Rev Bras Cineantropom Hum

original article

DOI: dx.doi.org/10.1590/1980-0037.2020v22e67037

Occurrence of overweight in schoolchildren and analysis of agreement between anthropometric methods

Ocorrência de excesso de peso em escolares e análise da concordância entre métodos antropométricos

Robson Damasceno de Lima[1]
https://orcid.org/0000-0003-2056-8384
Rodrigo Martins Pereira[2]
https://orcid.org/0000-0002-4808-4827
Vitor Rosetto Muñoz[2]
https://orcid.org/0000-0003-4280-6558
Raphael dos Santos Canciglieri[2]
https://orcid.org/0000-0001-7974-1757
Paulo Henrique Canciglieri[1,2]
https://orcid.org/0000-0003-4116-870X

Abstract – The child population is strongly affected by obesity. Accessible and reliable strategies for the obesity diagnosis are of utmost importance. The aim of this study was to identify childhood obesity according the WHO (World Health Organization): malnourished, healthy weight, overweight and obese. It was collected measures of height, Body Mass Index (BMI), Waist Circumference (WC) and Triceps Skinfold Thickness (TSF) of 449 children from Municipal School of Araras/SP, from 7 to 10 years old. It was performed a Spearman correlation test between BMI, WC and TSF variables. Also, was realized cross tabulation between the found results by the different methods, constructing a contingency table 2x2, with absolute frequency of boys and girls classified as "without overweight" and "with overweight". The concordance between methods was analyzed by *kappa* index. In the results, 28.3% of children presented overweight according to BMI, with higher prevalence in boys. Generally, the found results through TSF showed strong correlation with both BMI and WC (rs=0.7994 e rs=0.7519, respectively). The same was observed when data was analyzed separately by sex. When crossed the TSF data with BMI and WC, the *kappa* index demonstrated a satisfactory concordance (0.4419 e 0.5161, respectively). The TSF can be suggested a method to body composition assessment and cardiometabolic risk in children.

Key words: Anthropometry; Body composition; Children; Obesity; Overweight.

Resumo – *A população infantil mostra-se fortemente atingida pela obesidade. Estratégias acessíveis e confiáveis para o diagnóstico da obesidade são de extrema importância. O objetivo desse estudo foi identificar a obesidade infantil de acordo com a OMS (Organização Mundial de Saúde): desnutridas, peso saudável, sobrepeso e obesas. Foram coletadas medidas de estatura, Índice de Massa Corporal (IMC), Circunferência abdominal (CA) e Dobra Cutânea Tricipital (DCT) de 449 crianças de uma Escola Municipal na cidade de Araras/SP, de 7 a 10 anos de idade. Foi realizado o teste de correlação de Spearman entre as variáveis IMC, CA e DCT. Também foi realizado tabulação cruzada entre os resultados encontrados pelos diferentes métodos, construindo uma tabela de contingência 2x2, com a frequência absoluta de meninos e meninas classificados como "sem excesso de peso" e "com excesso de peso". A concordância entre os métodos foi analisada pelo índice kappa. Nos resultados 28,3% das crianças apresentaram excesso de peso de acordo com o IMC, com maior ocorrência entre os meninos. De modo geral, os resultados encontrados por meio da DCT apresentaram forte correlação tanto com IMC quanto com CA (rs=0,7994 e rs=0,7519, respectivamente). O mesmo foi observado quando analisados separadamente por sexo. Quando cruzados os dados de DCT com os de IMC e CA, o índice kappa revelou uma satisfatória concordância (0,4419 e 0,5161, respectivamente). A DCT pode ser sugerido como um método para investigação de composição corporal e risco cardiometabólico de crianças.*

Palavras-chave: *Antropometria; Composição corporal; Criança; Obesidade; Sobrepeso.*

