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HEALTH SCIENCES

Prevalence of overweight and obesity in 3-to-10-year-old children: assessment of different cut-off criteria WHO-IOTF

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Abstract: This study compares the prevalence of overweight and obesity between WHO/IOTF criteria. A total of 17,277 Portuguese children aged 3-10 years old were analysed. The prevalences of overweight-obesity were higher at WHO classification (19.8%-20.7%) than at IOTF classification (8.2%-16.1%), ($p<0.001$). Agreement between the criteria were substantial for overweight (Kappa= 0.67, $p<0.001$) and moderate for obesity (Kappa= 0.47, $p<0.001$). The prevalences ratio for inequality between criteria were greater for boys than for girls and lesser for children aged 6-7 than children aged 8-10 years old. The disparities between the two criteria and the higher overweight obesity prevalences highlight the needs to develop more studies.

Key words: Childhood obesity, obesity, overweight, pre-school children, WHO-IOTF references.

INTRODUCTION

Despite the substantial consensus on the definition of overweight and obesity, especially those based on body mass index (BMI), there are many different guidelines to define overweight and obesity (Flegal & Ogden 2011, Himes 2009). Among adults, the cut-off values related to health risk factors are based on fixed BMI values of 25 kg/m^2 for overweight and 30 kg/m^2 for obesity. For children and adolescents, due to the unclear relationship between health and BMI, there is a wide range of national and international reference, the most used criteria are from the CDC (Disease Control and Prevention), the WHO (World Health Organization) and IOTF (International Obesity Task Force) (Cattaneo et al. 2010, Cole et al. 2000, Cole & Lobstein 2012, de Onis et al. 2006, 2007, 2012, Flegal & Ogden 2011, Himes 2009, WHO 2006a, Valerio el al. 2017).

The prevalences of overweight and obesity in Portuguese children and adolescents are reported in national and subnational studies that meet the three aforementioned criteria, (Bingham et al. 2013, Cattaneo et al. 2010, Lissau et al. 2004, Minghelli et al. 2014, Moreira 2007, Padez et al. 2004, Tito et al. 2012, Sardinha 2011, Viveiro et al. 2016, Wijnhoven et al. 2012, 2014). However, the most frequently used criteria for childhood were those recommended by the IOTF which provide international age- and sex-specific cut-off points from 2-18 years old to evaluate prevalences of overweight and obesity. From 1981 to 2013, one of the tools that were most used to assess child and adolescent health in Portugal were the curves by the National Centre for Health and Statistics (NCHS) / Centers for Disease Control and Prevention (CDC) and their updates (DGS 2006, 2013), which allowed an evaluation of the growth and nutritional status

of children and adolescents. The WHO growth references were for the first time adopted by the Direcção Geral de Saúde (Portuguese Ministry of Health) at 2013 for child and youth growth and nutritional status assessment in the National Program for Child and Youth Health (DGS 2013).

According to the WHO Multicentre Growth Reference Study Group, the WHO (2006a) child growth standards can be used to assess a child's growth under optimal circumstances in different populations regardless of ethnicity, socio-economic status and food consumption. However, several studies that compared the results between the different criteria of the WHO and IOTF showed that the prevalences of overweight and obesity were different. Those differences varied by age, sex and nutritional status of the population index, and the overweight and obesity prevalence estimated by WHO criteria is higher than by the IOTF criteria (Kêkê et al. 2015, Monasta et al. 2011, Shields & Tremblay 2010, Sardinha et al. 2011, Valerio et al. 2017, Wijnhoven et al. 2012, 2014). Regardless of WHO or IOTF criteria, Portugal and other southern European countries such as Italy, Malta, and Slovenia had higher overweight prevalence than other European countries (Branca et al. 2007, Bingham et al. 2013, Cattaneo et al. 2010, Ng et al. 2014). Despite of the afore-mentioned concerned rates of overweight or obesity, few studies with Portuguese children aged three to ten years old compared the prevalences of overweight and obesity attending different standards of reference of nutritional status (Rito et al. 2012, Viveiro et al. 2016, Wijnhoven et al. 2014).

Thus, the objectives of the present study were two fold: i) to determine the overweight and obesity prevalences according to international systems, such as the WHO and IOTF criteria, in a representative sample of children aged 3-10 years old and access differences between the WHO and IOTF criteria by sex, age and mainland regions; ii) to assess the agreement and the inequality between the IOTF and the WHO criteria in classifying overweight or obesity by sex and age. It was hypothesized that overweight or obesity prevalences estimated by WHO criteria are higher than those estimated by the IOTF and inequality varied by age, sex and BMI level.

