Original Article

Characterization of food repertoire, selectivity, and consumption of ultra-processed food of children and adolescents with autism spectrum disorders in a city in Southern Brazil

Caracterização do repertório alimentar, seletividade e consumo de alimentos ultraprocessados de crianças e adolescentes com transtornos do espectro autista em um município do Sul do Brasil

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ABSTRACT

Introduction: Autism spectrum disorder (ASD) is associated with persistent deficits in social communication and social interaction across multiple contexts. About one in every 54 children has been identified with autism worldwide. Most of them have some kind of nutritional problem, such as food selectivity, which has been associated with inadequate nutrient intake. Our objective was to evaluate selectivity through food repertoire and characterize the quality of food intake of individuals with ASD according to the degree of food processing. **Methods:** We assessed 113 individuals with ASD between 2 and 19 years old. Among participants, 85% were male and 53.1% were children. All subjects were students at a specialized educational institution in Pelotas, RS, Brazil. We evaluated food repertoire by counting the variety of food mentioned in three 24-hour recalls, and we considered repertoire limited when it contained less than 20 different foods. The characterization of food consumed was performed according to the NOVA classification system: group 1: *in natura* or minimally processed foods and culinary ingredients; group 2: processed foods; and group 3: ultra-processed foods. **Results:** The average food consumption was 17.06 ± 5.05 items, ranging from 7 to 30 items. Most of the sample (70.4%) showed a limited food repertoire. A total of 213 food items were mentioned, of which 48.8% were ultra-processed and 39% were *in natura* or minimally processed. **Conclusion:** Most participants presented food selectivity as confirmed by their limited repertoire comprising less than 20 items. Also, they presented a high intake of ultra-processed food.

RESUMO

Introdução: O transtorno do espectro autista (TEA) está associado a déficits persistentes na comunicação social e interação social em múltiplos contextos. Cerca de uma em cada 54 crianças foi identificada com autismo em todo o mundo. A maioria delas apresenta algum tipo de problema nutricional, como a seletividade alimentar, que tem sido associada à ingestão inadequada de nutrientes. Nosso objetivo foi avaliar a seletividade por meio do repertório alimentar e caracterizar a qualidade da ingestão alimentar de indivíduos com TEA, de acordo com o grau de processamento dos alimentos. **Método:** Avaliamos 113 indivíduos com TEA entre 2 e 19 anos. Entre os participantes, 85% eram do sexo masculino e 53,1% eram crianças. Todos os sujeitos eram alunos de uma instituição de ensino especializada em Pelotas, RS, Brasil. Avaliamos o repertório alimentar contando a variedade de alimentos mencionada em três recordatórios de 24 horas, e consideramos repertório limitado quando continha menos de 20 alimentos diferentes. A caracterização dos alimentos consumidos foi realizada de acordo com o sistema de classificação NOVA: grupo 1: alimentos *in natura* ou minimamente processados e ingredientes culinários; grupo 2: alimentos processados; e grupo 3: alimentos ultraprocessados. **Resultados:** O consumo alimentar médio foi de 17,06 ± 5,05 itens, variando de 7 a 30 itens. A maioria da amostra (70,4%) apresentou repertório alimentar limitado. Foram citados 213 alimentos, sendo 48,8% ultraprocessados e 39% *in natura* ou minimamente processados. **Conclusão:** A maioria dos participantes apresentou seletividade alimentar confirmada pelo repertório limitado com menos de 20 itens. Além disso, apresentaram alta ingestão de alimentos ultraprocessados.

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INTRODUCTION

Autism spectrum disorder (ASD) is characterized by persistent deficits in social communication and social interaction across multiple contexts[1]. The global prevalence of ASD is 1.8% (one in every 54 children), and it is diagnosed four times more often in boys than in girls[1,2]. Most individuals with ASD present some food-related problems, including food selectivity and unusual eating patterns and rituals. Some examples are inflexibility of mealtimes, food routine rigidity, and hypersensitivity to food texture, color, and aroma[3,4]. These issues are observed more often in children with ASD than children with typical development[5].

Food selectivity is one of the main problems presented by individuals with ASD, and it negatively affects the quality of family meals. This selectivity may be characterized by three domains: food refusal, limited food repertoire, and a specific high-frequency intake[3]. Children with limited food repertoire had inadequate intake of a greater number of nutrients[3,6], refusal of fruits and vegetables[7], and behavioral problems during meals[8]. To be considered "selective", the individual must present one of these domains[3].

