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Diet quality and cardiometabolic risk in children and adolescents with excess weight

Qualidade da dieta e risco cardiometabólico em crianças e adolescentes com excesso de peso

Calidad de la dieta y el riesgo cardiometabolico de niños y adolescentes con exceso de peso

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ABSTRACT

Objective: To assess the quality of the diet of children and adolescents with excess weight and determine its relationship with cardiometabolic risk factors. **Methods:** This quantitative descriptive cross-sectional study was carried out from December 2016 to August 2018 with children and adolescents. Behavioral (regular physical activity, screen time), anthropometric (weight, height, Body Mass Index, abdominal circumference, neck circumferences) and dietary (24-hour recalls) data were collected, and biochemical data were retrieved from medical records. Insulin resistance (IR) was measured using the Homeostasis Model Assessment – Insulin Resistance (HOMA-IR) and diet quality was assessed using the Revised Diet Quality Index (*Índice de Qualidade da Dieta Revisado – IQD-R*). Analyses using Spearman's and Mann-Whitney U tests were performed with a significance threshold set at 5%. **Results:** The sample consisted of 100 children and adolescents, 71 (71%) of whom were girls, and the mean age was 9.42±2.89 years. The mean IQD-R was 61.16 (95%CI: 59.14 – 63.19) and none of the participants presented a good quality diet. No associations were found between the IQD-R score and cardiometabolic markers. However, negative associations were observed between "total vegetables and legumes" and HOMA-IR (r= -0.290), "dark green and orange vegetables and legumes" and HOMA-IR (r= -0.333) and "dark green and orange vegetables and legumes" and fasting insulin (r= -0.291). The participants who presented more than three cardiometabolic risk factors had a significantly higher score on the "solid fat and added sugar" component. **Conclusion:** None of the participants had a qualitatively adequate diet. The low intake of vegetables and legumes was associated with IR markers.

Descriptors: Health Promotion, Pediatric Obesity; Food Intake; Insulin Resistance; Cardiovascular Diseases.

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RESUMO

Objetivo: *Avaliar a qualidade da dieta de crianças e adolescentes com excesso de peso e determinar a relação com fatores de risco cardiometabólico.* ***Métodos:*** *Estudo quantitativo, transversal e analítico, realizado entre dezembro de 2016 e agosto de 2018, com crianças e adolescentes. Coletaram-se variáveis comportamentais (prática de atividade física e tempo de tela), antropométricas (peso, altura, índice de massa corporal, circunferência abdominal e do pescoço) e dietéticas (recordatório de 24 horas) e os dados bioquímicos foram consultados nos prontuários. Avaliou-se a resistência à insulina (RI), usando Homeostasis Model Assessment – Insulin Resistance (HOMA-IR), e a qualidade da dieta, por meio do Índice de Qualidade da Dieta Revisado (IQD-R). Análises realizadas pelos testes de Spearman e Mann-Whitney U, com nível de significância de 5%.* ***Resultados:*** *A amostra incluiu 100 crianças e adolescentes, sendo 71 (71%) do sexo feminino, média de idade de 9,42 ± 2,89 anos. IQD-R apresentou valor médio de 61,16 (IC 95%: 59,14 – 63,19) e nenhum participante apresentou dieta de boa qualidade. Não foram encontradas associações entre o escore do IQD-R e marcadores cardiometabólicos. Observaram-se associações negativas entre os componentes “vegetais totais e leguminosas” e HOMA-IR (r= -0,290), “vegetais verde-escuros, alaranjados e leguminosas” e HOMA-IR (r= -0,333) e “vegetais verde-escuros, alaranjados e leguminosas” com insulina de jejum (r= -0,291). Participantes com mais de três fatores de risco cardiometabólico tiveram pontuação significativamente maior do componente “gordura sólida e açúcar de adição”.* ***Conclusão:*** *Nenhum participante investigado apresentou dieta qualitativamente adequada. A baixa ingestão de vegetais e leguminosas foi associada com marcadores de RI.*

Descritores: *Promoção da Saúde, Obesidade Pediátrica; Consumo de Alimentos; Resistência à Insulina; Doenças Cardiovasculares.*