MATERIALS AND METHODS

Design and study population

The present study is an analysis of data collected in the Portuguese Prevalence Study of Obesity in Childhood (PPSOC), which is a mainland nationality cross-sectional study focusing on childhood obesity status and the role of socioeconomic and lifestyle factors associated with that outcome. The PPSOC sampling was based on a proportionate stratified random design with mainland district as the primary sampling unit and took into account the number of children by age and sex. The Archipelagos of Madeira and Azores were not considered. For each district, schools were randomly selected. Data were collected between March 2009 and January 2010 at private and public schools, from preschool to grade four of basic education. A total of 17,509 children aged 2–13 year old were recruited. Response rate was 57.4% (Statamakis et al. 2013). More details are available elsewhere (Bingham et al. 2013, Jago et al. 2012, Nogueira et al. 2013, Stamatakis et al. 2013). The present analysis excluded children aged two and 11 to 13 years old and included 17.277 children (8746 girls and 8531 boys) aged 3 to 10 years old whose BMI was known.

Measures

Anthropometric data collection techniques were standardized, teams were trained measurement

using WHO (1995) standardized procedures and two technicians at each school collected anthropometric measurements. Weight and height were performed with the children lightly dressed and without shoes (Bingham et al. 2013, Jago et al. 2012, Nogueira et al. 2013, Stamatakis et al. 2013). The BMI (body mass index) (kg/m^2) was subsequently calculated. The nutritional status of each child was classified according to the age and sex specific cut-off points of the International Obesity Task Force (IOTF) (Cole et al. 2000) and of the World Health Organization (WHO) child growth standards percentiles for preschool children, the 2006b WHO Child Growth Standards from 2 to 5 years of age (WHO Child growth standards) and the growth WHO Reference 2007 from 5 to 19 years of age (de Onis et al. 2014). The following categories of overweight and obesity (overweight-obesity) were used: non-overweight/obesity (NOO), overweight (OV) and obesity (OB), with an additional category overweight with obesity (OVOB).

The overweight-obesity categories NOO, OV and OB were matched between the two criteria for each child to assess the trend of level change IOTF vs. WHO and generated a dichotomous variable, the inequality, which became the dependent variable in our subsequent analysis: NOO-IOTF change to OV-WHO or OV-IOTF change to OB-WHO, and nutritional levels IOTF vs WHO were equal.

The information collected included decimal age, sex and municipality of the school of each child. For these analysis the independent variables of each child decimal age were categorized into the variable Age Group with three categories: 3-5 years, 6-7 years and 8-10 years; the municipalities to which each school belonged were rejoined to define a new variable Region according to the five categories of the mainland Portuguese NUTS 2 (Nomenclature of Territorial Units for Statistics) (PORDATA 2013) as Norte, Centro, Grande Lisboa (Metropolitan area of Lisbon), Alentejo and Algarve.

Statistical analysis

Descriptive statistics (frequencies and percentages) were calculated to each one of the criteria IOTF and WHO by sex, age and region. Subsequently, Chi-square tests were used to examine if there were significant differences between frequencies of BMI categories (non-overweight/obesity, overweight or obesity). To compare overweight (non-overweight and overweight categories) or obesity (not-obesity and obesity categories) between the two criteria the paired McNemar test was used. The rate of agreement Kappa (95% confidence intervals) was used for comparative analysis to assess the degree of agreement between the IOTF and WHO criteria to know the extent to which criteria had the same score to the same child (NOO, OV and OB; NOO and OV; OV and OB). This methodology was used to analyse the inter-rater reliability and was applied on the topics of this study (Kêkê et al. 2015, Valerio et al. 2017). The coefficient Kappa (95% confidence interval) was determined for all population and sex by age group. The agreement was interpreted as follows: 0.01-0.20 = slight; 0.21-0.40 = fair; 0.41-0.60 = moderate; 0.61-0.80 = substantial; 0.81-0.99 = almost perfect (Kêkê et al. 2015, Viera & Garrett 2005). The Poisson regression analysis, recommended to cross-sectional data with binary outcomes (Barros & Hirakata 2003) was used to estimate prevalence ratio (PR. 95% confidence intervals) of the dependent variable inequality (1= yes, disagreement between the IOTF and WHO criteria; 0= no, agreement between the IOTF and WHO criteria) based on the predictors sex, age group and IOTF category. This analysis was applied to the subsample without the cases of OB-IOTF category (1420) because it does not change the nutritional level. The significance for all comparisons and 95% confidence intervals

was set at 5%. The data were analysed with IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY.

