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Nutrient intake variability and number of days needed to estimate usual intake in children and adolescents with autism spectrum disorder

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Abstract

Children and adolescents diagnosed with autism spectrum disorder (ASD) present feeding problems that may influence food acceptance and refusal. However, data regarding dietary intake variability in this population are either not available in the literature or not well-known. This cross-sectional study aimed to identify the within-person and between-person variability, and the number of days needed for a 24-hour recall (24HR) to estimate the usual intake of children and adolescents with ASD. Data were collected from 284 patients assisted at a public neuropediatric health service in the city of Pelotas, Southern Brazil. Food consumption was assessed using three non-consecutive 24HR. Within-person (S^2_w) and between-person (S^2_b) variances, the variance ratio (VR), and the distribution of energy, macronutrients, and micronutrients were obtained using the Multiple Source Method® (version 1.0.1). The number of days of 24HR needed was calculated for correlation coefficients of 0.7, 0.8, and 0.9. For most nutrients, S^2_w was greater than S^2_b, resulting in RV>1, except for age-group analyses where children up to 5 years old showed VR<1. Two to three days of 24HR were estimated for most nutrients, considering a correlation coefficient of 0.8. Differences were observed according to sex and age group, with adolescents requiring more days of 24HR. These findings indicate the need to assess dietary variability among individuals with ASD according to the characteristics of this investigated population.

Key words: Autism Spectrum Disorder: Dietary Intake: Between-Person Variation: Within-Person Variation

Abbreviations: *ASD* Autism spectrum disorder, *24HR* 24-hour food recall, *FR* Foor record, *FFQ* Food frequency questionnaire, *MSM* Multiple source method, *VR* Variance ratio

Introduction

Autism spectrum disorder (ASD) is a neurodevelopmental disorder associated with difficulties in social interaction and communication, repetitive behaviour, and restrictive interests[(1)]. Studies investigating nutritional aspects in ASD have found a high prevalence of feeding difficulties, which are associated with different factors, such as feeding behaviour problems and sensory processing alterations[(2–5)]. These factors result in selective or excessive food consumption, impacting daily dietary repertoire and energy and nutrient intake[(6,7)].

In studies assessing food consumption, estimating usual intake (i.e. intake over a long period) of energy and nutrients is essential for investigating associations between diet and health. However, the method of data collection and day-to-day variability in consumption must be considered[(8)]. A recent systematic review highlighted the need for more detailed information on the methods used to assess dietary intake in individuals with ASD, as well as the inclusion of adjustments for estimating usual intake in their analyses[(9)].

Understanding the variation in food consumption from day-to-day for each individual (within-person variability) and between individuals (between-person variability) is required to obtain the necessary adjustments in analyses aimed at identifying the prevalence of inadequacies in intake[(8,10,11)]. Studies have shown that the variability of energy, macronutrient, and micronutrient intake varies according to age, sex, and country[(12–14)].

Food frequency questionnaires (FFQ), 24-hour recalls (24HR), and food records (FR) are the most used dietary instruments for assessing usual intake. All these instruments have strengths and biases discussed in the literature[(8)]. Short-term instruments, such as the 24HR and FR, when applied correctly, have a lower systematic error. However, they do not capture within-person variation and do not allow the usual intake to be estimated. Also, although this limitation may be mitigated by repeating the application of the instrument over several days, the number of repetitions required differs according to within and between-person variances, which are inherent to the nutrients of interest in the study population[(8,10,15)].

The number of studies investigating intake variability in typically developing children and adolescents is relatively limited, and until now, no study has reported these findings for individuals with ASD[(12,14–16)]. The particularities of the diagnostic and difficulties associated with eating in ASD directly affect food acceptance and refusal and, consequently, may contribute to lower dietary variability in these individuals[(4,17,18)]. The absence of data on dietary intake variability in this population represents a significant gap in the design of studies involving the collection and interpretation of dietary data. Additionally, factors including the heterogeneity observed among individuals with ASD, the higher prevalence of boys in the samples, and the different age groups are rarely considered in analyses of nutritional studies. As a result, the impact of these characteristics on the variation in food consumption remains unclear[19,20].

In this context, the main objective of this study was to estimate the within-person and between-person variability and the number of days of 24HR needed to estimate the usual intake of energy and nutrients in a sample of children and adolescents with ASD from southern Brazil. To our knowledge, this study constitutes the first investigation on nutrient variability within a population of children and adolescents with autism. Examining these aspects of dietary intake offers novel insights into our understanding of dietary aspects in this group, enriching the existing body of knowledge on nutrient variability and dietary assessment methods.

Methods

Design and study sample

A cross-sectional study was conducted with baseline data collected between July 2021 and April 2024, from a larger study with patients diagnosed with ASD from 2 to under 19 years, who were assisted at the public neuropediatric health service of a public university in the city of Pelotas, Southern Brazil. Two paediatric neurology professors, responsible for periodic care at this service, conducted the diagnosis of ASD. Out of 311 participants, 24 were excluded from the analyses for using dietary supplements, and another 3 were excluded due to missing dietary data, resulting in a final sample of 284.

