0	0	0	0	0	0	25	100	<0.001
20	Compliance with the menu (planned the same as executed)	0	0	0	50	100	0	100	100	100	100	1
21	Prioritize the use of locally/regionally/nationally produced food (in at least 30% of the food on the monthly menu)	100	100	100	100	100	100	100	100	100	100	0.20
22	Prioritize the presence of seasonal products (in at least 50% of all the products on the monthly menu, namely vegetables, fruit and fish)	0	50	100	100	100	100	75	100	100	100	0.164
23	Preference for natural and minimally processed products (a greater proportion of these are used in relation to ultra-processed products)	92	96	100	100	100	0	50	96	100	100	0.318
24	The oil used is not derived from genetically modified products	100	100	20	27	100	50	100	100	100	100	0.301
25	Virgin olive oil as a source of cooking fat (except for frying)	100	0	0	50	100	100	100	100	100	100	0.348
26	¼ of the plate filled with foods of plant origin	0	0	0	0	0	100	0	0	0	100	1
27	When preparing and cooking meals, use food in its whole form whenever possible	0	10	20	27	33	0	15	29	50	0	0.065
28	Preparation and availability of the monthly menu plan at least 15 days in advance	100	100	100	100	100	0	1	100	100	50	0.478
29	Use of iodized salt, with an iodization content of 30-60mg/kg of salt	100	100	100	100	100	100	1	100	100	100	0.366
30	Existence of a vegetarian option	100	100	100	100	100	100	1	100	100	100	0.478
31	Regular assessment of the satisfaction of the food on offer, monitoring waste and/or applying surveys	0	0	0	0	100	100	0	100	100	100	0.105
32	Strategies for minimizing food waste	0	50	100	100	100	0	75	100	100	100	0.356
Animal protein source items												
33	White meat at least once a week	100	100	100	100	100	0	94	100	100	100	0.504
34	Red meat no more than once a week	75	83	90	95	100	75	73	95	100	100	0.112
35	Unfractionated meat dish at least once a week	0	35	70	73	75	67	44	73	79	100	0.041
36	Fatty fish at least once a week	42	66	90	95	100	0	64	75	93	92	<0.001
37	Unfractionated fish dish at least once a week	50	75	100	100	100	42	69	88	100	100	0.12

		PORTUGAL					ITALY					
		TOTAL										
n		Min	P25	P50	P75	Max	Min	P25	P50	P75	Max	P-value*
38	Meat or fish fractional dishes no more than twice a week	0	15	30	32	33	50	23	33	69	100	<0.001
39	Dishes that include sausage products no more than once a month	100	100	100	100	100	0	92	100	100	100	0.202
40	Meat and fish free of visible skin and fat	100	100	100	100	100	67	100	100	100	100	1
41	Compliance with pre-established catch quotas for animal protein sources	0	50	100	100	100	100	75	100	100	100	0.024
42	Prioritize fish, taking into account its seasonality	0	50	100	100	100	0	75	100	100	100	0.093
Non-animal protein source items												
43	Offering beans as the main protein constituent, preferably or alternatively tofu, seitan, tempeh or soybeans	100	100	100	100	100	0	100	100	100	100	0.120
44	Alternating the type of legume between the different days of the week	100	100	100	100	100	100	100	100	100	100	0.018
45	Offering tofu, seitan, tempeh or soy as a protein constituent no more than once a month	0	0	0	20	40	100	0	0	100	100	<0.001
46	Compliance with the pre-established allowances for protein sources of non-animal origin	0	50	100	100	100	0	75	100	100	40	0.066
Carbohydrate source items												
47	Compliance with pre-established allowances for cereals side dishes	0	50	100	100	100	0	75	100	100	100	0.177
48	Adding vegetables and/or legumes to the side dish at least twice a week	67	83	100	100	100	0	63	83	100	100	<0.001
40	Prioritize the use of low refined cereals	0	0	0	0	0	50	0	0	0	100	0.025
50	Beans present in a side dish (vegetables or cereals) at least once a week	90	95	100	100	100	0	88	96	100	0	0.137
51	Compliance with pre-established capitations for vegetables	0	0	0	0	0	83	0	0	100	100	0.001
Vegetables side dish items												
52	Variety of different vegetables	100	100	100	100	100	0	75	100	100	100	0.742
53	Variety between raw and cooked vegetables	100	100	100	100	100	0	94	100	100	100	0.177
54	Give priority to seasonal vegetables (at least 50% of the vegetables on the monthly menu)	0	50	100	100	100	75	75	100	100	100	0.164
55	Extra virgin olive oil as a source of fat for seasoning raw salads and/or vegetables	100	100	100	100	100	0	75	100	100	100	0.903

		PORTUGAL					ITALY					
		TOTAL										
n		Min	P25	P50	P75	Max	Min	P25	P50	P75	Max	P-value*
Fruit and dessert items												
56	Daily supply of fresh fruit	100	100	100	100	100	0	65	100	100	100	0.608
57	At least 3 different varieties of fruit available every week	100	100	100	100	100	58	100	100	100	100	0.348
58	Offering fruit made without added sugar no more than twice a month	100	100	100	100	100	100	100	100	100	100	1
59	Sweet desserts offered no more than twice a month	0	33	67	83	100	100	0	83	100	100	0.15
60	Offer of vitamin C-rich fruit every week	100	100	100	100	100	0	94	100	100	100	0.83
61	Give priority to seasonal fruit (at least 50% of the fruit on the monthly menu)	100	100	100	100	100	75	75	100	100	100	0.42
62	Favor local fruit. namely local/regional/national	100	100	100	100	100	0	100	100	100	100	0.550
63	In the vegetarian option, offer sweet desserts without dairy products or vegetable alternatives	0	50	100	100	100	0	0	100	100	100	0.356
64	Compliance with pre-established capitations for fruits	100	100	100	100	100	100	100	100	100	100	0.177

*Mann-Whitney test

**Food supply in school context in Portugal and
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a qualitative assessment and a study of the
main associated factors**

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