Ethical considerations

The study protocol was approved by Direção Geral de Inovação e Desenvolvimento Curricular, Direção Geral da Educação (Ministry of Education). When data collection were developed the Portuguese Commission for Data Protection determined that analysis of these anonymous data were exempt from review. Informed permission to collect the data was obtained from the principal's office of the schools. Invitation to the parents or caregivers to participate in the study was sent and signed informed consent form indicating consent to each child participation in the study was obtained prior to data collection.

RESULTS

Overweight and obesity prevalences

The percentages of overweight-obesity among the 17.277 Portuguese children analysed according to the IOTF and WHO cut-off points by total population, sex, age, sex by age and region are presented in table I. According to the IOTF and the WHO criteria for the total population, overweight were 19.8% and 20.7% and obesity were 8.2% and 16.1%, respectively. For each one criterion, the difference was significant.

The IOTF prevalences by sex were significantly different; among boys, 17.8% for overweight and 7.5% for obesity and for girls, 21.8% for overweight and 8.9% for obesity. The WHO prevalences by sex were significantly different, however for boys, about 20.0% were classified as overweight and 17.6% as obese; corresponding rates for girls were 21.8% and 14.8% for overweight and obesity, respectively.

Regarding to age group, the IOTF criterion percentages were for overweight and obesity, respectively: 16.6% and 6.6% for those 3-5 years old, 19.2% and 9.2% for those 6-7 years old and 23.2% and 8.9% for those 8-10 years old. The WHO criterion prevalences showed for overweight and obesity, respectively: 21.2% and 13.0% for those 3-5 years old, 19.9% and 15.8% for those 6-7 years old and 20.9% and 8.9% to 19.2% for those 8-10 years old. For each classification by age group the difference was significant ($p<0.001$).

For sex by age to each classification the prevalences were significantly different for boys and girls. According to the IOTF criterion for boys overweight were 14.0%, 17.2% and 21.9% and obesity were 5.2%, 8.2% and 9.1%, for those 3-5, 6-7 and 8-10 years old, respectively. To the WHO criterion for boys overweight were 21.1%, 19.1% and 19.6% and obesity were 13.6%, 16.7% and 22.1%, for those 3-5, 6-7 and 8-10 years old, respectively. Among girls, to the IOTF classification overweight were 19.2%, 21.2% and 24.5% and obesity were 7.9%, 10.2% and 8.8%, respectively for those 3-5, 6-7 and 8-10 years old; to the WHO classification overweight were 21.4%, 20.6% and 22.2 % and obesity were 12.4%, 14.8% and 16.5%, respectively for those 3-5, 6-7 and 8-10 years old.

According to region, the prevalences provided by each of classification of weight status were significantly different ($p<0.001$), both with highest overweight-obesity percentages in the Norte (north), 22.1%-10.0% for IOTF criterion and 22.9%-19.4% for WHO criterion.

For the total population the prevalences between IOTF and WHO overweight-obesity categories were statistically different (X^2, $p<0.001$). As shows table I the prevalences of overweight were higher to the WHO references for boys, for boys by each age group, for girls aged 3-5 years old, for girls 8-10 years old and to age groups 3-5 and 8-10 years old. The prevalences of obesity were in most cases higher to the WHO references in comparison with the IOTF.

Table I. Prevalence of overweight and obesity by sex, age group and mainland region, according to IOTF and WHO criteria.

