Distortions in child nutritional diagnosis related to the use of multiple growth charts in a developing country

Distorções no diagnóstico nutricional de crianças relacionadas ao uso de múltiplas curvas de crescimento em um país em desenvolvimento

Distorsiones en el diagnóstico nutricional de niños relacionados al uso de múltiples curvas de crecimiento en un país en desarrollo

Ursula Viana Bagni[1], Ronir Raggio Luiz[2], Gloria Valeria da Veiga[3]

ABSTRACT

Objective: Since many health facilities still use different versions of growth references, this study aimed to estimate the diagnostic agreement of nutritional status and its possible distortions in the prevalence of nutritional disorders in children by using the growth curves of the National Center for Health Statistics (NCHS, 1977), and of the Centers for Disease Control and Prevention (CDC, 2000), considering the World Health Organization charts (WHO, 2006) as gold-standard.

Methods: A cross-sectional study developed with 646 children aged 12 to 60 months attending day care centers in Rio de Janeiro, Brazil. Weight-for-age, weight-for-height, height-for-age, and body mass index-for-age were evaluated. The cut-off values <-2 Z-score for weight-for-age, weight-for-height, height-for-age were used to classify weight and height deficits, and values >+2 Z-score for weight-for-height e body mass index-for-age were used to classify overweight.

Results: The frequencies of height-for-age deficits were underestimated when NCHS, and CDC curves were applied. The frequency of weight-for-age and weight-for-height deficits was overestimated when using CDC reference, particularly among females and children aged 12 to 23 months for weight-for-age, and among boys and children aged 24 to 60 months for weight-for-height. The use of NCHS resulted in deficit frequencies similar to WHO curve for weight-for-age and weight-for-height. Diagnosis of obesity by weight-for-height and body mass index-for-age was underestimated by using both NCHS and CDC curves particularly among children aged 24 to 60 months.

Conclusions: Since distortions in the estimated nutritional disorders may be collectively and individually harmful, it is recommended that only WHO 2006 standards be used for monitoring nutritional status of preschool age children, in order to obtain a reliable diagnosis.

Key-words: nutritional status; growth charts; child, preschool.

RESUMO

Objetivo: Visto que inúmeras unidades de saúde ainda utilizam curvas variadas para a avaliação do crescimento infantil, estimou-se a concordância diagnóstica do estado nutricional e suas possíveis distorções na prevalência de desvios nutricionais pela utilização das referências *National Center for Health Statistics* (NCHS, 1977) e *Centers for Disease Control and Prevention* (CDC, 2000), considerando como padrão-ouro a referência da Organização Mundial de Saúde (OMS, 2006).

Métodos: Estudo transversal desenvolvido com 646 crianças com idades entre 12 e 60 meses que frequentavam creches no Rio de Janeiro. Foram avaliados: peso para idade, peso para estatura, estatura para idade e índice de massa

Instituição: Universidade Federal do Rio de Janeiro (UFRJ), Rio de Janeiro, RJ, Brasil

[1]Doutora em Ciências Nutricionais pela UFRJ; Professora Adjunta da Faculdade de Ciências de Saúde do Trairi, Universidade Federal do Rio Grande do Norte (UFRN), Santa Cruz, RN, Brasil

[2]Doutor em Engenharia Biomédica pela UFRJ; Professor-Associado do Instituto de Estudos em Saúde Coletiva da UFRJ, Rio de Janeiro, RJ, Brasil

[3]Doutora em Nutrição pela Universidade Federal de São Paulo (Unifesp); Professora-Associada do Instituto de Nutrição da UFRJ, Rio de Janeiro, RJ, Brasil

Endereço para correspondência:
Ursula Viana Bagni
Rua Trairi, s/n – Centro
CEP 59200-000 Santa Cruz/RN
E-mail: ursulaviana@gmail.com

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corporal para idade, considerando valores <-2 escore Z de peso para idade, peso para estatura e estatura para idade como déficits ponderoestaturais e valores >+2 escore Z de peso para estatura e índice de massa corporal para idade como excesso de peso.

