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Evaluation of the psychometric properties of the Quality Index for School Food Menus

Avaliação das propriedades psicométricas do Indicador de Qualidade para Cardápios da Alimentação Escolar – IQCAE

Abstract

Objective: To assess the psychometric properties of the Quality Index for School Meal Menus [IQCAE – Indicador de Qualidade para Cardápios de Alimentação Escolar].

Methods: Methodological study that used secondary data from the Efficient Manager of School Feeding Award (Brazil), with 2,500 menus of 500 Brazilian municipalities. The following was assessed: (1) content validity; (2) criterion validity; (3) reliability; and (4) analysis of internal consistency. **Results:** The study of content validity verified that the IQCAE components were included in the consensus on healthy school meals. To confirm criterion validity, there was no difference between the experts evaluations and those of the IQCAE. Reliability was ratified by an interexaminer agreement study. The component *meat and eggs* was strongly correlated to the total score ($r=0.74$), followed by *vegetables, legumes and cereals, and tubers* ($r=0.73$; $r=0.68$; and $r=0.59$, respectively). Four of the components showed inverse correlation: *dairy products* ($r=-0.34$), *meal time compatible with meal type* ($r=-0.12$), *cured meat and sausages* ($r=-0.19$) and *sweet as dessert* ($r=-0.20$). **Conclusion:** Results showed that the IQCAE had enough psychometric properties to assess and monitor the quality of Brazilian school meal menus

Keywords: Validity. Quality index. School Feeding.

Resumo

Objetivo: Avaliar as propriedades psicométricas do Indicador de Qualidade para cardápios da Alimentação Escolar (IQCAE). **Métodos:** Estudo metodológico utilizou dados secundários do Prêmio Gestor Eficiente da Merenda Escolar (Brasil) com 2.500 cardápios de 500 municípios brasileiros. Foram avaliados: (1) validade de conteúdo; (2) validade de critério; (3) reprodutibilidade; e (4) a análise de consistência interna. **Resultados:** O estudo de validade de conteúdo verificou que os componentes do IQCAE foram contemplados no consenso sobre alimentação escolar saudável. Para confirmar a validade de critério, não houve diferença entre a avaliação dos especialistas e do IQCAE. A reprodutibilidade foi ratificada por meio da concordância em estudo interexaminadores. O componente *carnes e ovos* foi o mais fortemente correlacionado com a pontuação total ($r=0,74$), seguido de *vegetais, leguminosas e cereais, e tubérculos* ($r=0,73$; $r=0,68$; e $r=0,59$; respectivamente). Quatro dos componentes apresentaram esta correlação inversa: *laticínios* ($r=-0,34$), *horário compatível com a refeição* ($r=-0,12$), *embutidos* ($r=0,19$) e *doces como sobremesa* ($r=0,20$). **Conclusão:** Os resultados do estudo mostraram que o IQCAE apresentou propriedades psicométricas suficientes para avaliar e monitorar a qualidade de cardápios da alimentação escolar brasileira..

Palavras-chave: Validação. Indicador de qualidade. Alimentação Escolar.

INTRODUCTION

Food quality indexes based on food guides and nutritional recommendations allow to assess the diet of groups and individuals, in order to perform actions to prevent noncommunicable chronic diseases and nutritional deficiencies.¹ The use of these instruments demands specific adaptations for each country, population, location and purpose.^{2,3}

The Quality Index for School Meal Menus – IQCAE was developed in 2011⁴ within the scope of the Efficient Manager of School Feeding Award [PGEME – Prêmio Gestor Eficiente da Merenda Escolar]. This national award, offered by the Zero Hunger Action of the civil society organization of public interest [OSCIP-AFZ – Organização da Sociedade Civil de Interesse Público Ação Fome Zero] from 2004 to 2013, in Brazil, aimed at an effective collaboration so that the resources of the National Program of School Feeding – PNAE were directed, and spent at quality food expenditures for basic education students of the country, through the valorization of the municipalities management. Therefore, the ICQAE was designed to assess the category “Nutritional Efficiency”.⁵ Domene and Belik⁶ adapted the Index in 2012, which was structured with 12 components, nine with daily assessment and three with weekly assessment.