				IOTF			WHO	
		N	Non Overweight Obesity	Overweight	Obesity	Non Overweight Obesity	Overweight	Obesity
			% (N)	% (N)	% (N)	%(N)	% (N)	% (N)
Total		17277	72.0 (12431)	19.8 (3426)	8.2 (1420)	63.2 (10911)	20.7 (3580)	16.1 (2786)[b]
				(χ^2,p<0.001)			(χ^2,p<0.001)	
Sex	boys	8531	74.7 (6371)	17.8 (1520)[a]	7.5 (640)	62.4 (5325)	20.0 (1702)	17.6 (1504)[b]
	girls	8746	69.3 (6060)	21.8 (1906)	8.9 (780)	63.9 (5586)	21.5 (1878)	14.7 (1282)[b]
				(χ^2,p<0.001)			(χ^2,p<0.001)	
Age (years)								
boys	3-5	2888	80.8 (2333)	14.0 (404)[a]	5.2 (151)	65.3 (1885)	21.1 (610)	13.6 (393)[b]
	6-7	2516	74.6 (1878)	17.2 (432)[a]	8.2 (206)	64.2 (1615)	19.1 (480)	16.7 (421)[b]
	8-10	3127	69.1 (2160)	21.9 (684)[a]	9.1 (283)	58.4 (1825)	19.6 (612)	22.1 (690)[b]
				(χ^2,p<0.001)			(χ^2,p<0.001)	
girls	3-5	2849	72.9 (2078)	19.2 (546)[a]	7.9 (225)	66.2 (1886)	21.4 (609)	12.4 (354)[b]
	6-7	2549	68.6 (2749)	21.2 (541)	10.2 (259)	64.6 (1646)	20.6 (526)	14.8 (377)[b]
	8-10	3348	66.7 (2233)	24.5 (819)[a]	8.8 (296)	61.4 (2054)	22.2 (743)	16.5 (551)[b]
				(χ^2,p<0.001)			(χ^2,p<0.001)	
total	3-5	5737	76.9 (4411)	16.6 (950)[a]	6.6 (376)	65.7 (3771)	21.2 (1219)	13.0 (747)[b]
	6-7	5065	71.6 (3627)	19.2 (973)	9.2 (465)	64.4 (3261)	19.9 (1006)	15.8 (798)[b]
	8-10	6475	67.8 (4393)	23.2 (1503)[a]	8.9 (579)	59.9 (3879)	20.9 (1355)	19.2 (1241)[b]
				(χ^2,p<0.001)			(χ^2,p<0.001)	
Region:	Norte	5762	67.9 (3915)	22.1 (575)	10.0 (1272)	57.8 (3330)	22.9 (1317)	19.4 (1115)
	Centro	4239	72.4 (3070)	20.8 (882)	6.8 (287)	62.6 (2653)	22.8 (966)	14.6 (620)
	Grande Lisboa	2741	73.6 (2017)	18.7 (512)	7.7 (212)	66.3 (1817)	18.7 (513)	15.0 (411)
	Alentejo	2447	75.0 (1835)	16.9 (414)	8.1 (198)	67.7 81657)	18.0 (440)	14.3 (350)
	Algarve	2088	76.3 (1594)	19.8 (346)	8.2 (148)	69.6 (1454)	16.5 (344)	13.9 (290)
				(χ^2,p<0.001)			(χ^2,p<0.001)	

[a] **McNemar test comparison overweight IOTF vs WHO, p<0.05.**

[b] **McNemar test comparison obesity IOTF vs WHO, p<0.05.**

Agreement IOTF vs WHO

According to the IOTF-WHO levels, 16.7% of cases do not overlapped (p<0.001) BMI categories. Therefore, 20.7% of children who were classified as OV-WHO, corresponding to 11.9% OV-IOTF and 8.8% NOO-IOTF; furthermore, the 16.1% who were classified as OB-WHO corresponded to 7.9% who were also classified as OV-IOTF and 8.2% who were classified as OB-IOTF. For each sex, the NOO overlap was quite similar; it was 62.4% for boys and 63.9% for girls. Among the boys who were classified as OV-WHO, 7.7% were classified as OV-IOTF and 12.3% as NOO-IOTF; for girls, 16.1% were OV-IOTF and 5.4% NOO-IOTF. Among the boys who were classified as OB-WHO, 10.1% were classified as OV-IOTF and 7.5% OB-IOTF.