A recent study carried out in Pelotas, state of Rio Grande do Sul (RS), Brazil, showed that children with ASD follow a low-quality diet, with a low intake of whole grains, fruits, vegetables, milk, and dairy products, and a high intake of fats and added sugars[9]. Curtin et al.[10] showed that children with ASD prefer foods with a high caloric density and have a low intake of fruits and vegetables. Another study, also performed with children with ASD, in Curitiba, state of Paraná, Brazil, showed a high intake of ultra-processed products, such as processed meats, soft drinks, artificial juices, and candies. Artificial juice was consumed two or more times a day[11].

There is no doubt that food selectivity is a problem for child development, as it is associated with a dietary restriction with consequent nutritional inadequacy, especially in people with ASD. Thus, this study aimed to assess food selectivity based on the evaluation of food repertoire and to characterize the quality of food intake of individuals with ASD according to the degree of food processing at a specialized educational institution in the city of Pelotas (RS), Brazil.

METHODS

Study Design and Ethical Aspects

This was a cross-sectional study, performed at a specialized educational institution for autistic children and adolescents in the city of Pelotas (RS), Brazil. This research is part of a larger study named "Assessment of the nutritional status of individuals with Autism Spectrum Disorder", previously approved by the Research Ethics Committee of the Federal University of Pelotas (4.143.349). Those responsible for the students authorized their participation in the research and signed an informed consent form.

Sample

The study included children and adolescents with ASD who studied in the Care Center for Autism Dr. Danilo Rolim de Moura, where those responsible for the students agreed to participate in the research and answered the 24-hour dietary recalls (24HR) between November 2018 and November 2019.

Food Repertoire and Selectivity

Food selectivity was characterized by a limited food repertoire, as described by Bandini et al.[3]. We considered the food repertoire "limited" when it included less than 20 different foods in the three 24HR, as established in a previous study[12]. To assess food intake, our trained researchers conducted three 24HR by interviewing the participants in person or by telephone at three different moments (at least one referring to the weekend), with 4-month intervals. All interviewers were trained and used a photographic album of homemade measures to standardize 24HR data collection. Food preparations were represented as a single item, and foods from the same food group were assessed individually[3].

The characterization of foods/preparations mentioned in the 24HR was carried out following the NOVA classification proposed by Monteiro et al.[13], in 2016. The degree of food processing was classified into three groups (group 1: *in natura* or minimally processed and culinary ingredients; group 2: processed foods; and group 3: ultra-processed foods). *In natura* foods comprised those that did not require any alteration for consumption, acquired directly from plants or animals, such as leaves, fruits, eggs, and milk. Minimally processed foods were minimally altered natural foods, such as dry, polished, and packed or ground grains as flours, roots and washed or frozen tubers, pasteurized milk, and refrigerated meat cuts. Processed foods were substances obtained directly from nature that went through some processing of salt or sugar addition, such as canned vegetables, fruits in syrup, cheese, and bread. Ultra-processed foods consisted of foods that underwent industrial processing techniques, in addition to being formulations with many ingredients, such as soft drinks, sandwich cookies, packaged snacks, canned, processed meats, and fried foods in general.

Independent Variables

The independent variables were sex (male, female), age

(< 10 years old, $10 \leq 19$ years old)[14], skin color (white, non-white), mother's education level (no schooling, complete elementary school, complete high school, complete higher education), and monthly family income (no income, less than 1 minimum wage, from 1 to 3 minimum wages, more than 3 minimum wages). Sociodemographic data (sex, age, skin color, mother's education, and monthly family income) were collected from the nutritional anamnesis of the main study.

Statistical Analysis

Data were stored in Microsoft Excel® and assessed in GraphPad Prism®, 6.01. The categorical variables were described in percentages, and the continuous variables were expressed as means and standard deviations. The Student's t-test was used to compare the means of variables with normal distribution. Fisher's exact test was used to investigate associations. We considered a significance level of 5% in all analyses.

RESULTS

Thirteen among 349 students were excluded from this study for being older than 19 years. The total sample consisted of 336 students aged between 2 and 19 years. Among them, 157 were excluded for not accepting to participate in the study or due non-attendance. We included 179 students, of which 113 completed the three 24RH. Of these 113 individuals, 85% were male and 53.1% were children. Most individuals were white. The participants' mothers' education level was mostly of at least complete high school, with a monthly family income of 1 minimum wage or more (Table 1).

The average number of foods consumed was 17.05 ± 5.05, ranging from 7 to 30 items. The variety of foods was not associated with the independent variables (Table 2). Based on the participants' limited food repertoire, we found that 69% of the sample showed food selectivity. Of these, 66 were males and 44 were children. Most mothers of children with food selectivity had at least complete high school and earned more than 1 minimum wage monthly (Table 3).

