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Risk classification discrepancies in general and abdominal adiposity measures within Portuguese children

Discrepâncias na classificação de risco através de medidas de adiposidade geral e abdominal em crianças portuguesas.

Maria Elisabete Leal de Sousa

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2018

Dedication

À memória do meu pai e da minha avó.

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Abstract

Introduction: Body Mass Index (BMI), Waist Circumference (WC) and Waist-to-Height Ratio (WHtR) are measures used to evaluate general and abdominal adiposity, however little is known about their usefulness in children between the ages of 3 and 9 years old. Sociodemographic and lifestyle characteristics are related to obesity, however, their influence on some anthropometric measures isn't clear. **Aims:** To evaluate general adiposity by BMI, and abdominal adiposity by WC and WHtR; to evaluate the risk classification differences between these adiposity measures, and to identify the sociodemographic and lifestyle characteristics related with the prevalence of high adiposity. **Methods:** Participants were taken from the national representative sample of the IAN-AF 2015-2016 survey, including 483 children aged 3 to 9 years old. Anthropometric measures of weight, height and WC, and sociodemographic and lifestyle characteristics were obtained. The general adiposity was defined by BMI according to WHO, CDC and IOTF criteria. Abdominal adiposity was defined by WC≥P90% according to McCarthy, and by WHtR≥0.5 according to Ashwell. **Results:** The prevalence of overweight (pre-obesity and obesity) according to BMI for WHO was 31.5%, for CDC was 33,1%, and for IOTF was 26.8%. BMI according to WHO showed a classification discrepancy of 15.1% with WC and of 27.5% with WHtR, corresponding, respectively, to a moderate and a weak agreement. The prevalence of abdominal obesity is similar for WC (33.0%) and WHtR (33.5%), with a weak agreement between them, where 26.1% of children were differently classified. The adjusted association between of sociodemographic and lifestyle characteristics with anthropometric variables, it was verified: those who practiced regular physical activity or with parents with lower education had higher BMI; Low vegetable intake was associated with higher BMI and WHtR; Younger children had higher WHtR and lower WC; Children who lived with their fathers or grandparents had higher WHtR. **Conclusion:** About 1/3 of the children presented general or abdominal adiposity. BMI classification showed higher agreement with WC than with WHtR. WC and WHtR had a weak agreement. Some sociodemographic and lifestyle characteristic were associated with anthropometric measures.

Keywords: Childhood, obesity, overweight, sociodemographic, lifestyle

Resumo

Introdução: O Índice de Massa Corporal (IMC), Perímetro da Cintura (PC) e Relação PC/estatura (RPCE) são medidas utilizadas para avaliar a adiposidade geral e abdominal, porém pouco se sabe sobre a sua utilidade em crianças dos 3 aos 9 anos. As características sociodemográficas e de estilo de vida estão relacionadas com a obesidade, no entanto, sua influência sobre algumas medidas antropométricas não está clara. **Objetivos:** Avaliar a adiposidade geral segundo o IMC e a adiposidade abdominal de acordo com o PC e RPCE; avaliar as diferenças de classificação de risco entre as medidas de adiposidade e identificar as características sociodemográficas e de estilo de vida relacionadas com a prevalência de adiposidade elevada**. Metodologia:** Foram utilizados dados de 483 crianças dos 3 aos 9 anos que participaram no IAN-AF 2015-2016. Obtiveram-se medidas antropométricas de peso, estatura e PC, características sociodemográficas e de estilo de vida. A adiposidade geral foi definida pelo IMC de acordo com os critérios da OMS, CDC e IOTF. A adiposidade abdominal foi definida pelo PC≥90% de acordo com McCarthy e pela RPCE≥0,5 de acordo com Ashwell. **Resultados:** A prevalência de excesso de peso (pré obesidade e obesidade) de acordo com o IMC para a OMS foi de 31,5%, para o CDC 33,1% e para o IOTF 26,8%. O IMC, de acordo a OMS, teve uma discrepância de 15,1% com o PC e de 27,5% com a RPCE, apresentando uma concordância moderada e fraca, respetivamente. A prevalência de adiposidade abdominal é semelhante entre o PC (33,0%) e RPCE (33,5%), com uma concordância fraca entre elas, onde 26,1% das crianças foram classificadas de maneira diferente. Através da associação ajustada entre as características sociodemográficas e de estilo de vida com as variáveis antropométricas, verificou-se que: quem praticava atividade física ou quem tinha pais com menor escolaridade tinha maior IMC; A baixa ingestão de hortícolas foi associada ao maior IMC e RPCE; Crianças mais novas tiveram maior RPCE e menor PC. **Conclusão:** Cerca de 1/3 das crianças apresentaram adiposidade geral ou abdominal. A classificação do IMC mostrou maior concordância com o PC do que com a RPCE. Entre o PC e a RPCE houve uma fraca concordância. Algumas características sociodemográficas e de estilo de vida foram associadas a medidas antropométricas em estudo. **Palavras-Chave:** Infância, obesidade, excesso de peso, sociodemográfico, estilo de vida

