Nutritional status of iodine in pregnant and non-pregnant adolescents assisted at the Family Health Strategy in Vespasiano, MG

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Abstract

Objectives: to evaluate the nutritional status of iodine in pregnant adolescents, taking into account the increase in the demand for iodine during pregnancy and the absence of iodization strategies for this population.

Methods: cross-sectional study conducted with 62 pregnant and 71 non-pregnant adolescents assisted in primary care. The nutritional status of iodine was determined by urinary samples. The iodine concentration in the consumed culinary salt was also evaluated. For the comparative analyses of categorical variables, the Chi-square test was used and for the continuous variables, the Kruskal-Wallis test, considering a 95% confidence interval (CI) and significance level of 5%.

Results: the mean iodine concentration in household salt was 25.1 mg/kg (CI95%= 11.1-67.5 mg/kg), with higher mean content in culinary salt in the group of pregnant women (p<0.028). Regarding the nutritional status of iodine, 71% of pregnant adolescents were deficient and 29% iodine-sufficient, with significant difference when compared to 38% of deficiency and 62% of sufficiency in the control group (p<0.001).

Conclusions: there was an iodic deficiency among pregnant adolescents, even in the face of higher concentrations of iode in household salt, exposing a paradox between higher consumption and lower sufficiency in this group. Thus, it is suggested to consider iodine supplementation during pregnancy, seeking to minimize the effects of this deficiency on maternal and child health.

Key words *Iodine deficiency, Pregnant women, Adolescents, Dietary supplement, Public health*

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Introduction

Iodine is a micronutrient found in nature and obtained exclusively through dietary intake. The main foods considered good sources of this element are seafood and vegetables from iodine-rich soil.[1] The human body contains, on average, 20 mg of iodine, of which about 70 to 80% are found in the thyroid gland, with the aim of performing its main function, the synthesis of thyroid hormones Triiodothyronine (T3) and Thyroxine (T4). Such hormones are essential for human growth and development, acting mainly in neurogenesis.[2]

The body needs a minimum amount of iodine to perform its functions, and both the increase and the decrease in micronutrient intake cause important impacts on the health of the individual. According to the Recommended Dietary Allowances (RDA), it is recommended to ingest 120µg of iodine per day in females aged 9 to 13 years and 150µg by non-pregnant adolescents aged 14 to 18 years. In the case of pregnant and lactating women under the age of 18 years, ingestion of 220µg and 290µg per day is recommended, respectively.[3]

Iodine is not stored in the human body and therefore should be offered daily in small quantities. The use of iodated salt for human consumption is the universal strategy adopted to ensure the reduction of losses resulting from iodine deficiency.[4] To meet this need, it is recommended to strengthen 15 to 45 mg of the micronutrient per kilogram of culinary salt in accordance with the protocol of the National Health Surveillance Agency (ANVISA).[5] However, it is known that the nutritional need of the microelement varies according to age group and biophysiological state of the individual.[6]

For maintenance of body homeostasis during pregnancy, there is an increase in the demand for this micronutrient due to the growth and development of the fetus, in addition to a significant increase in urinary losses in pregnant women.[7] For this reason, the World Health Organization (WHO) recommends for pregnant women the average iodine intake of 250 µg, or 40% more than the population of the same age group.[8] In addition, adolescence should also be considered as a period of vulnerability to iodine deficiency due to the high rate of metabolism secondary to the pubertal rapid growth, which may lead to deceleration in weight-height development, pubertal retardation and even more serious consequences such as goiter in this population range.[9]

Iodine deficiency disorders (IDD) mainly affect pregnant women, nursing mothers, fetuses and neonates. The most critical period is from the second trimester of pregnancy until the third year after birth. Normal levels of thyroid hormones are necessary for optimal brain development of the newborn. Among the main repercussions on the health of this population, it is highlighted the increase in perinatal morbidity and mortality, cognitive and neuropsychic impairment to the child, in addition to higher frequencies of abortion and prematurity.[7]

In view of the facts presented, the present study aimed to evaluate the nutritional status of iodine in pregnant adolescents assisted in the public network of the municipality of Vespasiano (MG), compared to non-pregnant women, in addition to evaluating the adequacy of the strategy of fortification of culinary salt by determining the amount of iodine present in the salt consumed in the households of this population in particular.