Figure 1 shows the overweight and obesity percentages to WHO criterion, according to the contribution of IOTF classification, by sex and age. Across all ages, males who were categorized as OV-WHO were to the IOTF criterion more often classified as NOO-IOTF than OV-IOTF; the percentage of those classified as NOO-IOTF ranged between 9.5% and 10.4% across age groups, with the exception of those aged three and four years old (21.9% and 17.1%, respectively). The results were similar to those for OB-WHO; however, those cases who were placed as both OB-WHO and OB-IOTF ranged between 7.0% and 9.8% (with exception to 3 years, 3.4% and 4.5% to 4 years old) and those cases who were placed as both OB-WHO and OV-IOTF ranged from 8.0% to 13.4%, with higher overlap among those who were eight and ten years old. Across all ages, females who were classified as OV-WHO were more often classified as OV-IOTF than NOO-IOTF, the percentage of those classified as NOO-IOTF ranged between 2.7% and 6.0%, with exception of those who were aged 3 years old (15.4%). The results were quite similar to those for OB-WHO, with those classified as both OB-WHO and OV-IOTF ranging from 3.0% to 7.7% with exception of those aged 3 years old (5.2% OB-IOTF and 6.6% OV-IOTF).

According to the afore mentioned content, the overweight status of the OV-WHO category comprised children classified as OV-IOTF and NOO-IOTF and to obesity status, the OB-WHO comprised children classified as OV-IOTF and OB-IOTF. The strength of agreement between the two criteria were: substancial (Kappa=0.66, 95% CI 0.65-0.67, p<0.001) between the three categories, also substantial (Kappa=0.67, 95% CI 0.66-0.67, p<0.001) for the overweight category and decrease to moderate (Kappa= 0.47, 95% CI 0.45-0.49, p<0.001) for the obesity category. Table II shows the agreement coefficient Kappa to overweight and obesity between the two criteria for sex by age group: Regarding girls classified with overweight (Kappa= 0.82, 95% CI 0.80-0.83, p<0.001), for each age group there were almost perfect agreements. However, for those classified with obesity (Kappa= 0.62, 95% CI 0.59-0.65, p<0.001) the agreement decreased to substantial before the age of seven years and to moderate to 8-10 years old. For the boys the agreement was moderate to fair for those classified with overweight (Kappa= 0.49, 95% CI 0.46-0.51, p<0.001) and was fair (Kappa= 0.31, 95% CI 0.29-0.34, p<0.001) for boys classified with obesity.

As showed in table III, the Poisson regression for the dependent variable inequality of classification by the three predictors sex, age group and IOTF category reveled a statistically significant effect on the dependent variable: inequality was 2.13 (95% CI 1.97- 2.30) times greater for boys than for girls, 0.81 (95% CI 0.74-0.89) times lesser for children aged 6-7 (95% CI 0.67-0.,83) than children aged 8-10 years old and 3.44 (95% CI 3.19-3.71) times greater for overweight than for non-overweigh category.

Results show that overweight and obesity prevalences estimated by WHO criteria are higher than that estimated by the IOTF and inequality varied by age, sex and overweight-obesity level.

