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Brazilian school menus: an analysis of patterns and their relationship with sociodemographic factors and nutritional quality

Isabela Prado Martins[1*], Rafaella Guimarães Moraes Camargo[2], Evandro Marcos Saidel Ribeiro[3], Semíramis Martins Álvares Domene[4]

[1]Postgraduate Program in Nutrition, Federal University of Sao Paulo (UNIFESP), 862 Botucatu Street, Vila Clementino, 04023-062, São Paulo, SP, Brazil.

[2]Interdisciplinary Postgraduate Program in Health Sciences, Federal University of Sao Paulo (UNIFESP), 136 Silva Jardim, Santos, SP, Brazil.

[3]Department of Business, School of Economics Business Administration and Accounting of Ribeirão Preto, University of São Paulo (USP), 3900 Bandeirantes Avenue, Vila Monte Alegre, 14040-905, Ribeirão Preto, SP, Brazil.

[4]Department of Public Policies and Collective Health, Institute of Health and Society, Federal University of São Paulo (UNIFESP), 136 Silva Jardim Street, Vila Mathias, 11015-020, Santos, SP, Brazil.

***Corresponding author:** Isabela Prado Martins, Federal University of Sao Paulo (UNIFESP), 862 Botucatu Street, Vila Clementino, 04023-062, São Paulo, SP, Brazil, email: isabela.prado@unifesp.br

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Abstract

There is a gap in the understanding of meal patterns offered to students targeted by the National School Feeding Programme (PNAE). This study aimed to identify and analyse the menu patterns planned in schools participating in the PNAE. This observational cross-sectional study was carried out from a database consisting of 557 weekly menus from primary schools across Brazilian municipalities. We used Factor Analysis (FA) with Principal Components Analysis (PCA) to identify menu patterns. Nutritional quality assessment of the menus was based on the Revised School Feeding Menu Quality Index (IQCAE-R). Differences in nutritional quality and associations with sociodemographic factors were analysed using the Kruskal-Wallis test, followed by Wilcoxon post-hoc testing with Bonferroni correction. Two menu patterns were identified: (1) 'Traditional', predominantly composed of cereals and pasta, roots and tubers, legumes, vegetables, and meats and eggs; and (2) 'Snack', with a higher occurrence of bread, cakes, and biscuits, milk and dairy products, chocolate powder, and coffee and tea. The 'Traditional' pattern, consisting of food items commonly found in Brazilian food culture, and the 'Snack' pattern, characterised by the presence of sweets and highly processed foods, showed significant relationships with sociodemographic variables and nutritional quality of menus. Stimulating schools to provide meals that resemble the 'Traditional' pattern may contribute to the adoption of healthier dietary patterns, thus benefiting and strengthening health promotion through PNAE.

Keywords: school feeding; dietary pattern; public policy; nutrition programs and policies.

List of abbreviations: PNAE, National School Feeding Programme; IQCAE-R, Revised School Feeding Menu Quality Index; FA, Factor Analysis; PCA, Principal Components Analysis; PeNSE, National Survey of School Health; KMO, Kaiser-Meyer-Olkin; MHDI, Municipal Human Development Index; SVI, Social Vulnerability Index; IBGE, Brazilian Institute of Geography and Statistics; IPEA, Institute of Applied Economic Research; FLs, Factor loadings; BDG, Brazilian Dietary Guidelines; UPF, ultra-processed foods.

Introduction

The impact of diet on children and adolescent health is widely recognised[1-3]. Brazilian diet is currently characterised by an increased consumption of ultra-processed foods (UPF) along with a reduced intake of fresh and minimally processed foods[2,4-6]. According to data from the 2019 National Survey of School Health (PeNSE), the percentage of schoolchildren who reported the intake of UPF on the previous day ranges from 16.4% (flavoured yoghurts) to 49.3% (savoury biscuits)[7].

Monitoring and assessing dietary intake among schoolchildren can contribute to the adoption of healthy eating habits, which tend to persist over time[8-10]. Dietary intake can be assessed through the identification of dietary patterns, as how much and how often food is consumed and how food is combined are also important for a more comprehensive analysis of the diet[11].

It has already been shown that the food offered in educational institutions can closely reflect the quality of students' diets[12]. Therefore, healthier dietary patterns have been associated with the provision of adequate school meals[12-15].

