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Quality index for school meal menus: review and validation

Índice de qualidade para cardápios de merenda escolar: revisão e validação

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ABSTRACT
The Quality Index for School Meal Menus (*Índice de Qualidade para Cardápios da Alimentação Escolar* – IQCAE) is a tool that considers the nutritional and cultural dimensions of the menu. The IQCAE validation process showed the need to update it according to current resolutions and the planetary health emergency. To review and validate the new version of the IQCAE. This methodological study used a convenience sample of 425 municipalities proportionally distributed across the regions of Brazil, with 2,125 school menus offered from Monday to Friday. The tool was reviewed in two stages: the creation of a group of expert researchers and the analysis of the theoretical framework to define the components of the reviewed index. Criterion validity, structural validity, reliability, and reproducibility were assessed for validation. The IQCAE-R has 14 components, and its criterion validity is supported by moderate agreement between the experts' evaluation and its application to the menus. Regarding reproducibility, the mean scores of the evaluators showed no difference, showing that the tool provides the same result when applied repeatedly. Internal consistency was verified using the Spearman correlation, which ranged from weak to very strong. Finally, exploratory factor analysis was satisfactory for most items. The IQCAE-R met the validity and reliability criteria for evaluating school menus and incorporates sustainability components, current recommendations, and current PNAE guidelines.

Keywords: school feeding, menu quality index, PNAE.

RESUMO
O Índice de Qualidade para Cardápios da Alimentação Escolar (IQCAE) é uma ferramenta que considera as dimensões nutricionais e culturais do cardápio. O processo de validação do IQCAE mostrou a necessidade de atualizá-lo de acordo com as resoluções vigentes e a emergência sanitária planetária. O objetivo é revisar e validar a nova versão do IQCAE. Este estudo metodológico utilizou uma amostra de conveniência de 425 municípios distribuídos proporcionalmente pelas regiões do Brasil, com 2.125 cardápios escolares oferecidos de segunda a sexta-feira. O instrumento foi revisado em duas etapas: a criação de um grupo de pesquisadores especialistas e a análise da estrutura teórica para definir os componentes do índice revisado. A validade do critério, a validade estrutural, a confiabilidade e a reprodutibilidade foram avaliadas para validação. O IQCAE-R tem 14 componentes, e sua validade de critério é apoiada pela concordância moderada entre a avaliação dos especialistas e sua aplicação aos cardápios. Com relação à reprodutibilidade, as pontuações médias dos avaliadores não apresentaram diferença, mostrando que a ferramenta fornece o mesmo resultado quando aplicada repetidamente. A consistência interna foi verificada usando a correlação de Spearman, que variou de fraca a muito forte. Por fim, a análise fatorial exploratória foi satisfatória para a maioria dos itens. O IQCAE-R atendeu aos critérios de validade e confiabilidade para avaliação de cardápios escolares e incorpora componentes de sustentabilidade, recomendações atuais e diretrizes atuais do PNAE.

Palavras-chave: alimentação escolar, índice de qualidade do cardápio, PNAE.

1 INTRODUCTION

The Quality Index for School Meal Menus (*Índice de Qualidade para Cardápios da Alimentação Escolar* – IQCAE) was created to meet the need to evaluate school menus of the municipalities competing for the Efficient School Meal Manager Award (*Prêmio Gestor Eficiente da Merenda Escolar* – PGEME), linked to the Civil Society Organization of Public Interest (*Organização da Sociedade Civil de Interesse Público* – OSCIP) – Zero Hunger Action. The IQCAE was published in 2011, adapted the following year, and validated in 2020 (DOMENE et al, 2011; CAMARGO, BANDONI, DOMENTE, 2020).

Currently, few tools (4,5) are available to evaluate the quality of school menus, and the IQCAE is the only one that was validated (3). Among these tools, only the Quality Index of the Food and Nutrition Security Coordination (*Índice de Qualidade da Coordenação de Segurança Alimentar e Nutricional* – IQCOSAN) considers sustainability when evaluating school menus (5).

Assessing the sustainability dimension of school menus is essential, considering that food production is one of the causes of global climate change. Agriculture occupies around 40% of the land on Earth, and food production is responsible for about 30% of greenhouse gas emissions and 70% of freshwater use (6).

