Bioelectrical impedance values among indigenous children and adolescents in Rio Grande do Sul, Brazil

Laura Augusta Barufaldi,[1] *Wolney Lisboa Conde,*[2] *Ilaine Schuch,*[1]
Bruce Bartholow Duncan,[1] *and Teresa Gontijo de Castro*[3]

ABSTRACT

Objective.   To describe the nutritional status of indigenous children and adolescents in Rio Grande do Sul, Brazil, through bioelectrical values, and to compare the nutritional classifications of the anthropometric method to those of the body composition method.

Methods.   A cross-sectional survey was conducted of 3 204 subjects at 35 schools in the 12 Kaingang indigenous lands of Rio Grande do Sul, Brazil. Following World Health Organization recommendations, the weight and height (H) of each subject was measured twice and the body mass index/age (BMI/A) was classified. Body composition was assessed by Bioelectrical Impedance Vector Analysis (BIVA). Resistance (R) and reactance (Xc) were estimated using a bioelectrical impedance analyzer. Divergences between these two methods were performed on RXc graph.

Results.   Of the sample, 56.8% were adolescents and 50.6% were males. The mean values of phase angle were higher in adolescents, in males, and in individuals overweight by BMI/A. Mean values of R, Xc, R/H, and Xc/H were higher among children and among those with BMI/A ≤ +2 z scores. Divergences in overweight classification were: male children, 94.6%; male adolescents, 77.1%; female children, 85.4%; and female adolescents, 94.8%.

Conclusions.   The mean values of bioelectrical measures observed among the Kaingang children and adolescent were similar to those found for different populations in other studies. For both gender and age groups, differences were observed between nutritional classifications by BMI/age and by BIVA. These results reinforce the importance of employing multiple techniques, such as anthropometry and BIVA, when conducting nutritional assessments of a population.

Key words   Anthropometry; body weights and measures; electric impedance; nutrition assessment; indigenous health; ethnic groups; Brazil.

[1]   Departamento de Medicina Social, Faculdade de Medicina, Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil.
[2]   Departamento de Nutrição, Escola de Saúde Pública, Universidade de São Paulo, São Paulo, Brazil.
[3]   Departamento de Enfermagem Materno-infantil e Saúde Pública, Faculdade de Enfermagem, Universidade Federal de Minas Gerais, Belo Horizonte, Brazil. Send correspondence to Teresa Gontijo de Castro, tgontijo108@gmail.com

Information on the health and living conditions of marginalized ethnic groups is imperative for their social integration and the development of supportive public policies and subsidy programs. In Brazil, where the ethnic diversity of the indigenous groups is so broad and their geographic distribution is vast, under-standing the epidemiologic profile of indigenous populations is especially important to organizing, planning, and improving the quality of health care for these peoples (1).

The Kaingang people are among the five largest indigenous ethnic groups in Brazil, with approximately 30 000 indi-

viduals dispersed among more than 30 indigenous lands (IL) recognized by the National Foundation for Indigenous (Peoples Fundação Nacional do Indio; FUNAI) in São Paulo, Paraná, Santa Catarina, and Rio Grande do Sul (RS). In RS, they are spread across 12 IL, numbering approximately 16 000 individuals. The Kaingang have been in contact with non-Indigenous peoples since the 18th Century. During the process of colonization, and later, during the second half of the 20th Century, the Kaingang's lands were reduced to small fractions of their original span (2). Recently, a study observed precarious living conditions and high rates of stunting in children among the Kaingang in RS (3). Another study, conducted among the Kaingang in another state, pointed to a similar, precarious situation (4). Among this population, the concomitance of stunting and overweight/obesity has been observed, characteristics typical of the nutritional transition (3, 5, 6).

Most studies on the health conditions of indigenous peoples in Brazil have been conducted in the Amazon and in Brazil's Midwest (7, 8). Studies of IL located in the South, Southeast, and Northeast areas of Brazil are still scarce. Compared to the indigenous people of IL in other parts of Brazil, the health and nutritional status of those in the South, Southeast, and Northeast is worse, probably due to the more drastic territorial reductions endured by these peoples since their initial contact with non-Indigenous people (1). The significant land reduction has limited their ability to produce their own food and has forced them to make cultural adaptations, which in turn, have directly impacted their health and nutritional status.