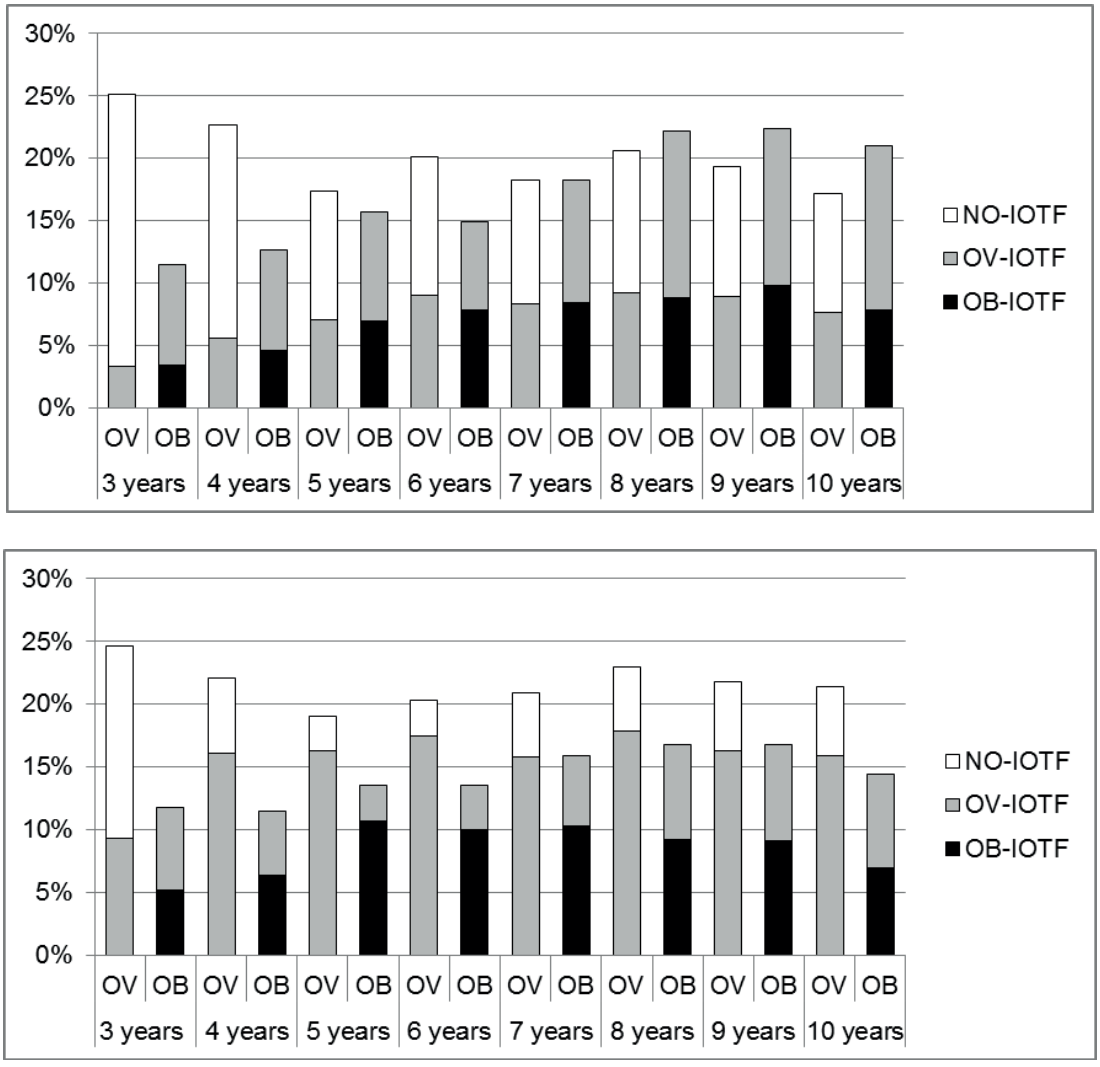

Figure 1. **Prevalence of overweight (OV) and obesity (OB) as function of the WHO criterion considering the disagreement of the WHO vs. the IOTF criteria by sex (boys, over; girls, below) and age (OB-IOTF, obesity; OV-IOTF, overweight; NO-IOTF, non- overweight).**

Table II. **Agreement Kappa coefficient (K) between WHO and IOTF references for overweight and obesity by sex and age group.**

			Overweight				Obesity	
Age		**Girls**	**Boys**			**Girls**	**Boys**	
group	Kappa	95% CI	Kappa	95% CI	Kappa	95% CI	Kappa	95% CI
3-5 years	0.77*	0.73-0.79	0.35*	0.35-0.39	0.65*	0.60-0.70	0.27*	0.23-0.32
6-7 years	0.86*	0.83-0.89	0.56*	0.51-0.61	0.70*	0.65-0.75	0.40*	0.34-0.45
8-10 years	0.82*	0.79-0.84	0.55*	0.51-0.59	0.54*	0.49-0.58	0.29*	0.25-0.32
Total	0.82*	0.80-0.83	0.49*	0.46-0.51	0.62*	0.59-0.65	0.31*	0.29-0.34

***p<0.001.**

Table III. Percentages and prevalence ratio (PR) for child inequality IOTF vs WHO classification to predictor sex, age group and IOTF.

				Inequality			
			No	Yes		p	95%CI
		N	% (N)	% (N)	Risk ratio		
Sex	Boys	7891	75.8 (5981)	24.2 (1910)	2.13	<0.001	1.97- 2.30
	Girls	7966	87.7 (6990)	12.3 (976)	1		
Age	3-5 years	5361	81.1 (4350)	18.9 (1011)	1.06	0.172	0.96-1.15
	6-7 years	4600	84.8 (3901)	15.2 (699)	0.81	<0.001	0.74-0.89
	8-10 years	5896	80.1 (4720)	19.9 (1176)	1		
IOTF	OV-IOTF	3426	60.1 (2060)	39.9 (1366)	3.44	<0.001	3.19-3.71
	NOO-IOTF	12431	87.8 (10911)	12.2 (1520)	1		

