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DOI: 10.12957/demetra.2015.16759

Distribution of resistance, reactance and phase angle values among indigenous Kaingáng students Kaingáng, Rio Grande do Sul, Brazil

Nicole Louise Gonzaga Oliveira Santos[1]
Ana Luiza Rodrigues Pellegrinelli[1]
Laura Augusta Barufaldi[2]
Wolney Lisboa Conde[3]
Maurício Soares Leite[4]
Ilaine Schuch[5]
Teresa Gontijo de Castro[6]

[1] Universidade Federal de Minas Gerais, Escola de Enfermagem, Departamento de Nutrição. Belo Horizonte-MG, Brasil.

[2] Universidade Federal do Rio de Janeiro, Instituto de Estudos em Saúde Coletiva. Rio de Janeiro-RJ, Brasil.

[3] Universidade de São Paulo, Faculdade de Saúde Publica, Departamento de Nutrição. São Paulo-SP, Brasil.

[4] Universidade Federal de Santa Catarina, Departamento de Nutrição. Florianópolis-SC, Brasil.

[5] Universidade Federal do Rio Grande do Sul, Departamento de Medicina Social, Faculdade de Medicina. Porto Alegre-RS, Brasil.

[6] The University of Auckland , Research Fellow of the Centre for Longitudinal Research - He Ara ki Mua- School of Population Health. Auckland, New Zealand.

Research financing: Fundo de Desenvolvimento da Educação, Brasil (via Centro Colaborador em Alimentação e Nutrição do Escolar da UFRGS).
Grant: Fundação de Amparo à Pesquisa do Estado de Minas Gerais.

Correspondence
Teresa Gontijo de Castro
Endereço eletrônico: teresagcastro108@gmail.com

Abstract

Objectives: To describe the distribution of bioelectrical measurements among the Kaingáng from Rio Grande do Sul (RS). Cross-sectional study conducted among students of the Indigenous Lands of RS (N= 3248). Height (H) was measured according to OMS. Resistance (R) and reactance (Xc) were obtained through bioimpedance, and were adjusted by H. The phase angle (AF) was estimated by: arc-tangent (Xc/R)*180/π. Mean values (SD) and centiles of the variables were calculated by gender and age group. Means were compared using t Student and ANOVA tests (p <0.05). The age proportions (%) among the evaluated individuals were: children (42.4), adolescents (56.0) and adults/elderly (1.6). In general, values of R and R/H were higher among younger individuals and females. Mean values of Xc and Xc/H changed among the different age groups, and, in general, lower values of AF were observed in those younger groups and females. Despite the limited possibilities of comparisons, in general, the tendencies of distribution of the bioelectrical values among the Kaingáng are in accordance with the results found in other investigations. This study is a pioneer in the description of bioelectrical measures for a Brazilian indigenous population, and it intends to serve as a base for comparisons with future studies in the area.

Keywords: Nutritional Assessment. Bioelectrical Impedance. Body Composition. South American Indians. Indigenous Health.

Introduction

The importance of studies that aim to evaluate the life and health conditions of indigenous peoples in Brazil is undeniable, considering the scarcity of papers of this nature, especially considering the huge ethnical diversity and the data that consistently show widely unfavorable health indicators for this segment of the Brazilian population.[1]

In relation to the nutritional condition, anthropometric studies have indicated an important prevalence of height deficit and overweight among indigenous children[2-5] and a growing gradient of overweight from this age range.[6-9] However, more detailed studies on the nutritional condition, combining other evaluation methods, are rare. The electrical bioimpedance analysis, considered a quick, non-invasive and low-cost method[10,11] was used, up to now, only in four studies in order to evaluate the body composition among indigenous peoples in Brazil.[12-15] For such, from the bioelectrical measurements, Fagundes et al,[12] Lourenço et al[13] and Simões et al[15] evaluated the body composition of indigenous people from Alto Xingu/ Ikpeng, Suruí (RO) and Xucuru-Kariri (MG), respectively, through predictive equations. Differently, the study made by Barufaldi et al[14] used the Bioelectrical Impedance Vector Analysis (BIVA) to analyze the bioelectrical values of the Kaingáng from Rio Grande do Sul, an analysis that uses the studied population as reference.