In addition to food selectivity, we classified the total number of foods/preparations following the NOVA classification (Table 4). The total number of foods/preparations mentioned by the whole sample was 213. Among those items, 48.8% were ultra-processed foods, and 39% were *in natura* or minimally processed foods and culinary ingredients. Table 5 describes the 10 most mentioned foods in the 24RH. The most frequent food was whole milk, followed by white rice, chocolate powder, beans, artificially flavored orange juice, margarine, cream cracker biscuit, black coffee, sandwich bread, and banana.

Table 1 – Sociodemographic characterization of children and adolescents with ASD, students at a specialized educational institution in Pelotas (RS), Brazil, in 2018 and 2019 (N = 113).

Variables	N	%
Sex		
Male	96	85.0
Female	17	15.0
Age group		
Children (< 10 years old)	60	53.1
Adolescents (≥ 10 years old)	53	47.0
Skin color		
White	99	87.6
Non-white	14	12.4
Mother's education level		
No schooling	2	1.9
Complete Elementary School	21	19.8
Complete High School	45	42.4
Complete Higher Education	38	35.9
Monthly family income*		
Less than 1 minimum wage	27	23.9
From 1 to 3 minimum wages	60	53.1
More than 3 minimum wages	19	16.8

*The sample was smaller (n=106) in variables "Mother's education level" and "Monthly family income".

Table 2 – Average food repertoire according to the sociodemographic variables of children and adolescents with ASD, students at a specialized educational institution in Pelotas (RS), Brazil, in 2018 and 2019 (N = 113).

Variables	Food Repertoire (Mean ± SD)*	P-value #
Sex		
Male	17.1 ± 5.1	0.7154
Female	16.7 ± 5.3	
Age group		
Children (< 10 years old)	16.3 ± 5.1	0.0957
Adolescents (≥ 10 years old)	17.9 ± 4.9	
Skin color		
White	17.0 ± 5.1	0.532
Non-white	17.9 ± 4.5	
Mother's education level**		
No schooling / Complete Elementary School / Complete High School	16.8 ± 5.2	0.9052
Complete Higher Education	17.0 ± 4.9	
Monthly family income		
No income / Less than 1 minimum wage	16.2 ± 4.9	
From 1 to 3 minimum wages	17.5 ± 2.1	0.4229##
More than 3 minimum wages	15.8 ± 2.8	

* Average of the variety of foods mentioned in three 24RH;
# P-value was achieved through Student's t-test
Fisher's exact test – Association between limited repertoire and variables
**The sample was smaller (n=106) in variables "Mother's education level" and "Monthly family income".

Table 3 – Prevalence of food selectivity according to the sociodemographic variables of children and adolescents with ASD, students at a specialized educational institution in Pelotas (RS), Brazil, in 2018 and 2019 (N = 113).

	N Selective individuals	%*
Sex		
Female (n=17)	12	70.6
Male (n=96)	66	68.7
Age group		
Children (< 10 years old; n=60)	44	73.3
Adolescents (≥ 10 years old; n=53)	34	64.1
Skin color		
White (n=99)	70	77.8
Non-white (n=14)	8	57.1
Mother's education level**		
No schooling / Complete Elementary School / Complete High School (n=68)	50	73.5
Complete Higher Education (n=38)	26	68.4
Monthly family income**		
Less than 1 minimum wage (n=27)	21	77.8
From 1 to 3 minimum wages / More than 3 minimum wages (n=79)	55	69.6

*Percentage of food selectivity in each variable.
**The sample size for the variables "Mother's education level" and "Monthly family income" was 106.

Table 4 – Characterization of the total of foods and preparations mentioned by children and adolescents with ASD, students in a specialized institute in Pelotas (RS), Brazil, in 2018 and 2019, following NOVA classification (variety: 213).

NOVA classification	N	%
In natura or minimally processed foods and culinary ingredients	83	39.0
Processed	26	12.2
Ultra-processed	104	48.8
Total	213	100.0

Table 5 – Classification, in descending order, of the 10 foods/preparations most mentioned by children and adolescents with ASD, students in a specialized institute in Pelotas (RS), Brazil, in 2018 and 2019.