Data collection and study variables

Data were collected in three interviews carried out by research nutritionists trained for this study. A standard questionnaire including sociodemographic, educational, clinical, and anthropometric questions was applied during previously scheduled face-to-face interviews.

The caregivers were asked to answer three non-consecutive days of the 24HR, with a one-week interval between each collection, regarding the dietary intake of the subject under assessment. The first and third R24H were administered face-to-face and covered weekdays. The second recall was collected by telephone interview and corresponded to a weekend day. Caregivers were instructed to report all foods and beverages consumed the day before the interviews, including meal and snack times and quantities consumed.

To improve data quality, the multi-pass method was used during the application of the 24HR[21]. In addition, a photo book of commonly used measurements was used to support the reporting of portions[22]. Regarding school meals, caregivers provided information about the food sent from home for consumption at school, as well as any leftovers. A total of 232 caregivers completed three days of 24HR at the end of the study, while 36 completed two days and 16 completed one day. The energy, macronutrient, micronutrient and fiber composition of the reported foods was calculated using the Brazilian Table of Food Composition (TBCA, version 7.2, Universidade de São Paulo, Food Research Center, 2023)[23].

The anthropometric data of weight (Kg) and height (cm) were measured using a digital scale with a capacity of 150 kg and accuracy of 100 g (TRENTIN, RS, Brazil) and a stadiometer coupled to the scale (maximum measurement of 213 cm and accuracy of 0.1 cm). For children with height under 100 cm, a horizontal stadiometer was used (maximum measurement of 100 cm and accuracy of 0.1 cm). These data were used to evaluate nutritional status using the Z-score of body mass index for age, and overweight was assessed according to the cutoff of +1 Z-score, established by the World Health Organization[24,25].

The following variables were used to describe the sample: age categorized by years (2-5, 6-9, 10-18); sex (female, male); skin colour (white, black, brown, or indigenous); per capita family income (US$) (< ½ , ½ - <1, ≥1 minimum wage), considering the Brazilian minimum wage according to the years of data collection; primary caregiver (mother, others); primary caregiver's years of schooling (≤8, ≥9); use of antipsychotic medication (yes, no) and overweight (yes, no).

Data analysis

The data were double entered into the EpiData® version 3.1 program (EpiData, version 3.1; The EpiData Association, Odense, Denmark, 2003-2005). All data were imported to STATA® statistical software version 15.1 (Stata Statistical Software, version 15.1. College Station, Texas, United States of America) for analysis.

The presence of outliers in energy and nutrient estimates was investigated by graphical visualization of the distribution and review of extreme values for each dietary variable. The identified inconsistencies, primarily related to errors in household measurements, were addressed and corrected without excluding any participants.

The standardized within-person (S^2_w) and between-person (S^2_b) variances, variance ratio ($VR = S^2_w / S^2_b$), the distribution of the measured intake, and the usual intake of energy and nutrients were obtained through analyses conducted in the Multiple Source Method ® version 1.0.1 (MSM) web application (Department of Epidemiology at the German Institute of Human Nutrition Potsdam-Rehbrücke) for each dietary variable investigated[26]. MSM is a statistical method developed to remove within-person random error in estimates of usual consumption distribution from data collected by short-term dietary assessment instruments. Details of the method are available in the publication by Haubrock *et al.*[27].

The equation proposed by Black *et al*.[28] was used to estimate the number of days needed to estimate usual intake: $d = (r^2/1-r^2) \times (VR)$ (equation 1),

where *d* is the number of days, *r* is the correlation coefficient required between measured intake and usual intake, and *VR* corresponds to the ratio between S^2_w and S^2_b. Correlation coefficients of 0.7, 0.8, and 0.9 were considered acknowledging that the higher the r, the greater the correlation between the information collected and usual intake[15,29].

The analyses were stratified according to age group and sex.

Ethical considerations

This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects were approved by the Research Ethics Committee of the Faculty of Medicine of the Federal University of Pelotas (CAEE: 94253518.0.0000.5317). Written informed consent was obtained from all those responsible for the participants.

Results

The mean age of the participants was 7.4 (SD 3.5) years, and 75.7% were children between 2 and 9 years old. Most of participants were male (82.8%), white (77.8%), and from families with a per capita income of under US$247.00 (88.4%). Almost half were using antipsychotic drugs (54.2%) and 66.7% were overweight. Approximately 73% of caregivers had 9 years or more of schooling and, for the greater part of the participants, mothers were the main caregivers (91.9%) (Table 1).

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Distribution of energy and nutrient intake

Table 2 shows the distribution of energy and nutrient intakes according to the crude and usual estimates. The mean intakes were similar in both estimates for all dietary variables, with a reduction in the standard deviation and differences in the distribution of intakes. In the analyses stratified by age group and sex, higher mean intakes were observed in the groups of boys and the older age group (10-18 years) for most of the nutrients (Supplementary material 1 and 2).