Moreover, studies on nutritional assessment of indigenous peoples were based mostly on anthropometric indicators (4, 8–10), and rarely on assessments of body composition. Although the body mass index (BMI) has an association with adiposity, it does not distinguish between weight changes due to fat mass, lean mass, or water (11). Therefore, the present study aimed to: (i) describe the nutritional status of children and adolescents from schools in 12 Kaingang IL in RS, Brazil, using bioelectrical impedance; and (ii) compare the differences in nutritional status classifications determined by anthropometric versus body composition methods.

METHODS

This was a cross-sectional study conducted in 35 schools in 12 Kaingang IL in Rio Grande do Sul, Brazil, recognized by FUNAI at the time of data collection in July–December 2008. The parent study (12) of the present one was commissioned by the National School Feeding Program, Ministry of Education of Brazil. Its purpose was to obtain information on the nutritional status of Kaingang students at schools in the IL of RS, to improve public policy planning and interventions.

As previously reported in more detail (12), the study population is characterized by a significant prevalence of overweight, according to BMI/age (BMI/A); and stunting, according to height-for-age index (H/A index). The prevalence of overweight observed among male and female children was 5.5% and 5.9%, respectively; while among adolescent males and females, the values were 5.0% and 8.6%, respectively. Low values for H/A index (< 2 z score) were found in male children, 16.2%; female children, 15.0%; male adolescents, 21.2%; and female adolescents, 18.5%.

The field research team consisted of four trained nutritionists. Prior to data collection, a pilot study was conducted in a non-Indigenous school in Porto Alegre, RS, to standardize techniques and methods for collection and registration of anthropometric and body composition measurements.

Demographic data, specifically gender and date of birth, were obtained from school enrollment records. If a birth date was missing in the school records, it was obtained from the local records of the National Health Foundation (Fundação Nacional de Saúde, FUNASA). Age was calculated as the difference between the date of the anthropometric evaluation and the student's date of birth. Of the 35 schools, 7 were visited a second time because fewer than 70% of the students had been assessed.

The anthropometric evaluation was performed by measuring weight (kg) and height (m) twice, according World Health Organization (WHO) recommendations (13). Weight was measured using a Marte® portable digital scale (Marte Balanças e Aparelhos de Precisão Ltd. Santa Rita do Sapucaí, Minas Gerais, Brazil) with a 150 kg capacity and precision of 50 g. Height was measured using

an Alturaexata® stadiometer (Alturaexata Ltd., Belo Horizonte, Minas Gerais, Brazil) with a 213 cm capacity and precision of 1 mm. BMI was calculated by dividing the weight by the square of the height. Values of height, weight, and BMI were standardized by age and gender, according to the values of the WHO Growth Curve (14), using the WHO Anthro 2005 (0–5 years of age) and WHO Anthro-Plus 2009 (> 5 years) software programs. Individuals with values of BMI/age above +2 z scores were considered to be overweight for this study.

Body composition was estimated according to resistance and reactance in W (ohms), using the Quantum II® bioelectrical impedance analyzer (RJL Systems, Clinton Township, Michigan, United States). The measurements were performed with the individual in the supine position on a coated mattress, free of electricity-conducting material, and at ambient temperature. Contact with the legs, arms, and trunk was avoided; the electrodes were placed according to the manufacturer's instructions. In addition, subjects had refrained from any intense physical activity in the 4 hours prior to measurement. Such activity can affect the fluids distribution and the concentration of free electrolytes between intra- and extracellular compartments, inducing changes in the results of resistance (15).

The Bioelectric Impedance Vector Analysis (BIVA) proposed in 1994 (16) was used to evaluate body composition. With this method, resistance (R) and reactance (Xc) are standardized by the height (H) and plotted as vectorial points on a RXc graphic (16), generating tolerance ellipses corresponding to the 50th, 75th, and 95th percentiles. In this analysis, displacements of vectors parallel to the higher axis of tolerance ellipses indicate progressive changes in tissue hydration. That is, long vectors, above the upper pole, indicate dehydration; while short vectors, below the lower pole, indicate hyperhydration with apparent edema. Vectors descending or migrating parallel to the minor axis indicate the amount of cell mass: above displacements (to the left) indicate higher amount of cell mass; below displacements (to the right), indicate smaller amount of cell mass (17).