The scientific literature presents different methods to assess the environmental impact of menus and diets, including calculating the carbon footprint, water footprint, and ecological footprint of the dishes on a menu (7), linking these parameters to the degree of food processing in a diet (8), and the contribution of ultra-processed foods to the diet (9). Multidimensional indices are also used, such as the World Index for Sustainability and Health (WISH), in a scoring system developed from the recommendations of the EAT-Lancet Commission (10).

Brazil has few tools to assess sustainable eating and the validated tools are generally aimed at the adult population (11,12). No study has focused on children and/or adolescents, or on the school environment.

The emergence of global climate change and the growing prevalence of chronic non-communicable diseases (CNCDs) associated with poor diet and the role of school feeding policies and programs should be part of cross-cutting actions to promote planetary sustainability (6).

Considering the universal nature of the National School Feeding Program (*Programa Nacional de Alimentação Escolar* – PNAE) and the gap in the literature on sustainability in the preparation of school menus, improving the tools that contribute to strengthening social control and monitoring its implementation is important, in line with the new guidelines of the program (13). Therefore, this study aimed to review and validate the new version of the IQCAE (3).

2 METHODS

This methodological study used a convenience sample of 425 municipalities distributed proportionally across the regions of Brazil, with 2,125 school menus offered from Monday to Friday. The tool was reviewed in two stages: the creation of a group of expert researchers and the analysis of the theoretical framework to define the components of the reviewed index.

Stage 1. Creation of the group of expert researchers

The group included Brazilian and UK researchers, due to their participation in the Sustainable School Feeding Workshop (*Workshop Alimentação Escolar Sustentável*). The event, which took place in June and July 2021 and was promoted and funded by the British Council UK, enabled early career researchers in Brazil and the UK to integrate.

Stage 2. Theoretical and scientific framework and definition of the components of the reviewed index

This stage considered: literature reviews on indices that assess the quality of school meals, diet, and healthy and sustainable systems; and official documents from the Brazilian Ministry of Health (14) and Ministry of Education (13,15). The limitations identified, according to the new regulations, after the IQCAE[3] was validated were also considered. In total, 24 working meetings were held over six months and the result of the studies conducted by the group of experts was the proposal for the components of the Revised Quality Index for School Meal Menus (IQCAE-R). The performance of the IQCAE-R was evaluated by analyzing the psychometric properties presented in Chart 1 (3,16-18).

The following analyses were performed for validation: criterion validity, based on each expert's assessment of the quality of menus and the IQCAE-R; interobserver reproducibility with members of the research team; internal consistency, to find how much each component

contributes to the final IQCAE-R score; and structural validity, based on exploratory factor analysis of the components to verify the explanatory power of the variables and their correlations. For consultation with specialists and interobserver evaluation, participants received and signed an informed consent form (CAAE: 18020619.9.0000.5505).

Chart 1. Psychometric properties analyzed for the validation of the Revised Quality Index for School Meal Menus. Brazil, 2023.

Question	Strategy	Sample selection	Activity performed
Criterion validity *Does the IQCAE-R give compatible scores to menus considered by experts to be of low, medium, or high quality?*	Study of agreement between the evaluation of menus by experts—considered the gold standard—and the results of the IQCAE-R, using the intraclass correlation coefficient and the kappa correlation coefficient (3,16,17).	Experts and researchers in the field of school feeding, selected among the authors of scientific articles and official documents	Evaluation of eight menus according to their knowledge and classification into high, medium, and low quality; score: 0 to 100
Reproducibility *Does the IQCAE-R show agreement in the results obtained from repeated applications?* *Does the IQCAE-R show agreement between the evaluators on the same menu?*	Study of agreement between the numerical results provided by the interexaminer evaluation and the result of the IQCAE-R, using the intraclass correlation coefficient. Blocked analysis of variance (ANOVA) was performed for the results between evaluators (3,16,17).	Members of the research group	Evaluation of 15 menus using the IQCAE-R
Internal consistency *What is the relationship between the IQCAE-R components and the final score?*	Estimation of the Spearman linear correlation coefficient to check the influence on the final score (3,16,17).	IQCAE-R components and final score	Estimation of the Spearman correlation coefficient, considering 14 evaluation components in 2,125 daily menus
Construct validity (structural) *What is the explanatory power of the components in their correlations?*	Exploratory factor analysis (EFA) to evaluate the factor structure of the IQCAE-R (18).	IQCAE-R components and final score	EFA considering 14 evaluation components in 2,125 daily menus

Source: prepared by the authors.