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List of Abbreviations

APCOI: Association Against Childhood Obesity

BMI: Body Mass Index

CDC: Centres for Disease Control and Prevention

COSI: Childhood Obesity Surveillance Initiative

DGS: Portuguese General Directorate of Health

ECOG: European Childhood Obesity Group

EG: Electronic Games

GLM: General Linear Model

IAN-AF: National Food, Nutrition and Physical Activity Survey

IDEFICS: Identification and prevention of Dietary-and lifestyle-induced health Effects in Children and infants

IOTF: International Obesity Task Force

NCHS: National Centre for Health Statistics

NUTS II: National Territorial Units

TV: Television

WC: Waist Circumference

WHO: World Health Organization

WHtR: Waist-to-Height Ratio

zBMI: BMI for-age z-score

zHeight: Height-for-age z-score

zWaist: Waist Circumference z-score

zWeight: Weight-for-age z-score

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Introduction

Childhood obesity is considered one of the main public health problems of the 21st century [1], being associated with long term consequences on the state of health and quality of life [1, 2]. According to the World Health Organization (WHO), obesity is defined as abnormal or excessive accumulation of fat that can reach degrees capable of affecting health [3]. Obesity is a chronic disease with a multifactorial genesis, which constitutes a risk factor for the development and exacerbation of diseases, for example, hypertension, cardiovascular disease, diabetes, among other [4, 5]. The prevalence of childhood obesity is worrisome. In 2016, an estimated 42 million children under the age of 5 years and over 340 million children and adolescents aged 5-19 were overweight (pre-obese and obese) worldwide. Between 1975 and 2016, there was a substantial increase in the prevalence of overweight among children and adolescents aged 5-19 years, from 4% to 18%, being similar among girls (18%) and boys (19%) [3, 6]. In Europe, according to estimates from the WHO Childhood Obesity Surveillance Initiative (COSI), 2010, approximately 1 in 3 children aged 6-9 years were overweight [7]. In Portugal, a study by the Association Against Childhood Obesity (APCOI) collected data on children between the ages of 2 and 10, during the 2016-2017 school year, in the seven National Territorial Units (NUTS II), and revealed that 28.5% of children were overweight, of which 12.7% were obese [8].

The excessive fat, characteristic of obesity, is a consequence of low energy expenditure, resulting from sedentary behaviours such as low physical activity, and poor eating habits [2, 9, 10]. These behaviours are established in early childhood and can persist into adulthood [2]. Among obese individuals, fat mass not only differs in quantity but also in distribution, and both adipose tissue in the abdominal region and total fat causes serious health problems [11]. Growth patterns and nutritional status are important indicators of health and well-being of children and adolescents. The growth of the human body is a complex and non-linear process with different velocities during the life cycle, and the first years of life are one of the most vulnerable periods [12]. The first phase of growth, corresponding to fetal and infant life, is essentially regulated by environmental factors, and nutrition is one of the main limiting factors. Anthropometry is a direct method of nutritional assessment, it is based on measuring body composition and physical variations at different ages. It is important for monitoring the health of children and adolescents, as well as for determining their nutritional status. It is widely used in clinical practice because it is easy to apply, cheap, effective and non-invasive. However, changes in body composition and the continuous height increase that occur in childhood and adolescence make it difficult to classify obesity in this population [(11)]. Moreover, the secular tendency of growth presents challenges when classifying children. Nevertheless, the rapid increase in weight in relation to height contributes to the increase of childhood obesity prevalence [(13, 14)]. Therefore, an appropriate choice of anthropometric parameters for the evaluation of the nutritional status will give more precise indications about the different types of malnutrition with effects on the development of the child and the adolescent [(15)].