However, despite its acknowledged potential to describe and evaluate the nutritional condition, the analyses that use the electrical bioimpedance measurements need to deal with specificities of the method, which may constitute limitations for some applications. One of them refers to the use of predictive equations of the body constitution in population groups that are different from those that originated the equations.[11] In order to overcome this limitation, several studies[14,16-23] have used the BIVA Analysis as an alternative to the equations, since this method allows analyses that use the own studied population as reference, not other reference populations.

Acknowledging the importance of the descriptions of the bioelectrical parameters that constitute the BIVA analysis, therefore, results in efforts directed toward studying the distributions of the resistance, reactance and phase angle values in different populations, and also in proposals to establish reference values for bioelectrical values.[10,16,24,25] In fact, studies verified that variables such as gender, race/ethnicity, body mass index and age influenced the distribution pattern of the resistance – reactance vector.[10,16,24,25] Therefore, this reinforces the need for investigations that provide further knowledge on the behavior of bioelectrical variables according to these variables in different populations.

In that sense, and considering the lack of studies on the distribution of bioelectrical values in Brazilian indigenous populations, the objective of this study was to describe the gender-age distribution of the resistance (R), reactance (Xc) and phase angle (AF) values, as well as adjusted R and Xc values for height among indigenous people enrolled at the Kaingáng schools of Rio Grande do Sul, Brazil.

Methods

The Kaingáng belong to the Macro-Jê linguistic branch, and are one of the largest indigenous peoples in Brazil. The first records of contact with non-indigenous date back to the 18th century. In 2000, the National Indian Foundation (FUNAI) acknowledged 30 Indigenous Lands of this ethnicity in Brazil, from which, 12 were located in the State of Rio Grande do Sul (RS), which corresponds to a very reduced part of the territories that were traditionally covered by this ethnicity. In RS, there are approximately 16 thousand individuals.[26] The traditional Kaingáng economy was based on hunting, fishing, harvest and complementary agriculture. Currently, agriculture is a basic element, and there are both collective farm areas managed by FUNAI and family areas. Craft sales and service provisions for rural producers are also income sources.[27] The records available indicate an epidemiological profile characterized by the persistence of respiratory and infectious-parasitic diseases as the main causes for hospitalization, together with a growing record of obesity and associated disorders.[3,28,29] Health assistance, in turn, has serious problems.[30,31]

This study originated from a school-based transversal survey, conducted with all indigenous schools located on Kaingáng Indigenous Lands in the State of Rio Grande do Sul, with an agrarian situation acknowledged by FUNAI at the time of the filed work, from July to December, 2008. In 2008, there were 5,102 indigenous students enrolled on the 35 schools of the Kaingáng Indigenous Lands of Rio Grande do Sul; however, at the time of the filed work, 8.6% of them had been transferred or had evaded school, with 4,662 effectively remaining, which were enrolled on July 2008. From them, 896 (19.2%) did not deliver the signed Free and Clear Consent Term (FCCT), 71 (1.5%), even having signed FCCT, refused to participate in the research, and, 434 (9.3%) had FCCT signed, but were not evaluated, since they were absent from school on the evaluation days.

Gender and age information were collected directly from the enrollment records of the schools, using a structured questionnaire. When there were no records of the birth date at the schools, the information was obtained through the records of the local medical centers of the National Health Foundation (FUNASA), which covered the indigenous school (for more details, see Castro et al.)[32]

It was not possible to obtain the birth date of six individuals (0.13%), despite the fact that they were examined. Other 7 (0.15%) refused to participate in the bioelectrical impedance evaluation. Therefore, the population of this study was constituted by 3,248 Kaingáng indigenous individuals (69.7% of the total that attended the schools at the time of the research). Statistically significant differences were not observed among the indigenous individuals evaluated and those who were not evaluated, according to their age range, in relation to the gender proportion. However, higher age means were observed among the non-evaluated children and adolescents.