Resultados: As frequências de déficit de estatura para idade foram subestimadas pelas referências NCHS, e CDC. A frequência de déficit de peso para idade e para estatura foi superestimada por CDC, particularmente entre meninas e crianças entre 12 e 23 meses para o peso para idade e entre meninos e crianças entre 24 e 60 meses para o peso para estatura. O uso da referência NCHS ocasionou frequências de déficit semelhantes àquelas obtidas com a OMS para o peso para idade e o peso para estatura. NCHS e CDC subestimaram o diagnóstico do excesso de peso para peso para estatura e índice de massa corporal para idade, particularmente entre meninas e crianças entre 24 e 60 meses.

Conclusões: Como distorções na estimativa dos desvios nutricionais podem trazer prejuízos em nível individual e coletivo, recomenda-se que apenas a referência OMS, 2006, seja utilizada para vigilância nutricional de pré-escolares, a fim de se obter um diagnóstico fidedigno.

Palavras-chave: estado nutricional; gráficos de crescimento; pré-escolar.

RESUMEN

Objetivo: Visto que innúmeras unidades de salud todavía utilizan curvas variadas para evaluar el crecimiento infantil, se estimó la concordancia diagnóstica del estado nutricional y las posibles distorsiones en la prevalencia de desvíos nutricionales por el uso de las referencias National Center for Health Statistics (NCHS-1977) y Centers for Disease Control and Prevention (CDC-2000), considerando como estándar oro la referencia World Health Organization (WHO-2006).

Métodos: Estudio transversal, desarrollado con 646 niños entre 12 y 60 meses frecuentando guarderías en Rio de Janeiro, Brasil. Se evaluaron: peso para la edad (P/I), peso para estatura (P/E), estatura para edad (E/I) e Índice de Masa Corporal para Edad (IMC/I), teniendo en cuenta valoras <-2 Z escore de P/I, P/E, E/I como déficits ponderoestaturales, y valores >+2 Z escore de P/E e IMC/I como exceso de peso.

Resultados: Las frecuencias de déficit de E/I fueron subestimadas por las referencias NCHS-1977 y CDC-2000. La frecuencia de déficit de P/I y P/E fue sobrestimada por CDC-2000, en especial entre muchachas y niños entre 12 y 23 meses para P/I, y entre muchachos y niños entre 24/60 meses de edad para P/E. El uso de la referencia NCHS-1977 ocasionó frecuencias de déficit semejantes a aquellas obtenidas con la referencia WHO-2006 para P/I y P/E. NCHS-1977 y CDC-2000 subestimaron el diagnóstico de exceso de peso para P/E e IMC/I, en especial entre muchachas y niños entre 24 y 60 meses.

Conclusiones: Como distorsiones en la estimativa de los desvíos nutricionales puede traer perjuicios en nivel individual y colectivo, se recomienda utilizar solamente la referencia WHO-2006 para vigilancia nutricional de preescolares, a fin de obtener un diagnóstico fidedigno.

Palabras clave: estado nutricional; curva de crecimiento; pre-escolar.

Introduction

Anthropometric indices are frequently used to evaluate and monitor children's nutritional status[1,2], because they consist of simple and low invasive measurements, besides requiring low cost equipments. They are useful to assess the impact of nutritional interventions and describe nutritional outcomes in epidemiological studies and are also used as health and development indicators for populations or countries, since growth and body measurement ratios are affected by unfavorable health and nutritional conditions, regardless of their etiology[2-4]. Height-for-age (H/A), weight-for-height (W/H), and weight-for-age (W/A) are indices traditionally used in children's nutritional assessment. Recently, body-mass-index-for-age (BMI/A) has also been recommended as an important nutritional index for this purpose[1,5-9].

For over two decades, the main reference for children's nutritional assessment all over the world was the set of growth curves of the National Center for Health Statistics, published in 1977 (NCHS-1977). Besides the fact of being built based on studies conducted between 1929 and 1974 in samples from the American population[10,11], these charts were also criticized because they reflected the growth of children fed with industrialized formulas, who showed a different size and growth pattern from those fed with breast milk or mixed feeding[7,12]. After a detailed review aiming to minimize the methodological limitations of these charts, the Centers for Disease Control and Prevention released a new set of growth curves in 2000 (CDC-2000), still considered unsuitable for international use due to the fact of being

based only on data from American children and including data from bottle-fed children[4,13].