3 RESULTS

We defined and characterized the items of the revised index in two dimensions: 1) components of healthy eating; and 2) sustainability components. Chart 2 shows the IQCAE-R components.

Chart 2. Items defined for the IQCAE-R according to dimension, score, and evaluation frequency. Brazil, 2023.

DIMENSION	Components	How to scale it in the index	Score	Frequency
HEALTHY EATING	Fruits*	Score higher than the other items according to the presence of fruits	Positive	Daily
	Vegetables*	Scores higher than the other items according to the presence of vegetables	Positive	Daily
	Cereals and tubers	Score according to the presence of cereals and tubers	Positive	Daily
	Legumes	Score according to the presence of legumes	Positive	Daily
	Eggs, poultry, and fish	Score according to the presence of eggs, poultry, and fish	Positive	Daily
	Milk and dairy products	Score according to the presence of milk and dairy products	Positive	Daily
	Sweets and sweet dishes	Score according to the presence of sweets and sweet dishes	Negative	Daily
	Processed foods	Score according to the frequency of processed foods	Negative	Weekly
	Regional sweet dishes*	Score according to the adequacy of the frequency of regional sweet dishes according to Resolution 06/2020	Conditional	Weekly
	Time of day compatible with the meal*	Score according to time compatibility with the type of meal	Positive	Weekly
SUSTAINABILITY	Ultra-processed foods*	Score according to the presence of ultra-processed foods	Negative	Daily
	Red meat	Score according to the presence of red meat	Negative	Weekly
	Regional foods	Score according to the presence of regional foods	Positive	Weekly
	Sociobiodiversity foods*	Scoring according to the presence of sociobiodiversity foods	Positive	Weekly

Legend: *Components included in both dimensions: (i) healthy eating and (ii) sustainability since they are involved in all domains.
Source: prepared by the authors.

In the healthy eating dimension, seven components scored positively, two scored negatively, and one was conditional. In the sustainability dimension, two components had positive and negative scores.

3.1 DEVELOPMENT OF THE REVISED QUALITY INDEX FOR SCHOOL MEAL MENUS (IQCAE-R)

The new version of the tool, called IQCAE-R, includes daily and weekly evaluation components. The daily evaluation components correspond to food groups, such as cereals and tubers; legumes; vegetables; fruits; eggs, poultry, and fish; and milk and dairy products (6,14). These components score positively. Sweets and sweet dishes and ultra-processed foods, on the other hand, score negatively.

The weekly evaluation components depend on how often these foods are offered during the week and whether the intention is to inhibit or encourage the consumption of these foods in school feeding practices. Thus, the presence of regional and sociobiodiversity foods and the provision of meals at compatible times contribute to better results. Regional sweet dishes, processed foods, and red meat, on the other hand, are components that deserve attention. The IQCAE-R provides weekly scores from 0 to 100 points. Chart 3 shows the new version of the index with its components and respective scores.

Chart 3. Revised Quality Index for School Meal Menus. Brazil, 2023.

REVISED QUALITY INDEX FOR SCHOOL MEAL MENUS							
No.	**Daily evaluation components**	Monday	Tuesday	Wednesday	Thursday	Friday	Outcome
		Score					
1	Cereals and tubers	3	3	3	3	3	Sum of components 1 to 8
2	Legumes	3	3	3	3	3	
3	Vegetables	3.5	3.5	3.5	3.5	3.5	
4	Fruits	3.5	3.5	3.5	3.5	3.5	
5	Eggs, poultry, and fish	3	3	3	3	3	
6	Milk and dairy products	3	3	3	3	3	