The bioelectrical impedance values were measured using the Quantum II® Impedanciometer (*RJL Systems,* Clinton Township, Michigan, USA). The individuals were lying down on a mattress covered with a non-conducing material and on a place with room temperature. Legs and arms were separated, avoiding the contact with the trunk. Two pairs of electro-adhesives were placed on the right hand and foot. On the hand, the electro-adhesives were placed on an imaginary line that divides the ulna in two and on the first joint of the middle finger. On the foot, they were placed on an imaginary line that divides the medial malleolus into two and on the base of the middle finger. The resistance (R) and reactance (Xc) values were measured and recorded in ohms (Ω). Considering that the intense physical activity may affect the resistance values,[11,33] it was requested that four hours prior to this evaluation the individuals had no intense physical activity. However, to measure these values, it was not possible to control the room temperature, hydration and fastening. The phase angle, in degrees, was calculated according to the following formula: arc-tangent (reactance/resistance)*180/π.[10] Height measurements were obtained, in duplicates, with a stadiometer from the brand AlturaExata® (Alturaexata Ltda., Belo Horizonte, Minas Gerais, Brazil), with precision of one millimeter and capacity for 213 cm. The measurement was made according to the recommendations of the World Health Organization (WHO).[34]

The data collection in the field was conducted by four previously qualified nutritionists. This study was approved in all required instances for researches with indigenous peoples in Brazil: Research Ethics Committee of Universidade Federal do Rio Grande do Sul (protocol # 2007726), National Research Ethics Commission (protocol # 14,449), National Council for Scientific and Technological Development (CNPq) and National Indian Foundation (process # 1141/ 08 CGEP/ 08). The data were only collected from individuals that authorized it by signing, whether in written or digitally, the Free and Clear Consent Term (underage individuals had the term signed by their tutors).

The R and Xc values were adjusted according to the height (R/H and Xc/H). Mean values were calculated (and their respective ranges with 95% reliability) for the bioelectrical parameters, according to the gender and age ranges. For comparisons between two means, Student's t test was used for independent samples, and the ANOVA test to compare three or more means. The analyses were conducted on the SPSS 10.0 software, using $p < 0.05$ as a significant value. All continuous variables shown in this study met the normality principles, according to the test by Smirnoff-Kolmogorof.

Results

From the entire evaluated population, 1637 (50.4%) individuals were males, and the age varied between 3 and 66.14 years old. The proportions of evaluated individuals by age range were: 42.4% children (under 10 years old), 56.0% adolescents (10-19 years old) and 1.6% adults and elderly people ($\geq$ 20 years old).

Tables 1 and 2 describe the mean values and standard deviations for R, R/H, Xc, Xc/H and AF, respectively, for females and males. For both genders, the mean values of R and R/H were different across the age ranges, and higher values were observed among younger individuals, being reduced as the age increased. Also for both genders, the mean values of Xc, Xc/H and AF were statistically different across the age ranges. The mean values for AF were lower among younger individuals, both among males and females.

The comparison of the mean values of the bioelectrical parameters between the genders indicated that R and R/H had higher mean values among the indigenous females, with the exception of the age ranges from 3-6 years old, 10-11 years old, 19-20 years old, and those over 30 years old (for R), and 3-6 years old, 10-11 years old, 11-12 years old, 12-13 years old, and those over 30 years old (for R/H). The Xc and Xc/H means had significant differences only for some age ranges, especially among 13-17 year-old adolescents, who had higher mean values than the adolescents (data not shown on the table).

Table 1. Mean values (intervals with 95% reliability) of the bioelectrical parameters (resistance, reactance, resistance by height, reactance by height and phase angle) of female Kaingang students. Indigenous Lands of Rio Grande do Sul, Brazil, 2008.