Globally, school feeding programs reach over 400 million children and are found in at least 148 countries[16]. School meals, which benefit hundreds of millions of school-age children daily, potentially provide positive outcomes in at least four sectors: education, health and nutrition, social protection, and the local agricultural economy[17].

National school meal policies in many countries provide guidance, for example, on limiting the consumption of highly processed foods or even on the total nutrient and calorie requirements that school meals should meet[18]. In general, when free and universal school meals have sound nutritional guidelines, they can benefit student diet quality, especially among those experiencing food insecurity[19].

Brazil has the National School Feeding Programme (PNAE), a long-standing and relevant public policy that contributes to safeguarding the right to food[20]. The programme, which provides meals to around 40 million schoolchildren attending 145,000 educational institutions across the country, aims to support the development of students by providing meals that meet their nutritional needs during the school period and to encourage healthy eating practices[21,22]. Ensuring that meals comply with legislation is a key tool for public

management and health monitoring, and the assessment of the nutritional quality of school menus can help to achieve this goal[23-25].

Thus, schools are a favourable environment for interventions and contribute to healthy dietary patterns, both through providing students with food and nutritional education and a reference on dietary habits that promote environmental responsibility and food and nutritional security[13, 26-28].

In this context, considering that the analysis of school menu patterns has been underexplored in the literature, this study aims to identify the menu patterns planned in Brazilian public schools participating in the PNAE and to analyse the relationship of such patterns with sociodemographic factors and the nutritional quality of the menus.

Methods

Study design and data collection

This is a cross-sectional observational study. The sample consisted of menus from state elementary schools operating part-time, morning or afternoon (administered by the municipal or state government). The menus were planned during the academic years from 2022 to 2024, after the most critical periods of the Covid-19 pandemic[29.30], and followed the regulations of the current PNAE Resolution[31]. Data on school menus were obtained through random sampling, corresponding to 10% of the total number of municipalities per Brazilian state[32]. The meal plans were collected through telephone or email contact with either the Municipal Department of Education or the dietitian responsible for school meals, as well as through research on official municipal government websites.

We considered weekly menus (Monday through Friday) and selected the first complete week of the monthly menu; some menus offer a small meal, like a snack, and some are a full meal. If there were any missing or inconsistent information, holidays, or commemorative dates, we selected the following weekly plan that fulfilled inclusion criteria.

Identification of Menu Patterns

We used Factor Analysis (FA) with Principal Components Analysis (PCA) to identify menu patterns. At this stage, foods were categorised into 16 groups based on nutritional equivalence: 1) cereals and pasta, 2) roots and tubers, 3) legumes, 4) vegetables and greens,

5) fruits, 6) meats and eggs, 7) processed meats, 8) soups and broths, 9) breads, cakes and biscuits, 10) butter and margarine, 11) milk and dairy products, 12) powdered chocolate drinks, 13) fruit juice (fresh or frozen fruit, not from concentrate), 14) industrialised sugar-sweetened beverages, 15) coffee and teas, 16) sweets, porridge and desserts. The weekly frequency of the foods included in the meals was used for FA, thus allowing the analysis of the patterns present in the menus. Supplementary Table S1 presents the weekly frequency distribution of the 16 food groups in the menus weekly frequency distribution of the 16 food groups in the menus.

For culinary preparations, if a recipe was included on the menu, its specific ingredients were considered. However, when the menu did not include a recipe, the preparation was standardized based on the most frequently used version across the menus.

FA was preceded by a data adequacy analysis using the Kaiser-Meyer-Olkin (KMO) test. Values above 0.50 were considered acceptable for factor analysis to proceed, as established by Kaiser (1974)[33] on factor analysis principles. Correlations between variables were assessed using Bartlett's test of sphericity ($p<0.05$)[34].

Cattell's scree plot test criteria were applied to determine the number of factors to retain (Supplementary Figure S1). The maximum number of factors to retain is suggested based on the inflection point of the curve. Next, the factor matrix was subjected to Varimax orthogonal rotation, and groupings with factor loadings equal to or greater than 0.30 in the resulting matrix were considered[34].

Kruskal-Wallis test and Wilcoxon post-hoc test with Bonferroni correction were used to investigate differences between menu patterns and sociodemographic data, as well as the nutritional quality of the menus.