Variance components and days required for calculating usual intakes

In general, S^2_w was higher than between-person variance (S^2_b) for most of the dietary variables, resulting in VR values of >1. Exceptions were observed for fiber, retinol, riboflavin, calcium, iron, phosphorus, and copper (RV<1). The highest VR values were observed for cholesterol (1.64), monosaturated fatty acids (1.59), and saturated fatty acids (1.56), while the lowest values were obtained for calcium (0.52) and riboflavin (0.79) (Figure 1). The number of days of 24HR required to estimate usual intake, considering the correlation coefficient of 0.8, ranged from two to three for most nutrients, except calcium and riboflavin, for which a single day may be sufficient for obtaining an estimate of usual intake. For the 0.7 and 0.9 correlation coefficients, the range varied from one to two days, and two to seven days, respectively (Table 3).

Analyses conducted with male participants showed similar results to the total sample, with VR≥1 for most of the variables. For girls, the VR was predominantly <1. There were differences between sexes in the values of S^2w, S^2b, and VR; however, no pattern was observed directed at a specific sex. The group of girls, compared to the boys, had lower VR values for most of the dietary variables. Higher VR values were obtained for saturated fatty acids (1.86), monosaturated fatty acids (1.72), and potassium (1.71) for boys, and for niacin (2.27), cholesterol (2.07), and zinc (1.29) in the group of girls (Supplementary material 3). Based on the correlation coefficient of 0.8, most of the variables required more days of 24HR in the group of boys (one to three days) compared to the group of girls (one to four days) (Table 4).

There were differences in S^2_w and S^2_b values between age groups, with higher VR values for most of the variables in 10 to 18 age group (0.93 - 3.69), except for lipids, saturated fatty acids, monosaturated fatty acids, thiamine, niacin, phosphorus, sodium, and potassium, whose VR values were higher in the 6 to 9 age group (0.82 - 3.61). For the group between 2 and 5 years old, the VR ranged from 0.38 to 1.34 and the S^2_b values were higher than the S^2w values for 15 of the 23 variables analysed (VR<1), with the exception of proteins, monosaturated fatty acids, polyunsaturated fatty acids, cholesterol, niacin, vitamin C, sodium and zinc. In the other age groups, VR>1 was obtained for almost all the nutrients; however, the opposite was observed for retinol, vitamin C, calcium, and iron for children between 6 and 9 years old, and only for calcium in the older age group (Table 5) (Supplementary material 4).

A correlation coefficient of 0.8 indicates that one to two days of 24HR were needed to estimate usual intake in children aged 2 to 5 years, while one to six days were required for older children (6-9 years). In the group of adolescents (10-18 years), the range of days, using the same coefficient, varied from two to seven days (Table 6).

Discussion

The present study had three main findings. Firstly, it was identified that children and adolescents with ASD have higher S^2_w values for most dietary variables. The second finding indicated differences in S^2_w and S^2_b for different nutrients when stratified by sex and age group, with higher S^2_b values observed in children up to 5 years old and an increase in S^2_w for older children and adolescents. However, it was not possible to identify the direction of these alterations according to sex. Finally, based on the obtained VRs, two to three days of 24HR are sufficient to obtain food consumption with a good correlation with usual intake (0.8). To our knowledge, this is the first study to examine nutrient variability and the number of days needed to estimate the usual intake of children and adolescents with autism, and to provide evidence on how sex and age group affect the variance.

Previous studies have identified S^2_w and S^2_b variability of energy and nutrients in samples of typically developing children and adolescents in different countries, with observed VR values above and below one[10,12,13,15,30,31]. In the current study, S^2_w was higher than S^2_b for most nutrients, in analyses not stratified by sex or age. Additionally, the VR values obtained in our sample were lower than those observed in other studies[12,29]. Several factors may contribute to these results. We believe that behavioural fluctuations, medication use, and variations in the quantities of food consumed, despite a restricted feeding repertoire, could reflect a higher S^2_w.

The assessment of food consumption during childhood presents challenges due to the use of reporting by caregivers and day-to-day variation, as quantity and variety of foods

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consumed change throughout different stages of growth and development(14,32). In our sample, different S^2_w and S^2_b values were obtained according to age group, with higher S^2_b values in the 2- to 5-year-old group and increased S^2_w in subsequent age groups. These findings may be explained by the reduced variety of foods consumed by children and the increase of the food repertoire as age progresses(30,33,34). Furthermore, evidence indicates that individuals with ASD often have more limited food repertoires compared to control groups[4,6,36]. However, studies on feeding difficulties in ASD have not comprehensively investigated the influence of age on food refusal(4,17,36).