The IQCAE was used in evaluation studies of combined programs – National Program of School Feeding and Food Acquisition Program,⁶ in addition to being used in the last editions of the PGEME; recent studies applied it to assess school food menus under different perspectives: antioxidant activity of fruits and vegetables and quality of school food from the purchase of food from family agriculture.^{7,8} However, there are no studies on the psychometric properties of this tool. This article aimed to assess the reliability and validity of the IQCAE.

METHODS

This is a methodological study, which used secondary data from menu database used for the implementation of the Efficient Manager of School Feeding Award, in 2011, with 2,500 menus from 500 Brazilian municipalities. The IQCAE performance was measured according to analyses of the psychometric properties of the tool, as shown in table 1, and as proposed by Andrade et al.,³ and Guenther et al.² Content validity analysis was carried out in consultation with experts with professional experience with school feeding;⁹ criterion validity considered the perception of each expert on menu's quality; inter-examiner reproducibility was conducted with non-expert participants and internal consistency was checked to estimate how much each component interferes with the instrument's final score. For all stages involving humans, the Informed Consent Form was sent to request participant agreement.

Except for the first analysis, the other results were obtained and processed in the statistical software *Statistical Package for Social Sciences 18*, adopting the critical value of $p < 0.05$.

This study was approved by the Research Ethics Committee of the Federal University of São Paulo – CAAE no. 42685615.1.0000.5505.

Table 1. Strategies employed to assess the Quality Index for School Meal Menus. Brazil, 2020.

Analysis of the evidence of external validity			
Question	Strategy	Sample selection	Performed activity
<p>Content validity <i>Is the IQCAE content aligned to a theoretical framework?</i></p>	Consensus on healthy eating in the school context, ¹⁰ among experts in the field through the Delphi method, and the components of the IQCAE	Experts in the field of school feeding, selected among authors of scientific articles and of official documents	The consensus result was compared with the IQCAE components
<p>Criterion validity <i>Does the instrument attribute maximum score to the assessed menus by high quality experts?</i></p>	Study of association and agreement between the evaluation of the menus by experts and the result of the IQCAE evaluation, through the Pearson's linear correlation coefficient and Kappa's correlation coefficient. ^{2,3}	Consensus participants ¹²	Evaluation of 10 menus according to its knowledge and classifications in high, intermediate and low quality; score: 0 to 5.
Analysis of evidence of internal validity			
<p>Reliability <i>Is there reliability in the results in repeated applications?</i></p>	Study of the correlation between the numerical results produced in inter-examiner evaluation and the result of the IQCAE evaluation, through the Bland-Altman graph, intraclass correlation coefficient, Student's <i>t</i> -test and the sign test. Analyses of variance were performed in blocks for the results between evaluators. ^{2,3}	Members of the research group	Evaluation of 10 menus with application of the IQCAE
<p>Internal consistency <i>Which is the relation between the IQCAE components and the final score?</i></p>	Estimation of Pearson's linear correlation coefficient ^{2,3}	-	-

RESULTS

Evaluation of the menus according to the IQCAE: 2,500 daily menus were assessed, which generated 500 weekly menus registered in the database (500 scores). The score of the menus generated values between 0.28 and 4.4 points.

The results of validity and reproducibility are shown in table 3.

Content Validity: It was verified that, of the 12 IQCAE components, 11 are contemplated in the topics extracted from the consensus on healthy eating in the school context (table 2).

Table 2. Verification of compatibility between the components of the Quality Index for School Meal Menus (IQCAE) and the result of the consensus between experts on healthy eating in the school context. Brazil, 2020

Consensus on healthy eating	IQCAE components
Regular intake of fruits, legumes, vegetables, cereals, meats, milks and milk products is compatible with a healthy diet.	Cereals and tubers
For the Brazilian food standard, it is important to value the consumption of beans and other legumes.	Legumes
A healthy diet is composed, mostly, of <i>in natura</i> food.	Vegetables
	Fruits
Considering school meals, the daily presence of meat of eggs is adequate.	Meat and eggs
Regular intake of fruits, legumes, vegetables, cereals, meats, milks and milk products is compatible with a healthy diet.	Dairy products
Lunch meals must be served between 10:30a.m. and 2:30p.m.; as for snacks, before 10:30a.m. and after 2:30p.m.	Meal time compatible with the meal type
Offering candy to replace a meal is inadequate.	Candies in place of meals
The daily offer of processed meats is not adequate.	Cured meat and sausages
Sugar-rich foods – chocolate, candies and sandwich cookies – may be part of a healthy diet, if consumption is not common and/or in small quantities.	Sweets as dessert
The daily offer of formulated food is not adequate.	Ultra-processed foods
-	Other food