Age range	N	Resistance (ohms)	Resistance/height (ohms/meters)	Reactance (ohms)	Reactance/height (ohms/meters)	Phase angle (degrees)
3– 6[a]	24	735.2 (713.8 - 756.5)	699.2 (675.1 - 723.3)	63.4 (60.8 -65.9)	60.2 (57.8 -62.5)	4.9 (4.7 - 5.0)
6 – 7	97	725.8 (713.5 - 738.0)	643.8 (630.5 - 657.1)	67.6 (65.9-69.2)	59.9 (58.2 - 61.6)	5.3 (5.2 -5.3)
7 – 8	186	710.7 (701.3 - 720.0)	608.4 (598.7 -618.1)	67.3 (66.0 - 68.5)	57.7 (56.4 - 58.8)	5.4 (5.3 -5.4)
8 – 9	194	697.4 (688.4 - 706.3)	569.7 (560.6- 578.6)	66.8 (65.6 -67.9)	54.5 (53.4 -55.6)	5.5(5.4 -5.5)
9 – 10	204	693.7 (684.7 -702.6)	538.8 (529.9 - 547.7)	66.9 (65.7 -68.0)	52.0 (50.8 -53.0)	5.5 (5.4 - 5.5)
10 – 11	191	668.3 (657.6 - 678.9)	495.5 (484.0 - 507.0)	65.2 (63.9 -66.4)	48.3 (47.1 -49.5)	5.6 (5.5 -5.6)
11 – 12	172	650.5 (640.2 - 660.7)	461.9 (452.5 - 471.3)	64.9 (63.6 - 66.1)	46.1 (45.0 -47.1)	5.7 (5.6 -5.7)
12 – 13	159	618.5 (608.8 - 628.1)	423.2 (415.2 - 431.1)	63.5 (62.4 -64.5)	43.4 (42.5 -44.2)	5.9 (5.8 -5.9)
13 – 14	122	606.0 (595.8 - 616.1)	406.4 (398.2 - 414.6)	65.8 (64.3 -67.2)	44.1 (43.0 -45.1)	6.2 (6.0 - 6.3)
14 – 15	97	610.6 (598.8 - 622.3)	403.9 (394.8 - 412.9)	68.8 (67.3 -70.2)	45.5 (44.3 - 46.5)	6.5 (6.3 -6.6)
15 – 16	72	606.6 (593.5 - 619.6)	403.64 (394.5 - 412.7)	68.7 (67.1 -70.2)	45.7 (44.6 - 46.6)	6.5 (6.3 - 6.6)
16 – 17	35	585.1 (562.5 - 607.6)	385.62 (369.0 -402.2)	68.3 (65.3 -71.2)	44.9 (42.9 - 46.9)	6.7 (6.4 -6.9)
17 – 18	20	580.8 (558.8 - 602.7)	382.18 (364.7 - 399.6)	68.9 (64.8 -72.9)	45.4 (42.3 - 48.3)	6.8 (6.5 - 7.0)
18 – 19	5	560.2 (514.0 -606.3)	367 (326.4 -407.5)	65.0 (59.2 - 70.7)	42.6 (37.5 -47.5)	6.7 (6.2 -7.1)
19 – 20	2	572.0 (530.8 - 613.1)	395.36 (390.7 -399.9)	68.0[c]	47.0 (44.2 - 49.8)	6.8 (6.2 -7.3)
20 - 30	14	564.5 (534.4 - 594.5)	370.99 (349.7 - 392.1)	64.4 (60.4 -68.3)	42.3 (39.4 -45.1)	6.5 (6.2 - 6.7)
> 30[1]	17	463.8 (443.2 - 484.3)	305.19 (290.4 -319.9)	55.8 (52.1 - 59.4)	36.7 (34.2 -39.2)	6.9 (6.6 -7.1)
P[b]	0.000	0.000	0.000	0.000	0.000	0.000

N=1594

[a]Age ranges were grouped / p[b]= value of the ANOVA test to compare the means among age ranges/ [c]It was not possible to calculate IC 95%, since the standard deviation was equal to zero.

Table 2. Mean values (intervals with 95% reliability) of the bioelectrical parameters (resistance, reactance, resistance by height, reactance by height and phase angle) of male Kaingang students. Indigenous Lands of Rio Grande do Sul, Brazil, 2008.