The Body Mass Index (BMI) represents the ratio of an individual's weight to height squared (kg/m^2), and estimates the prevalence of obesity [(11, 16)]. It is used as a screening tool to assess children's nutritional status, because high BMI values may reflect excess of body fat. However, BMI doesn't estimate body composition, that is, it can't differentiate between muscle and fat mass [(17-19)], and isn't sensitive to the change in adiposity during childhood [(20-22)]. The BMI varies with children's age and sex and is classified using specific references, through growth charts [(17, 19)]. Growth curves are used as reference or standard to compare the measurements of the children, helping to determine the degree to which physiological needs for growth and development are met during childhood period, however they shouldn't be used as a single instrument of clinical diagnosis [(23, 24)]. There are different criteria to define children's nutritional status, in particular: the WHO [(23, 25)], Centers for Disease Control and Prevention (CDC) [(24)] and International Obesity Task Force (IOTF) [(5, 26)]. These criteria were developed according to specific and different population bases. IOTF growth curves were developed based on a cross-sectional study with representative samples from 6 countries (Brazil, Great Britain, Hong Kong, the Netherlands, Singapore, and the United States). The specific curves for sex and age were developed through means calculated among the 6 countries [(5, 26)]. IOTF established cut-off points for thinness, pre-obesity and obesity according to BMI values at 18 years old [(5, 26)]. Other criteria, as CDC and WHO are based on percentiles or z-scores [(23, 24)]. CDC growth curves, developed in 2000, were based on data collected by the National Centre for Health Statistics (NCHS) resulting from five national health and nutrition surveys applied to American children and adolescents [24]. WHO growth curves, for children aged 0 to 5 years, resulted from the Multicentre Growth Reference Study (MGRS), that was undertaken between 1997 and 2003, the purpose of which was to assess the growth and development of infants and young children across the world. This study assessed healthy children who have been breastfed and grew in a healthy environment [23]. In 2007, WHO reconstructed the NCHS references using the same statistical methodology for developing growth curves for 0 to 5 years, and obtained the references for 5 to 19 years [25]. It is important to note that the NCHS references refer to American children [24]. According to the European Childhood Obesity Group (ECOG) there is broad international consensus concerning the utility of the WHO child growth standards for assessing children's growth, since the data used to develop these curves depict normal human growth and can be used to assess children everywhere, regardless of ethnicity, socioeconomic status, and type of feeding [27]. Studies comparing the 3 criteria, showed differences between the classifications, as expected, since the 3 criteria were developed under different conditions [28-31]. However, there is general agreement that studies of childhood obesity prevalence should be reported according to different criteria, to facilitate comparison with other studies [32]. In 2013, the Portuguese General Directorate of Health (DGS), adopted the WHO growth curves to monitor the nutritional status of Portuguese children and adolescents [33]. Although there is consensus on the use of this criteria, it is important to make a comparison with the other criteria, since not all studies use the WHO criteria[28].