In 2006, the World Health Organization (WHO) published new reference growth charts for children under five years of age (WHO-2006), which, differently from the previous references that described how American children grew, represent a prescriptive approach on how children from all over the world should grow. Based on the Multicenter Growth Reference Study, undertaken between 1997 and 2003 in countries from different regions in the world, these standards were considered the most appropriate and powerful instrument to assess the nutritional status of children in this age group, regardless of their ethnic and cultural characteristics, since, in optimal conditions, all children have a similar growth pattern[7,12,14-16].

In Brazil, newborns began to receive a new version of the Child's Health Booklet including these growth charts only during the first semester of 2007. The Child's Health Booklet is a document that has been used by the Brazilian Ministry of Health since 1984 to monitor and assess children's growth and development from their birth on and to record their vaccination history. Since its implementation, the document underwent several changes; however, the older versions that had already been distributed, developed by the Ministry of Health in different occasions, were not replaced. Therefore, different versions of this document, including different growth references, can still be found in health facilities throughout the country, a reality that may also be present in many countries that adopted these new growth standards.

The use of these various growth charts to assess children's nutritional status both in clinical practice and in epidemiological studies may result in different diagnoses and thus in different prevalences of nutritional disorders. When nutritional deficiencies and excesses are underestimated, children are deprived from a more appropriate follow-up, which may result in the maintenance and worsening of the disorders. On the other hand, overestimating growth disorders may imply in early and unnecessary interventions in healthy children, with a consequent burden on health systems and bad use of resources from assistance programs. At the population level, inconsistencies in the prevalences of nutritional disorders may hinder the implementation and the improvement of public intervention policies[3,17].

Thus, the present study aimed to deepen the discussion on these issues and for this purpose was based on the estimation of prevalences of nutritional disorders using anthropometric indices of children aged 12 to 60 months attending day care centers in Rio de Janeiro, Brazil, in order to estimate the degree of diagnostic agreement, as well as possible distortions in the prevalences obtained by using NCHS-1977 and CDC-2000 charts in comparison to those obtained by WHO-2006 charts, considered the "gold standard".

Methods

The anthropometric data assessed in this study were generated from two cross-sectional studies conducted in 2006 and 2007, in public and private day care centers in the city of Rio de Janeiro, Brazil, chosen by convenience sampling. The study conducted in 2006 aimed to evaluate the effect of weekly rice fortification with iron on anemia frequency and hemoglobin concentration among children aged 12 to 60 months attending public day care centers[18]. The study conducted in 2007 aimed to estimate the prevalence of inadequate nutrient intake among children aged 24 to 72 months attending public and private day care centers in Rio de Janeiro.

The anthropometric measurements of the children assessed in 2006 (n=425) were compiled in only one database, together with the measurements obtained in children from the same age group in the 2007 study (n=353). For the 132 children who participated in both surveys, only the information collected in 2006 was considered. Therefore, the analysis included data for a total of 646 children aged 12 to 60 months, of both sexes. Children aged 24 months or older were weighed on a portable electronic scale (Kratos-Cas®), with a capacity of 150kg and a resolution of 50g. Height was measured with the children in the standing position, using a portable anthropometer (Alturexata®), with a 213cm scale and a resolution of 0.1cm. Children under 24 months were weighed unclothed on a digital pediatric scale (Filizola®) with a resolution of 10g. Length was measured with the children in the supine position, using a portable anthropometer (Alturexata®)[1].

We assessed the following anthropometric indices: weight-for-age (W/A), height-for-age (H/A), weight-for-height (W/H), and body mass index-for-age (BMI/A), establishing cut off values below -2 Z score for W/A, W/H, H/A and BMI/A to define weight and height deficits, and above +2 Z score for W/H and BMI/A to define overweight[7]. Z scores were calculated by the Epi Info 3.3.2 software (CDC, Georgia, United States) for CDC-2000 reference values and by the WHO Anthro 2005 Beta software (WHO, Geneva, Switzerland) for WHO-2006 and NCHS-1977 reference values. Statistical analyses were performed using SPSS 17.0 (SPSS Inc., Chicago, USA) and were stratified by sex and age group (12 to 24 months and 24 to 60 months).