Methods

This is a cross-sectional study conducted in the municipality of Vespasiano (MG) from January 2017 to December 2018, previously approved by the Ethics Committee on Research with Human Beings of the Faculty of Health and Human Ecology (CAAE 50860515.0.0000.5101). Urine collection and home culinary salt samples were collected from pregnant adolescents who started follow-up in Basic Health Units (BHUs) of the Family Health Strategy (FHS) program in the municipality of Vespasiano (MG), and from non-pregnant adolescents enrolled in public schools in the city. Those who were available to participate in the study were asked to present the duly signed Free and Informed Consent Form (FICF), in the case of having more than 18 years of age, and by their respective legal guardian in the case of less than 18 years of age.

The sample was a convenience sample.[10] All pregnant adolescents aged between 10 and 19 years, in any gestational period, attended in prenatal consultations in the BHUs of the municipality were elected to participate. The control group consisted of non-pregnant adolescents of the same age group, regularly enrolled in schools in the public network of Vespasiano. To detect a 20% difference in urinary iodine concentration between groups, whose mean controls are 110 µg/L, with a standard deviation of 10 µg/L, with a statistical power of 80% and a significance threshold of p=0.05, the control group (non-pregnant adolescents) should be composed of at least 50 adolescents. Adolescents with confirmed or reported thyroid disease or using iodine-containing drugs were excluded from the study, as well as those who did not properly deliver urine and culinary salt samples, or who did not deliver signed FICFs for participation in the research.

A total of 150 adolescents, 69 pregnant and 81 non-pregnant women met the inclusion criteria of the study. In the group of pregnant women, three were excluded for presenting insufficient or contaminated culinary salt samples and four for not delivering urine or salt samples. In the control group, 10 adolescents did not deliver the samples or the TCLE. Thus, 133 adolescents were obtained, 62 pregnant and 71 non-pregnant.

The collection of urinary samples and culinary salt was preceded by the application of a form, containing information on age, origin, gestational age, thyroid disease or use of medications for iodine supplementation. The samples were collected according to the prenatal care schedule of each health team or in the pregnant women's homes. In relation to the control group, recruitment was carried out in the schools of the public network of Vespasiano (MG), monthly, with institutional authorization.

For the collection of urinary samples, a kit labeled for identification of the participant was used, containing a disposable plastic cup for urine deposition and a container for the final storage of the material. The containers were packed in polystyrene boxes with plastic ice and promptly transported to a refrigerator at 4°C. Finally, the samples were forwarded for analysis at the Bromatology Laboratory of the School of Nutrition of the Federal University of Ouro Preto (UFOP), without identification in relation to the groups of participants.

For the collection of culinary salt, the adolescents were asked to bring samples containing 30 to 40g of the salt consumed in their homes. The samples were stored and identified in a plastic container with a screw cap. They remained at room temperature in a place free of moisture and direct sunlight until sending for analysis in the same laboratory.

The analyses were performed blindly, so that the responsible professionals were not aware of the group belonging to each sample. Urinary iodine concentration (UIC) was determined by the Sandell–Kolthoff method, recommended by the International Council of Control for Iodine Deficiency Disorders (ICCIDD) and modified by Esteves.[7,11]

The nutritional status of iodine was determined by the UICs, and classified as "deficient", "optimal", "risk of induced iodine hyperthyroidism" and "risk of adverse effects (iodine induced hyperthyroidism and autoimmune thyroiditis)", according to the classification values recommended by the WHO.[7] Nutritional status is considered deficient in iodine when urinary excretion is below 150 μg/L for pregnant women and 99.9 μg/L for adolescents; optimal nutritional status excretion between 150.0 and 249.9 μg/L for pregnant women and between 100 and 199.9 μg/L for adolescents; risk of hyperthyroidism excretion between 250.0 and 499.9 μg/L for pregnant women and between 200 and 299.9 μg/L for adolescents; and risk of adverse effects excretion above 500 μg/L for pregnant women and above 300 μg/L for adolescents.