The influence of age on the increase in VR values in typically developed children has been previously observed in the literature(10,13,14,30,31). However, discrepant results compared to our study were reported by Ollberding *et al.*(16), who found that the highest VR values were observed in the group of children (6 to 11 years), compared to the group of adolescents (12 to 17 years). In Brazil, studies have been carried out on different age groups; however, they are also limited to samples of typically developing children and adolescents and from different regions of the country, primarily from the northeast and southeast. Padilha *et al*.(15) (13 to 32 months) and Salles-Costa *et al*.(37) (6 to 30 months) found VR<1 for most of the nutrients analysed, except for polyunsaturated fatty acids, energy, fiber(15), and vitamin C(15,37). Conversely, a study with preschool children (1 to 6 years) obtained VR>1 values, including data from participants across all five macro-regions of Brazil (south, southeast, central west, north, and northeast)(14). However, the inclusion of a few cities per region affects the representativeness of the data.

As for adolescents, studies conducted in São Paulo and Rio de Janeiro found higher S^2_w values compared to S^2_b for most nutrients (VR>1)(29,38,39). Different results were presented in the study by Lima *et al*.(40), carried out with individuals aged 10 to 19 years residing in the city of Natal (northeast Brazil), where higher S^2_b values were obtained (VR<1).

Our study sample had a higher proportion of boys, consistent with the latest prevalence estimate of ASD from the Centers for Disease Control and Prevention(41). Differences in nutrient intake variability have also been observed in studies with typically developed children and adolescents. Caswell *et al.*(12) found lower VRs in a samples of Zambian girls (4 to 8 years old) compared to boys, corroborating with our findings. In contrast, other studies have reported higher VRs for females when analysing nutrient intake variability(30,39,40). Other studies reported lack of consistent findings that could indicate possible discrepancies in within-person and between-person variances among boys and girls[13,16,31].

The use of within and between-person variance to determine the number of days of 24HR is widely recognised and recommended[8,28,42]. Results observed in samples of Brazilian children and adolescents presented intervals ranging from 1 to 16 days for younger children (aged 1 to 6 years)[14,15,30], from 4 to 14 days for older children (6 to 11 years)[16], and 2 to 16 days for adolescents (12 to 18 years)[16,39], for correlation coefficients ≥0.8. Intervals of 1 to 5 days were obtained considering coefficients of 0.9 for samples of children and adolescents[37,40]. However, most studies have estimated a greater number of days for coefficients ≥0.9[14,15,29–31,38,39].

In the current study sample, a range of 1 to 3 days of 24HR was required to estimate the intake of most nutrients to obtain correlations of 0.7 and 0.8 with usual intake. In addition, it was highlighted the necessity to consider the characteristics of the target population in estimating the required number of 24HR days. The increase in the number of days, proportional to higher VR values, observed for older children and adolescents, as well as variations between girls and boys in different nutrients, has been previously reported in studies with children and adolescents without a diagnosis of ASD[30,31,39].

Although the application of several days of 24HR increases the precision of food consumption estimates, it results in higher costs and requires greater availability from the interviewees to report the data[8,34]. The findings of this study have relevant implications for the design and interpretation of data from research on children and adolescents with ASD. Considering that validation studies of FFQs developed for this age group generally found correlations ≤0.7, the results indicate that 1 to 2 days of 24HR may provide similar estimates to those obtained with FFQs commonly used in epidemiological studies with samples with and without ASD diagnoses[43–45].

The presented results provide support for the planning of methodologies for dietary data collection for children and adolescents with ASD. It also provides data for adjustments in analyses of the distribution and adequacy of food consumption in this population. The use of external dietary variability data is supported by previous studies, which indicate the applicability of previously collected values of S^2_w in order to correct estimates of the distribution of usual intake in studies with only one day of 24HR, on the condition that these data come from a sample with characteristics similar to those of the investigated population[11,46]. However, the application of repeated 24HR is still the most recommended method[47,48].

Our study has limitations inherent to the dietary method applied, such as the potential for underestimation or overestimation of food portions which can impact dietary intake estimates. To minimize this bias, we used a photo book of household measurements, and all nutritionists were trained to identify potential inconsistencies during the 24HR interviews. Additionally, sample restrictions should be considered, as the results were derived from children and adolescents attending a public health service in a city in Southern Brazil, which restricts the external validity of the study. Therefore, the interpretation and use of current findings require caution, as dietary habits and variability are influenced by multiple sociodemographic factors and may differ between populations[8]. Furthermore, there is a need for similar investigations with the adult population with ASD, as evidence suggests the presence of feeding problems in this age group as well[49].

Conclusion

In this study, the within-personal variance was predominantly higher than the between-person variance for most of the nutrients analysed, resulting in estimates of two to three days of 24HR needed to assess usual intake, considering the correlation coefficient of 0.8. The findings differed according to age and sex, suggesting the importance of including these aspects in the design and interpretation of results related to food consumption in ASD. Future studies may analyse how socioeconomic characteristics, behavioural, and clinical factors may influence food consumption and variability of nutrient intake in individuals with ASD.

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Conflict of interest

The authors declare that there are no conflicts of interest.

Authorship

The author's responsibilities were as follows: E.S. participated in the designing of the study, statistical analysis, interpreting of data, and writing the manuscript. E.V.J. supported the plan of statistical analysis and interpretation of data. L.H., K.C., S.V., and J.V. participated in designing the study and interpretation of data. All authors contributed to the writing or revising of the manuscript and approved the final version.

