



Trabajo Original

Obesidad y síndrome metabólico

Body mass index cutoff point estimation as obesity diagnostic criteria in Down syndrome adolescents

Estimación del punto de corte del índice de masa corporal como criterio diagnóstico de obesidad en adolescentes con síndrome de Down

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Abstract

Introduction: Adolescents with Down syndrome (DS) show high rate of overweight and tend to accumulate high amount of fat compared to the same people without the syndrome.

Objective: To estimate the cutoff point of the Body Mass Index (BMI) for the diagnosis of obesity in adolescents with DS according to different references for BMI in relation to the percentage of body fat (%BF) measured by dual-energy X-ray absorptiometry (DXA).

Methods: The sample was composed of 34 adolescents with DS (aged: 10 to 17 years old). BMI was evaluated according to the references of the International Obesity Task Force (IOTF), the World Health Organization (WHO) for the general population, and Myreliid et al. and Styles et al. for people with DS. The %BF was assessed by whole body DXA and classified according to National Health And Nutrition Examination Survey (NHANES, 2011).

Results: The boys were significantly taller than the girls and this %BF higher than boys. All references who have used BMI to assess obesity was positively associated with %BF measured by DXA in the diagnosis of obesity. Using the ROC curve in relation to %BF by DXA, all references showed high sensitivity, but the z-score of BMI by WHO showed better specificity, with the value of the accuracy of 0.82 for the cutoff point above 2.14.

Conclusions: All the references used for the diagnosis of obesity were associated with %BF measured by DXA, and the cutoff point of z-scores above 2.14 by WHO showed better specificity.

Key words:

Down syndrome.
Body mass index.
ROC curve. DXA.
Anthropometry.

Resumen

Introducción: adolescentes con síndrome de Down (SD) muestran alta tasa de sobrepeso y tienden a acumular gran cantidad de grasa en comparación con los adolescentes sin el síndrome.

Objetivo: estimar el punto de corte del índice de masa corporal (IMC) para el diagnóstico de obesidad en adolescentes con SD de acuerdo con las diferentes referencias para el IMC en relación con el porcentaje de grasa corporal (%GC) obtenido por el absorciometría con rayos X de doble energía (DXA).

Métodos: la muestra se compone de 34 adolescentes con SD (10 a 17 años). El IMC se evaluó de acuerdo con las referencias de la International Obesity Task Force (IOTF), Organización Mundial de la Salud (OMS) para la población general, y Myreliid et al. y Styles et al. para personas con SD. El %GC fue evaluado por DXA y clasificado según NHANES (2011).

Resultados: los niños fueron significativamente más altos que las niñas, y estas con mayor %GC que los niños. Todas las referencias que han utilizado el IMC se asociaron positivamente con el %GC medido por DXA en el diagnóstico de la obesidad. Utilizando la curva ROC en relación con %GC por DXA todas las referencias mostraron alta sensibilidad, pero el score-z del IMC por la OMS mostró mejor especificidad, con el valor de exactitud de 0,82 para el punto de corte por encima de 2,14.

Conclusiones: todas las referencias utilizadas para el diagnóstico de obesidad se asociaron con el %GC medido por DXA, y el punto de corte del score-z por encima de 2,14 por la OMS mostró mejor especificidad.

Palabras clave:

Síndrome de Down.
Índice de masa corporal.
Curva ROC.
DXA. Antropometría.

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INTRODUCTION

The life expectancy of the population with Down syndrome (DS) has been increasing over the last 40 years (1), but studies show a high rate of overweight in children and adolescents with DS (2,3). For some authors, children and adolescents with DS tend to accumulate high amount of fat (4) compared to the same people without the syndrome due to sedentarism (5), inadequate food that worsens over the years (6) and low physical fitness (7,8). Certain comorbidities commonly found in this population may aggravate or be aggravated by obesity, such as congenital heart defects (9,10), reduction of immunological function (11), obstructive sleep apnea (12), diabetes mellitus (13), among others.