1 University Center of the Hermínio Ometto Foundation - FHO. Araras, SP. Brazil.

2 Campinas State University. School of Applied Science. Limeira, SP. Brazil.

Received: 13 August 2019
Accepted: 20 September 2019

How to cite this article
Lima RD, Pereira RM, Muñoz VR, Canciglieri RS, Canciglieri PH. Occurrence of overweight in schoolchildren and analysis of agreement between anthropometric methods. Rev Bras Cineantropom Desempenho Hum 2020, 22:e67037. DOI: http://dx.doi.org/10.1590/1980-0037.2020v22e67037

INTRODUTION

Obesity is defined as the excessive accumulation of body fat and can be determined by the percentage of adipose tissue presented by the individual. It is a chronic disease considered a worldwide problem, reaching epidemic proportions in both developing and developed countries, regardless of gender and age[1].

The child population is, also, strongly affected by obesity, which is considered a concerned scenario. Currently in Brazil, 34.8% of girls and 25.9% of boys are overweight and have been increasing over the decades[2,3]. Obesity phenotype is high associated with lifestyle changes achieved by contemporary society, where children consume large amounts of foods with high levels of fat and carbohydrate. As well, the reduction of physical activity levels[4,5].

The overweight at this stage of life is a risk factor for a number of health problems, which may manifest on early age or late age. Among these, we can highlight physiological and metabolic complications such as elevation in blood pressure, dyslipidemia, cardiovascular disease and type 2 diabetes; postural changes, accompanied by joint pain, as well as psychological problems related to low self-esteem and self-concept[6–9].

There are evidences that a great number of obese children and adolescents will remain obese when they reach adulthood [9]. Therefore, the older you are and the greater overweighed you are, the most difficult it will be to reverse, due to the incorporated eating habits and installed metabolic changes. For that reason, strategies to combat this condition have become important. Not only in pursing the weight lost, but also in diagnostic overweight in an accessible and reliable way. Thus, both Body Mass Index (BMI)[10] and skinfold method[11] are widely used for diagnosis. However, the studies which uses skinfold measures the thickness of more than one skinfold, such as triceps, subscapular and suprailiac[12]. Thus, it was proposed the use of triceps skinfold (TSF) as a respectable method to identify overweight in school-age children.

The present study aimed to identify the nutritional status and body fat content of children aged 7 to 10 years in a municipal school of the city of Araras, state of São Paulo, Brazil. Therefore, BMI, TSF and WC methods were used to correlate the results obtained and to compare the agreement between the methods, besides providing subsidies for the best choice of methods for the analysis of body composition of school age children.

METHOD

The present study was classified as a cross-sectional, observational and quantitative field research. Anthropometric measurements of height, body mass, WC and TSF were collected from 449 children (209 boys and 240 girls from a municipal school in the city of Araras/SP, aged 7 to 10 years. All children were previously instructed to wear shorts and t-shirt, and to remain barefoot to measure body mass and height.

Participants' body mass was measured using a Filizola® scale with 100g divisions and maximum load of 150 kg, as well as a portable Sanny® stadiometer for height measurement. Those two data were used to calculate BMI, where the body mass value in kilograms (Kg) is divided by the square of the height in meters (m^2). The BMI value was applied to classify the nutritional state of the subjects as malnourished, healthy, overweight and obesity. For this, we used the percentile table proposed by the World Health Organization, considering gender and age[13], and the cutoff values proposed by Division of Nutrition, Physical Activity and Obesity of Centers for Disease Control and Prevention[14].

To obtain the WC, all children were positioned in anatomical position, with a measuring tape in a horizontal plane over the umbilical scar, and being analyzed in WC percentiles according gender and age[15].

To obtain the TSF, a Sanny® adipometer was used. The anatomical point of the TSF was determined parallel to the longitudinal axis of the arm on the posterior face, and the point was the average distance between the superolateral edge of the acromion and the oclecranon. For the analysis of the Percentiles, the gender and age of the children were considered[16]. The same Physical Education teacher performed all evaluations.