RESUMEN

Objetivo: *Evaluar la calidad de la dieta de niños y adolescentes con exceso de peso y determinar la relación con los factores de riesgo cardiometabolico.* ***Métodos:*** *Estudio cuantitativo, transversal y analítico realizado entre diciembre de 2016 y agosto de 2018 con niños y adolescentes. Se recogieron las variables de conducta (práctica de actividad física y tiempo de pantalla), antropométricas (peso, altura, índice de masa corporal, circunferencia abdominal y del cuello) y dietéticas (recordatorio de 24 horas) y los datos bioquímicos han sido consultados de los historiales clínicos. Se evaluó la resistencia a la insulina (RI) usando el Homeostasis Model Assessment – Insulin Resistance (HOMA-IR) y la calidad de la dieta a través del Índice de Calidad de la Dieta Revisado (ICD-R). Los análisis han sido realizados por las pruebas de Spearman y Mann-Whitney U con el nivel de significancia del 5%.* ***Resultados:*** *La muestra ha sido de 100 niños y adolescentes de los cuales 71 (71%) era del sexo femenino con la media de edad de 9,42 ± 2,89 años. El ICD-R presentó el valor medio de 61,16 (IC 95%: 59,14 - 63,19) y ningún participante presentó dieta de buena calidad. No se ha encontrado asociaciones entre la puntuación del ICD-R y los marcadores cardiometabolicos. Se ha observado asociaciones negativas entre los componentes “vegetales totales y leguminosas” y el HOMA-IR (r= -0,290), “vegetales verde-oscuros, anaranjados y leguminosas” y el HOMA-IR (r= -0,333) y “vegetales verde-oscuros, anaranjados y leguminosas” y la insulina de ayuno (r= - 0,291). Los participantes con más de tres factores de riesgo cardiometabolico tuvieron la puntuación significativamente mayor en el componente “grasa sólida y azúcar de adición”.* ***Conclusión:*** *Ningún participante investigado presentó la dieta cualitativamente adecuada. La baja ingesta de vegetales y leguminosas se ha asociado con los marcadores de RI.*

Descriptores: *Promoción de la Salud, Obesidad Pediátrica; Consumo de Alimentos; Resistencia a la Insulina; Enfermedades Cardiovasculares.*

INTRODUCTION

Childhood obesity is a serious public health problem worldwide. Its occurrence is strongly associated with comorbidities, such as insulin resistance (IR), type 2 diabetes (T2D), arterial hypertension and dyslipidemia, which considerably increase the risk of cardiovascular outcomes in adulthood[1,2].

The etiology of obesity is complex and multifactorial, with interactions between biological, environmental, psychosocial, and cultural factors. However, its incidence has been attributed mainly to an environment that encourages excessive consumption of processed and ultra-processed foods and physical inactivity[2,3].

Government interventions, such as the National Health Promotion Policy (*Política Nacional de Promoção da Saúde – PNPS*), which includes the Promotion of Adequate and Healthy Eating (*Promoção da Alimentação Adequada e Saudável – PAAS*) as one of its guidelines, aim to promote the development of health-promoting environments, food and nutrition education, and food regulation. Such actions are essential to encourage children and adolescents to adopt healthy eating patterns[3].

Studies have assessed the impact of energy intake and consumption of isolated foods or nutrients and their effects on obesity in children and adolescents[4,5]. However, these individual food/nutrient associations with health outcomes do not consider the chemical complexity of foods and the wide range of eating habits. Thus, it is important to use indices that assess the overall food intake. Diet quality indices have been proposed to determine general dietary patterns and evaluate the combination of different types of foods and nutrients in relation to the dietary recommendations proposed by national dietary guidelines(6,7).

In 2004, the Healthy Eating Index (HEI) was adapted for the Brazilian population, resulting in the Diet Quality Index (*Índice de Qualidade da Dieta – IQD*). After HEI was updated to HEI-2005, IQD was revised in accordance with the recommendations of the Dietary Guidelines for the Brazilian Population(8) and the latest version was called the Revised Diet Quality Index (*Índice de Qualidade da Dieta Revisado – IDQ-R*). The update based on the Brazilian dietary guidelines enabled the use of IQD-R as a tool to measure and monitor the current nutritional recommendations proposed for various stages of life(6,7).

The analysis of food intake using diet quality indices allows a global assessment of the diet, which facilitates the development of strategies to promote healthy eating and prevent diseases and nutritional problems. Due to the need to investigate the overall quality of the diet of overweight and obese children and adolescents, the present study aimed to assess the quality of the diet of overweight and obese children and adolescents and to determine its relationship with cardiometabolic risk factors.