Sociodemographic Variables and Nutritional Quality of the Menus

The following sociodemographic variables related to the municipalities were considered: geographical region, population size, Municipal Human Development Index (MHDI), and the Social Vulnerability Index (SVI), as published by the Brazilian Institute of Geography and Statistics (IBGE)[32] and the Institute of Applied Economic Research (IPEA)[35].

To assess the nutritional quality of the menus, data were organised in a Microsoft Excel® spreadsheet and the Revised School Meal Menu Quality Index (IQCAE-R) was calculated. IQCAE-R considers one meal per day over a full week (Monday to Friday) to determine a final score based on the daily and weekly frequency of food items, and acknowledges aspects related to healthiness and sustainability of the diet. The criteria used in the IQCAE-R have been published[36]; briefly, the IQCAE-R has 14 components, organized into two dimensions: "Healthy Eating- HE" and "Sustainability - S". Seven components score positively on the first dimension (HE), two score negatively, and one is conditional. In the Sustainability dimension (S), two components generate either positive or negative scores.

Data analysis

Data analysis was carried out with R® software (version 4.3.1). Differences were considered statistically significant at the level of $p < 0.05$.

Ethics

This study was approved by the Research Ethics Committee of the Federal University of São Paulo (CEP/Unifesp), São Paulo Campus, under the registry number 71239723.90000.5505.

Results

The sample comprised 557 five-day weekly menus from primary education schools in different Brazilian municipalities. Of these menus, 73.3% consisted primarily of large meals, while 26.7% consisted of small meals. Most menus correspond to the 2023 academic year (63.91%), and 70.74% were classified as having average nutritional quality. Table 1 presents the descriptive analysis of the studied sample.

The adequacy of the FA model was confirmed (KMO = 0.76) with significant correlations between the variables ($p < 0.001$). Two factors (patterns) were identified as appropriate for the analysis: 'Traditional' and 'Snack'. Factor loadings (FLs) for the food groups are presented in Table 2.

The identified menu patterns were named according to their composition and in line with terminologies adopted in other studies. The 'Traditional' pattern explained most of the variance (20.3%) and consisted of cereals and pasta (0.80), roots and tubers (0.47), legumes

(0.69), vegetables and greens (0.77), and meats and eggs (0.75). Negative FLs were observed for soups and broths (-0.58), breads, cakes and biscuits (-0.37), and sweets, porridge and desserts (-0.32) in this pattern. The 'Snack' pattern represented 15.7% of the variance and was characterised by breads, cakes, and biscuits (0.73), milk and dairy products (0.80), powdered chocolate drinks (0.56), and coffee and teas (0.38), with negative FLs for the items in the 'Traditional' pattern. The two patterns together explained 36% of the variance in data.

Table 3 presents the median factor score for the menu patterns and the differences according to sociodemographic variables and nutritional quality of the menus.

There were significant differences between median factor scores across Brazilian regions. Regarding the 'Traditional' pattern, Midwest and South median scores were similar, as well as North and Northeast scores. The latter had the lowest values. The highest value was found in the Southeast, and it was statistically different from all other region scores. As for the 'Snack' pattern, the South region had the highest median score, while the Southeast had the lowest; North, Midwest and Northeast median scores were intermediate and not statistically different.

Large cities and metropolitan areas, as well as cities with higher MHDI, showed higher medians for the 'Traditional' pattern. There were no differences between the municipality size and MHDI for the 'Snack' pattern. Regarding the SVI categories, higher medians were associated with better strata for the 'Traditional' pattern, while the 'Snack' pattern showed the opposite performance. Regarding nutritional quality of the menus, statistically significant differences were found between all categories for both patterns, with a higher median for the 'Traditional' pattern among menus with higher nutritional quality. Conversely, the 'Snack' pattern showed a lower median within this category and a higher median among lower quality menus.

Discussion

In this study, we identified two patterns of Brazilian school menus: 'Traditional' and 'Snack'. The relationship between these patterns and sociodemographic variables related to the municipalities as well as the nutritional quality of the menus were investigated.