As well as the analysis of urine samples, culinary salt analysis was also blind in relation to the groups, according to the technique recommended by the Ministry of Health, in which, in the face of potassium iodide (KI) and in acidic medium, potassium iodide (KIO_3) reacts by releasing iodine, which is immediately titrated with sodium thiosulfate, using starch solution as an indicator.[12] The iodine content present in the salt sample is expressed in mg/kg of salt and obtained by the equation: (V.f.105.8) / P = mg iodine/kg of salt, in which: V = volume of thiosulfate spent on titration; f = sodium thiosulfate solution correction factor; P = weight in grams of the salt sample.[12] As determined by ANVISA Resolution RDC Nº. 23/2013, the classification of the iodine content in salt for human consumption should follow the following parameters: adequate: 15 to 45 mg/kg, insufficient: <15 mg/kg and excessive >45mg/kg.[13]

The results were presented as mean, standard deviation (SD) and median, or absolute frequency and percentage, according to the type of variable. The variables analyzed in the study were age, gestational age categorized into first, second and third trimester, urinary iodine concentration and iodine content in a household salt sample. The data obtained were stored in spreadsheets of the Microsoft Excel software® 2010.

The mean and median concentrations of iodine in culinary salt and urine were compared to the recommended normality standards.[5,7] For the analysis of categorical variables, Pearson's chi-square test was used and for continuous variables, such as gestational age and age, the Kruskal-Wallis test was used.

The significance level adopted was 5%, the confidence interval (CI) 95%. By correlation analysis, the variables whose values presented $p<0.05$ were considered statistically significant. All analyses were carried out with the aid of the IBM SPSS 25.0 program (IBM Corp).

Results

The mean age of the study population was 17 years (CI95%= 14 - 19; SD= 1.6), with an average of 18 years (CI95%= 16 -19; SD= 1.2) for the group of pregnant women and 16 years of age (CI95%= 14 - 19; SD= 1.6) in the group of non-pregnant women. Among the pregnant women, 32.2% were in the 2nd trimester of pregnancy, 19.4% in the 3rd trimester and 4.8% in the first trimester, and for 43.6% of the pregnant women there was no confirmation of this data.

Regarding the concentration of iodine in urine, the mean value of 108.2 µg/L (CI95%= 0.4 - 229.3; SD= 50.2) was observed in the total population. Among the pregnant women, a mean value of 115.9 µg/L (CI95%= 0.4 - 229.3; SD= 58.1) and among non-pregnant women of 101.3 µg/L (CI95%= 11.2 - 154.2; SD= 40.9). Analyzing the nutritional status by iodine, there was a deficiency in 71% of pregnant adolescents and in 38% of non-pregnant adolescents, as shown in Table 1. There was no adolescent with nutritional status corresponding to excess of iodine, with risk of iodine-induced hyperthyroidism or risk of adverse effects.

Regarding the concentration of iodine in the salt of household consumption, the mean value found was 25.1 mg/kg (CI95%= 11.1 - 67.5; SD= 10.4). Among pregnant women, the mean value was 28.9 mg/kg (CI95%= 11.1 - 67.5; SD= 11.8) and among non-pregnant women it was 21.8 mg/kg (CI95%=12.4 - 52.6; SD= 7.5). According to the parameters recommended by ANVISA, the salt available in the home of 114 adolescents (85.7%) had adequate iodine concentration, in 11 (8.3%) households had excessive concentration and in only 8 (6.0%), insufficient. Figure 1 shows the frequencies of iodine content in household salt obtained in each group.

The median age, urinary iodine and iodine concentration in salt showed significant difference between the study groups (pregnant *versus* non-pregnant adolescents), after the chi-square tests and Kruskal-Wallis test (Table 2). There was no significant difference in age, urinary iodine and iodine concentration in salt between gestational trimesters (p>0.05). The statistically significant ratio(p<0.001) of urinary iodine among pregnant and non-pregnant adolescents showed a higher excretion of iodine in the group of pregnant women, although this excretion is below the reference value considered appropriate during pregnancy (150.0 to 249.9 µg/L). Also according to Pearson's qui-square test, there was no statistically significant relationship between iodine concentration in culinary salt and iodine concentration in urine (p=0.221), as shown in Figure 2.

Discussion

Relevant number of studies relate iodine and pregnancy deficiency.[14-16] However, there are few studies that have investigated its impact on adolescence[17,18] and no specific study on iodine deficiency in pregnant adolescents in Brazil was identified.