METHODS

This quantitative analytical cross-sectional study was carried out from December 2016 to August 2018 with children and adolescents with previous nutritional diagnosis of overweight or obesity attending the outpatient clinic of the pediatric endocrinology department of the Walter Cantídio Teaching Hospital (*Hospital Universitário Walter Cantídio – HUWC*), located in the city of Fortaleza, Ceará, Brazil.

The study included a convenience sample of male and female participants aged 9-13 years treated for overweight or obesity. Patients with syndromes and those who did not provide the information needed for data collection were excluded. Identification, behavioral, anthropometric and dietary data were collected after obtaining written consent and assent. Biochemical data and data on the presence of *acanthosis nigricans* were retrieved from medical records.

Behavioral variables included regular physical activity and screen time, the latter corresponding to the time spent in front of television, monitors in general and/or cell phone. Children and adolescents who did some sport or recreational activities for at least 60 minutes a day, five times a week, were considered physically active(9). Screen time was considered excessive when it exceeded two hours a day(10).

Weight and height were measured according to recommendations from the Ministry of Health(11). Nutritional status was classified following determination of the body mass index (BMI), which was calculated by dividing weight (kg) by height² (m²). Classification was performed considering the BMI-for-age (BMI/A) z-scores on the growth charts of the World Health Organization (WHO)(12). Participants were categorized into overweight (+1 ≤ Z-BMI < +2), obese (+2 ≤ Z-BMI < +3) and severely obese (Z-BMI ≥ +3). Abdominal circumference (AC) and neck circumference (NC) were measured in duplicates using inelastic measure tapes. AC was measured at the midpoint between the last rib and the superior border of the iliac crest, with values above the 90th percentile for sex and age suggesting risk(13). The NC was measured at the base of the neck at the height of the cricothyroid cartilage. In men with prominence, NC was measured below prominence. NC classification considered the cutoff values for age and sex(14).

Data on biochemical tests were collected from the most recent records of glycemia, insulin and lipid profile (total cholesterol, HDL-C, LDL-C and triglycerides). In the analysis of the results, the following values were considered desirable: fasting glucose <100mg/dl, total cholesterol <150mg/dl, HDL-C ≥45mg/dl, LDL-C and triglycerides <100mg/dl. IR was assessed using the Homeostasis Model Assessment – Insulin Resistance (HOMA-IR), with IR confirmed when HOMA IR >2.5(15).

Usual food intake was assessed using two 24-hour dietary recall (24HR) collected by trained researchers. The 24HR were completed by the child or adolescent in the presence of a guardian. The listed foods were grouped according to the groups presented in the Dietary Guidelines for the Brazilian Population(8) and evaluated according to their nutrient content using the Brazilian Food Composition Table (*Tabela Brasileira de Composição de Alimentos – TACO*)(16).

IQD-R was used to assess the quality of the diet. This index consists of 12 components that characterize different aspects of a healthy diet. The 12 components consist of nine food groups, two nutrients (saturated fat and sodium), and the last component is sum of the energy value resulting from the intake of solid fat, alcohol and added sugar (In Portuguese: Gord_AA). To calculate the IQD-R, foods were initially grouped into food groups. After that, these foods were converted into servings according to the energy value of the portion presented in the dietary guidelines. The number of servings was then adjusted to an isocaloric consumption of 1000 kcal according to the methodological recommendations of the IQD-R[6]. For all components based on food groups, a full score (5 or 10) was adopted for intakes equal to or greater than the recommended amounts. The minimum score (zero) indicates that there was no intake of food from that group. The intermediate scores were calculated proportionately according to the amount consumed. Saturated fat, sodium and *Gord_AA* are reversely scored in relation to the components of the food groups, that is, a lower intake has a higher score (Table I)[6,7].

Table I - Distribution of the Revised Diet Quallity Index (***Índice** de Qualidade da Dieta Revisado*) scores and servings, 2011.