To determine excess body fat in children and adolescents with DS, researchers have used some indirect and doubly indirect methods. Among these various techniques, absorptiometry with dual energy X-ray absorptiometry (DXA) (14,15) and body mass index (BMI) (16,17) have been widely used to assess the nutritional state (2). Several graphic weight, height and BMI for specific DS were created (2,16-19), but so far there is no consensus for a standardization for both the technical procedures as for anthropometric parameters for this population (20).

The DXA is one of the most accurate and useful tools to assess body composition and determine the distribution of fat and is considered the gold standard for this purpose. It is an imaging procedure that allows the quantification of bone mass, muscle and fat, divided by body parts or the entire body (21,22).

Thus, the aim of this study was to estimate the BMI cutoff point for the diagnosis of obesity in adolescents with DS according to different references for BMI classification in relation to the percentage of body fat (%BF) measured by DXA.

MATERIALS AND METHODS

STUDY DESIGN AND PARTICIPANTS

A total sample of 34 adolescents with DS (aged 10 and 17 years), 18 males (mean: 14.8 ± 2.1 years) and 16 females (mean: 13.7 ± 2.5 years). It is a cross-sectional descriptive study, conducted in 2013, two DS treatment referral centers located in the city of Campinas (São Paulo - Brazil). This study was approved by the Ethic Committees for Human Being Research of the School of Medical Sciences (FCM); University of Campinas (UNICAMP), and was conducted in accordance with the declaration of Helsinki for human studies – under number 783/2011, and only participated in the study adolescents with written permission of their parents and/or guardians.

METHODS

Two techniques were used: to assess the nutritional status BMI and DXA for body composition.

ANTHROPOMETRY

To calculate BMI, weight and height of adolescents' measurements were made, according to standardized procedures (23). Weight was measured (kg) using portable digital scales to the nearest 0.1 kg. Height was measured (cm) using a vertical stadiometer to the nearest 0.1 cm. From those measurements, BMI was calculated using the formula (kg/m^2). BMI values was analyzed according to data from the International Obesity Task Force (IOTF) (24) and the World Health Organization (WHO) (25) and converted to standard deviation scores (z-score), according to each of these two international reference parameters. The adolescent was considered obese when he presented the z-score ≥ 2 , for these two references. It was also rated the BMI according to the specific references to the DS structured by Myrelid et al. (16) and Styles et al. (17). As Myrelid et al. (16), the adolescent was considered obese when his BMI was ≥ 2 Standard Deviation (SD). While, according to Styles et al. (17), the adolescent was considered obese when his BMI was \geq percentile 98 (P98).

BODY COMPOSITION ASSESSMENT

Body composition was analyzed using whole-body DXA equipment (Lunar iDXA - GE Healthcare - USA). With regard to the %BF obtained by DXA, the adolescents was considered obese when the %BF was \geq P90, according to the classification of the NHANES (26). To assess the frequency of obesity according to each BMI reference in relation to %BF estimated by DXA, the adolescents were classified into two groups, eutrophic (including normal and overweight) and obese.

STATISTICAL ANALYSIS

Data was presented as mean, variance, absolute and relative frequencies. For evaluation of variables according to sex the Mann-Whitney test. For comparing the frequency of obesity according to several references was used Fisher's exact test. For the analysis of correlation between the diagnostic of obesity references the z-score of BMI by IOTF, by WHO in relation to %BF by DXA was employed by the Spearman correlation coefficient. Regarding the %BF by DXA, Receiver Operating Characteristic curves (ROC curves) were constructed to determine the cut-off weight and BMI of adolescents with DS for the diagnosis of obesity. For all statistical analysis was considered significant difference when $p \leq 0.05$.

RESULTS

A total sample of 34 adolescents were evaluated, 18 males (52,9%) and 16 females (47,0%).