Criterion validity: 20 researchers contributed with this stage. It was possible to verify the association between the scores of the experts and the IQCAE score ($r=0.63$ to 0.98); agreement between the evaluations of the experts and the IQCAE result for the quality categories of the menus ($r=0.56$ and 1.00). For both the scores and categories, correlation coefficients were from moderate to very strong, and all were within the confidence interval.

Reliability: Eight evaluators contributed to this stage. The similarity between the results of the IQCAE application in the inter-examiner study was ratified through the intraclass correlation coefficient ($r \geq 0.94$; $p > 0.05$), through the *t*-test and the sign test ($p > 0.05$).

To verify the consistency between the eight evaluators, the analysis of variance model in blocks and the intraclass correlation coefficient were used, and the Bland-Altman graph was built. The result showed that

there was no difference between the mean scores of the evaluators ($p=0.74$), and that the value of the intraclass correlation coefficient was 0.97 (0.93; 0.99). The results show that there is a consistency between the scores of the eight evaluators.

Internal consistency: The values of Pearson's correlation between the IQCAE components and the final score varied from weak to strong; the component *meats and eggs* was the most strongly correlated with the total score ($r=0.74$), followed by *vegetables*, *legumes*, and *cereals and tubers* ($r= 0.73$; $r= 0.68$; and $r= 0.59$, respectively). Four components showed inverse correlation: *dairy products* ($r=-0.34$), *meal time compatible with meal type* ($r=-0.12$), *cured meats and sausages* ($r=-0.19$) and *sweets as dessert* ($r=-0.20$).

Table 3. Outcomes from reliability and validity analysis. Brazil, 2020.

Analysis	Outcomes
<i>Content validity</i>	The content validity showed that healthy eating markers and risk attributes considered by experts were contemplated on IQCAE.
<i>Criterion validity</i>	The criterion validity showed that both for to the notes and categories, the correlation coefficient was moderate to very strong and all were within confidence interval.
<i>Reliability</i>	The reliability was confirmed through agreement of the inter-examiners assessment.
<i>Internal consistency</i>	The internal consistency was presented trough correlations between the components and the final score, which only four out of 12 components showed weak correlations.

DISCUSSION

In Brazil, since 1988, the right to food for all students enrolled in basic education has been included in the Federal Constitution;¹⁰ another milestone in school feeding occurred in 2009 with the publication of Law 11,947, which provides for this service,¹¹ and also the legal parameters for the elaboration of menu.¹² However, little is known about the compliance of the requirements established by the legislation. The supervisory organ of the PNAE is the School Feeding Council, which grants the application of the resources as well as all the processes involved in the functioning of the program.¹² However, the inspection on the quality of the menu is still precarious, considering the results obtained in the evaluation of Brazilian school feeding.¹³

The development of tools to assess the quality of foods aims to assist, in a simple and fast way, the activities of the dietitian, school meal directors, public managers and of the population in general. Only one instrument is available in literature to assess school menus in Brazil, though not validated.¹⁴ It is worth mentioning, therefore, the originality of this validation study with a combination of methods to ensure the consistency of the obtained results, and also the nature of the instrument, which, although it generates a score, is qualitative in character and does not demand calculation of nutritional values. This particularity of the instrument meets the current guidelines of the Food Guide for the Brazilian Population.¹⁵