The Spearmen correlation test was performed between the variables BMI, WC and TSF, with a statistical significance as $p < 0,05$. The test was executed on BioEstat 5.3.® program.

A cross tabulation was also performed between the results found by the different methods and constructing a 2x2 contingency table, with the absolute frequency of boys and girls classified as "non-overweight" and "overweight". Then, the *kappa* index analysis was performed, thus allowing evaluate of the agreement between the methods os diagnosis of obesity. The *kappa* index was classified as proposed by Landis and Koch[17] and, also, performed by the BioEstat 5.3.® program.

All procedures followed the principles of Ethics Committee for Human Research, under protocol CAE number 64158617.3.0000.5385. For involving minors, parents and/or guardians signed the Informed Consent agreeing to data collection.

RESULTS

Table 1 shows the results regarding the occurrence of overweight and obesity in the children participating in the study, totally and divided by gender. Overall, 28.3% of 449 children were overweight (127 children) according to BMI, 31% male (n = 65) and 25.9% female (n = 62). On the other hand, girls had a higher occurrence of overweight, but the number of obese was higher among boys (Table 1).

The Lillieforns test showed that it was a non-normal sample. Thus, the Spearman coefficient was performed, so that when correlated BMI and TSF, we observed an $r_s = 0.7994$ ($p<0.05$), revealing a strong correlation (Figure 1A). Strong correlations between the methods were also observed

when analyzes were made separately by gender, with r_s = 0.7901 ($p<0.05$) for boys and r_s = 0.8220 ($p<0.05$) for girls (Figures 1C and 1E respectively). The same pattern was noticed when we executed the correlations of WC with TSF, with r_s = 0.7519 ($p<0.05$) for the whole sample (Figure 1B), with r_s = 0.7653 ($p<0.05$) for the boys (Figure 1D) and r_s = 0.7550 ($p<0.05$) for girls (Figure 1F).

Table 1. Occurrence of overweight and obesity.

	Malnourished	Health Weight	Overweight	Obese
	% (n)	% (n)	% (n)	% (n)
Every Sample				
BMI	4,5 (20)	67,3 (302)	15,6 (70)	12,7 (57)
TSF	5,3 (24)	39,4 (177)	25,4 (114)	29,8 (134)
WC	2,9 (13)	39,9 (179)	25,2 (113)	32,1 (144)
Boys				
BMI	4,8 (10)	64,1 (134)	14,8 (31)	16,3 (34)
TSF	3,3 (7)	53,1 (111)	19,1 (40)	24,4 (51)
WC	2,9 (6)	39,7 (83)	27,8 (58)	29,7 (62)
Girls				
BMI	4,2 (10)	70,0 (168)	16,3 (39)	9,6 (23)
TSF	7,1 (17)	59,2 (142)	20,0 (48)	13,8 (33)
WC	2,9 (7)	40,0 (96)	25,4 (61)	31,7 (76)

Note. BMI: Body Mass Index; TSF: Triceps Skinfold Thickness; WC: Waist Circumference.

The cross tabulation of the results obtained by BMI, WC and TSF are presented in 2x2 contingency tables, with Table 2 being the cross tabulation of BMI TSF results and Table 3 the cross tabulation of WC and TSF results. When the BMI and TSF data were crossed, the *kappa* index revealed a satisfactory agreement, both for the whole sample (0.454) and for boys (0.4260) and girls (0.4527) (Table 2). Satisfactory agreement was also found when WC and TSF results were crossed, with a *kappa* index of 0.5161 for the entire sample, 0.5381 for boys and 0.4970 for girls (Table 3).

DISCUSSÃO

In our study, we found overweight in 28.3% of children (15.6% overweight and 12.7% obesity) (Table 1). These numbers may be related to the fact that currently a number of social factors contribute to increased physical inactivity and decreased energy expenditure of children, among them the advancement of technology that makes electronic games more attractive and policy-related factors, such as decreased safety for leisure activities on the streets and reduction of free space for such activities[18]. Corroborating our finding, studies report an alarming number of overweight children[19,20].