In this study, it was observed that pregnant adolescents have a significant degree of iodine deficiency, verified by low urinary excretion of the mineral. In addition to the inherent vulnerability of the age group studied, pregnancy proved to be an even more significant factor for the lack of this microelement. These findings point to pregnancy in adolescence as a predisposing condition for the nutritional deficiency of iodine, requiring a greater supply of the element for these pregnant women.

The Universal Salt Iodization Policy is recognized as a safe and sustainable population strategy to ensure adequate iodine intake and eliminate IDDs worldwide.[19] Household salt was established as a goal to have an iodine concentration greater than 15 mg/kg.[19] Regarding the salt samples evaluated in this study, 85.7% had adequate iodine concentration, 8.3% had excessive concentration and only 6.0% had

Table 1

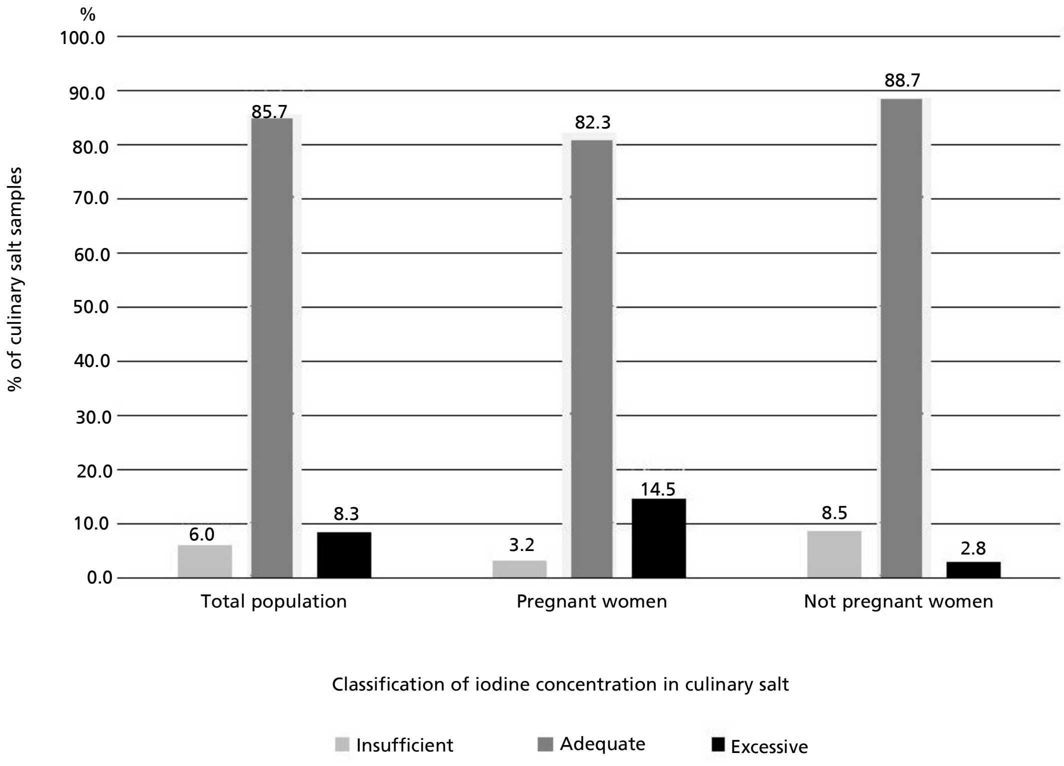
Nutritional status of iodine by group and by gestational trimester according to the criteria established by the WHO.

Nutritional status of iodine	Pregnant		Gestational trimester								Non-Pregnant Women	
			1st		2nd		3rd		not informed			
	n	%	n	%	n	%	n	%	n	%	n	%
DeDeficient	44	71.0	2	3.22	14	22.58	11	17.74	18	29.03	27	38.0
Optimal	18	29.0	1	1.61	6	9.67	1	1.61	9	14.51	44	62.0
Total	62		3		20		12		27		71	

WHO= World Health Organization.

Figure 1

Classification of iodine concentration in culinary salt among the study groups according to the criteria established by ANVISA.



ANVISA = *Agência Nacional de Vigilância Sanitária* (National Health Surveillance Agency).