Age range	N	Resistance (ohms)	Resistance/height (ohms/meters)	Reactance (ohms)	Reactance/height (ohms/meters)	Phase angle (degrees)
3 – 6[a]	24	684.1 (657.9 -710.2)	651.5 (621.3 - 681.7)	61.5 (58.6 - 64.3)	58.6 (55.3 - 61.8)	5.2 (4.9 -5.4)
6 – 7	111	691.7 (678.8 -704.5)	614.2 (599.9 - 628.4)	64.2 (62.6 - 65.7)	57.0 (55.5 -58.4)	5.3 (5.1 - 5.4)
7 – 8	157	676.9 (668.1 -685.6)	571.2 (562.3 -580.0)	65.9 (64.6 - 67.1)	55.7 (54.4 - 56.9)	5.6 (5.4 - 5.7)
8 – 9	191	667.5 (659.1 -675.8)	545.8 (537.4 -554.0)	66.3 (65.1 - 67.4)	54.2 (53.1 -55.2)	5.7 (5.6 - 5.7)
9 – 10	189	657.9 (649.6 -666.1)	517.0 (509.2 - 524.8)	67.4 (66.2 -68.5)	52.9 (51.9 - 53.9)	5.9 (5.8 - 5.9)
10 – 11	189	655.9 (646.7 -665.0)	488.7(478.1 -499.2)	66.3 (65.0 - 67.5)	49.4 (48.1 - 50.6)	5.8 (5.7 - 5.8)
11 – 12	183	633.1 (623.5 -642.6)	455.0 (443.6 - 466.3)	64.1 (62.9 - 65.2)	46.0 (44.7 - 47.1)	5.8 (5.7 - 5.8)
12 – 13	171	600.6 (589.1 -612.0)	421.4 (411.1 - 431.7)	63.6 (62.4 - 64.7)	44.6 (43.5 - 45.5)	6.1 (6.0 - 6.1)
13 – 14	117	570.9 (556.9 -584.8)	387.4 (374.6 -400.0)	61.1 (59.7 - 62.4)	41.4 (40.1 - 42.5)	6.2 (6.0 -6.3)
14 – 15	90	531 (518.6 - 543.3)	342.0 (331.8 - 352.0)	60.1 (58.7 - 61.4)	39.0 (38.0 - 40.0)	6.6 (6.4 - 6.7)
15 – 16	84	533.6 (520.5 -546.6)	337.8 (327.6 - 347.9)	63.3 (61.6 - 64.9)	40.0 (38.8 - 41.1)	6.8 (6.6 - 6.9)
16 – 17	55	494.5 (479.6 -509.3)	306.3 (294.6 - 317.8)	63.8 (61.6 -65.9)	39.4 (37.9 - 40.8)	7.4 (7.1 - 7.6)
17 – 18	26	492.6 (471.7 -513.4)	301.9 (290.3 - 313.5)	65.7 (62.5 - 68.8)	40.3 (38.3 - 42.1)	7.6 (7.3 - 7.8)
18 – 19	16	493.1 (461.5 -524.6)	308.1 (287.9 - 328.1)	68.6 (64.2 - 72.9)	42.9 (39.9 - 45.9)	8.0 (7.6 - 8.3)
19 – 20	12	507.1 (483.5 -530.6)	306.9 (287.2 - 326.4)	66.5 (61.9 -71.0)	40.3 (36.8 - 43.7)	7.5 (7.1 - 7.8)
20 - 30	7	429 (390.1 - 467.8)	265.6 (236.3 - 294.8)	61.7 (56.1 - 67.2)	38.2 (34.1 - 42.2)	8.3 (7.9 - 8.6)
> 30[1]	15	447.1 (424.0 - 470.1)	285.9 (259.2 -312.5)	60.9 (57.0 - 64.7)	38.61 (36.1 - 41.0)	7.8 (7.2 - 8.3)
P[b]		0.000	0.000	0.000	0.000	0.000

N=1637

[a]Age ranges were grouped / p[b]= value of the *ANOVA* test to compare the means among the age ranges.

Discussion

The study indicated that the mean values for resistance (R) and resistance/height (R/H) were higher for females, and, for most age ranges, among adolescents. The reactance (Xc) and Xc/H means varied according to the age ranges, and the mean values for phase angle (AF) were, in general, lower for younger individuals and higher for males.