The values of R/H and Xc/H were standardized in relation to age, for each sex, and by linear regression with age, as the independent variable. The standard-

ized residues of these regression models were used, as *z* scores, to evaluate the nutritional status in the RXc graphics. Individuals with values out of the 95% confidence ellipse, in the quadrant located at the left on the bottom of the chart, were classified as being overweight. The 95% interval of tolerance ellipse indicates statistically significant difference in vector position (*P* < 0.05) (18). The comparison of overweight classification by BIVA and BMI/age was made by the analysis of RXc graphics, highlighting cases of overweight according to BMI/age. Divergent classifications were assumed when overweight individuals, classifieds by BMI/age, were located within the 95% interval of the tolerance ellipse on the graphic.

Comparisons between means were performed by Student *t* test for independent samples, and between proportions by the homogeneity of proportions test, based on Pearson's χ^2 statistic. The phase angle was calculated by the formula: arctangent (reactance/resistance) × 180°/π (19). *P* values < 0.05 were considered to be statistically significant. Analysis and RXc graphics were performed using STATA® 10.0 (StataCorp LP, College Station, Texas, United States).

The study was approved by the Research Ethics Committee of the Federal University of Rio Grande do Sul (Universidade Federal do Rio Grande do Sul, Protocol n° 2007726); the National Commission on Research Ethics (Comitê Nacional de Ética em Pesquisa, Protocol n° 14.449); the National Council on Scientific and Technological Development (Conselho Nacional de Desenvolvimento Científico e Tecnológico); and FUNAI (case CGEP 1141–1108). Data were collected only from individuals with a "Free and Informed Consent" form signed by either the parents or a legal guardian. Study participants who were diagnosed with a severe nutritional disorder were referred to the local FUNASA unit.

RESULTS

Of the 4 528 individuals enrolled at the beginning of 2008, 2.5% had dropped out of school, and 1.2% had transferred. Therefore, the number of individuals actually enrolled at the time of the study was 4 360. Of these, 681 (15.6%) did not have a "Free and Informed Consent" form signed by their parent/legal guardian; 66 (1.5%) refused to participate in the study; 405 (9.3%) had a signed consent form, but were absent on the data collection day; 1 individual did not have a birth date on record; and 3 refused to perform the biological impedance evaluation. In all, 3 204 indigenous children and adolescents, representing 73.6% of the regular students at the time of the survey, were evaluated.

Table 1 shows the numbers and percentages of individuals evaluated at the schools in each IL, described by gender and age. The children in the study were from 3.7 – 19.8 years of age, with a mean of 10.8 years (± 2.9). Males constituted 50.6% of the sample. Comparing sample and losses, there were no statistically significant differences for gender (*P* = 0.20) or age (*P* = 0.53). Only 13 (0.94%) were less than 5 years of age. Despite the small number of children under 5 years, they were included in the analyses since they were, in fact, part of the age distribution at the schools studied.

The bioelectrical impedance values —according to age, gender, and BMI/age categories—are presented in Table 2. The mean values of phase angle were higher in adolescents, in males, and in individuals who were overweight according to BMI/age. The mean values of R, Xc, Xc/H, and R/H were higher among children than adolescents, and among those with BMI/age ≤ +2 *z* scores than among those who were overweight. With the exception of Xc/H among children, these indices were statistically higher among females.

The disagreement in nutritional status classification between BIVA and BMI/age are located in the lower left of the graphs presented in Figure 1. In this quadrant, individuals had high body mass in relation to lean tissue, suggestive of accumulated fatty tissue. The number of children beyond the 95% ellipse (2.6% of them) was higher than the 1.5% observed among adolescents (χ^2 = 4.919, *P* = 0.027). Classification differences were 94.6%, 85.4%, 77.1%, and 94.8%, respectively, for male children, female children, male adolescents, and female adolescents.

DISCUSSION

This study represents, in absolute numbers, the largest nutritional survey of a single ethnic indigenous group in Brazil and pioneered the use of BIVA for

TABLE 1. Study sample composed of 3 204 students enrolled at 35 schools in 12 Kaingang indigenous lands (IL) in Rio Grande do Sul, by gender, age group, and IL, Brazil, 2008

	Males n = 1 621				Females n = 1 583				
	Children		Adolescents		Children		Adolescents		Total
Indigenous land	No.	%	No.	%	No.	%	No.	%	No. (100%)
Cacique Doble	38	27.3	35	25.2	25	17.9	41	29.6	139
Carreteiro	10	33.3	9	30.0	6	20.0	5	16.7	30
Guarita	202	21.4	262	27.7	222	23.6	258	27.3	944
Inhacorá	38	21.4	61	34.2	26	14.6	53	29.8	178
Irai	29	18.9	49	32.0	39	25.5	36	23.6	153
Ligeiro	59	18.8	106	33.8	56	17.8	93	29.6	314
Monte Caseiros	34	36.2	16	17.0	25	26.6	19	20.2	94
Nonoai	82	17.8	139	30.2	116	25.2	124	26.8	461
Rio da Várzea	21	20.0	31	28.2	24	21.8	34	30.9	110
Serrinha	93	20.9	126	28.4	108	24.4	116	26.3	443
Ventarra	10	16.4	18	29.5	11	18.0	22	36.1	61
Votouro	57	20.6	96	34.7	50	18.1	74	26.6	277
Total	673	21.0	948	29.6	708	22.1	875	27.3	3 204