Among genders, boys had a higher occurrence of overweight than girls, accompanied by a higher occurrence of obesity (Table 1). Opposite

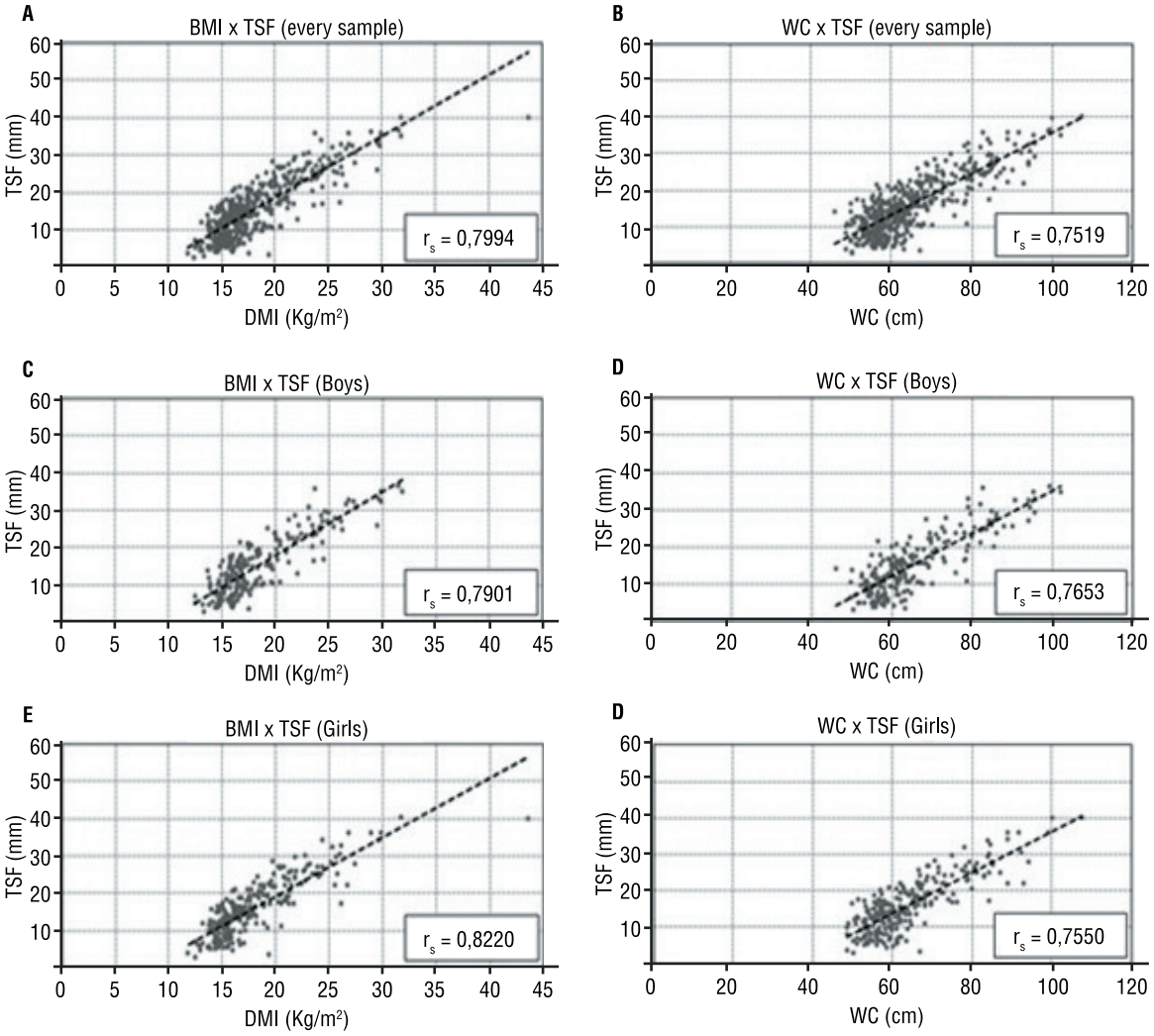

Figure 1. Spearman correlation coefficients between BMI - Body Mass Index (kg/m²) and TSF - Triceps Skinfold Thickness (mm) and between WC - Waist Circumference (cm) and TSF - Triceps Skinfold Thickness (mm).

data were observed in the literature, since there are studies showing the highest occurrence in girls[21], or even found no difference between the genders[19]. Therefore, we can suggest that obesity at school age is not correlated with gender.

According to literature data[19–21], BMI is widely used for the diagnosis of overweight and obesity when dealing with large populations, supported by a several studies that have shown that it is a reliable method for this purpose. A study of children in a public school with a mean age of 9.2 ± 1 years showed good agreement between BMI and skinfold method[22]. Similar results were compared with those obtained by X-ray double emission densitometry (DEXA) method, considered the gold standard for body composition evaluation[23]. In the present study, we observed that only the measurement of TSF thickness is a method that shows good agreement with BMI and may be a new strategy for investigating the nutritional status of school-age children. Moreover, it is also considered a fast, practical and relatively low cost method, with easy interpret results.

Table 2. Frequency of children classified as "no overweight" and "overweight".

		Body Mass Index (BMI)		
		No overweight	Overweight	All
Triceps Skinfold Thickness (TSF)	Every Sample			
	No overweight	196	5	201
	Overweight	126	122	248
	All	322	127	449
	Kappa index: 0,4419			
	Boys			
	No overweight	83	3	86
	Overweight	61	62	123