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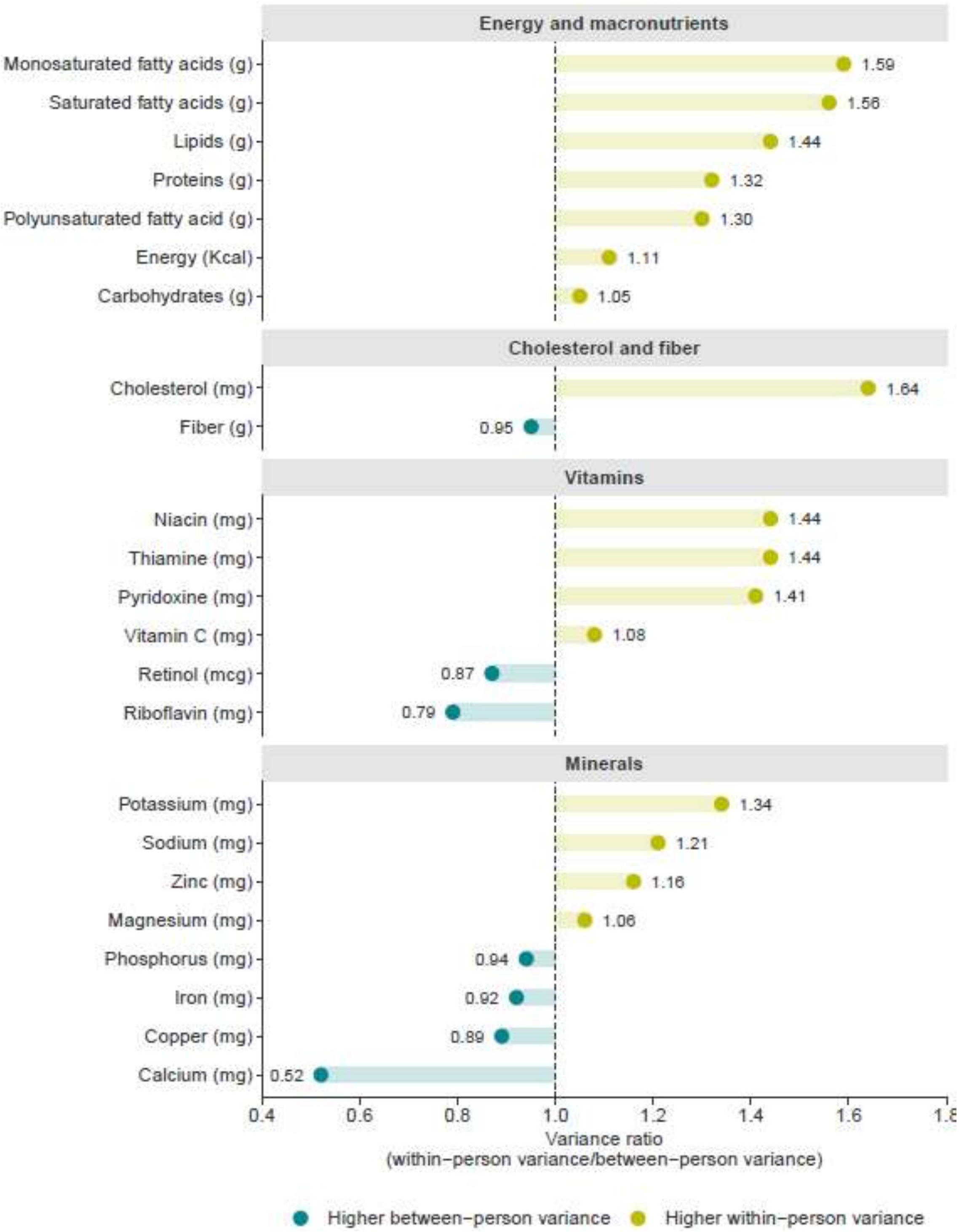

Figure 1. Variance ratio of energy, macronutrients, and micronutrients in children and adolescents with autism spectrum disorder. Pelotas, Brazil, PANA Study (n=284)

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Table 1. Socioeconomic and demographic characteristics of children and adolescents with autism spectrum disorder. Pelotas, Brazil, PANA Study (n=284)

Variables	**n**	**%**
Age (Years)		
2 - 5	118	41.6%
6 - 9	97	34.1%
10-18	69	24.3%
Sex		
Male	235	82.8%
Skin colour		
White	221	77.8%
Black, indigenous, or mixed race	63	22.2%
Primary caregiver		
Mother	261	91.9%
Others*	23	8.1%
Primary caregiver's education (years)†		
≤ 8	77	27.4%
≥ 9	204	72.6%
Family income per capita (US$)		
< 123,52	132	46.5%
123,52 a < 247,00	119	41.9%
≥ 247,00	33	11.6%
Use of antipsychotic medication		
Yes	154	54.2%
Overweight‡		
Yes	176	66.7%

*Other caregivers include fathers, grandparents, foster parents, and other family members.