It is necessary to use other indicators to complement the BMI information, since the BMI provides no information about body fat distribution, in particular that localized in the abdominal region. Central fat distribution is associated with greater health risks than total body fat [34-36]. Abdominal adiposity is associated with an increased risk of metabolic complications, such as insulin resistance, hyperlipidemia, cardiovascular risk factors among other comorbidities, in adults and children [37, 38]. Although measurements such as waist circumference (WC) and waist-to-height ratio (WHtR) can be used to assess abdominal adiposity, little is known about the capacity of these indicators to predict the value of abdominal fat mass in children [19-21]. Nevertheless, the WC and WHtR have shown to be better indicators of cardiometabolic risk than BMI in both adults and children[39]. In adults the WC is used to determine abdominal adiposity, but in children this measure can be influenced by growth and puberty [20, 21]. Hence, the WC requires specific cut-off points for sex and population [38, 40]. There are different references to assess the WC, one of them is from McCarthy *et al,* who developed WC percentiles according sex and age obtained from data collected from British children [41]. WC, as well as BMI, depends on age and sex [42] and the height has influence on the WC along the children's growth, although its effect is quantitatively unknown [38]. The WHtR, calculated by dividing WC by height, is a measure that aims to overcome the WC and BMI limitation. Compared to BMI, the WHtR is easier to use and a more sensitive screening tool in detecting health risks. The WHtR cut-off (WHtR≥0.5) can be applied in children and adult and can be used for different sex and ethnic group [38, 40, 42, 43]. Some studies reported that boys had higher risk as compared to girls, because girls have "better" distribution of fat throughout the body, while in boys fat is more localized at the abdominal region [38, 43, 44]. In adults WHtR is a better predictor of intra-abdominal fat than WC [45] and is also considered to be a better predictor of cardiometabolic risk factors than BMI and WC [35]. WHtR is a slightly better predictor than WC alone, this is probably because WHtR establishes a relationship between the WC and height. Comparing individuals with the same WC, those with shorter height have higher cardiometabolic risk than taller individuals Using WC alone appears not to be sufficient to determine abdominal adiposity [43, 45].

Lifestyle behaviours influencing the individual process of obesity development are driven by individual factors, such as genetic composition, gender, age, and environmental, socioeconomic, cultural, lifestyle and nutritional factors [10, 12, 46]. The nutritional status of children can reflect the socioeconomic status of the family. The socioeconomic status of families is usually assessed through family income, parents' education, occupation, and household composition [46, 47]. To develop strategies with the impetus to reduce the prevalence of childhood obesity, it is important to understand how their determinants and associated factors are related. Environmental factors such as television (TV) viewing time and playing electronic games (EG), duration of sleep over the weekend and weekdays, physical activity, as well as parental characteristics should be considered[46]. According to Bingham *et al*, who evaluated children from continental Portugal, between the ages of 3 and 10, parents low level of education, TV viewing time and time spent playing EG were factors associated with obesity. Exercise practice was a protective factor for the development of obesity [48]. Physical activity impacts energy balance and has been shown to be beneficial to the health of children. A study conducted in the United States of America (EUA) revealed that children who didn't meet the physical activity guidelines were at risk of being overweight [(49)]. A review corroborated the results of the aforementioned study and also verified the association of the number of hours of sleep during the week and the weekend with the development of obesity. They found that the number of sleeping hours varied during the week and weekend and that sleeping 8 hours or less per day was associated with a higher risk of developing obesity, however if the hours of sleep "lost" during the week are recovered at the weekend this risk was partially reduced [(50)]. A national cross-sectional study conducted with children aged 6-19 in Lebanon concluded that childhood obesity is associated with an obesogenic environment, in which diet and physical activity are the main factors. In that study, children's adiposity was positively associated with the sedentary lifestyle and parental socioeconomic characteristics, such as level of education and employment. Parental unfavourable socioeconomic characteristics were presented as a risk factor for adiposity only in children aged 6 to 11 years [(51)]. According to the Portuguese National Food, Nutrition and Physical Activity Survey 2015-2016 (IAN-AF), 72% of children between the ages of 3 and 9 had a fruit and vegetable intake lower than recommended by WHO (400 g per day) [(52)]. The APCOI also corroborated the low consumption of fruits and vegetables among Portuguese children, and showed that obese children are the ones who eat less vegetables, with an intake of 38% lower than the recommendations [(8)].

The high prevalence of childhood obesity makes evident the need for rigorous research on it associated factors in the Portuguese population. According to what have been exposed, it was considered relevant to explore this issue in children between the ages of 3 and 9 years old. The following specific aims were established for the present study:

- To evaluate the prevalence of general adiposity by BMI according to WHO, CDC and IOTF criteria;
- To evaluate the prevalence of abdominal adiposity according to WC, WHtR;
-To identify the sociodemographic and lifestyle characteristics related with the prevalence of general and abdominal adiposity;
-To evaluate the risk classification discrepancies between these 3 adiposity measures.