Components	**Scores**				
	0	**5**	**8**	**10**	**20**
Total fruits[a]	0	⟷	1.0 serving/1000 kcal		
Whole fruits[b]	0	⟷	0.5 serving/1000 kcal		
Total vegetables[c]	0	⟷	1.0 serving/1000 kcal		
Dark green and orange vegetables, and legumes[d]	0	⟷	0.5 serving/1000 kcal		
Total cereals[e]	0	⟷	2.0 serving/1000 kcal		
Whole cereals[f]	0	⟷	1.0 serving/1000 kcal		
Milk and dairy[g]	0	⟷	⟷	1.5 serving/1000 kcal	
Meat, eggs and legumes[h.]	0	⟷	⟷	1.0 serving/1000 kcal	
Oils[i]	0	⟷	⟷	0.5 serving/1000 kcal	
Saturated fat[k]	≥15	⟷	⟷	10 ⟷	≤ 7.0% of TEI
Sodium[l]	≥2.0	⟷	⟷	1.0 ⟷	≤ 0.7g/ 1000 kcal
Gord_AA[m]	≥35	⟷	⟷	⟷	≤10% of TEI

[a]: Includes fruits and fresh fruit juice; [b]: All fruits, except fruit juice; c: All vegetables and legumes, but only if they exceed the total score for meat, eggs, and legumes; [d]: All dark green and yellow vegetables, and legumes, but only if they exceed the total score for meat, eggs and legumes; [e]: Cereals, roots and tubers; [F]: All foods with whole cereals; [g]: Includes milk and dairy and soy-based beverages; [h]: All kinds of meat, eggs, soy products and legumes when meat intake does not meet one serving/1000 kcal; [i]: Oils, fish and vegetable liquids; non-hydrogenated salad dressing, heavy dairy cream or similar is excluded; [j]: Total saturated fat in the diet; [k]: Total saturated fat in the diet; [l]: Sodium from foods and sodium from salt; [m]: Calories from solid fat, alcohol and added sugars
Source: Adapted from Previdelli et al, 2011[9].

Legumes were not included in HEI-2005; however, because they are part of the Brazilian eating habit and constitute an important source of proteins, fibers, and minerals, the servings of this group were included in IQD-R under the component “meat and eggs” until the maximum score was achieved (190 kcal = 1 serving = 10 points). In case of surpluses, the energy value obtained from legumes was computed into the groups “total vegetables” and “dark green and orange vegetables”, simultaneously[6].

The sum of the scores of all components generates the final IQD-R score, which can range from zero to 100. With regard to the classification of the diet quality, a total IQD-R score < 65 indicates “poor diet” and IQD-R ≥ 85 indicates “adequate diet”. Thus, scores between 65 and 84 are considered intermediate[7].

Diet scores were correlated with cardiometabolic markers (physical inactivity, biochemical markers – total cholesterol, LDL-C, HDL-C, triglycerides, fasting glucose and fasting insulin – and anthropometric markers – AC and NC). Participants were divided into two groups according to the number of markers. The first group comprised those who presented with up to three risk factors and the second group included those who presented with four or more risk factors, with the latter being at higher risk. Thus, it was possible to analyze the quality of the diet according to the different risk profiles.

The electronic tool REDCap, hosted at the Clinical Research Unit of the teaching hospitals complex at the Federal University of Ceará, was used for data collection and management. The numerical variables were presented as mean, standard deviation, median and percentiles. Data on categorical variables were described as frequency and prevalence rate. Spearman’s coefficient was used to check for correlations between the variables. The Mann-Whitney U test was used to compare the groups. Finally, the Statistical Package for the Social Sciences (SPSS), version 22.0 (USA), and R 3.3.1 were used for statistical analysis with the significance threshold set at 5%.

The project was approved by the Human Research Ethics Committee of the Federal University of Ceará (Approval No. 1.834.828). Children/adolescents and their guardians were informed about the research project and signed Assent and Informed Consent forms.

RESULTS

The sample consisted of 100 children and adolescents. In all, 71% (n=71) were girls and the mean age was 9.42 ± 2.89 years. Most children (79%; n=79) had some degree of obesity. The characterization of the sample is described in Table II.

As for the assessment of behavioral variables, most of the sample (71%; n=71) spent more than two hours a day on screen-related activities, with this group being predominantly composed of girls (46%; n=46). Similarly, there was a high prevalence of physical inactivity (79%; n=79), with a higher share of female participants (59%; n=59).

Table II - Characterization of the sample according to behavioral, anthropometric and biochemical variables. Fortaleza, Ceará, 2019.