7	Sweets and sweet dishes	−1	−1	−1	−1	−1	
8	Ultra-processed foods	−1	−1	−1	−1	−1	
	Daily evaluation components	Criterion				Score	
9	Red meat	If the frequency is 0 to 2				1.5	Sum of components 9 to 14
		If the frequency is 3 or 4				−1	
		If the frequency is >4				−2	
10	Regional sweet dishes	If the frequency is 0 or 1				0	
		If the frequency is 2 or 3				−2	
		If the frequency is >4				−4	
11	Processed foods	If the frequency is 0 or 3				0	
		If the frequency is ≥4				−2	
12	Regional foods	If the frequency is 1 or 2				0.5	
		If the frequency is ≥3				1	
13	Sociobiodiversity foods	If the frequency is 1 or 2				0.5	
		If the frequency is ≥3				1	
14	Time of day compatible with the meal	If the frequency is ≥3				1.5	

Source: prepared by the authors.

Evaluation of menus using the IQCAE-R: We evaluated 425 weekly menus, with 2,125 daily menus registered in the database (425 scores). The menu scores ranged from 4.5 to 83.5 points.

Criterion validity: 17 researchers contributed to this stage. The agreement between the experts' evaluations and the IQCAE-R score ranged from moderate to excellent (r=0.56 to 0.94). The agreement between the experts' evaluations and the IQCAE-R score for menu quality categories was 0.47 (Fleiss' kappa), which shows moderate agreement between the experts when evaluating a menu. The 95% confidence interval for Fleiss' kappa was 0.36 to 0.45, which suggests that the kappa value is statistically significant.

Reproducibility: 12 evaluators contributed to this analysis. The intraclass correlation

coefficient confirmed the similarity between the results of the application of the IQCAE-R in the interobserver study, which ranged from 0.92 to 0.98. To verify the agreement between the 12 evaluators, we used blocked ANOVA. The ANOVA results showed no difference between the mean scores of the evaluators (p=0.001), based on multiple comparisons with Bonferroni correction.

Internal consistency: The Spearman correlation values between the IQCAE-R components and the final score ranged from weak to very strong. The "vegetables" component had the highest correlation with the total score (r=0.84), followed by "legumes," "cereals and tubers," "sweets and sweet dishes," and "eggs, poultry, and fish" (r=0.75; r=0.7; r=0.59; r=0.57, respectively). Four components showed a moderate correlation: fruits (r=0.49); regional foods (r=0.47); ultra-processed foods (r=0.46); and milk and dairy products, with an inverse correlation (r=−0.39). Four components showed weak correlations: sociobiodiversity foods (r=0.23); red meat (r=−0.23); regional sweet dished (r=0.06); and time of day compatible with the meal (r=0.02). The "processed foods" component showed no correlation with the final score.

Construct validity (structural): To verify sampling adequacy and later perform EFA, we used the Kaiser-Meyer-Olkin (KMO) test and Bartlett's test of sphericity. Both provided satisfactory results for sampling adequacy (0.80; p<2.2e-16, respectively). Table 1 shows the results of the commonalities obtained using EFA.

Table 1. Result of the commonalities obtained using EFA. Brazil, 2023.

Component	Commonalities
Cereals and tubers	0.70
Legumes	0.57
Vegetables	0.70
Fruits	**0.19**
Eggs, poultry, and fish	0.57
Milk and dairy products	0.38
Sweets and sweet dishes	0.76
Ultra-processed foods	0.68
Red meat	0.64
Regional sweet dishes	**0.03**

Processed foods[a]	-
Regional foods	0.39
Sociobiodiversity foods	**0.22**
Time of day compatible with the meal	**0.02**

[a]The variable "processed foods" showed no variance and was therefore excluded from the analysis.
Source: prepared by the authors.

After EFA, we also obtained 42% of explained variance from two dimensions and some variables had factor loadings of less than 0.3. However, we kept these items in the tool for further tests and adjustments in the future.

4 DISCUSSION

The study was based on a tool that had already been validated to evaluate school menus, which considered the opinions of experts from different fields. Moreover, we consulted PNAE actors about their perceptions and barriers to the provision of healthy and sustainable school meals, using focus groups in municipalities with different realities (unpublished data).