Methods

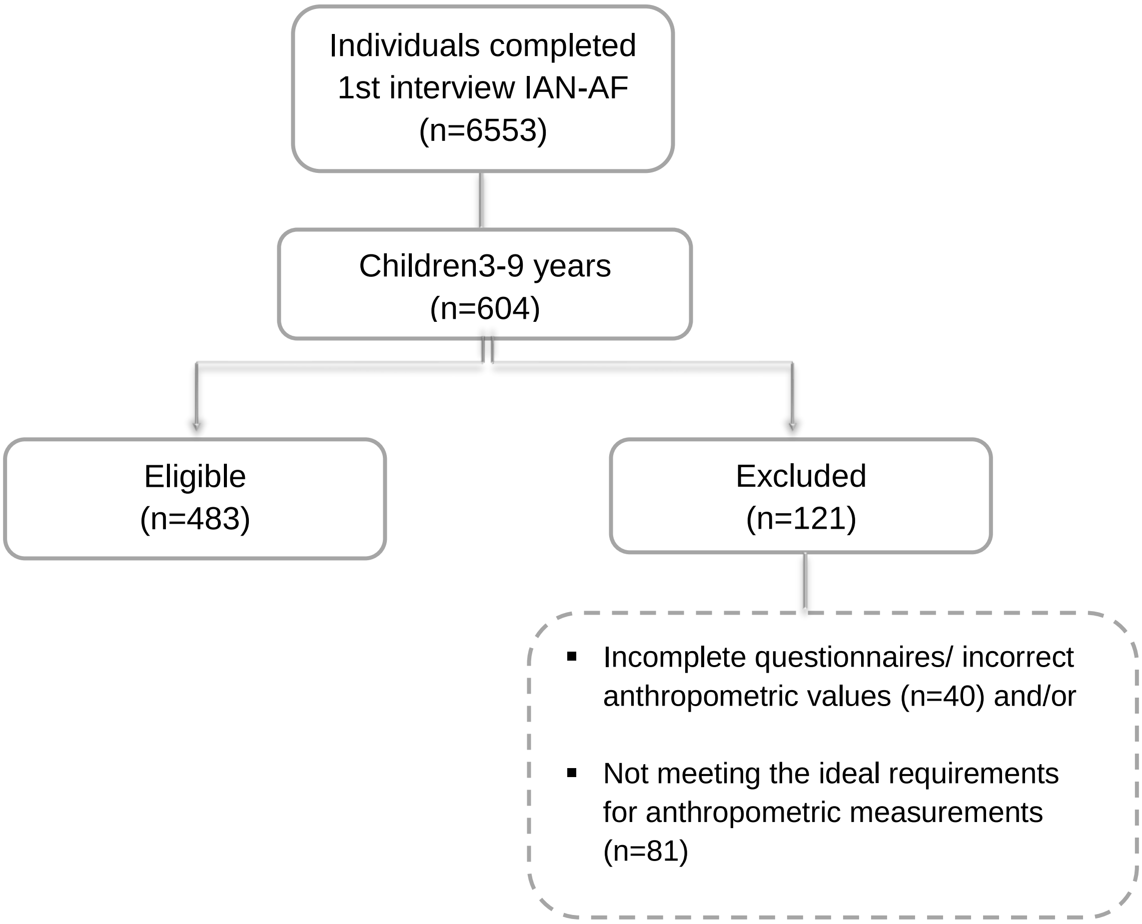
Population and sample

The IAN-AF is a cross-sectional study that obtained a representative sample of the non-institutionalized Portuguese population, with ages between 3 months and 84 years old, registered in the National Health Registry. A random selection of the Functional Health Units was performed per each Territorial Unit (NUTS II, i.e. North, Centre, Lisbon metropolitan area, Alentejo, Algarve, Madeira and Azores), weighted by number of individuals registered in each health unit. Afterwards, a random selection, of individuals was carried out with a fixed number of elements per sex and age group. Recruitment was done by telephone and should individuals accept to participate, the booking of the necessary two interviews was done for their Health Unit or private residence. In the first interview, the study process was explained in full and in case of acceptance, the legal tutors/ participants signed an informed consent. For this dissertation, only the data collected in the first interview was considered.