Variables	%	n
Sex		**100**
Girls	71.00	71
Boys	29.00	29
Physical activity		**100**
Active	21.00	21
Inactive	79.00	79
Screen time		**93**
≤ 2 hours	31.18	29
> 2 hours	68.82	64
BMI-for-age		**100**
Overweight	21.00	21
Obesity	48.00	48
Severe obesity	31.00	31
Abdominal circumference		**90**
Cardiometabolic risk	60.00	54
No cardiometabolic risk	40.00	36
Neck circumference		**87**
Cardiometabolic risk	85.06	74
No cardiometabolic risk	14.94	13
Presence of *Acanthosis nigricans*		**100**
Yes	62.00	62
No	38.00	38
Biochemical tests		
Fasting glucose*[1]	83.68 ±10.45	84
Fasting insulin**[1]	11.20 ±13.84	55
HOMA-IR**[1]	2.31 ±3.35	54
Total cholesterol*[1]	160.90 ±32.13	83
HDL cholesterol*[1]	43.22 ± 10.61	79
LDL cholesterol*[1]	98.15 ± 30.93	74
Triglycerides*[1]	105.84 ± 51.78	79

*: Data presented as mean ± Standard Deviation; **: Data presented as median ± Standard Deviation; [1]: Data presented in milligrams per deciliter (mg/dl); HOMA-IR: Homeostasis Model Assessment – Insulin Resistance; HDL Cholesterol: High density lipoprotein cholesterol; LDL: Low density lipoprotein cholesterol

The mean quality score for the participants' diet was 61.16 (95%CI: 59.14 – 63.19), with no statistical difference between sexes. Most of the participants (63%; n=63) had a total IQD-R below 65 and were hence classified as having a "poor diet". Another 37% (n=37) of the participants were classified as having an "intermediate" diet, with scores of 67-84, and none of the participants exhibited a "good diet" (score ≥ 85). The components with the lowest scores were "oils", "whole cereals" and "dark green and orange legumes" (Table III). The groups with the highest frequency of minimum intake (zero score) were: "oils" (80%), "whole cereals" (66%), "total vegetables and legumes"

(32%), "dark green and orange and legumes" (35%) and "whole fruits" (31%). In none of the components was the maximum score achieved.

There were no correlations between the total IQD-R score and BMI-for-age, body circumferences, biochemical tests, behavioral variables, and *acanthosis nigricans*. However, when the components were analyzed separately, there were negative associations between: "total vegetables and legumes" and HOMA-IR (r=-0.290; p=0.033), "dark green and orange legumes" and HOMA-IR (r= -0.333; p=0.014), and "dark green and orange legumes" and fasting insulin (r= -0.291; p=0.027).

Although the mean HOMA-IR was below the cut-off value for the diagnosis of IR (Table II), the prevalence rate for this condition was 44.44% (n=24) among those whose data were available for calculation (n=54). Other IR markers, such as AC and NC were positively correlated with HOMA-IR (r=0.435 and p=0.002; r=0.360 and p=0.013) and with fasting insulin (r=0.450 and p=0.001; r=0.397 and p=0.005).

After splitting participants into groups according to the number of cardiometabolic risk factors, it was observed that those who had more than three risk factors had a significantly higher score for the *Gord_AA* component (p=0.018), thereby suggesting a lower intake of solid fat and white sugar (Table IV).

Table III - Values for the components of the Revised Diet Quality Index (***Índice** de Qualidade da Dieta Revisado*) distributed in median, minimum and maximum percentile values and median values per sex. Fortaleza, Ceará, 2019.

Components of the Revised Diet Quality Index	**Total Median n=100**	**P25 Total**	**P75 Total**	**Girls' Median n=71**	**Boys' Median n=29**
Total fruits	2.94	1.68	5.00	2.77	3.32
Whole fruits	2.50	0.00	3.05	2.50	1.53
Total vegetables and legumes	2.50	0.00	2.91	2.50	1.11
Dark green and orange and vegetables, and legumes	2.37	0.00	3.81	2.50	2.50
Total cereals	4.97	4.25	5.00	4.98	4.94
Whole cereals	0.00	0.00	1.56	0.00	0.00
Milk and dairy	5.22	2.59	7.42	5.97	3.45
Meat, eggs and legumes	9.20	6.71	10.00	9.35	8.91
Oils	0.00	0.00	0.00	0.00	0.00
Saturated fat	8.97	6.95	9.76	8.77	9.25
Sodium	9.44	8.41	10.00	9.08	9.73
Gord_AA	16.70	12.8	20.00	16.80	14.00
Total score	61.60	54.3	67.9	62.1	59.1
TEI	1370	1095	1562	1316	1434