†Missing data for 3 participants.

‡Assessed based on body mass index for age. Missing data for 20 participants.

Table 2. Distribution of crude and usual estimates of energy, macronutrient, and micronutrient intake in children and adolescents with autism spectrum disorder. Pelotas, Brazil, PANA Study (n=284)

Variables	**Estimated intake**					**Usual intake**				
	Mean	**SD**	**P25**	**P50**	**P75**	**Mean**	**SD**	**P25**	**P50**	**P75**
Energy (Kcal)	1781.2	571.5	1367.1	1726.7	2146.8	1782.7	480.8	1434.9	1742.4	2080.0
Carbohydrates (g)	248.4	87.4	189.5	239.7	305.4	248.6	73.9	195.8	243.8	298.1
Proteins (g)	59.2	21.7	43.2	57.3	69.4	59.3	17.8	46.6	58.4	69.1
Lipids (g)	61.2	26.5	40.9	55.8	75.4	61.4	21.3	45.6	57.6	72.9
Saturated fatty acids (g)	21.5	9.1	14.8	20.0	27.0	21.5	7.2	16.4	20.5	25.6
Monosaturated fatty acids (g)	18.8	9.2	11.7	16.7	23.7	18.8	7.1	13.5	17.7	23.0
Polyunsaturated fatty acid (g)	13.4	8.0	8.1	11.6	17.0	13.5	6.7	8.8	11.9	16.9
Cholesterol (mg)	192.6	121.7	103.4	166.4	258.8	193.4	97.9	123.3	174.6	252.3
Fiber (g)	16.5	9.1	9.8	14.4	21.5	16.6	7.9	11.0	15.3	20.2
Retinol (mcg)	310.5	272.3	137.3	264.5	399.9	305.4	199.8	161.7	280.3	410.7
Thiamine (mg)	1.1	0.5	0.8	1.1	1.4	1.1	0.4	0.9	1.1	1.4
Riboflavin (mg)	1.5	0.8	1.1	1.4	2.0	1.5	0.7	1.1	1.5	1.9
Pyridoxine (mg)	0.9	0.5	0.6	0.8	1.2	0.9	0.4	0.7	0.9	1.2
Niacin (mg)	11.3	6.8	6.7	10.3	14.8	11.3	5.1	8.0	10.6	14.4
Vitamin C (mg)	82.7	80.2	20.7	59.2	116.2	83.9	69.1	32.3	64.5	116.5
Calcium (mg)	744.3	412.1	422.8	682.7	993.4	745.3	375.5	441.3	685	990.6
Magnesium (mg)	214.7	77.8	159.8	208.9	251.2	215	66.1	168.1	209.1	248.5
Iron (mg)	8.3	3.8	5.7	7.7	10.5	8.3	3.3	6.1	7.8	10.1
Phosphorus (mg)	1021.4	348.5	774.3	992.4	1222	1022.2	300.1	816.7	1001.3	1202.9
Sodium (mg)	2166	893.2	1521	2046.3	2695.6	2168.9	734.7	1658.3	2086.7	2614.9
Potassium (mg)	1969.5	660.0	1539.1	1886.4	2378.9	1971.7	538	1599.7	1927.2	2320.7
Copper (mg)	0.9	0.5	0.6	0.8	1.1	0.9	0.4	0.6	0.8	1.1
Zinc (mg)	8.6	4.1	5.8	7.9	10.3	8.6	3.4	6.3	8.2	10.2

Note: values estimated using the Multiple Source Method® program. SD = standard deviation. P = percentil.

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Table 3. Variances of within-person and between-person variability and the number of days of 24-hour dietary recall needed to estimate usual energy, macronutrient, and micronutrient intake in children and adolescents with autism spectrum disorder. Pelotas, Brazil, PANA Study (n=284)

Variables	**Dietary variability**		**Number of days needed**		
	S^2_w	S^2_b	**r 0.7**	**r 0.8**	**r 0.9**
Energy (Kcal)	11.522	10.386	1	2	5
Carbohydrates (g)	3.727	3.538	1	2	4
Proteins (g)	0.891	0.674	1	2	6
Lipids (g)	0.137	0.095	1	3	6
Saturated fatty acids (g)	0.114	0.073	1	3	7
Monosaturated fatty acids (g)	0.211	0.133	2	3	7
Polyunsaturated fatty acid (g)	0.250	0.193	1	2	5
Cholesterol (mg)	0.289	0.176	2	3	7
Fiber (g)	0.409	0.432	1	2	4
Retinol (mcg)	0.238	0.273	1	2	4
Thiamine (mg)	0.163	0.113	1	3	6
Riboflavin (mg)	0.155	0.197	1	1	3
Pyridoxine (mg)	0.164	0.116	1	3	6
Niacin (mg)	0.209	0.146	1	3	6
Vitamin C (mg)	4.498	4.157	1	2	5
Calcium (mg)	10.684	20.669	1	1	2
Magnesium (mg)	1.226	1.155	1	2	5
Iron (mg)	0.606	0.661	1	2	4
Phosphorus (mg)	81.986	87.292	1	2	4
Sodium (mg)	1.057	0.872	1	2	5
Potassium (mg)	3.361	2.499	1	2	6
Copper (mg)	0.144	0.162	1	2	4
Zinc (mg)	0.136	0.117	1	2	5