Resistance is the opposition the body offers to a passing alternate electrical current. In tissues with large amounts of water and electrolytes, this current will be better conducted, creating lower resistance values. In tissues with low amounts of water, such as tissues rich in lipids, the electrical current will be more difficultly conducted, thus, offering higher resistance values.[21] Reactance represents an additional opposition caused by the insulation capacity in relation to a passing electrical current by the cellular membranes and tissues. High reactance values indicate a healthy cellular membrane.[17]

When comparing the mean R, R/H, Xc and Xc/H values of this study with the values from the study by Buffa et al,[17] conducted with a group of pre-menarche (10-14 years old) and post-menarche (11-15 years old) Italian adolescents, they were similar across all age ranges. The study by Guida et al, [20] conducted with eight-year-old Italian children, indicated mean values for R, R/H, Xc and Xc/H similar to the ones for eight-year-old children of this study. In the study by De Palo et al, [21] conducted with individuals from 2-15 years old, the R and R/H values were always higher than the ones recorded among the Kaingáng, for all age ranges. A study by Piccoli et al,[16] conducted with 3 different groups of eutrophic American adults, from the Third National Health and Nutrition Examination Survey - NHANES III - (non-Hispanic Caucasians, non-Hispanic afro-descendants and American-Mexican), indicated mean R, R/H, Xc and Xc/H values, among men and women on the age range from 20-29 years old, always higher than the ones on this study. Similarly to what was observed among the Kaingáng, De Palo et al[21] and Piccoli et al[16] found higher values for R and R/H on females when Italian adolescents between 14-15 years old and American adults between 20-29 years old were evaluated, respectively.

A study by Maleska - Massalska et al,[35] conducted among Taiwanese adults from 20 to 40 years old and Polish adults from 20 to 26 years old found mean values for R and R/H that were always lower than the ones for the Kaingáng population, while the values found for Xc and XC/H were similar to what was recorded among the male Kaingáng. The study by Micheli et al,[36] developed among male Italian athletes (20 - 30 years old) found similar values than the Kaingáng of the same gender and age range for R/H and Xc/H.

Bosy - Westphal et al[23] evaluated the variation of mean values for R and Xc according to the BMI of German children, adolescents e adults. In general, the mean values for R and Xc for the Kaingáng children and adolescents were similar to the mean values indicated among the eutrophic Germans. However, among the Kaingáng adolescents from both genders between 10-13 years old, the mean values for R and Xc were close to the ones recorded among Germans with a BMI between 20-25 kg/m^2, and, among the female Kaingáng adolescents between 14-17 years old, the mean R values were close to those reported among the German female adolescents with BMI of 19 to 25 kg/m^2.

The phase angle reflects changes to the electrical conductivity of the body, and indicates whether or not there are changes to the integrity of cellular membranes and the intracellular space, thus, reflecting the hydric distribution on the intra- and extracellular spaces, and it is directly associated to the amount of thin mass of the individual. Studies suggest that phase angle values obtained through bioelectrical impedance are related to the morbidity and mortality prognostics of the individual.[33] The mean AF values found on this study, stratified according to the age range, were similar to the other studies found with Italian children and adolescents.[17,20,21] The study by Maleska - Massalska et al,[35] conducted with adults, reported lower AF values than the ones recorded among the Kaingáng.

It is noteworthy that the differences observed for the bioelectrical value standards among the different genders and age ranges may be correlated mostly with the nutritional condition. In fact, Piccoli et al[16] illustrated that among women there is greater variability on the structure of soft tissues and hydration, in comparison to men, possibly due to the complex hormonal influence. Studies also indicated toward the consistent transformation standard of soft tissues as age advances due to the loss of muscular mass from 50 years old,[16] and the loss of soft tissues is more prominent for males.[24,37]

The design of this study allowed the evaluation of almost 70% of the population of indigenous people enrolled at the Kaingáng indigenous schools of RS. However, there should be reservations when extrapolating the results to the universe of the Kaingáng in RS and the Kaingáng schools of the state. Firstly because this study was conducted only with individuals enrolled at indigenous schools; secondly, it was observed a significant difference on the age mean among the individuals that participated in the study and the school losses. Moreover, the data shown here must be analyzed at all time considering the fact that, in this study, it was not possible to control all influencing aspects of bioimpedance, such as the assurance of 4 hours of fastening before the test, the room temperate, the hydration condition, the use of diuretics, and the stage of the menstrual cycle (for female adolescents). Additionally, the interpretation of these measurements must also consider that, on the evaluated population, there were children and adolescents, individuals that are going through a growth phase, which may oftentimes result in temporary bioelectrical values.[21] The fact that the sexual maturation stage of the adolescents was not evaluated represents another limitation of the study. Buffa et al[17] found greater mean values for R/H and Xc/H among pre-menarche adolescents, in opposition to post-menarche ones.