Food/preparation	NOVA classification	Number of mentions
Whole milk	*In natura* or minimally processed	360
White rice	*In natura* or minimally processed	307
Chocolate powder	Ultra-processed	237
Beans	*In natura* or minimally processed	233
Artificially flavored orange juice	Ultra-processed	120
Margarine	Ultra-processed	116
Cream cracker biscuit	Ultra-processed	107
Black coffee	*In natura* or minimally processed	105
Sandwich bread	Ultra-processed	95
Banana	*In natura* or minimally processed	89

DISCUSSION

Most children and adolescents with ASD presented food selectivity, as confirmed by the limited food repertoire we identified. Food selectivity was not associated with the socio-demographic variables in our sample. Regarding food characterization, about half of the foods and preparations mentioned in 24HRs were ultra-processed. The present study showed that selective individuals had the same sociodemographic characteristics of those who consumed a greater variety of foods. These findings corroborate other studies, where food selectivity of individuals with ASD is not associated with the mother's sex, age, color, and/or education[3,15].

In Boston, 2019, a study characterized food selectivity through food refusal and limited food repertoire in 59 children with typical development (TD) and compared the results with 56 children with intellectual disability (ID), all children in the age group between 3 and 8 years. Part of the ID sample presented ASD. The authors concluded that children with ASD had a higher risk of having food selectivity, which could be attributed to their disorder[15]. This corroborates our findings, in which most of the individuals evaluated presented food selectivity.

Another study investigated the food repertoire of children with ASD between 3 and 9 years old and showed that only 19% of participants consumed less than 10 foods in their daily routine, 26% consumed between 11 and 20 items, and 55% consumed more than 21 items[16]. Another study compared children between 3 and 12 years old with their siblings with TD. Its findings corroborate our study, in which most children consumed less than 20 varieties of foods in their usual diet, suggesting that the disorder might influence this characteristic[17]. Our findings showed no significant difference in food selectivity between the age groups studied. A recent qualitative study assessed young adults with ASD (between 18 and 23 years old) and showed that food selectivity may change over time. This research also suggested the development of longitudinal studies that propose strategies to deal with food selectivity[18].

A study involving 151 children and adolescents with ASD from Malaysia showed that food selectivity is a risk factor for body mass index (BMI) increase and attributed this to the quality of foods[19]. We did not evaluate BMI as a classification of nutritional status in our study. However, most individuals assessed predominantly consumed ultra-processed foods, which are rich in fats, sodium, and calories[13] and can be associated with excessive weight gain. In addition, ultra-processed foods have, among other ingredients, food additives in their composition, such as artificial coloring, flavoring, preservatives, and artificial sweeteners, which seem to influence some behaviors, such as irritability, restlessness, and sleep disorders in individuals with ASD[20].

This finding reinforces the need for nutritional monitoring of these individuals. Another study assessed changes in the food selectivity of 18 children with ASD at two different moments (mean interval of 6.4 years) without interventions. It showed that the food repertoire remained the same in this period. These findings reinforce the need for multidisciplinary interventions since childhood[21].

A recent study carried out in Brazil concluded that 28% of the caloric contribution of autistic children's diet came from ultra-processed foods, while only 4.3% came from *in natura* fruits[22]. The study comprised 29 children with ASD aged between 3 and 12 years. The results corroborate the findings of the present study, in which we observed a high prevalence of consumption of ultra-processed foods and a low prevalence of *in natura* foods. A similar result was also found in 2019, which indicated that children with ID follow a diet with a limited intake of fruits and vegetables[15]. This preference maybe explained by the sensorial aspects of industrialized products, which are standardized for appearance, smell and texture, features that facilitate acceptance by individuals with selectivity[4].

We must highlight that the food repertoire in the present study was of approximately 17 foods on average, which is close to the figure described in the literature[3]. Another recent study that supports the present findings identified a variety in food repertoires between 7 and 36 items in children with ID, while the TD children presented a significantly greater variety of 12 to 42 items[15].

Among the limitations of the present study, we highlight the large number of losses and/or refusals to participate in the study considering the total number of students enrolled in the care center, and lack information about the severity of ASD. Another limitation was using only the limited food repertoire to classify selectivity. This choice might have underestimated the total number of selective individuals, since food selectivity can also be characterized by the assessment of food refusal and high-consumption of a single product[3]. However, as positive aspects, we highlight the sample size, the originality of the data, and the classification of the foods consumed, which showed the high consumption of ultra-processed foods.

CONCLUSION

We concluded that most individuals with ASD in the sample showed food selectivity, which was confirmed by their limited food repertoire. In addition, there was a high intake of ultra-processed foods. These findings reinforce the need for intervention and nutrition monitoring of individuals with ASD. We suggest further studies to characterize food selectivity and the quality of food intake in order to develop multidisciplinary intervention strategies focused on the food intake of individuals with ASD.

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