Table 2

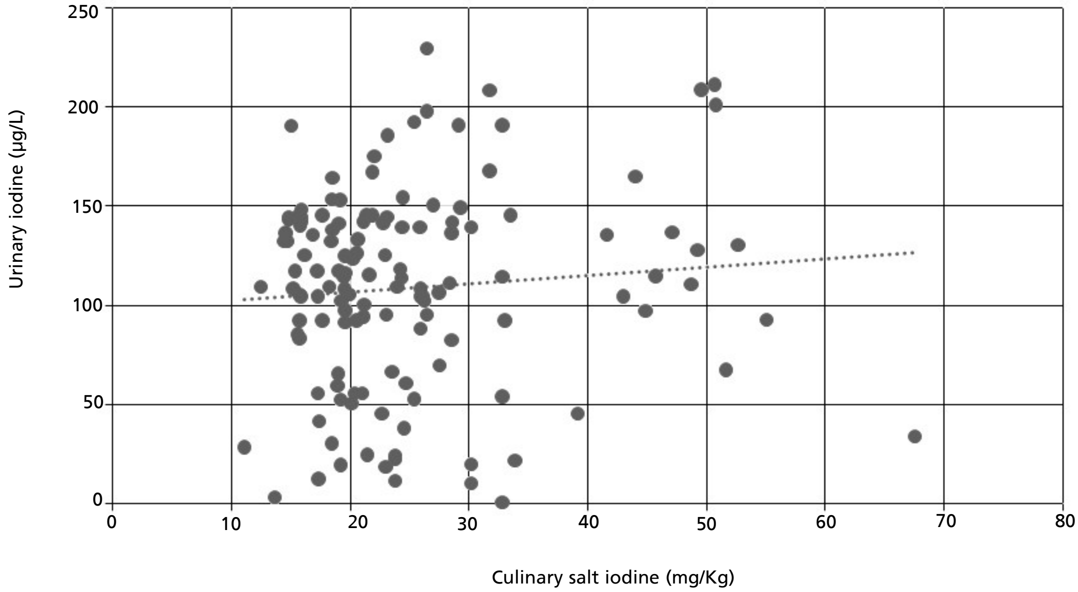
Bivariate analyses comparing median age, urinary iodine and iodine concentration in salt among the study groups.

Variables	Pregnant (n=62)	Non-Pregnant (n=71) Women	*p*
Age (years)	18 ± 1.2	16 ± 1.6	0.005*
Urinary iodine (µg/L)	114.5 ± 61.2	108.2 ± 40.9	<0.001**
Iodine concentration in salt (mg/kg)	26.1 ± 11.8	20.2 ± 7.5	0.028**

* Kruskal-Wallis test; ** Pearson's chi-square test.

Figure 2

Correlation between iodine concentration in salt (mg/kg) and iodine concentration in urine (µg/L) in the study population.



p = 0.221 (Pearson's chi-square test).

insufficient concentration. This result was aligned with the National Salt Iodation Impact Assessment survey conducted between 2013 and 2014.[19] The study cited used 1,121 home salt samples from schoolchildren from different regions of the country, in which 93.6% contained concentration within the required cutoff point.[19] Macedo *et al*.,[12] in a study with 182 pregnant women in the municipality of Diamantina, found 99.5% of the samples of culinary salt with iodine levels above 15 mg/kg, but, different from what was found in this study, 80.8% of the samples presented iodine levels above the maximum limit. It is observed that, according to the latest studies conducted and the data obtained, the Universal Iodation Program is efficient in order to ensure the minimum intake of iodine in the cooking salt.[12,19]

However, it is important to emphasize that this program adopts the population of schoolchildren (6 to 14 years) as a reference standard for the nutritional situation of iodine in the country, presenting as a limitation the fact that it cannot be trusted to cover other groups more vulnerable to iodic deficiency, such as adolescents and pregnant women. This agrees with some studies that address nutrition by iodine of schoolchildren and pregnant women. Yan *et al*.,[20] evaluating 11 Chinese provinces in 2005, showed that pregnant women had significantly lower median urinary iodine concentrations than schoolchildren, with a difference of 50 µg/L between the two groups. Gowachirapant *et al*.[21] found similar results in a study conducted in Bangkok. Urinary iodine concentration was measured in a population of 302 individuals composed of pregnant women and schoolchildren from the same family. The median found in pregnant women was 108 µg/L and in children 200 µg/L.[21] These findings, associated with the results of the present study, point to the importance of the paradox between adequate iodine excretion among schoolchildren and deficient in pregnant women.