Conclusions

The distribution trends of the mean resistance (R), resistance/height (R/H) and phase angle (AF) values among the Kaingáng, according to the age range and gender, confirmed the findings of other studies, although the mean values recorded varied occasionally. However, since this is the first study that describes the distribution of the bioelectrical values on an indigenous population, the possibilities of comparison with other populations of this nature are still limited, and they are restricted to comparisons to the values recorded with non-indigenous groups. It is expected that this study serves as a base for comparisons for future studies to be conducted with indigenous peoples, nationally and internationally, and to broaden the discussions of the bioimpedance and anthropometry alliance when these peoples are evaluated.

References

1. Santos, RV; Coimbra Jr CEA. Cenários e tendências da saúde e da epidemiologia dos povos indígenas no Brasil. In: Coimbra Jr. CEA, Santos RV, Escobar AL, organizadores. Epidemiologia e saúde dos povos indígenas no Brasil. Rio de Janeiro: Ed. Fiocruz, Abrasco; 2003. p.13-47.
2. Orellana JDY et al. Nutritional status and anemia in Suruí indian children, Brazilian Amazon. J. Pediatr. 2006; 85:383-8.
3. Kühl AM, Corso ACT, Leite MS, Bastos JL. Perfil nutricional e fatores associados à ocorrência de desnutrição entre crianças indígenas Kaingang da Terra Indígena de Mangueirinha, Paraná, Brasil. Cad. Saude Publica 2009;25(2):409-20.
4. Leite MS, Leite MS, Santos RV, Coimbra Jr CEA, Gugelmin SA, Kac G, et al. Alimentação e nutrição dos povos Indígenas no Brasil. In: Kac G, Sichieri R, Gigante DP, organizadores. Epidemiologia nutricional. Rio de Janeiro: Editora Fiocruz, Atheneu; 2007. p. 503-18.
5. Horta BL et al. Nutritional status of indigenous children: findings from the Firsty National Survey of Indigenous People's Health and Nutrition in Brazil. Int. J. Equity Health 2013; 12 (23):1-13.
6. Cardoso AM et al. Inquérito nacional de saúde e nutrição dos povos indígenas. Rio de Janeiro: FUNASA, ABRASCO, Banco Mundial, 2009.

7. Leite MS, Santos RV, Gugelmin AS, Coimbra Jr CEA. Crescimento físico e perfil nutricional da população indígena Xavánte de Sangradouro-Volta Grande, Mato Grosso, Brasil. Cad. Saúde Publica 2006; 22(2):265-76.

8. Gugelmin AS, Santos RV. Uso do Índice de Massa Corporal na avaliação do estado nutricional de adultos indígenas Xavánte, Terra Indígena Sangradouro-Volta Grande, Mato Grosso, Brasil. Cad. Saúde Publica 2006; 22(9):1865-72.

9. Gimeno AS, Rodrigues D, Canó EN, Lima EE, Schaper M, Pagliaro H, et al. Cardiovascular risk factors among Brazilian Karib indigenous peoples: Upper Xingu, Central Brazil, 2000. J. Epidemiol. Comm. Health 2009; 63(4):299-304.

10. Barbosa-Silva MCG, Barros AJD, Wang J, Heymsfield SB, Pierson Jr RN, et al. Bioelectrical impedance analysis: population reference values for phase angle by age and sex. Am. J. Clin. Nutr. 2005; 82(1):49-52.

11. Dehghan M, Merchant AT. Is bioelectrical impedance accurate for use in large epidemiological studies? Nutr. J. 2008; 7:1-7.

12. 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(6):483-489.

13. 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; 20:564-571.

14. Barufaldi LA et al. Bioelectrical Impedance values among indigenous children and adolescents in Rio Grande do Sul, Brazil. Rev. Panam. Salud Publica 2011; 30(1):39-45.

15. Simões BS, Machado-Coelho GLL, Pena JL, Freitas SN. Perfil nutricional dos indígenas Xukuru-Kariri, Minas Gerais, de acordo com diferentes indicadores antropométricos e de composição corporal. Ciênc. Saúde Coletiva 2013; 18 (2):405-411.