Figure 1 shows the Flowchart representative of the sample selection for the present dissertation. From entire sample of the 6553 participants in the IAN-AF, 604 of the first interview participants, were children of ages between 3 and 9 years old. Data was obtained from the General Questionnaire, comprising sociodemographic characteristics, health condition and food intake; Physical Activity and Anthropometric Questionnaire. Children under 3 years old and above 9 were excluded due to some differences in the applied questionnaires. Children who had incomplete/incorrect data or whose anthropometric measurements was conducted under unsuitable conditions, (i.e., posture/behavior changes observed, or done while they were clothed) were excluded. As such, 483 children with ages between 3 and 9 make up the sample to be considered for this study.

A more detailed methodology of IAN-AF can be found in “Protocol for design and development” [(53)].

Figure 1: Flowchart representative of the sample selection for the present study



Data collection

Data collection was computer assisted (CAPI) and performed by duly trained interviewers [(53-55)]. Information gathering was done presencially in two moments and took place between October 2015 and September 2016.

Socio-demographic data

The information on the participant's sex and age (calculated through the evaluation date and the participant's birth date) was automatically imported from the National Health Registry database and confirmed upon first contact with the participant. In this age group the questionnaires were filled in by the legal representative (i.e., father, mother, grandmother) of the child. Data on the child's household composition, education level and occupation of the parents was collected. Relatively to the household composition, when the parents were separated in joint custody situations all applicable options were selected (father, mother and/or companion). In accordance to the frequency of the answers obtained for this variable, 5 groups were created: living only with their father and mother; living only with their mother, father and siblings; living with their mother, father, grandparents and with/without siblings; single-parent family, with / without grandparents and with/without siblings; others (encompasses all possible remaining combinations).

The parents' level of education was defined according to the following categories: 0 to 4th grade, 5th to 6th grade, 7th to 9th grade, 10th to 12th grade, technical courses and higher education. The parents' maximum education category was considered in the statistical treatment. In relation to parents' occupation, 3 categories were considered: worker for remuneration or profit, unemployed and any other condition (retired, permanently disabled, student, domestic servant, performing mandatory military service or mandatory community service). In the statistical analysis, 2 groups were considered: working and not working (the remaining conditions).

Information on the children's health condition was gathered, namely the existence of any health problem that would imply regular health care. The most commonly named health condition was asthma. Other diseases such as diabetes, gastrointestinal disease, among others, showed small frequency values. Considering the given answers, two disease groups were created: asthma and other diseases.

Lifestyle data

- **Food Intake**

Information about the last month frequency of eating fruit or vegetables juices, fruit, vegetables soup and vegetables on plate was collected. The frequencies considered in the questionnaire were transformed into average daily consumption according to the following: never (0 per day), <1 per month (0.5/30 per day), 1-3 per month (2/30 per day), 1 per week (1/7 per day), 2-3 per week (2.5/7 per day), 4-6 per week (5/7 per day), 1 per day (1 per day), 2 per day (2 per day), ≥3 per day (4 per day) and "don't know" was treated as missing value. For the statistical treatment, the daily total vegetable consumption (soup and plate) was calculated. For the purpose of comparison whether the consumption of fruit and vegetables was in accordance with the WHO recommendation, it was assumed that the consumption of these foods once a day corresponds to 1 portion per day and the total consumption was calculated considering fruit and vegetables together. The consumption of fruit and vegetable juices wasn't considered in this calculation, since juices don't correspond to the consumption of 1 piece of fruit [56, 57].

- **Physical activity**

In this questionnaire some questions about sedentary behaviors, viewing TV or playing EG during the week and the weekend were asked; also, some questions about practice of regular structured physical activity outside of their school (physical education classes excluded). Moreover, the duration of sleep during the week and weekend were asked. For the sedentary activities the following daily time periods were considered: none, ≤15 minutes, 30 minutes, 1h, 2h, 3h, 4h, 5h, ≥ 6h. The total number of hours expended in sedentary activities was calculated, considering that ≤15 minutes, 30 minutes and ≥6h correspond, respectively, to 0.125h, 0.5h and 7h. It was computed the average sleeping time during the week and the weekend and this values were compared with the recommendations by the American Academy of Sleep Medicine [58].