DISCUSSION

The present study as far as we know is the first to analyse the overlap of the prevalences of overweight and obesity between the WHO and IOTF cut-off criteria among a cross-sectional representative sample of children aged three to ten years old from each mainland Portuguese district. The prevalences of overweight/obesity were higher according to both the WHO and IOTF classifications. The globally prevalences reported by the Europe PMC Funders Group for children and adolescents in developed countries, were 23.8% of boys and 22.6% of girls being either overweight or obese in 2013. For children aged 6-9 years old in Portugal and other southern European countries such as Greece, Spain and Italy higher overweight/obesity prevalences are shown than in other European countries participating in the COSI surveys (WHO criteria), respectively, for overweight, 21.6%, 25.3%, 24.8% and 23.2% and for obesity, 13.9%, 22.8%, 18.2% and 19.5% (COSI 2019).

The overall prevalence of OVOB according to the WHO was higher, at approximately 36.8% (20.7% OV and 16.1% OB), than that according to the IOTF, which was 28.0% (19.8% OV and 8.2% OB). This result was in agreement with other studies about childhood that also observed that the WHO classification estimated higher prevalences of overweight and obesity than the IOTF classification (Monasta et al. 2011, Kêkê et al. 2015, Shields & Tremblay 2010, Valerio et al. 2017, Wijnhoven et al. 2012, 2014). Results about French children aged 4-12 years old reported by Kêkê et al. (2015) also found similar trend between the two criteria, the prevalences of overweight were higher for WHO (20.0%) / IOTF (16.2%) as also the prevalences for obesity WHO (11.6%) / IOTF (6.7%). For Italian children aged 5–17 years Valerio et al. (2017) reported that IOTF classified more children as non-overweight/ obesity or overweight and less cases as obesity when compared to WHO criterion. Also a study with Portuguese children aged 6–8 years old, observed during 2007-2008, found higher values to WHO criterion than to IOTF criterion: 28.1% and 8.9% to IOTF and 37.9% and 15.3% to WHO, for overweight and obesity, respectively (Rito et al. 2012). Boys showed OVOB difference between

the criteria, about 18%-IOTF and 20%-WHO, for each age group, the percentage of OVOB-WHO was higher than OVOB-IOTF for 3-5 years old (34.3%-WHO / 23.1%-IOTF) and 8-10 years old (40.1%-WHO / 32.2%-IOTF). The prevalence of OV-IOTF was higher than OV-WHO for 8-10 years old; this one may be related with the cases of children classified in the extremes of the percentiles that define overweight. For Portuguese children Viveiro et al. (2016) also observed that the WHO criterion estimated higher percentages of overweight than the IOTF criterion (girls, 7-8 years old, 25.0%-IOTF and 23.3%-WHO and 10-11 years old 25.7%-IOTF and 21.9%-WHO; boys, 9 -10 years old, 28.6%-IOTF and 25.1%-WHO). The prevalence of OB-WHO was always approximately twice than that of OB-IOTF for sex (boys 17.6%-WHO / 7.5%-IOTF, and girls 14.7%-WHO/ 8.3%-IOTF) and age groups (3-5 years old, 13.0%-WHO/ 6.9%-IOTF; 6-7 years old 15.8%-WHO/ 9.2%-IOTF and 8-10 years old 19.2%-WHO/ 8.9%-IOTF). Similar prevalences were found in COSI Portugal, 2007/2008 study with children aged 6-8 years 15.3% OB-WHO/ 8.9%- OB-IOTF (Rito et al. 2012). The present results were in agreement with those observed in a study of primary school children in Europe; they reported prevalences of OVOB-WHO and OVOB-IOTF ranging from 19.3% to 49.0% and 11.2% to 37.2% in boys, respectively, and 18.4% to 42.5% and 14.7% to 34.7% in girls, respectively (Wijnhoven et al. 2012). In Canadian children aged groups 2-5 and 6-11 years old, similar results were observed, the prevalence of obesity results were lower when based on IOTF criterion (6.3% and 8.0%, respectively) than on WHO criterion (10.6% - 14.3%, respectively) (Shields & Tremblay. 2010). When the analysis of the prevalence of OVOB in Portuguese children and adolescents aged 10 to 18 years using the IOTF and WHO criteria, the authors also found differences ranging from 21.6% to 32.7% in girls and 23.5% to 30.7% in boys, respectively (Sardinha et al. 2011). The analysis of the overlapping classifications between the two methodologies shows that a proportion of the children who were classified as neither overweight nor with obesity by the IOTF methodology were classified as overweight by the WHO methodology, and some children classified overweight by the IOTF were classified with obesity by the WHO. Regardless of age, among those classified as NOO-IOTF, there was a greater percentage of boys than girls who were classified as OV-WHO, and the percentage of NOO-IOTF decreased with age. Additionally, regardless of age, among those classified as OB-WHO, boys were more often also classified as OV-IOTF than girls. As suggested the decreasing overlap between criteria among boys may be explained by the lower WHO cut-offs for overweight and obesity in boys than in girls who are between three and 10 years old (Wijnhoven et al. 2012). The rates of the agreement between the two criteria IOTF–WHO were substantial for overweight and moderate for obesity categories. These results were in the range of those observed by other European studies, however the rate of the agreement for obesity was lesser (Kêkê et al. 2015, Valerio et al. 2017). For sex and age the boys show fair to moderate agreement in contrary to the girls showing substantial agreement, with exception to obesity for the age group 8-10 years that decrease to moderate. This disagreement between sex and age was also noted in other studies (Kêkê et al. 2015, Shields & Tremblay 2010, Valerio et al. 2017). Those differences may be related with variations in the age, the sex and the BMI of the structure in the population analysed. The Kappa reliability coefficient frequently used, however is affected by the prevalence of the population under study (Wongpakaran et al 2013), which may be a limitation of the results of the present study. The strengths of this study include the measured