Ferreira *et al*.[22] conducted a study in the city of Ribeirão Preto (SP) with a sample of 191 pregnant women over the age of 18 years and a control group of 58 non-pregnant women of the same age group, showing that, among pregnant women, the median urinary iodine was 137.7µg/L, with 57% of the sample below 50 µg/L. These results corroborate those found in this study, whose data showed 71% of iodic deficiency in the pregnant population of the municipality of Vespasiano, with a median of 114.5 μg/L despite the adequate iodization of culinary salt found in most samples.

Preventing iodine deficiency during pregnancy is essential for the formation of the embryo and fetus.[23,24] Low iodine intake during pregnancy is associated with restricted fetal growth, higher prevalence of preeclampsia, increased risk of sub-fertility, and preterm delivery.[24,25] Furthermore, depending on the gestational period, impairment due to deficiency differs,[26] and at early ages of pregnancy there is a greater association with delay in neuropsychomotor development, since the brain is particularly sensitive to this deficiency, leading to changes in behavior and decreased cognitive abilities in the offspring, problems in attention and visual processing, as well as changes in motor skills;[14,23] as from 20 weeks is related to fetal distress, musculoskeletal malformations and small fetuses for gestational age.[14,23] Iodine deficiency can last until the sixth week after delivery, when urinary iodine levels gradually increase.[27] In meta-analysis of five studies,[28] it has been shown that when iodine supplementation is introduced early during pregnancy, preferably in the first 4 weeks, there is a marked increase in IQ in the future in children.

As already pointed out, most studies on iodine status so far have been conducted among primary school children and pregnant adult women; studies on adolescents and young adults are limited. In view of the above, the importance of assessing the nutritional status of iodine in this population is reinforced,[24,29] since the main current intervention policy does not cover the vulnerabilities of this age group. This study collaborates with the view on the nutritional status of iodine in pregnant adolescents in the country.

Further studies are needed to establish the association between iodic disability and the long-term effects on maternal and child health, which are still conflicting. Thus, it would be appropriate to structure an effective action policy in Brazil that would cover the population most at risk for IDDs. Along the lines of what is already recommended in other countries, such as the United States, it is extremely important to discuss micronutrient supplementation for the population concerned.[30]

The study's limitation is the form of iodine analysis in culinary salt, which should not be used as an isolated way of evaluating iodine intake, which should be evaluated through food surveys such as 24-hour Recall or Food Frequency Questionnaire. It is also emphasized that the eating habits of different individuals, especially when rich in industrialized foods, can change the dietary availability of the micronutrient. In addition, the study presents some limitations in the analysis of the association between gestational age and iodine deficiency and as well in relation to the sample criterion adopted - convenience sample, because some adolescents did not answer the questionnaire satisfactorily and many pregnant women in the city did not perform prenatal care in the UBSs. Thus, the results found in this study do not necessarily reflect the nutritional status of iodine of the entire population of pregnant adolescents in the municipality of Vespasiano (MG).

Based on the results presented, it is concluded that there is a high prevalence of iodine deficiency in the group of pregnant adolescents, even in the face of higher iodine concentrations in household salt observed in this group, exposing an interesting paradox between greater amounts consumed and lower mineral sufficiency in these pregnant women. These findings reinforce the importance of rigorous monitoring of the nutritional status of iodine among the groups known to be more vulnerable and to establish specific nutritional actions aimed at these population groups with greater vulnerability to iodine deficiency, in addition to the intervention policy to combat IDDs currently in force in Brazil, thus contributing to the reduction of long-term adverse effects on maternal and child health.

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Authors' contribution

Rates SPM: conception and elaboration of the project, material collection, data analysis, writing of manuscript and academic orientation. Capanema FD: conception and elaboration of the project, data analysis, writing of manuscript and academic orientation. Amaral B: design and elaboration of the project, collection of material, data analysis, writing of the manuscript. Secundino CM: design and elaboration of the project, collection of material, data analysis, writing of the manuscript. Michelli LMS: design and elaboration of the project, collection of material, data analysis, writing of the manuscript. Pereira RCM: discussion and writing of the final text. Ued VF: methodological review and writing of the final text. Nogueira-de-Almeida CA: methodological review and writing of the final text. All authors approved the final version of the article.

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