Z score means for the anthropometric indices obtained by the WHO-2006 chart were compared with those obtained by NCHS-1977 and CDC-2000 charts, using the paired t-test. The prevalences of nutritional disorders were compared by the McNemar test. The diagnostic agreement of nutritional status was assessed by thee kappa test (k), with a classification ranging from perfect (when k=1.00) to weak (when k was between 0.20 and 0.00) according to the criteria of Landis & Koch[19]. Statistical significance was set at $p<0.05$ in all analyses.

The studies were approved by two Research Ethics Committees of the Universidade Federal do Rio de Janeiro, and all procedures involving children were undertaken only after their guardians signed a free and informed consent, as stated in the Resolution 196/96 of the Brazilian Ministry of Health[20].

Results

Among the 646 children assessed, 53.4% were male and 84.8% were aged 24 to 60 months. In general, z score means for the anthropometric indices obtained by NCHS-1977 and CDC-2000 charts were significantly different from those obtained by WHO-2006 charts, being higher for W/A, W/H and BMI/A, and lower for H/A (Table 1).

The frequency of H/A deficit was significantly lower when CDC-2000 and NCHS-1977 curves were used (except for children from 12 to 23 months) in comparison with those

Table 1 - Comparison of mean Z-scores and standard deviations for the analyzed anthropometric indices in children aged 12 to 60 months attending public and private daycare centers in Rio de Janeiro, RJ, Brazil

	n	WHO-2006		CDC-2000			NCHS-1977		
		Mean	SD	Mean	SD	*p*-value*	Mean	SD	*p*-value*
Height-for-Age	638	-0.48	1.06	-0.19	1.02	<0.01	-0.24	1.06	<0.01
Sex									
Male	339	-0.45	1.06	-0.18	1.01	<0.01	-0.21	1.02	<0.01
Female	299	-0.52	1.06	-0.20	1.03	<0.01	-0.28	1.00	<0.01
Age group									
12 to 23 months	97	-0.81	1.06	-0.59	0.92	<0.01	-0.80	0.97	0.42
24 to 60 months	541	-0.42	1.05	-0.12	1.02	<0.01	-0.14	1.05	<0.01
Weight-for-Age	645	0.11	1.04	-0.03	1.14	<0.01	-0.05	1.17	<0.01
Sex									
Male	344	0.13	1.07	-0.01	1.14	<0.01	-0.04	1.18	<0.01
Female	301	0.09	1.02	-0.06	1.14	<0.01	-0.05	1.16	<0.01
Age group									
12 to 23 months	98	-0.05	0.90	-0.67	1.00	<0.01	-0.47	0.96	<0.01
24 to 60 months	547	0.14	1.07	0.08	1.13	<0.01	0.03	1.19	<0.01
Weight-for-Height	637	0.51	1.05	0.19	1.07	<0.01	0.22	1.02	<0.01
Sex									
Male	338	0.51	1.08	0.18	1.10	<0.01	0.17	1.04	<0.01
Female	299	0.52	1.02	0.21	1.04	<0.01	0.27	1.01	<0.01
Age group									
12 to 23 months	97	0.46	0.96	0.08	1.02	<0.01	0.02	0.98	<0.01
24 to 60 months	540	0.52	1.06	0.21	1.08	<0.01	0.25	1.03	<0.01
BMI-for-Age**	540	0.57	1.07	0.27	1.08	<0.01	–	–	–
Sex							–	–	–
Male	286	0.56	1.08	0.20	1.14	<0.01	–	–	–
Female	254	0.58	1.06	0.34	1.02	<0.01	–	–	–
Age group							–	–	–
12 to 23 months	–	–	–	–	–	–	–	–	–
24 to 60 months	540	0.57	1.07	0.27	1.08	<0.01	–	–	–

*Comparison with WHO-2006 charts using the Paired *t* Test; **Not completely assessed because there were no available references for all children according to NCHS-1977 standards, as well as for children aged 12 to 24 months according to CDC-2000 standards; SD: standard deviation; BMI: body mass index

Table 2 – Comparison of the frequency of nutritional disorders (%) and diagnostic agreement (k) in children aged 12 and 60 months attending public and private daycare centers in Rio de Janeiro, RJ, Brazil