TABLE 2. Mean values (± standard deviation) of bioelectrical measures according to age categories, gender and body mass index (BMI)/age categories, Kaingang indigenous lands, Rio Grande do Sul, Brazil, 2008

Bioelectrical impedance measures[a]	Children and adolescents												
	Males (n = 1 621)		Females (n = 1 583)			BMI/age > +2 z score (n = 201)		BMI/age ≤ +2 z score (n = 3 003)			Total (n = 3 204)		
BMI	Mean	SD	Mean	SD	P value[b]	Mean	SD	Mean	SD	P value[c]	Mean	SD	P value[d]
Children (No.)	673		708			79		1 302			1 381		
R (Ohm)	671.5	60.8	705.0	64.8	< 0.001	633.9	53.9	691.9	64.2	< 0.001	688.7	65.0	< 0.001
Xc (Ohm)	65.9	8.2	66.9	8.4	0.025	62.5	5.9	66.7	8.4	< 0.001	66.5	8.3	< 0.001
R/H (Ohm/m)	558.8	71.5	585.5	77.5	< 0.001	507.1	73.9	576.4	74.1	< 0.001	572.5	75.8	< 0.001
Xc/H (Ohm/m)	54.8	7.6	55.5	8.4	0.105	49.8	6.2	55.5	8.0	< 0.001	55.2	8.0	< 0.001
Phase angle	5.6	0.7	5.4	0.6	< 0.001	5.7	0.5	5.5	0.6	0.004	5.5	0.6	< 0.001
Adolescents (No.)	948		875			122		1 701			1 823		
R (Ohm)	589.4	86.1	629.3	70.4	< 0.001	558.5	67.3	612.3	81.1	< 0.001	608.6	81.4	—[e]
Xc (Ohm)	63.8	8.1	65.8	8.2	< 0.001	60.9	7.6	65.1	8.1	< 0.001	64.8	8.2	—
R/H (Ohm/m)	410.3	86.9	437.9	68.5	< 0.001	381.7	61.1	426.8	80.1	< 0.001	423.6	79.7	—
Xc/H (Ohm/m)	44.2	7.4	45.7	6.6	0.007	41.6	6.4	45.1	7.0	< 0.001	44.9	7.0	—
Phase angle	6.3	0.9	6.0	0.7	< 0.001	6.3	0.7	6.1	0.8	0.006	6.1	0.8	—

[a] R(resistance); Xc (reactance); R/H (resistance adjusted by height); Xc/H (reactance adjusted by height).
[b] Student t test for independent samples: mean comparisons between gender.
[c] Student t test for independent samples: mean comparisons between BMI/age categories.
[d] Student t test for independent samples: mean comparisons between children and adolescents.
[e] No data.