Note: variability values were estimated using the Multiple Source Method® program. Results for the number of days were obtained using the formula proposed by Black *et al.*[29], considering the correlation coefficients of 0.7, 0.8, and 0.9. r = correlation coefficient. S^2_w = within-person variance. S^2_b = between-person variance. VR= S^2_w/S^2_b.

Table 4. Variances of intra- and inter-individual variability, variance ratios, and number of days needed for 24-hour recall to estimate usual energy, macronutrient, and micronutrient intake according to sex of children and adolescents with autism spectrum disorder. Pelotas, Brazil, PANA Study (n=284).

Variables	Boys (n=235)						Girls (n=49)					
	Dietary variability			Number of days needed			Dietary variability			Number of days needed		
	S^2_w	S^2_b	VR	r 0.7	r 0.8	r 0.9	S^2_w	S^2_b	VR	r 0.7	r 0.8	r 0.9
Energy (Kcal)	1.113	0.857	1.30	1	2	6	0.068	0.080	0.84	1	1	4
Carbohydrates (g)	1.194	1.035	1.15	1	2	5	0.508	0.493	1.03	1	2	4
Proteins (g)	0.880	0.609	1.44	1	3	6	0.307	0.224	1.37	1	2	6
Lipids (g)	0.426	0.259	1.65	2	3	7	0.147	0.139	1.06	1	2	5
Saturated fatty acids (g)	0.355	0.191	1.86	2	3	8	0.085	0.092	0.92	1	2	4
Monosaturated fatty acids (g)	0.217	0.127	1.72	2	3	7	0.199	0.149	1.34	1	2	6
Polyunsaturated fatty acid (g)	0.230	0.164	1.40	1	2	6	0.433	0.342	1.26	1	2	5
Cholesterol (mg)	0.266	0.167	1.60	2	3	7	0.446	0.216	2.07	2	4	9
Fiber (g)	0.492	0.444	1.11	1	2	5	0.187	0.260	0.72	1	1	3
Retinol (mcg)	0.227	0.258	0.88	1	2	4	0.270	0.340	0.79	1	1	3
Thiamine (mg)	0.151	0.089	1.70	2	3	7	0.160	0.170	0.94	1	2	4
Riboflavin (mg)	0.177	0.199	0.89	1	2	4	0.146	0.296	0.49	1	1	2
Pyridoxine (mg)	0.167	0.106	1.58	2	3	7	0.125	0.109	1.15	1	2	5
Niacin (mg)	0.208	0.150	1.39	1	2	6	0.684	0.302	2.27	2	4	10
Vitamin C (mg)	4.702	4.200	1.12	1	2	5	5.523	6.003	0.92	1	2	4
Calcium (mg)	10.979	19.060	0.58	1	1	2	10.471	29.812	0.35	1	1	1
Magnesium (mg)	0.434	0.333	1.30	1	2	6	0.347	0.476	0.73	1	1	3
Iron (mg)	0.603	0.604	1.00	1	2	4	0.364	0.387	0.94	1	2	4
Phosphorus (mg)	95.983	77.812	1.23	1	2	5	73.970	164.068	0.45	1	1	2
Sodium (mg)	0.512	0.350	1.46	1	3	6	7.089	7.717	0.92	1	2	4
Potassium (mg)	0.593	0.347	1.71	2	3	7	11.597	17.403	0.67	1	1	3
Copper (mg)	0.150	0.152	0.98	1	2	4	0.148	0.197	0.75	1	1	3
Zinc (mg)	0.132	0.106	1.25	1	2	5	0.179	0.139	1.29	1	2	5

Note: Variability values were estimated using the Multiple Source Method® program. Results for the number of days were obtained using the formula proposed by Black *et al.*[29], considering the correlation coefficients of 0.7, 0.8, and 0.9. r= correlation coefficient. S^2_w= Within-person variance. S^2_b = Between-person variance. VR= S^2_w/S^2_b.

Table 5. Variances of within-person and between-person variability of energy, macronutrient, and micronutrient according to age group of children and adolescents with autism spectrum disorder. Pelotas, Brazil, PANA Study (n=284).