Table I shows the general characteristics of the 18 boys and 16 girls with DS. There was no statistically significant difference

Table I. General characteristics of the sample of the 34 adolescents with Down syndrome

Variable	Males (n = 18)		Females (n = 16)		p*
	Mean ± SD	Variation	Mean±SD	Variation	
Age (years)	14,8 ± 2,1	10,6-17,8	13,7 ± 2,5	10,0-17,4	0,198
Height (m)	1,49 ± 0,09	1,32-1,62	1,42 ± 0,06	1,33-1,54	0,010
Weight (kg)	57,9 ± 11,7	32,4-73,7	53,6 ± 13,0	35,5-83,3	0,211
BMI (kg/m ²)	25,7 ± 4,5	18,6-32,7	26,3 ± 5,8	18,2-41,9	0,959
BMI IOTF (z-score)	1,68 ± 0,92	-0,01-2,99	1,81 ± 1,02	-0,59-3,41	0,721
BMI WHO (z-score)	1,67 ± 0,96	-0,40-3,12	1,77 ± 1,12	-0,85-3,57	0,670
BF DXA (%)	30,59 ± 9,4	13,8-48,8	41,92 ± 7,41	27,4-50,7	0,001

* Mann-Whitney test. BMI: body mass index; IOTF: International Obesity Task Force; WHO: World Health Organization; BF: Body fat; DXA: Dual energy X-ray absorptiometry; SD: standard deviation.

between genders for age, weight, BMI, BMI z-score of the IOTF and the WHO. A significant statistical difference only at the time, with higher values in boys, and %BF estimated by DXA, with higher values in girls.

All references evaluating BMI were associated with the %BF assessed by DXA in the diagnosis of obesity in this sample (Table II).

The correlation between the %BF by DXA and BMI by several references was positive and significant, $r = 0.61$ with BMI (kg/m²) ($p < 0.001$), $r = 0.68$ with z-score of BMI by IOTF ($p < 0.001$) and $r = 0.74$ with BMI z-score by WHO ($p < 0.001$).

Using the ROC curve, in relation to the %BF by DXA, all parameters showed high sensitivity, but the z-score of BMI by WHO

Table II. Obesity frequency of 34 adolescents with Down syndrome according to each BMI reference in relation to percentage body fat (%BF) by DXA

Variable		%BF (DXA)*		Obesity frequency (%)	p**
		Eutrophic	Obesity		
BMI IOTF	Eutrophic	18	3	38,2%	0,001
	Obesity	2	11		
BMI WHO	Eutrophic	14	0	58,8%	0,001
	Obesity	6	14		
BMI Styles et al.	Eutrophic	15	0	55,9%	0,001
	Obesity	5	14		
BMI Myreid et al.	Eutrophic	17	5	35,3%	0,005
	Obesity	3	9		
%BF (DXA)	Eutrophic	20	-	41,2%	
	Obesity	-	14		

*NHANES, 2011; **Fisher's exact test. BMI: body mass index; IOTF: International Obesity Task Force; WHO: World Health Organization; %BF: percentage body fat; DXA: Dual energy X-ray absorptiometry.

Table III. Parameters of the ROC curve for the diagnosis of obesity in 34 adolescents with Down syndrome

Variable	AUC ± SE	CI95%	p	Criterion	Sen (%)	Spe (%)	Accuracy (%)
Weight (kg)	0,76 ± 0,08	0,60-0,92	0,010	> 49,5	92,86	55,00	68
BMI (kg/m ²)	0,90 ± 0,05	0,80-1,00	0,000	> 26,26	92,86	80,00	79
Z-score IOTF	0,93 ± 0,04	0,84-1,00	0,000	> 2,11	100,00	75,00	85
Z-score WHO	0,93 ± 0,04	0,84-1,00	0,000	> 2,14	92,86	85,00	82

AUC: area under curve; SE: standard error; CI95%: confidence interval of 95%; Sen: sensitivity; Spe: specificity; BMI: body mass index; IOTF: International Obesity Task Force; WHO: World Health Organization; %BF: percentage body fat; DXA: dual energy X-ray absorptiometry.

showed better specificity (85%) with an accuracy of the 82% for the cut-off point above 2.14 (Table III).