FIGURE 1. Bioelectrical impedance individual vectors plotted in the 95% tolerance ellipse, by gender and age, of 3 204 students enrolled at 35 schools in 12 Kaingang indigenous lands, Rio Grande do Sul, Brazil, 2008
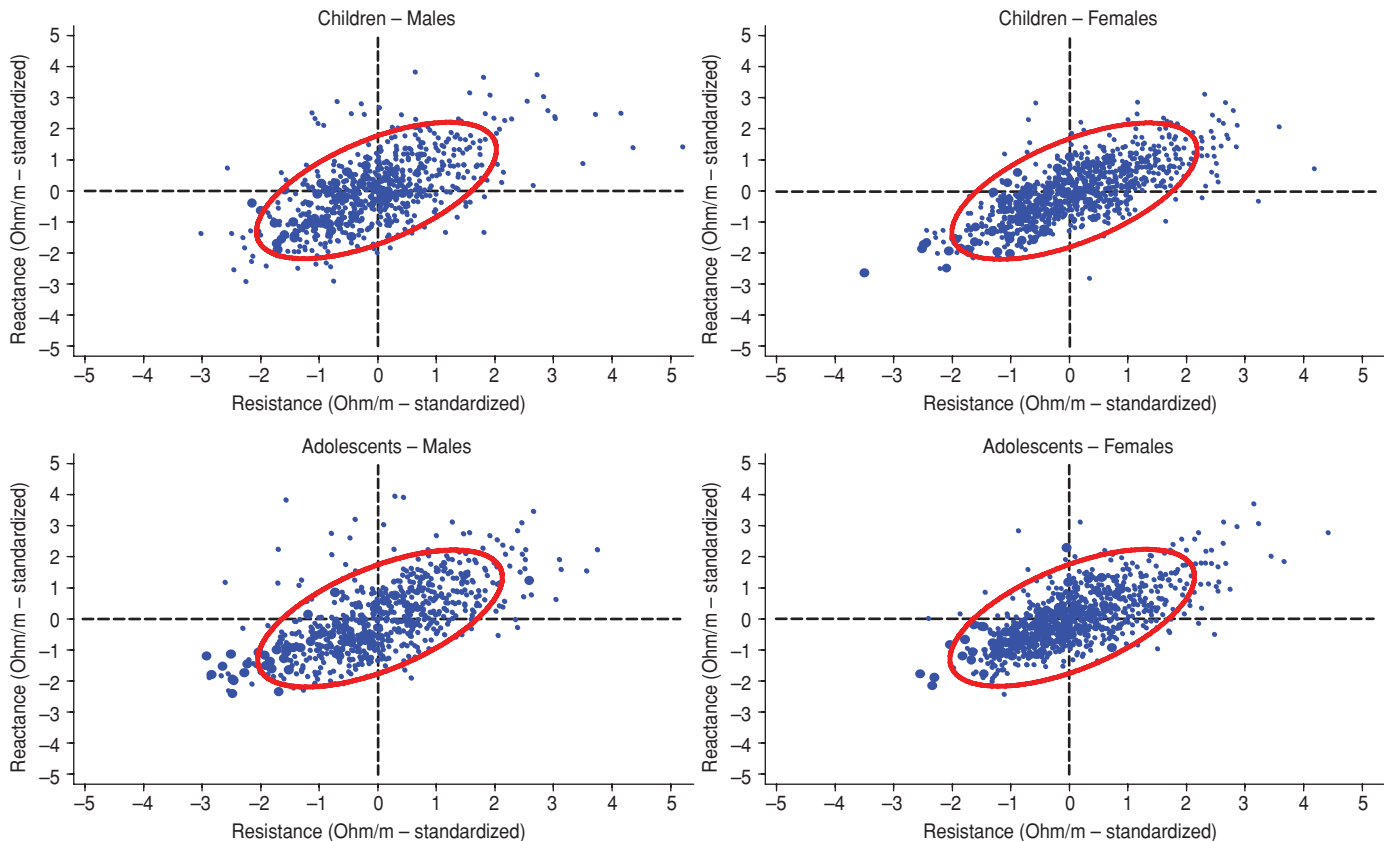
Note: Highlighted points are individuals with overweight as defined by the World Health Organization (14).

assessing body composition among an indigenous population in the world.

Studies conducted with non-indigenous children and adolescents showed mean values of bioelectric measures—R, Xc, R/H, Xc/H—and phase angles similar to those of the Kaingang (18, 20–22), and corroborate the observation of increasing phase angle means with increasing age (18, 20). However, an important aspect to be noted when interpreting bioelectrical measures is that, since the evaluated individuals are in their growth phase, the values observed may be temporary (18).

The few national (19, 23) and international (24, 25) studies that employed body composition of indigenous peoples by bioelectrical impedance based their results on equations for estimating body composition. The need for equation assumptions with bioelectrical impedance can be overcome by using the BIVA method since it is based on direct measurements of resistance and reactance (16), which are affected, in turn, only by errors cause by measurement equipment and biological variables (26). In addition, the use of residues from regression models of R/H and Xc/H, adjusted by gender and age, permits performing self-reference for the study population, minimizing the variability of body composition attributed to socioeconomic differences, present when the reference population is distinct from that of the study. Unfortunately, few studies were found that employed BIVA for body composition assessment in childhood and/or puberty (11, 18, 27, 28). One, a study of children in Italy, illustrated frequencies of weight excess by BIVA, according to categories of BMI established by Cole et al. (29). This study observed 1.8% of weight excess among eutrophic individuals, 5.9% among those overweight, and 20.7% among obese (11). However, it must be taken in account that the Italian study was limited to children 8 years of age, carried out the construction of the tolerance ellipses from bioelectrical measurements of normal children by BMI, and used the 75% tolerance ellipse as the cutoff point for excess body fat.