		WHO–2006	CDC–2000			NCHS–1977	
	n	%	%	*p*-value*	k**	%	*p*-value*	k**
Height–for–Age deficit	638	8.5	3.9	<0.01	0.61	5.2	<0.01	0.74
Sex								
Male	339	6.8	3.5	<0.01	0.67	4.4	<0.01	0.78
Female	299	10.4	4.3	<0.01	0.56	6.0	<0.01	0.71
Age group								
12 to 23 months	97	14.4	8.2	0.03	0.70	12.4	0.50	0.91
24 to 60 months	541	7.4	3.1	<0.01	0.58	3.9	<0.01	0.67
Weight–for–Age Deficit	645	2.0	4.7	<0.01	0.59	2.9	0.31	0.81
Sex								
Male	344	1.2	2.6	0.06	0.61	1.7	0.50	0.80
Female	301	3.0	7.0	<0.01	0.58	4.3	0.13	0.81
Age group								
12 to 23 months	98	0.0	10.2	NC	NC	4.1	NC	NC
24 to 60 months	547	2.4	3.7	0.02	0.78	2.7	0.50	0.93
Weight–for–Height Deficit	637	0.3	2.7	<0.01	0.21	0.3	1.00	0.50
Sex								
Male	338	0.6	4.1	<0.01	0.24	0.3	1.00	0.67
Female	299	0.0	1.0	NC	NC	0.3	NC	NC
Age group								
12 to 23 months	97	1.0	3.1	0.50	0.49	2.1	1.00	0.66
24 to 60 months	540	0.2	2.6	<0.01	0.13	0.0	NC	NC
High Weight–for–Height	637	5.5	4.2	<0.01	0.86	3.5	<0.01	0.76
Sex								
Male	338	5.3	4.4	0.25	0.90	3.6	0.03	0.79
Females	299	5.7	4.0	0.06	0.82	3.3	0.02	0.73
Age group								
12 to 23 months	97	2.1	1.0	1.00	0.66	2.1	1.00	1.00
24 to 60 months	540	6.1	4.8	0.02	0.88	3.7	<0.01	0.74
Body Mass Index–for–Age Deficit#	540	0.0	1.7	NC	NC	–	–	–
Sex								
Male	286	0.0	2.8	NC	NC	–	–	–
Female	254	0.0	0.4	NC	NC	–	–	–
Age								
12 to 23 months	–	–	–	–	–	–	–	–
24 to 60 months	540	0.0	1.7	NC	NC	–	–	–
High BMI–for–Age#	540	7.2	5.2	<0.01	0.83	–	–	–
Sex								
Male	286	7.7	5.2	<0.02	0.79	–	–	–
Female	254	6.7	5.1	0.13	0.86	–	–	–
Age group								
12 to 23 months	–	–	–	–	–	–	–	–
24 to 60 months	540	7.2	5.2	<0.01	0.83	–	–	–

NC: non-computable; * Comparison with WHO-2006 charts using the McNemar Test; **Agreement with WHO-2006 charts using the kappa test ($p<0.01$ in all analyses); # Not completely assessed because there were no available references for all children according to NCHS-1977 standards, as well as for children aged 12 to 24 months according to CDC-2000 standards; BMI: body mass index

obtained by the WHO-2006. The use of CDC-2000 standards resulted in higher deficit frequencies for W/A, W/H and BMI/A. This difference was more evident among girls and children aged 12 to 23 months for W/A, and among boys and children aged 24 to 60 months for W/H. However, the use of the NCHS-1977 reference showed similar deficit frequencies to those obtained with the WHO-2006 reference for W/A and W/H. Overweight frequency according to W/H was underestimated by using both CDC-2000 and NCHS-1977 charts, particularly among girls and children aged 24 to 60 months. Overweight frequency according to BMI/A was also underestimated by using CDC-2000 (Table 2).

When the agreement of each nutritional classification were assessed for the entire group by the kappa test, it was observed that the diagnoses obtained using the WHO-2006 reference showed higher agreement with those obtained by NCHS-1977 curves than with those obtained by CDC-2000 curves, both for deficits in H/A (k=0.74 vs. k=0.61) and W/A (k=0.81 vs. k=0.59). Lower agreements were observed in the diagnosis of W/H deficit, particularly comparing WHO-2006 and CDC-2000 standards (k=0.21). The agreement of WHO-2006 charts with CDC-2000 and NCHS-1977 charts was classified as good for the diagnosis of overweight (k=0.86 and k=0.76 respectively) (Table 2).