The 'Traditional' pattern explained the largest percentage of variance and was characterised by food items commonly found in the Brazilian dietary culture. This pattern is

consistent with recommendations of the Brazilian Dietary Guidelines (BDG)[37] and PNAE legislation[31], which aim to increase the consumption of fresh and minimally processed foods and to reduce the intake of sweets and ultra-processed foods (UPF).

This pattern was shown to have a direct relationship with the nutritional quality of menus. The presence of natural, fresh, and minimally processed foods explains its association with higher-quality menus. These food groups are key components of a healthy diet, as they improve nutrient intake, prevent nutritional deficiencies, and promote sustainable diets[37,38].

The PNAE provides guidelines for the development of school menus and, according to the resolution in force at the time the menus were drawn up, recommended that at least 75% of federal resources be allocated to the purchase of fresh or minimally processed foods, while discouraging the acquisition of ultra-processed products[31]. Updates to the program's resolution have further prioritized the procurement of fresh foods, establishing a minimum of 80% in 2025 and 85% from 2026 onward, and recommending against the purchase of products with front-of-pack nutrition labels that indicate high levels of critical nutrients[39].

Furthermore, the 'Traditional' pattern showed differences according to sociodemographic variables, with higher factor loadings among municipalities in the Southeast region, larger cities, and those with higher human development and lower social vulnerability. Regarding regional differences in menu quality, Souza and Castro (2020)[40] have found higher average weekly frequencies of vegetables in the Midwest, Southeast, and South of Brazil. On the other hand, UPF availability was higher in the Midwest and Southeast of the country. Nevertheless, Souza and Castro (2020)[40] have evaluated menus from early childhood education institutions. It is worth noting that PNAE legislation is more stringent for nurseries, as the provision of UPF for children under the age of three is prohibited[31].

The composition of the 'Traditional' pattern is consistent with other findings on dietary patterns of children and adolescents[41-44]. However, research has shown that in addition to cereals and pasta, roots and tubers, legumes, vegetables, and meats, the 'Traditional' pattern also includes processed and cured meats[45,46] or artificial juice[45]. The quality of school meals is associated with better overall eating patterns among children and adolescents, as demonstrated both in Brazil[12,15] and abroad[47]. The identification of school menu patterns in Brazil, however, is unprecedented and offers a new investigative strategy for research and monitoring of this important public policy.

The other pattern identified in this study was named ‘Snack’ as it showed high FLs for breads, cakes and biscuits, milk and dairy products, powdered chocolate drinks, and coffee and teas. This can be explained by the presence of sweets and highly processed foods, characterised by high energy density and high sugar and trans fat levels[48,49]. Although it is recommended that a maximum of 20% of federal resources be allocated to the purchase of processed and UPF[31], these foods are still very present in school menus. It is important to note that a new resolution has been issued, establishing a stricter limit of 15% in 2025 and further reducing it to 10% from 2026 onward[39].

These results are supported by the study of Alvarez and Slater (2019)[50], who reported a significant availability of UPF in snack-type meals in municipalities in the state of São Paulo. These UPF included mainly breads, biscuits, processed meats, sugar-added juice from concentrate, and jelly. Similarly, Martinelli et al. (2014)[51] have found that in school menus from municipalities in southern Brazil foods offered in snacks were mainly processed meats, sweet biscuits, and chocolate drinks, which have low nutritional value.

According to the literature, snack-type meals consumed by children and adolescents usually have an unhealthy profile, despite variations in their naming (‘snack’, ‘junk food’, ‘traditional snack’, ‘monotonous’) and composition, which can include processed meats, juice, butter and margarine, or fruits[41-43,45,46].

One of the main factors influencing the consumption of school meals are socioeconomic determinants[52,53], as demonstrated by Cesar et al. (2020)[54] and Viana et al. (2025)[55], in studies carried out with students from public schools in the southern region of Brazil, where the greatest adherence to school meals occurred among students with lower incomes. Similarly, Horta et al. (2019)[56] studied school meal consumption and social vulnerability risk among children living in a large Brazilian city. They have found that students living in high/very high social vulnerability risk areas consumed school meals more frequently than those living in areas at low/medium social vulnerability risk. Moreover, these findings highlight the role of PNAE in correcting and preventing dietary inadequacies related to social inequalities, as adherence to school meals is associated with better diet quality[56].