This study aimed to review and validate the IQCAE-R so that it can be used to evaluate menus with a view to sustainability. This is not only a guideline of the program (13), but also a topic of special attention, especially after the COVID-19 pandemic, which has weakened the Brazilian food system (19).

PNAE is one of the largest public policies in Brazil, in terms of scope, lifespan, resources used, among others. Designing menus in a sustainable way can contribute to the health of school children and the planet, since food production is one of the biggest causes of climate change, in addition to the synergy with other global concerns (6,20). It also contributes to the development of fairer, more localized, inclusive, and regenerative food systems (19).

Due to the interest in incorporating advances in the area of food and nutrition and in the legislation governing the PNAE, we reviewed and validated the new version of the IQCAE-R in order to make it useful for the program, in terms of monitoring the quality of menus, considering aspects such as the presence of foods that are markers for health promotion and the absence of foods whose frequent consumption increases the risk of illness.

In the literature, few studies have validated tools that assess diet quality (17,21,22) or evaluate school menus in Brazil, such as the study by Camargo et al. (3).

Criterion validity is generally based on applying the tool to be validated and then comparing it with a tool considered as the "gold standard." Some authors suggest analyzing agreement (23,24) to compare results. This study considered the opinion of experts as the gold standard, since no tool that evaluates school menus had been validated and was considered the gold standard. The validation study by Caivano et al. also performed this analysis (21).

The correlations between the components and the final score show the level of contribution of each item to the variation of the total score. The components "vegetables," "legumes," "cereals and tubers," "sweets and sweet dishes," and "eggs, poultry, and fish" showed a higher correlation with the final score of the tool. These correlations vary and are influenced according to the sample of menus under study. Moreover, the components with higher correlation also showed higher frequency. The same applies to components with weak correlations: we kept these items in the IQCAE-R, since they are important for a healthy diet with the respective scores. This was similar to the validation study of the original version of the IQCAE (3). Meal quality is complex to measure, and all its dimensions are unlikely to be perfectly covered by any set of variables. This is one reason for not estimating Cronbach's alpha for this analysis, although validation studies in the literature still frequently use this test (16,17,21).

For Cronbach (1951), internal consistency represents the degree of association between the items in a tool. Estimating Cronbach's alpha can be one of the analyses, but when using tools that assess meal/diet quality, this value will be influenced according to the sample to which the index was applied (25). Therefore, the use of the Spearman correlation coefficient is justified.

To assess the reproducibility of the IQCAE-R, we considered interobserver agreement, a criterion also used in other validation studies (24,26). This analysis shows that the use of the IQCAE-R is reliable: its application by different evaluators provides similar results. Moreover, the results of the Bland-Altman plot, along with the results of the intraclass correlation analyses, the t-test, and the sign test, analyzed together, show agreement between the evaluators, similar to the validation study of the original version of the IQCAE and other validation studies by Caivano et al (21).

The KMO test and Bartlett's test of sphericity showed adequate values for performing EFA (27). Commonality values and factor loadings were adequate/satisfactory for most components of the tool, in line with the findings by Teixeira et al. (2021). However, in this study, we did not exclude items with lower than expected factor loadings and commonalities.

5 CONCLUSION

This study was based on a tool that had already been validated to assess school menus, which considered the opinions of experts from different fields. We reviewed and developed a tool applicable to the PNAE that evaluates the quality of menus, considering aspects such as the presence of foods that promote health and the absence of foods considered to be risky. Moreover, we express even greater concern about the sustainability components included in the groups of red meat, ultra-processed foods, regional and sociobiodiversity foods, and time compatibility with the type of meal.

Reviewing and validating the IQCAE-R encourages the incorporation of multidisciplinary scientific advances into regulatory mechanisms for school feeding management. The inclusion of sustainability components represents a significant improvement that contributes to the health of people and the planet.

The IQCAE-R proved to be a valid and reliable tool to evaluate Brazilian school meals. Its use can provide data to support the monitoring of the PNAE and contribute to the promotion of food and nutrition security in schools. We suggest that the tool be incorporated and applied by managers and professionals who work with school meals.

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