The IQCAE showed structural reliability and validity when used to assess the quality of Brazilian school meal menus. Psychometric parameters showed little variation between repeated applications and good agreement when comparing the evaluation of the menus by experts and the results obtained with the IQCAE scores. The content validity was ratified since the dimensions that emerged from the consensus built in the

consultation with experts on healthy eating in the school context were contemplated. Another study of the same nature and context, but focused on promoting health, was also assessed by experts in the field with the resource of the Delphi technique.¹⁶ Andrade et al.³ performed this analysis through comparison between the components of the instrument and the recommendations of the Ministry of Health;³ other authors did the same through focal groups.¹⁷⁻¹⁹

Veiros and Martinelli¹⁴ used the Food Guide for the Brazilian Population (2006), the guidelines of the World Health Organization, Law 11,947/2009, Resolution 38/2009, and Inter-ministerial Ordinance 1,010/2006 as theoretical basis. Both the Guide (2006) and Resolution already suffered alterations, however, they were in force at the time.

The authors divide the instrument in foods that must be controlled (preparations with added sugar and products with sugar; processed meats or industrialized meat products; concentrated, powdered or dehydrated foods; breakfast cereals, cakes and cookies; flatulent, hard-to-digest foods; drinks with low nutritional content; preparation with similar color in the same meal; fried foods, fatty meals and sauces) and foods that are recommended (in natura fruits; salads; non-starchy vegetables; cereals, breads, pasta and starchy vegetables; whole foods; meat and eggs; legumes; milk and dairy products).

The organization of the IQCAE, similarly, includes healthy food marker components (cereals and tubers; legumes; vegetables; fruits; meats and eggs; milk, cheeses and yogurts and time compatible with meal) and risk attributes (candy as meals; processed food; candy as dessert and formulated food), and includes the main characteristics for the analysis of school food menus, according to experts' opinions.⁹ The IQCAE was developed in the context of the Efficient Manager of School Feeding Award, so that it was possible to assess the meals of competing city halls; the component *other foods* was added to the instrument as a way to assess the importance given to school feeding by city halls.

Criterion validity was supported through analyses of association and consistency between the results of the experts and the IQCAE scores, that is, the menus considered as of high, intermediate and low quality by the experts corresponded to the menus assessed as of high, intermediate and low quality according to the category generated by the IQCAE. In addition, the scores arbitrarily given by the experts (0 to 10) also corresponded to the scores generated by the IQCAE; which demonstrates the capacity of the instrument to capture menus with different qualities, as Guenther et al.,² also found out.

The correlations between the components and the final score might indicate how much each component influenced on the variation of the total score. The components *meats and eggs*, followed by *vegetables*, *legumes*, and *cereals and tubers*, showed a stronger correlation with the final score of the instrument. These data may vary according to the studied sample of menus; this suggests that these components were more frequent. The same is true for the components that showed weak correlations: these items remained in the instrument since they are considered important to compose a healthy diet with their respective scores.

The quality of the meals or diets are of complex measurement and will not be perfectly studied by any set of selected variables. The reproducibility or reliability of IQCAE was verified from the inter-examiner evaluations, a strategy also adopted in other validation studies.^{17,18} This analysis indicates that the application of the instrument by different evaluators will generate similar results. The Bland-Altman graph, the results of the intraclass correlation analyses, the *t*-test and the sign test, analyzed together, showed consistency among evaluators.

CONCLUSION

This study provided evidence for internal and external analyses of the IQCAE; as demonstrated by the consensus between experts. High quality menus, according to the results of the index, were equally recognized by researchers in a blind study as high quality; the inter-examiner evaluations and the study of correlations between the components of the instrument and the final score complement methodological strategies with the same purpose.

Given these results, it can be concluded that the IQCAE features good reliability and validity to be used as an instrument to evaluate and monitor the quality of Brazilian school food menus. Its application can, therefore, generate data to support the monitoring of programs relevant to the promotion of Food and Nutritional Security in Schools.

The authors made the IQCAE spreadsheet developed in Microsoft Excel available through an electronic address. The spreadsheet assists in the evaluation of the menu, with the sum of components per day and week. It is only necessary to fill the presence or absence of the components of the instrument. It also holds a guidance manual for the application of the IQCAE.

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Contributors

Camargo RGM and Domene SMA participated in the project design, data analysis and interpretation, article writing and critical review of the content, and in the approval of the final version to be published. Bandoni DH participated in the critical review of the content and final approval of the version to be published.

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