In our study the ‘Snack’ pattern - mainly composed of sweets and highly processed foods - showed higher FLs in municipalities with ‘very high’ SVI. Furthermore, results of the study carried out by Barde, Nogueira Bezerra and Sichieri (2025)[57] revealed that in the last

decade, young Brazilians have observed a reduction in the nutritional quality of their diet, with an increase in the consumption of fast food, especially among male adolescents and those with lower family income, and a reduction in the consumption of traditional foods of the Brazilian population, such as rice.

These findings underscore the importance of improving local strategies to enhance the nutritional quality of menus offered to students, especially in municipalities with high SVI, as they are often the main consumers of school meals[56]. Higher FLs for the 'Snack' pattern were also observed in the South region, in smaller municipalities, and those with poorer development indicators.

Another important finding of this study is that fruits did not reach sufficient FLs to explain the pattern in school menus. This result is consistent with research on the dietary patterns of children and adolescents[41-43] and reflects the low frequency that this food group is offered. Regular provision of fruits is fundamental for developing healthy eating practices[39], and PNAE legislation[31,38] determines they are made available for students at least twice a week.

A relevant factor that can influence the composition of school menus is the role of nutritionists in the Program. According to a recent study by Medeiros et al. (2025)[58], despite the growing number of professionals over the years, it was found that the number of nutritionists linked to the PNAE is still insufficient, which can compromise the quality and scope of nutritional interventions in the program[58].

This study presents the limitation of having its database established from the collaboration of dietitians who agreed to send their menu plans, as there is no registration system for school menus that allows for PNAE monitoring. This may have introduced a positive selection bias in the study. On the other hand, this study stands out for its pioneering approach, as it is one of the few that investigate school menu patterns, thus offering a broad perspective on the meals planned for students targeted by PNAE and examining differences in sociodemographic data and nutritional quality of menus.

Conclusion

By using factor analysis to investigate Brazilian school menus we identified two menu patterns: 'Traditional' and 'Snack'. The study of the relationships between these patterns and sociodemographic variables and menu nutritional quality has revealed that the 'Traditional' pattern is more common in larger municipalities with lower vulnerability risk. This result highlights the need for additional strategies aimed at vulnerable municipalities, particularly smaller ones with poorer development indicators. Stimulating schools to provide meals that resemble the 'Traditional' pattern could help municipal governments to promote benchmarks that encourage schoolchildren to adopt healthier dietary patterns, therefore benefiting and strengthening health promotion through PNAE.

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For minor adjustments, ChatGPT was used in the language alignment process.

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Conflict of interest

The authors declare that they have no conflicts of interest to declare.

Authorship

The authors' contributions are as follows: I. P. Martins contributed to the study's conception, data analysis, and writing. R. G. M. Camargo contributed to the study's conception, data analysis, and writing. E. M. S. Ribeiro contributed to the study's conception, data analysis, and review. S. M. A. Domene contributed to the study's conception, data analysis, writing, and review. All authors have read and approved the final version of this manuscript.

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Table 1. Descriptive analysis of school menus (n = 557). Brazil, 2024.

Sample characteristics	**n**	**%**
Geographic region		
North	45	8.08
Northeast	179	32.14
Midwest	48	8.62
Southeast	166	29.80
South	119	21.36
Municipality size[1]		
Small I and II	340	61.04
Medium	74	13.29
Large and metropolitan areas	143	25.67
Municipal Human Development Index (MHDI)[2]		
Low/very low	86	14.44
Medium	185	33.21
High/very high	286	51.35
Social Vulnerability Index[3]		
Very low	79	14.18
Low	206	36.98
Medium	117	21.0

		1
High	99	17.77
Type of public management		
Municipal	526	94.43
State	31	5.57
School year		
2022	184	33.03
2023	356	63.92
2024	17	3.05
Nutritional Quality of Menus[4]		
Low	81	14.54
Medium	394	70.74
High	82	14.72

[1]Municipality size based on the number of inhabitants: small I and II (up to 50,000 inhabitants), medium (50,000 to 100,000), large cities and metropolitan areas (over 100,000); [2] *Municipal Human Development Index (MHDI)*: very low/low (0 to 0.599), medium (0.600 a 0.699), high/very high (0.700 to 1); [3] Social Vulnerability Index (SVI): very low (0 to 0.200), low (0.201 to 0.300), medium (0.301 to 0.400), high (0.401 to 0.500), very high (0.501 to 1); [4] Nutritional Quality of Menus according to IQCAE-R: low (0 to 30 points), medium (> 30 to 60 points), and high (> 60 to 100 points).