Some factors are likely to be responsible for the increasing prevalence of overweight among indigenous communities. Indigenous populations have, over time, decreased their levels of physical activity (7), introduced new foods into their diet (usually those typically Western), and decreased their consumption of local and natural foods (3). These changes may be related to the significant prevalence of overweight among Kaingang children and adolescents. The eminence of overweight since childhood among Kaingang is worrying, since it greatly increases the risk of overweight in adolescence and adulthood. Children with a BMI above the 85th percentile were 1.3 times more likely to be obese at 20–29 years of age; and the risk increased to 17.5 if they were obese at 15–17 years of age (30). Obesity is the most common cause of increased insulin resistance, associating strongly to dyslipidemia and type 2 diabetes mellitus (31). Although studies on the prevalence of diabetes among indigenous populations are scare, the available statistics show that diabetes has reached epidemic levels, putting indigenous groups around the world at-risk (32).

The comparison between nutritional status classification by BMI/age and BIVA showed important divergences. High percentages of divergences were also demonstrated by a study conducted in 2008 among children 8 years of age (11) that compared overweight according to BIVA versus BMI as defined by another study (29). The results of the present study give rise to questions regarding the appropriateness of using international growth curves (14) to assess nutritional status for ethnically homogeneous populations such as the Kaingang. Finding a percentage of agreement between the two methods was not possible because, although there are established cutoff points for overweight based on BMI/age, there is no consensus in the literature on the cutoff points for excess body fat using BIVA. The aforementioned challenges point to the need for more studies using BIVA, studies that might elucidate nutritional diagnostics and behaviors of bioelectrical measures at different stages of the lifecycle and among various populations.

This study presents some limitations that should be considered in the interpretation of the results. The first is related to the cross-sectional design of the study that makes it unfeasible to establish causality. Despite the large number of children and adolescents evaluated in the 12 IL (73.6% the regularly-enrolled students), the 80% considered ideal was not obtained. Although there were no differences detected between the losses and the sample, relative to the proportions of age and gender, it was not possible to evaluate differences from other potential sources of bias, such as comorbidity, socioeconomic status, and/or access to health services. Due to these facts, caution should be taken regarding the extrapolation of these results to the entire population of Kaingang children and adolescents in the Kaingang schools of RS.

Another aspect to be considered when interpreting these results is related to collecting resistance and reactance measurements. Both measurements may be affected by factors such as diet, exercise, fluid intake prior to assessment, hydration status, use of diuretics, menstrual cycle, and room temperature (15). In this study, the only control was avoidance of intense physical activity prior the assessment. Also, the values of resistance could have been influenced by climatic oscillation during the field work, which took place in July (winter, with average temperatures of 17.3 °C)–December (late spring, with average temperature of 24.7 °C).[4] In addition, the absence of data regarding the status of sexual maturation among the adolescents may have influenced bioelectrical impedance measures. In fact, a study conducted in 2002 (27) found lower values of R/H, Xc/H, and phase angle among girls after, as opposed to before, menarche.

In conclusion, the mean values of bioelectrical measures observed among Kaingang children and adolescents were similar to those found for different populations in other studies, where, except for the phase angle, measurements were higher among children than adolescents. For both gender and age groups, the deviations in the RXc graphics indicate a higher proportion of fat mass compared to fat-free mass. Differences between nutritional classifications by BMI/age and BIVA were present.

Hopefully, the results of this study will encourage and expand the discussion on public nutrition policies aimed at indigenous peoples. Since a reference for body composition analysis does not exist, and few studies have compared methods, these results reinforce the importance of employing multiple techniques, such as the anthropometric ones and BIVA, when possible, in the nutritional assessment of populations.

---

[4] 8° Distrito de Metereologia do Rio Grande do Sul. [Spreadsheet]. Rio Grande do Sul, Brazil: 2010.