	All	144	65	209
	Kappa index: 0,4260			
	Girls			
	No overweight	113	2	115
	Overweight	65	60	125
	All	178	62	240
	Kappa index: 0,4527			

Note. BMI: Body Mass Index; TSF: Triceps Skinfold Thickness.

Table 3. Frequency of children classified as "no overweight" and "overweight".

		Waist Circumference (WC)		
		No overweight	Overweight	All
Triceps Skinfold Thickness (TSF)	Every Sample			
	No overweight	143	58	201
	Overweight	49	199	248
	All	192	257	449
	Kappa index: 0,5161			
	Boys			
	No overweight	64	22	86
	Overweight	25	98	123
	All	89	120	209
	Kappa index: 0,5381			
	Girls			
	No overweight	79	36	115
	Overweight	24	101	125
	All	103	137	240
	Kappa index: 0,4970			

Note. WC: Waist Circumference; TSF: Triceps Skinfold Thickness.

Others studies were performed comparing the results obtained by BMI and skinfold method[11,24]. Januário et al.[11] investigated the occurrence of obesity in 200 children from 8 to 10 years old in public schools in Londrina – PR. The authors observed a *kappa* index of 0.43 for boys and 0.50 for girls. These results are similar to those observed in our study, 0.43 for boys and 0.45 for girls (Table 2). Similar results were observed

by Landis and Koch[17] that evidenced a moderate agreement between the methods. It should be taken into consideration that in our study only the TSF was evaluated, while the study by Januário et al.[11] used both TSF and subscapular fold. Thus, this study proposes that only TSF measurement can be a new method for diagnosis of obesity for adolescents, given the strong correlation with BMI (Figure 1) and the moderate agreement by the *kappa* index (Table 3), revealing the TSF may also be a good method for the diagnosis of cardiometabolic risk in this population. Since WC has been proposed as an important tool for this purpose[25,26].