TEI: Total Energy Intake; *Gord_AA*: Solid fat, alcohol and added sugar

Table IV - Median of the components of the Revised Diet Quality Index (***Índice** de Qualidade da Dieta Revisado*) according to the quantity of cardiometabolic risk factors. Fortaleza, Ceará, 2019.

Components of the diet	**≤ 3 Cardiometabolic risk factors (n=26)**	**>3 Cardiometabolic risk factors (n=74)**	**p**
Total fruits	2.59±1.60	3.07±1.71	0.421
Whole fruits	1.99±1.69	2.50±1.89	0.164
Total vegetables and legumes	2.50±1.99	2.50±1.85	0.955
Dark green and orange vegetables, and legumes	2.37±1.79	2.34±1.89	0.831
Total cereals	4.96±0.92	4.97±0.76	0.940
Whole cereals	0.00±1.47	0.00±1.37	0.941
Milk and dairy	5.92±2.46	4.93±3.31	0.688
Meat, eggs and legumes	9.02±2.20	9.26±1.92	0.710
Oils	0.00±1.91	0.00±1.49	0.114
Saturated fat	8.85±1.77	9.02±2.45	0.679
Sodium	8.91±1.72	9.59±1.28	0.076
Gord_AA	14.77±4.03	17.48±4.34	0.018*
Total IQD-R score	59.80±10.10	62.23±10.36	0.193

*: Statistically significant values; *Gord_AA*: Solid fat, alcohol and added sugar; *IQD-R: Índice de Qualidade da Dieta Revisado* (Revised Diet Quality Index)

DISCUSSION

The results of the present study showed the qualitative inadequacy of the diet of children and adolescents with excess weight since no participant met the nutritional recommendations proposed by the Brazilian dietary guidelines and most of them presented a diet classified as "poor diet". Similar findings were reported in studies conducted in Brazil[7] and abroad[17] using different IQD. The identification of the quality of the diet of children and adolescents by means of indices is essential for the development of educational actions within health and public policies aimed at health promotion.

The individual analysis of the components of the index allows to identify the main dietary inadequacies in a given population. The low intake of whole cereals, vegetables and fruits was consistent with other studies of the same age group[18,19]. In a study carried out in São Paulo with 812 adolescents, only 6.4% of the participants consumed fruits and vegetables according to Brazilian recommendations, and 22% did not consume any type of fruits and vegetables[20]. These results are similar to those in the present study, in which 26.77% of children and adolescents did not report habitual consumption of vegetables and 16.67% did not consume fruits.

Increasing the consumption of fruits and vegetables is constantly suggested by all health agencies as an important component for promoting cardiovascular health and preventing chronic diseases, such as obesity and diabetes mellitus. This is because these food groups are important sources of nutrients, such as fiber, potassium, vitamins, and antioxidant phytochemicals. However, the consumption of fruits and vegetables hardly reaches the daily recommendations (400g/day), especially among children and adolescents[21,22]. It should be noted that in the present study the consumption of vegetables may have been even lower than that reported since the inclusion of legumes in this group may have increased the component scores and overestimated the intake of this group of foods. On the other hand, the decreased oil intake should be interpreted with caution since the analysis of food consumption is performed considering cooked foods, thus making it impossible to accurately quantify the oil used in the preparation of the food.

In our study we found negative associations of consumption of "total vegetables and legumes" and "dark green and orange legumes" with IR markers. The mechanisms by which vegetables influence IR are not well understood, but this may happen because of their high fiber content, which can delay gastric emptying and inhibit the rate of macronutrient absorption, thereby generating a lower glycemic and insulinemic response to the intake of food[23]. In addition, considering the synergism between nutrients, there may also be a contribution from bioactive compounds widely found in these vegetables. Experimental studies have shown that flavonoids can inhibit enzymes and glucose transporters in the small intestine, thus delaying the absorption of ingested carbohydrates and reducing postprandial glycemia and insulin spikes[24].