Variaveis	**2-5 years (n= 118)**			**6-9 years (n= 97)**			**10-18 years (n=69)**		
	S^2_w	**S^2_b**	**VR**	**S^2_w**	**S^2_b**	**VR**	**S^2_w**	**S^2_b**	**VR**
Energy (Kcal)	9.814	12.216	0.80	0.402	0.249	1.62	1.002	0.492	2.04
Carbohydrates (g)	3.461	4.262	0.81	0.218	0.177	1.23	0.261	0.092	2.85
Proteins (g)	0.999	0.764	1.31	6.769	5.018	1.35	2.088	1.304	1.60
Lipids (g)	1.249	1.268	0.99	0.183	0.071	2.57	0.126	0.083	1.52
Saturated fatty acids (g)	0.978	1.130	0.87	0.135	0.037	3.61	0.171	0.103	1.66
Monosaturated fatty acids (g)	0.413	0.370	1.12	0.255	0.084	3.02	0.230	0.121	1.89
Polyunsaturated fatty acid (g)	0.233	0.215	1.08	0.319	0.255	1.25	1.135	0.307	3.69
Cholesterol (mg)	0.343	0.269	1.28	0.912	0.622	1.47	13.427	3.946	3.40
Fiber (g)	0.323	0.457	0.71	0.856	0.841	1.02	1.136	0.588	1.93
Retinol (mcg)	10.070	16.954	0.59	0.247	0.285	0.87	0.559	0.301	1.86
Thiamine (mg)	0.124	0.174	0.71	0.163	0.046	3.59	0.233	0.124	1.88
Riboflavin (mg)	0.130	0.250	0.52	0.226	0.198	1.14	0.270	0.232	1.17
Pyridoxine (mg)	0.173	0.190	0.91	0.090	0.052	1.72	0.205	0.093	2.21
Niacin (mg)	0.563	0.419	1.34	0.195	0.095	2.05	0.214	0.108	1.99
Vitamin C (mg)	4.525	3.665	1.23	6.645	7.902	0.84	15.733	10.085	1.56
Calcium (mg)	100.426	261.309	0.38	75.560	93.247	0.82	1.518	1.627	0.93
Magnesium (mg)	0.655	0.904	0.73	0.391	0.298	1.31	27.524	20.407	1.35
Iron (mg)	0.335	0.419	0.80	0.171	0.176	0.97	1.498	0.641	2.34
Phosphorus (mg)	74.330	113.463	0.66	64.155	47.197	1.36	96.188	83.645	1.15
Sodium (mg)	0.374	0.337	1.11	8.426	4.095	2.06	7.240	3.802	1.90
Potassium (mg)	13.633	16.017	0.85	0.360	0.157	2.30	17.719	12.545	1.41
Copper (mg)	0.144	0.193	0.75	0.146	0.124	1.18	0.148	0.108	1.37
Zinc (mg)	0.156	0.138	1.13	0.103	0.094	1.09	0.151	0.102	1.48

Note: Variability values were estimated using the Multiple Source Method® program. S^2_w= Within-person variance. S^2_b = Between-person variance. VR= S^2_w/S^2_b.

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Table 6. Number of days of 24-hour dietary recall required to estimate the usual energy, macronutrient, and micronutrient intake according to age group of children and adolescents with autism spectrum disorder. Pelotas, Brazil, PANA Study (n=284).

Variables	**2-5 years (n= 118)**			**6-9 years (n= 97)**			**10-18 years (n=69)**		
	r 0.7	**r 0.8**	**r 0.9**	**r 0.7**	**r 0.8**	**r 0.9**	**r 0.7**	**r 0.8**	**r 0.9**
Energy (Kcal)	1	1	3	2	3	7	2	4	9
Carbohydrates (g)	1	1	3	1	2	5	3	5	12
Proteins (g)	1	2	6	1	2	6	2	3	7
Lipids (g)	1	2	4	2	5	11	1	3	6
Saturated fatty acids (g)	1	2	4	3	6	15	2	3	7
Monosaturated fatty acids (g)	1	2	5	3	5	13	2	3	8
Polyunsaturated fatty acid (g)	1	2	5	1	2	5	4	7	16
Cholesterol (mg)	1	2	5	1	3	6	3	6	14
Fiber (g)	1	1	3	1	2	4	2	3	8
Retinol (mcg)	1	1	3	1	2	4	2	3	8
Thiamine (mg)	1	1	3	3	6	15	2	3	8
Riboflavin (mg)	1	1	2	1	2	5	1	2	5
Pyridoxine (mg)	1	2	4	2	3	7	2	4	9
Niacin (mg)	1	2	6	2	4	9	2	4	8
Vitamin C (mg)	1	2	5	1	1	4	1	3	7
Calcium (mg)	1	1	2	1	1	3	1	2	4
Magnesium (mg)	1	1	3	1	2	6	1	2	6
Iron (mg)	1	1	3	1	2	4	2	4	10
Phosphorus (mg)	1	1	3	1	2	6	1	2	5
Sodium (mg)	1	2	5	2	4	9	2	3	8
Potassium (mg)	1	2	4	2	4	10	1	3	6
Copper (mg)	1	1	3	1	2	5	1	2	6
Zinc (mg)	1	2	5	1	2	5	1	3	6

Note: Results for the number of days obtained using the formula proposed by Black *et al.*[29], considering the correlation coefficients of 0.7, 0.8, and 0.9. r= correlation coefficient.