16. Piccoli A, Pillon L, Dumler F. Impedance vector distribution by sex, race, body mass index, and age in the United States: standard reference intervals as bivariate z scores. Nutrition 2002; 18(2):153-167.

17. Buffa R, Floris G, Marini E. Bioelectrical impedance vector in pre- and postmenarcheal females. Nutrition 2002; 18(6):474-478.

18. Buffa R, Floris G, Marini E. Assessment of nutritional status in free-living elderly individuals by bioelectrical impedance vector analysis. Nutrition 2009; 25(1):3-5.

19. Buffa R, Baali A, Lahmam Um, 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. Pediatr. 2009; 55(6):406-408.

20. 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(2):133-141.

21. 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):417-424.

22. Savino F, Grasso G, Cresi F, Oggero R, Silvestro L. Bioelectrical impedance vector distribution in the first year of life. Nutrition 2003; 19(6):492-6.

23. Bosy-Westphal A, Danielzik S, Dörhöfer RP, Piccoli A, Müller MJ. Patterns of bioelectrical impedance vector distribution by body mass index and age: implications for body-composition analysis. Am. J. Clin. Nutr 2005; 82(1):60-8.

24. Saragat B, Buffa R, Mereu E, De Rui M, Coi A, Sergi G, et al. Specific bioelectrical impedance vector reference values for assessing body composition in the Italian elderly. Exp. Gerontol. 2014; 50:52-6.

25. Margutti AV, Monteiro JP, Camelo JS Jr. Reference distribution of the bioelectrical impedance vector in healthy term newborns. Br. J. Nutr. 2010; 104(10):1508-13.

26. Ricardo CA. organizador. Povos indígenas no Brasil 1996/2000. São Paulo: Instituto Socioambiental; 2000.

27. Veiga J. Aspectos fundamentais da cultura Kaingáng. São Paulo: Curt Nimuendajú; 2006. 254 p.

28. 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.

29. Gilio J, Mioranza SL, Takizawa MGMH. Parasitismo intestinal em índios da reserva indígena de Rio das Cobras. Rev. Bras. Anal. Clin. 2006; 38:193-5.

30. Hökerberg YHM, Duchiade MP, Barcellos C. Organização e qualidade da assistência à saúde dos índios Kaingang do Rio Grande do Sul. Cad. Saúde Publica 2001;17(2):261-72.

31. Diehl EE. Agravos na saúde Kaingang (Terra Indígena Xapecó, Santa Catarina) e a estrutura dos serviços de atenção biomédica. Cad. Saúde Pública 2001;17(2):439-45.

32. Castro TG, Schch 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 Publica 2010; 26(9):1766-76.

33. Baumgartner RN, Electrical impedance and total body electrical conductivity. In: Roche AF, Heymsfield S, Lohman TG. Human body composition. Champaing, IL: Human Kinetics; 1996. p. 79-107.

34. World Health Organization. Physical status: the use and interpretation of anthropometry. Geneva: WHO; 1995. Technical Report Series 854.

35. Maleska-Massalska T Smolen A, Madro E, Surtel W. Bioimpedance vector pattern in Taiwanese and Polish college students detected by bioelectric impedance vectorial analysis: preliminary observations. The Scientific World J [Internet]. 2012; 1-5. Disponível em: http://www.researchgate.net/publication/224972728_Bioimpedance_Vector_Pattern_in_Taiwanese_and_Polish_College_Students_Detected_by_Bioelectric_Impedance_Vector_Analysis_Preliminary_Observations

36. Micheli ML, Pagani L, Marella M, Gulisano M, Piccoli A, Angelini F, et al. Bioimpedance and impedance vector patterns as predictors of male elite soccer players. Int. J. Sports Physiol. Perform. 2014; 9(3):532-539.

37. Guida B, Laccetti R, Gerardi C, Trio R, Perrino NR, Strazzullo P, et al. Bioelectrical impedance analysis and age-related differences of body composition in the elderly. Nutr. Metab. Cardiovasc. Dis. 2007; 17(3):175-180.

Received: September 03, 2015
Accepted: October 18, 2015