Table 2. Distribution of factor loadings according to each pattern of Brazilian school menus. Brazil, 2024.

Food or food group	Menu Patterns		h^2
	Pattern 1 'Traditional'	**Pattern 2 'Snack'**	
Cereals and pasta	**0.80**	**-0.50**	0.896
Roots and tubers	**0.47**	**-0.31**	0.320
Legumes	**0.69**	**-0.39**	0.627
Vegetables and greens	**0.77**	**-0.33**	0.707
Fruits	0.23	-0.01	0.052
Meats and eggs	**0.75**	**-0.42**	0.729
Processed meats	0.05	-0.12	0.018
Soups and broths	**-0.58**	-0.07	0.343
Breads, cakes, and biscuits	**-0.37**	**0.73**	0.666
Butter and margarine	-0.09	0.26	0.079
Milk and dairy products	-0.14	**0.80**	0.655
Powdered chocolate drinks	0.01	**0.56**	0.314
Fruit juice	-0.21	0.05	0.047
Processed sugary drinks	-0.18	0.13	0.050
Coffee and teas	-0.06	**0.38**	0.146
Sweets, porridge and desserts	**-0.32**	0.04	0.108
Number of items	5	4	
Variance (%)	20.3	15.7	
Cumulative variance (%)	20.3	36.0	

h^2=communality. Factor loadings ≥0.3 or ≤-0.3 are highlighted as they were regarded as significant.

Table 3. Median factor scores for the menu patterns according to sociodemographic variables and the nutritional quality of the menus. Brazil, 2024.

Variables	Menu Patterns			
	Pattern 1 'Traditional'		Pattern 2 'Snack'	
	Median	IIQ	Median	IIQ
Geographycal region				
North	-0.38[c]	1.09	0.05[b]	1.17
Northeast	-0.84[c]	1.05	0.04[b]	1.19
Midwest	0.26[b]	1.32	-0.19[b]	1.10
Southeast	0.89[a]	0.69	-0.64[c]	0.18
South	0.25[b]	1.04	0.45[a]	1.68
Municipality size[1]				
Small I and II	-0.13[b]	1.61	-0.19[a]	1.22
Medium	-0.08[b]	1.46	-0.45[a]	1.04
Large and metropolitan areas	0.49[a]	0.91	-0.55[a]	1.14
Municipal Human Development Index (MHDI)[2]				
Low/very low	-0.83[c]	0.74	0.00[a]	1.06
Medium	-0.17[b]	1.64	-0.25[a]	1.07
High/very high	0.53[a]	1.08	-0.46[a]	1.20
Social Vulnerability Index[3]				
Very low	0.45[a b]	1.23	-0.34[ab]	1.45
Low	0.62[a]	1.02	-0.55[b]	1.01
Medium	0,09[b]	1.55	-0.06[ab]	1.30
High	-0.88[c]	1.14	-0.18[ab]	1.05
Very high	-0.85[c]	0.79	0.19[a]	1.28
Nutritional Quality of Menus[4]				
Low	-0.98[c]	1.02	0.36[a]	1.17
Medium	0.10[b]	1.37	-0.25[b]	1.21
High	0.95[a]	0.67	-0.65[c]	0.13

IIQ: Interquartile Range.

[1]Municipality size based on the number of inhabitants: small I and II (up to 50,000 inhabitants), medium (50,000 to 100,000), large and metropolitan areas (over 100,000); [2] *Municipal Human Development Index (MHDI)*: very low/low (0 to 0.599), medium (0.600 a 0.699), high/very high (0.700 to 1); [3] Social Vulnerability Index (SVI): very low (0 to 0.200), low (0.201 to 0.300), medium (0.301 to 0.400), high (0.401 to 0.500), very high (0.501 to 1); [4] Nutritional Quality of Menus according to IQCAE-R: low (0 to 30 points), medium (> 30 to 60 points), and high (> 60 to 100 points). Different letters within the same column indicate statistical significance ($p<0.05$) according to Wilcoxon post-hoc test with Bonferroni correction.