Discussion

Since the WHO published new child growth references in 2006, nearly 111 countries adopted these standards to monitor their children from birth to five years of age[21]. Although Brazil has also adopted these charts, the nutritional assessment of many children is still based on previous growth references in health services throughout the country, especially in the poorer regions, a reality that may be present in many countries that adopted WHO-2006 standards. Thus, by showing the distortions in the nutritional diagnosis of children from a developing country like Brazil, this paper aimed to make managers and healthcare professionals aware of the importance of undertaking all necessary efforts to use the WHO-2006 reference instead of the previous ones, as well as the need of increasing the range of tools available in the work routine of the health professionals responsible for monitoring children's nutritional status, in order to prevent impairments in their growth and development.

The higher prevalence of height deficit found by using WHO-2006 charts has already been predicted by the WHO[7], showing a trend of NCHS-1977 and CDC-2000 curves to underestimate this nutritional disorder. Considering the characteristics of the WHO-2006 reference, it would be natural that its use resulted in a higher frequency of height deficit than that obtained with other references, since the height values for -2 z score of WHO-2006 standards are higher and thus more children were found to be below this cut off value. This is due to the fact that WHO-2006 charts were developed based on data from children who lived in optimal environmental conditions and thus were capable of achieving their full genetic growth potential. Therefore, this reference is more sensitive in identifying linear growth deficits than the previous ones[7].

Although the study showed good diagnostic agreement for H/A deficit when comparing NCHS-1977 and CDC-2000 charts with WHO-2006 curves, we observed that in clinical practice a significant number of children who already had an important growth deficit would not be identified with this problem, particularly girls and children aged 24 to 60 months, who showed moderate agreement for CDC-2000 curves. Taking into account that height deficit can be a consequence of important health conditions, such as recurrent infectious diseases, inadequate and/or insufficient nutrition, and poor nutrient absorption and assimilation impaired for prolonged periods[9], early identification of this nutritional disorder is essential in the search for strategies to correct these conditions and prevent their recurrence. Thus, in practical terms, keeping with the use of NCHS-1977 and CDC-2000 standards in health services, instead of WHO-2006 standards, could imply in systematically depriving children with poor growth from receiving an individualized intervention, which favors the perpetuation and worsening of the health condition and of the nutritional status. When it comes to the collective diagnosis of the nutritional status of children under 5 years of age, underestimating the situation may imply a lower resource investment for its prevention and control.

As for W/A and W/H deficits, it was observed that the use of WHO-2006 and NCHS-1977 charts resulted in similar frequencies and good diagnostic agreement. However, the use of the CDC-2000 reference did not show good agreement and led to significant higher deficit frequencies than those found by using WHO-2006 curves for the same indices, since weight values for -2 Z scores are lower in WHO-2006 standards and thus less children are found below this cut off point according to

these charts[7]. As observed in this study, although CDC-2000 standards were revised with methodological care, their use can still overestimate the number of children with low weight-for-age, since the values for -2 Z score are much higher than those of the WHO-2006 reference.

In younger children, this result can be justified not only by the fact that American children, who composed CDC-2000 charts, had higher weight than children from other populations worldwide, but also by the fact that WHO-2006 curves included only exclusively breastfed children or those predominantly breastfed until 4-6 months of age, who had their complementary feeding based on vegetables, meat, eggs, and fruits, as well as children who continued partial breastfeeding for at least 12 months[7,12]. Children with such characteristics tend to have a lower weight than that of bottle-fed children[4,7,12,22], as observed in this study, in which W/A deficit was not found in any children under 24 months by using WHO-2006 standards, while the use of CDC-2000 charts resulted in a deficit of 10.2%, suggesting that they really overestimates W/A deficit.

It is important to highlight that isolated weight deficits may be very common in this age group and does not necessarily indicate long-term problems (e.g., weight loss due to a short-term disease). Therefore, it is important to follow children longitudinally in order to evaluate if there is some long-term problem in their growth pattern. However, if a growth reference that overestimates this nutritional condition is used in health services for all assessments, distortions in the weight gain curve may occur and erroneously indicate a need of intervention. Considering an eutrophic child as presenting nutritional deficit, besides burning health services by unnecessarily directing resources to healthy individuals, may lead to several inappropriate decisions. Parents' concern that their children perhaps are not receiving adequate nutrition may favor the early weaning of exclusively breastfed infants or even the excessive offer of energy-providing foods to children with adequate weight[22], which favors excessive weight gain and contributes to worsening obesity epidemic.