BMI, national mainland representativeness and the age range 3-10 years old. This age range with the analysed by Sardinha et al. (2011) gives information from Portuguese childhood and adolescent years across 2008-2010.

The disparities between prevalences of overweight and obesity observed between IOTF and WHO classifications as suggested by other studies may be related with the difference of design to define overweight and obesity cut offs by sex and age, the IOTF to the range 2-18 years of age, taking into attention the BMI cut-points for adults and based on six large nationally representative cross sectional growth studies data to provide internationally comparable prevalence rates of overweight and obesity by at exact half year ages (Cole et al. 2000) and not intended as clinical definitions (Flegal & Ogden 2011); the WHO based on two datasets, with different definitions for overweight above and below the age of five years old, for evaluation of children growth under optimal circumstances and intended for clinical use in monitoring children's growth (Cattaneo et al. 2010, de Onis & Lobstein 2010, Flegal & Ogden 2011, Himes 2009, Monasta et al. 2011, Ogden et al. 2007, Shields & Tremblay 2010).

Considering that obesity and overweight in childhood and adolescence are strongly associated with risk factors for cardiovascular diseases, diabetes, orthopaedic problems, mental disorders, lower self-esteem and long-term adverse health outcomes in adults, the hight WHO-based prevalences of overweight and obesity observed in Portuguese children highlight the deviation of optimal nutritional status and the role of constraints to healthy growth with risk of short term and long term health outcomes. The WHO growth charts cut off compared with the IOTF cut offs shows higher prevalences of overweight and obesity and the disparities between criteria vary with sex and age among preschool and primary school Portuguese children, which could have important implications on health prevention strategies, health care and parental care for those in childhood and adolescence.

CONCLUSION

The prevalences of overweight and obesity were higher according to the WHO classification than according to the IOTF classification; the greatest difference was observed for the obesity category. For sex and age the boys show fair to moderate agreement contrary to the girls who show moderate to substantial agreement. Sex and age group were predictors of inequality between IOTF vs WHO categories of overweight or obesity. Considering that obesity is a multifactorial condition this deviation of optimal nutritional status suggests that it is important to explore genetic factors, prenatal environment factors, physiologic status, individual behaviors, environmental and social factors that may constraints to healthy growth and can play a role in *weight* gain and future health. Results observed in the study highlight the importance of the methodology of classification of overweight and obesity to design a study, for interpreting results, comparing data and public health strategies.

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AG conceptualized the study, carried out the analyses, drafted the initial manuscript, reviewed and revised the manuscript and approved the final manuscript as submitted. AG, VR-M, IM and CP contributed to the data collection. VR-M and AM-R reviewed critically initial manuscript, reviewed and revised the manuscript and approved the final manuscript as submitted. HN, IM and CP reviewed and revised the manuscript and approved the final manuscript as submitted.