REFERENCES

1. Santos RV, Coimbra Jr CEA. Cenários e tendências da saúde e da epidemiologia dos povos indígenas do Brasil. In: Coimbra Jr. CEA, Santos RV, Escobar AL, eds. Epidemiologia e saúde dos povos indígenas no Brasil. Rio de Janeiro: Editora Fiocruz; 2003. Pp. 13–47.
2. Ricardo CA, ed. Povos indígenas no Brasil 1996/2000. São Paulo: Instituto Socioambiental; 2000.
3. Menegolla IA, Drachler ML, Rodrigues IH, Schwingel LR, Scapinello E, Pedroso MB, et al. Estado nutricional e fatores associados à estatura de crianças da Terra Indígena Guarita, Sul do Brasil. Cad Saúde Pública. 2006;22: 395–406.
4. Kuhl AM, Corso ACT, Leite MS, Bastos JL. Perfil nutricional e fatores associados à ocorrência de desnutrição entre crianças indígenas Kaingáng da Terra Indígena de Mangueirinha, Paraná, Brasil. Cad Saúde Pública. 2009;25:409–20.
5. Ribas DLB, Sganzerla A, Zorzatto JR, Philippi ST. Nutrição e saúde infantil em uma comunidade indígena Teréna, Mato Grosso do Sul, Brasil. Cad Saúde Pública. 2001;17:323–31.
6. Fundação Nacional de Saúde. Diagnóstico de Saúde da População Indígena. Estado do Rio Grande do Sul. Brasília: Fundação Nacional de Saúde; 1996.
7. Leite MS, Santos RV, Gugelmim AS, Coimbra Jr CEA. Crescimento físico e perfil nutricional da população indígena Xavánte de Sangradouro-Volta Grande, Mato Grosso, Brasil. Cad Saúde Pública. 2006;22:265–76.
8. Mondini L, Canó EM, Fagundes U, Lima EES, Rodrigues D, Baruzzi RG. Condições de nutrição em crianças Kamaiurá — povo indígena do Alto Xingu, Brasil Central. Rev Bras Epidemiol. 2007;10:39–47.
9. Leite MS, Santos RV, Coimbra Jr. CEA. Sazonalidade e estado nutricional de populações indígenas: o caso Wari', Rondônia, Brasil. Cad Saúde Pública. 2007;23:2631–42.
10. Buitrón D, Hurtig A, San Sebastián M. Estado nutricional en niños naporunas menores de cinco años en la Amazonía ecuatoriana. Rev Panam Salud Publica. 2004;15:151–9.
11. Guida B, Pietrobelli A, Trio R, Laccetti R, Falconi C, Perrino NR, et al. Body mass index and bioelectrical vector distribution in 8-year-old children. Nutr Metab Cardiovasc Dis. 2008;18:133–41.
12. Castro TG, Schuch I, Conde WL, Veiga J, Leite MS, Dutra CLC, et al. Estado Nutricional dos indígenas Kaingang matriculados em escolas indígenas do estado do Rio Grande do Sul, Brasil. Cad Saúde Pública. 2010;26(9):1766–76.
13. World Health Organization. Physical status: the use and interpretation of anthropometry. Report of a WHO Expert Committee. Geneva: WHO; 1995. [Technical Report Series no. 854].
14. World Health Organization. WHO child growth standards: length/height-for-age, weight-for-age, weight-for-length, weight-for-height and body mass index-for-age: methods and development. Geneva: World Health Organization; 2006.
15. Dehghan M, Merchant AT. Is bioelectrical impedance accurate for use in large epidemiological studies? Nutr J. 2008;7:1–7.
16. Piccoli A, Rossi B, Pillon L, Bucciante G. A new method for monitoring body fluid varation by bioimpedance analysis: the RXc graph. Kidney Int. 1994;46:534–9.
17. Piccoli A, Pastori G. BIVA software. Padova, Italy: Department of Medical and Surgical Sciences, University of Padova; 2002.
18. De Palo T, Messina G, Edefonti A, Perfumo F, Pisanello L, Peruzzi L, et al. Normal values of the bioelectrical impedance vector in childhood and puberty. Nutrition. 2000;16(6): 417–24.
19. Lourenço AEP, Santos RV, Orellana JDY, Coimbra Jr CEA. Nutrition transition in Amazonia: obesity and socioeconomic change in the Suruí Indians from Brazil. Am J Hum Biol. 2008;20:564–71.
20. Escobar AL, Santos RV, Coimbra Jr. CEA. Avaliação nutricional de crianças indígenas Pakaanóva (Warí), Rondônia, Brasil. Rev Bras Saúde Matern Infant. 2003;3:457–61.
21. Houtkooper LB, Going SB, Lohman TG, Roche AF, Loan MV. Bioelectrical impedance estimation of fat-free body mass in children and youth: a crossvalidation study. J Appl Physiol. 1992;72(1):366–73.
22. Danford LC, Schoeller DA, Kushner RF. Comparison of two bioelectrical impedance analysis models for total body water measurement in children. Ann Hum Biol 1992;19(4):603–6.
23. Fagundes U, Kopelman B, Oliva CAG, Baruzzi RG, Fagundes-Neto U. Avaliação do estado nutricional e da composição corporal das crianças índias do Alto Xingu e da etnia Ikpeng. J Pediatr. 2004;80:483–9.
24. Caballero B, Himes JH, Lohman T, Davis SM, Stevens J, Evans M, et al. Body composition and overweight prevalence in 1 704 schoolchildren from 7 American Indian communities. Am J Clin Nutr. 2003;78:308–12.
25. Rising R, Swinburn B, Larson K, Ravussin E. Body composition in Pima Indians: validation of bioelectrical resistance. Am J Clin Nutr. 1991;53:594–8.
26. Kyle UG, Bosaeus I, De Lorenzo A, Deurenberg P, Elia M, Gómez JM, et al. Bioelectrical impedance analysis—part I: review of principles and methods. Clin Nutr. 2004;23:1226–43.
27. Buffa R, Floris G, Marini E. Bioelectrical Impedance Vector in Pre- and Postmenarcheal Females. Nutrition. 2002;18:474–8.
28. Buffa R, Baali A, Lahmam A, Amor H, Zouini M, Floris G, et al. Assessment of nutritional status in the Amazigh children of Amizmiz (Azgour Valley, High Atlas and Morocco). J Trop Ped. 2009;55(6):406–8.
29. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. Br Med J. 2000;320:1–6.
30. Whitaker RC, Wright JA, Pepe MS, Seidel KD, Dietz WH. Predicting obesity in young adulthood from childhood and parental obesity. N Engl J Med. 1997;337:869–73.
31. Caprio S. Insulin resistance in childhood obesity. J Pediatr Endocrinol Metab. 2002;15(suppl 1): 487–92.
32. Secretariat of the United Nations Permanent Forum on Indigenous Issues. State of the world's indigenous peoples. New York: United Nations; 2009.