However, it is important to highlight that the present study used more than one doubly indirect method to obtain body fat[12]. Although the literature describes the gold standard technique[23] as a more accurate technique, the results obtained by measuring the TSF corroborate the other methods used to analyze body composition. In view of this, it would be interesting to perform a comparative analysis between the method used in this study with a gold standard technique, in an attempt to obtain consistent and homogeneous information among them, to elect a new method with potential of easy applicability and cost benefit.

CONCLUSION

In the present study, it was possible to observe that approximately one in four children from 7 to 10 years old are overweight, and this occurrence is higher among boys. The TSF method showed a strong correlation with both BMI and WC, with a satisfactory agreement between the methods. Thus, we can conclude that TSF can be a good method for investigating body composition and cardiometabolic risk for schoolchildren of both sexes.

COMPLIANCE WITH ETHICAL STANDARDS

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors. This study was funded by the authors.

Ethical approval

Ethical approval was obtained by the Ethics Committee for Human Research, Hermínio Ometto Foundation, CAE protocol number 64158617.3.0000.5385 and the protocol was written according to the standards set by the Declaration of Helsinki.

Conflict of interest statement

The authors have no conflict of interests to declare.

Author Contributions

Conceived and designed the experiments: PHC. Performed the experi-

ments: RDL. Analyzed the data: RDL, RMP, VRM, RSC, PHC. Contributed reagents/materials/analysis tools: PHC. Wrote the paper: RDL, RMP, VRM, RSC, PHC. All authors read and approved the final version of the manuscript.

REFERENCES

1. Brandão AP, Brandão AA, Berenson GS, Fuster V. Síndrome metabólica em crianças e adolescentes. Arq Bras Cardiol 2005;85(2):79–81.
2. Brasil. Instituto Brasileiro de Geografia e estatística. Pesquisa de Orçamentos Familiares. Antropometria e Análise do Estado Nutricional de Crianças e Adolescentes no Brasil. Rio de Janeiro; 2006;
3. Guedes DP, Miranda Neto JT, Almeida MJ, Silva AJRM. Impacto de fatores sociodemográficos e comportamentais na prevalência de sobrepeso e obesidade de escolares. Rev Bras Cineantropom Desempenho Hum 2010;12(4):221–31.
4. Chiarelli G, Zampier Ulbrich A, Labronici Bertin R. Composição corporal e consumo alimentar de adolescentes da rede pública de ensino de Blumenau (Brasil). Rev Bras Cineantropom Desempenho Hum 2011;13(4):265–71.
5. Garcia L, Fisberg M. Atividades físicas e barreiras referidas por adolescentes atendidos num serviço de saúde. Rev Bras Cineantropom Desempenho Hum 2011;13(3):163–9.
6. Juárez-López C, Klünder-Klünder M, Medina-Bravo P, Madrigal-Azcárate A, Mass-Díaz E, Flores-Huerta S. Insulin resistance and its association with the components of the metabolic syndrome among obese children and adolescents. BMC Public Health 2010;10(1):318.
7. Rolland-Cachera MF, Deheeger M, Maillot M, Bellisle F. Early adiposity rebound: causes and consequences for obesity in children and adults. Int J Obes 2006;30 (Suppl 4):S11-7.
8. Silva LR, Rodacki ALF, Brandalize M, Lopes MFA, Bento PCB, Leite N. Alterações posturais em crianças e adolescentes obesos e não-obesos. Rev Bras Cineantropom Desempenho Hum 2011;13(6):448–54.
9. Deshmukh-Taskar P, Nicklas TA, Morales M, Yang SJ, Zakeri I, Berenson GS. Tracking of overweight status from childhood to young adulthood: the Bogalusa Heart Study. Eur J Clin Nutr 2006;60(1):48–57.
10. Leite N, Milano GE, Lopes WA, Tanaka J, Dressler VF, Radominski RB. Comparação entre critérios para índice de massa corporal na avaliação nutricional em escolares. Rev Educ Física/UEM 2008;19(4):557-63.
11. Januário RSB, Nascimento MA, Barazetti LK, Reichert FF, Mantoan JPB, Oliveira AR. Índice de massa corporal e dobras cutâneas como indicadores de obesidade em escolares de 8 a 10 anos. Rev Bras Cineantropom Desempenho Hum 2008;19(3):266–70.
12. Sant'Anna M de SL, Priore SE, Franceschini S do CC. Métodos de avaliação da composição corporal em crianças. Rev Paul Pediatr 2009;27(3):315–21.
13. World Health Organization. BMI-for-age (5–19 years). 2016; Available from: <https://www.who.int/growthref/who2007_bmi_for_age/en/>[2016 april 10].
14. Centers for Disease Control and Prevention. Childhood obesity. 2010; Available from: <https://www.cdc.gov/healthyschools/obesity/facts.htm>[2016 april 10].
15. Benjumea M V, Molina DI, Arbeláez PE, Agudelo LM. Circunferencia de la cintura en niños y escolares manizaleños de 1 a 16 años. Rev Col Cardiol 2008;15(1):23–34.
16. Frisancho AR. Anthropometric Standards for the Assessment of Growth and Nutritional Status. Press U of M, editor. 1990.
17. Landis JR, Koch GG. The Measurement of Observer Agreement for Categorical Data. Biometrics 1977;33(1):159.