DISCUSSION

In the general population, the use of BMI to assess obesity has high association with %BF by DXA (27), as well as with the risk in long-term comorbidities (28). However, in people with DS, the use of BMI, due to short stature (4,18) and the tendency to high weight (27), could lead to error, overestimating the diagnosis of obesity. In addition, one should remember that BMI does not differentiate fat mass in lean body mass (29). Therefore, this study sought to estimate the cutoff point of BMI and to verify the accuracy of these BMI references both to the general population (WHO and IOTF) and for people with DS (16,17) in diagnose obesity in relation to %BF analyzed by DXA.

The sample of adolescents with DS (18 males and 16 females) were analyzed together for not presenting significant differences between the gender, beyond that already expected as the height and %BF. Considering that only adolescents were included in this study, stage of life where sex hormones determine the difference in height and body composition between men and women.

In DS, several studies have evaluated children, adolescents, youth and adults, through the BMI, which have detected high levels of obesity (3,14,30). Considering the results of this study in relation to obesity, it was found that obesity was present among 58.8% (20 of 34 cases) of the adolescents with DS, when used references from the WHO (25) for the z-score and BMI 38.2% (13 of 34 cases) by IOTF (24). When used specific indicators of BMI for DS, 35.3% (12 of 34) were obese as references to Myreliid et al. (16) and 55.9% (19 of 34) according to the classification of Styles et al. (17).

According to the %BF by DXA, obesity was present in 41.1% (14 of 34) of adolescents with DS, showing that references the WHO (25) and Styles et al. (17) overestimated the obesity diagnosis in this group of teenagers evaluated for %BF, while references to Myreliid et al. (16) and the IOTF (24) underestimated, despite all these references used present good association with the %BF by DXA. In accordance with a New Zealand study using bioimpedance to assess %BF by means of three equations, Loveday et al. (14) compared and validated the results in relation to the %BF obtained by DXA, in 70 cases of DS aged 5 to 18 years and concluded that the bioelectrical impedance showed validity to measure the %BF (14).

Regarding the correlation of %BF by DXA with different BMI references the general population (IOTF and WHO) in obesity assessment, the results of this study showed good correlation, the most significant correlation with the z-score of the BMI by WHO ($r = 0.74$). In accordance with Bandini et al. (31) who evaluated the excess body fat in 32 cases of DS, aged 13 and 21 years, through the BMI of National Center for Disease Control and Prevention (CDC) 2000, found moderate correlation between BMI and %BF ($r = 0.50$). Already Hill et al. (32), assessed the resting energy expenditure and adiposity through the z-score for BMI, skin folds and DXA in 28 children with DS and 35 in a control group without the syndrome, noted a strong correlation of

the %BF obtained from measurements of skinfold thickness and DXA ($r = 0.97$) and concluded that skin folds can be used to estimate body fat instead of DXA, without leading to important errors, although there are not specific folds equations skin for people with DS.

In this study, despite the association of all references that evaluated the BMI with the %BF estimated by DXA for diagnosis of obesity in adolescents with DS, the cutoff point above 2.14 assessed by the BMI of WHO (25) showed the best specificity (85%), with an accuracy of 82%. This result was similar to Bandini et al. (31) who observed the cutting bridge above the CDC 2000 P95 with better sensitivity and specificity for the determination of excess body fat in relation to %BF obtained by the DXA. However, it is important to note that the absence of reference values for the correct analysis of the cutoff points for BMI and DXA criteria for children and adolescents with DS hinder its exact applicability.

Considering the results of this study and others cited here for evaluation of %BF in children and adolescents with DS, it was found that, regardless of the methods used is high excess fat percentage and that there is a need to establish specific criteria and reference values for this population.

Limitations of this study were the sample size and the use of %BF obtained by the DXA in relation to the general population according NHANES (26).

We believe that the criteria that use the BMI (WHO and IOTF) for estimating obesity, as well as references based on specific curves for the population with DS are associated with %BF estimated by the DXA and concluded that the cutoff point of z-score above of 2.14 of WHO presented the best specificity with an accuracy of 82%.

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