In the present study, the prevalence of IR assessed by HOMA-IR may have been underestimated due to the impossibility of performing the calculation in the entire sample due to the absence of biochemical data. The increase in AC and NC and the presence of *acanthosis nigricans* have been suggested as clinical markers equivalent to HOMA-IR[25]. Thus, considering the changes found in these markers, it can be implied that IR may to be higher than that identified by HOMA-IR.

The comparison of diet component scores between groups according to the amount of cardiometabolic risk factors showed that those who had more risk factors consumed significantly less *Gord_AA* (p=0.018). This result differs from the current evidence described in the literature, which supports associations of added sugars with increased adiposity, AC and dyslipidemia, these risk factors being already established for the development of cardiovascular disease[26].

The reason for this discrepancy between the findings may be due to the greater compliance with the guidelines received during the nutritional monitoring consultations and, consequently, to the changes in food intake in the group that had a higher number of risk factors, thus resulting in a healthier dietary pattern. On the other hand, this inconsistency can also be attributed to an underestimated report consciously or unconsciously made by individuals with excess weight[27].

BMI, AC, NC and HOMA-IR were not significantly associated with the IQD-R score in the present study. Similarly, a study carried out in Turkey using HEI-2005 to analyze the diet of children and adolescents also found no correlations of the total score on the index with BMI and AC[28]. On the other hand, negative associations of the diet quality index scores and lifestyle (Healthy Lifestyle-Diet Index) with BMI, AC and HOMA-IR suggest that poor quality diets may predispose or intensify the IR[29]. The disagreement between the results in the present study can be justified by the unavailability of data on HOMA-IR in the entire sample and by the difference in the composition of and score range between the food indices used to assess the quality of the diet.

With regard to behavioral aspects, most children and adolescents analyzed in the present study had a sedentary lifestyle and exceeded the screen time recommendations proposed by the Brazilian Society of Pediatrics. This sedentary behavior has been associated with less healthy eating habits, possibly due to the consumption of ultra-processed foods in front of television and the influence of fast food advertising[30]. In the present study, regular physical activity and screen time were not associated with the total IQD-R score, but other studies have shown that the overall quality of the diet has been better in children and adolescents with screen time less than two hours a day[31].

The low quality of the diet and the high prevalence of physical inactivity found in the population of the present study are worrisome since both are risk factors for the development and progression of obesity. The assessment of eating and behavioral habits is increasingly evident due to its close relationship with the prevention and control of diseases and the promotion of health. The findings of this study made it possible to identify a group of children and adolescents at nutritional risk. The results obtained from the analysis of food components may serve as a guide for planning, monitoring and evaluating local nutritional intervention programs.

The limitations of the present study include the small sample size, the unavailability of biochemical tests performed on all the participants, and the absence of individuals at normal weight to compare the results. In addition, the scarcity of Brazilian studies using the same diet analysis tool in this population, as well as the variation in the composition and scoring of international indices, make it difficult to compare the studies. The cross-sectional design can also be pointed out as a limitation, as the analysis at different times could assess adherence to nutritional guidelines promoted by professionals and identify whether changes in diet quality are accompanied by changes in nutritional status and other cardiometabolic parameters.

The findings, however, can be used as a guide for planning new nutritional education strategies targeted at this population with a view to promoting health and preventing NCDs.

CONCLUSION

In conclusion, the quality of the diet of the children and adolescents participating in this study was classified as “poor” according to the IQD-R. No associations were found between the total IQD-R score and cardiometabolic markers. However, the individual analysis of the components showed an increase in HOMA-IR in dietary patterns with low vegetable intake and a reduced consumption of *Gord_AA* in those that exhibited more cardiometabolic risk factors.

CONFLICTS OF INTEREST

The authors have no conflicts of interest to declare.

CONTRIBUTIONS

Maria Rafaela Martins de Oliveira, Carla Soraya Costa Maia and **Alane Nogueira Bezerra** contributed to the study conception and design; the acquisition, analysis and interpretation of data; and the writing and/or revision of the manuscript. **Matheus Aragão Dias Firmino** and **Luana Matos de Souza** contributed to the study conception and design and the acquisition, analysis, and interpretation of data. **Ana Paula Dias Rangel Montenegro** and **Renan Magalhães Montenegro Júnior** contributed to the writing and/or revision of the manuscript.

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