RESUMEN

Valores de impedancia bioeléctrica en niños y adolescentes indígenas en Rio Grande do Sul, Brasil

Objetivo.   Describir el estado nutricional de niños y adolescentes indígenas en Rio Grande do Sul, Brasil, mediante los valores de impedancia bioeléctrica y comparar las clasificaciones nutricionales del método antropométrico con las del método de composición corporal.

Métodos.   Se llevó a cabo un estudio transversal en 3 204 participantes de 35 escuelas de los 12 territorios indígenas habitados por el pueblo kaingang (o guayaná) del estado de Rio Grande do Sul (Brasil). Según las recomendaciones de la Organización Mundial de la Salud, se midió el peso y la talla (T) de cada participante en dos oportunidades y se clasificó el índice de masa corporal (IMC) según la edad. La composición corporal se evaluó mediante análisis vectorial de impedancia bioeléctrica. La resistencia (R) y la reactancia (Xc) se calcularon con un analizador de impedancia bioeléctrica. Las divergencias entre estos dos métodos se analizaron con un gráfico RXc.

Resultados.   De la muestra, 56,8% eran adolescentes y 50,6% eran varones. Los valores medios del ángulo de fase fueron mayores en los adolescentes, en los varones y en los individuos con sobrepeso según el IMC/edad. Los valores medios de R, Xc, R/T y Xc/T fueron mayores en los niños y en las personas con puntajes z de IMC/edad ≤ +2. Se observaron las siguientes divergencias en la clasificación del sobrepeso: 94,6% para los niños, 77,1% para los adolescentes, 85,4% para las niñas y 94,8% para las adolescentes.

Conclusiones.   Los valores medios de las medidas de impedancia bioeléctrica observados en niños y adolescentes kaingang fueron similares a los encontrados en diferentes poblaciones en otros estudios. Se observaron diferencias entre las clasificaciones nutricionales por IMC/edad y por análisis vectorial de impedancia bioeléctrica en ambos sexos y grupos etarios. Estos resultados destacan la importancia de emplear múltiples técnicas, como la antropometría y el análisis vectorial de impedancia bioeléctrica, cuando se efectúan evaluaciones nutricionales de una determinada población.

Palabras clave   Antropometría; pesos y medidas corporales; impedancia eléctrica; evaluación nutricional; salud indígena; grupos étnicos; Brasil.