18. Lazzoli JK, Nóbrega ACL da, Carvalho T de, Oliveira MAB de, Teixeira JAC, Leitão MB, et al. Atividade física e saúde na infância e adolescência. Rev Bras Med Esporte 1998;4(4):107–9.
19. Maffeis C, Banzato C, Talamini G. Waist-to-Height Ratio, a useful index to identify high metabolic risk in overweight children. J Pediatr 2008; 152(2):207-13.
20. Magarey A, Daniels L, Boulton T, Cockington R. Predicting obesity in early adulthood from childhood and parental obesity. Int J Obes 2003;27:505–13.
21. Guedes DP, Miranda Neto JT, Almeida MJ, Martins e Silva AJR. Impacto de fatores sociodemográficos e comportamentais na prevalência de sobrepeso e obesidade de escolares. Rev Bras Cineantropom Desempenho Hum 2010;12(4):221–31.
22. Jensen NSO, Camargo T de FB, Bergamaschi DP. Índice de massa corpórea e perímetro da cintura são bons indicadores para classificação do estado nutricional de crianças. Cien Saude Colet 2016;21(4):1175–80.
23. Tuan NT, Wang Y. Adiposity assessments: agreement between dual-energy X-ray absorptiometry and anthropometric measures in U.S. children. Obesity 2014;22(6):1495–504.
24. Monteiro POA, Victora CG, Barros FC, Tomasi E. Diagnóstico de sobrepeso em adolescentes: estudo do desempenho de diferentes critérios para o Índice de Massa Corporal. Rev Saude Publica 2000;34(5):506–13.
25. Hou X, Lu J, Weng J, Ji L, Shan Z, Liu J, et al. Impact of waist circumference and body mass index on risk of cardiometabolic disorder and cardiovascular disease in Chinese adults: a national diabetes and metabolic disorders survey. PLoS One 2013;8(3):e57319.
26. Klein S, Allison DB, Heymsfield SB, Kelley DE, Leibel RL, Nonas C, et al. Waist Circumference and Cardiometabolic Risk: a Consensus Statement from Shaping America's Health: Association for Weight Management and Obesity Prevention; NAASO, the Obesity Society; the American Society for Nutrition; and the American Diabetes Associat. Obesity 2007;15(5):1061–7.

Corresponding author
Robson Damasceno de Lima
University Center of the Hermínio Ometto Foundation – FHO
José Ometto Avenue, 254, Fátima Garden, Araras/São Paulo - Brazil.
Zip Code: 13607-059.
Email: robson_852@hotmail.com