As to overweight, although the agreement was classified as good when NCHS-1977 and CDC-2000 charts were compared with the WHO-2006 reference, the frequencies of high W/H were significantly different, especially among children aged 24 to 60 months, which shows that these standards may underestimate excessive weight gain and the actual number of overweight and obese children. In the assessment of BMI/A, an anthropometric index that has been widely recommended for the proper diagnosis of obesity in all age groups, including infants[6], such condition was also present when comparing CDC-2000 and WHO-2006 references.

This phenomenon has already been predicted by researchers from the WHO[7], since weight values for +2 Z scores are lower in WHO-2006 charts, and thus more children go beyond this cut off point by using this standard, which can be explained by the characteristics of the population that composed each of the assessed references, as previously mentioned. Thus, it should be emphasized that the maintenance of the use of NCHS-1977 and CDC-2000 charts in health services may lead to underestimation and therefore to the absence of intervention to prevent excessive weight gain in preschool children, since these standards only identify excessive weight when it is already severe. This is particularly worrying in Brazil, where a significant increase in obesity prevalence has been observed[23], affecting almost 7% of children under 5 years of age[24].

The results presented here are in agreement with those reported by other authors. When comparing the frequencies of nutritional disorders obtained by using WHO-2006 and CDC-2000 references in children under five years of age, Onis *et al*[25] observed that there was a trend of the CDC-2000 curves to overestimate malnutrition and underestimate overweight in this age group. In a study with two-year-old Bangladeshi children, Saha *et al*[26] found that the use of NCHS-1997 charts resulted in a higher prevalence of deficits in W/A (54.8 vs. 41.0%) and W/H (20.2 vs. 13.6%) and a lower frequency of H/A deficit (38.0 vs. 54.5%) as compared with the WHO-2006 reference, a behavior also observed by Julia[27] in children aged from 18 to 24 months in Indonesia. In Brazil, we found only one publication on the subject, which compares the frequencies of nutritional disorders based on NCHS-1977 and WHO-2006 standards in a sample of indigenous children under 60 months[28]. The authors also found lower height deficits and higher weight-for-age deficits when they used NCHS-1977 curves.

It is highlighted that, although the WHO developed an algorithm to convert the population prevalence calculated from the previous NCHS-1977 and CDC-2000 charts to that expected for the new reference[29], there were no tools for this kind of correction at the individual level. A limitation of the present study was the non-randomness of the sample, which was made up by convenience with children who attended day care centers in Rio de Janeiro. However, this study did not intend to extrapolate the prevalences found to

any other population. Additionally, it would be unlikely to find different results for diagnostic agreement if the study was conducted with a random sample of children living in Rio de Janeiro. Another limitation is the lack of children aged 0 to 12 months and the reduced number of those aged 12 to 24 months in the sample, which may have affected the analyzes and interpretations related to this age range.

However, considering the scarce literature on the differences in nutritional disorder estimates when applying NCHS-1977, CDC-2000 and WHO-2006 standards in developing countries, as well as on their implications for health policies and services, we believe that this study will be useful to expand the discussion on the subject and reinforce the need of the anthropometric assessment of preschool children to be exclusively performed with WHO-2006 standards, both in health services and in epidemiological studies, according to the recommendations of the WHO[7] and the Brazilian Ministry of Health[30].

It is concluded that NCHS-1977 and CDC-2000 charts lead to a distortion in the nutritional diagnosis of Brazilian children. Therefore, every effort should be made, both by managers and local healthcare professionals, to ensure the use of the WHO-2006 reference, since it favors the early diagnosis of nutritional disorders and allows children at nutritional risk to be appropriately monitored for a better growth and development, besides ensuring the generation of reliable and useful information for decision making in the public health field. This is a highly important issue not only for Brazil, but for other developing countries as well, where the implementation of WHO-2006 standards for children's nutritional assessment has not reached all children yet, especially those living in the poorer regions.

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