Anthropometric data

The collection of anthropometric data (weight, height and WC) was conducted by duly trained researchers and according to the international standard [54]. During the anthropometric evaluation, participants were asked to be in their underwear, without shoes, removing all accessories, such as watches, etc. Weight was measured using an electronic portable scale, with a digital reader, calibrated up to 0.1kg (SECA 813, Hamburg, Germany). Height was registered in centimeters up to 1mm, participants were measured standing with the use of a wall-leaned stadiometer with a mobile part (SECA 213, Hamburg, Germany). The height measurement for these children was done in the following manner: the child's accompanier was asked to hold the child's knees and ankles, while having the legs stretched and the feet on the ground; to help reach maximum height, a slight pressure was exerted on the abdominal region. When the child's body was correctly positioned, the researcher placed the child's head in the *Frankfort* plane. The waist circumference was registered in centimeters up to 0.1 cm, measured above the skin in the abdominal region (the point between the upper edge of the iliac crest and the 12th rib). For this measurement the participant had to stand completely still on his/her feet, with his/her upper body in a vertical position, with a relaxed abdomen and arms remaining parallel along the body (or crossed at chest level), palms turned inwards, head in an upright position, feet parallel, slightly apart and firmly planted on the ground, with body weight distributed equally across both feet. If measurements were not done according to the procedure manual, such fact would be registered.

BMI was calculated by the relation between weight and height squared and the classification was performed according to the following categories: low weight, normal weight, pre-obesity and obesity. To classify individuals in different categories, specific BMI z-scores for sex and age were used, according to 3 criteria. In accordance to the WHO criteria for children under 5 years of age, pre-obesity and obesity is defined by the z-scores +2SD and +3SD, respectively; and for children over 5 years of age, pre-obesity and obesity are defined by the z-scores +1SD and +2SD, respectively [23, 25]. Under the CDC criteria, pre-obesity is defined by the 85th percentile and obesity by the 95th percentile [24] and the z-scores corresponding to theses percentiles were calculated. The IOTF defines pediatric overweight and obesity according to the percentiles that correspond, at the age of 18 years, to the

BMI cut-offs in adulthood of ≥25kg/m2 and ≥30kg/m2, respectively [5, 26]. Abdominal adiposity was defined according to the 90th percentile of WC, established for sex and age by the McCarthy cut-off points [41]; and by WHtR (WC/height) cut-off 0.5 according to Aswell [45].

Ethics

The IAN-AF data collection followed the rules of conduct expressed in the Declaration of Helsinki of the World Medical Association [59] and its respective updates as well as those in the current national legislation, guaranteeing the confidentiality of the personal information collected. The approval of this study was given by the National Committee of Data Protection, the Ethics Committee of the Public Health Institute of Oporto's University and the Regional Health Administrations (ARS) [53-55]. The parents/ legal tutors of all participants gave their written informed consent to participate after the children agree to participate.

Statistical analysis

Unweighted and weighted data were considered for the statistical treatment. The data presented were weighted according to a sample design considering the distribution of the Portuguese population, according to the *CENSUS* 2011, by the 7 regions (Nuts II) and the cluster effect for the Functional Health Unit to which the participant belonged [54, 55]. We computed frequencies for the categorical variables and means for quantitative variables. The Weight-for-age z-score (zWeight), Height-for-age z-score (zHeight) following the WHO and CDC criteria, BMI- for-age z-score (zBMI) for WHO, CDC and IOTF criteria and WC z-score (zWaist) following the McCarthy references were calculated through *LMS Growth* software [5, 23-26, 41, 60]. The WHtR was calculated as WC divided by height [45]. Unweighted paired samples t-test and Pearson's correlation were used to determine differences between means and correlation between anthropometric variables, respectively. General adiposity was estimated according to BMI cut-offs and abdominal adiposity according to WC and WHtR. To analyse the agreement between these measurements we used the unweighted Cohen's k coefficient. We used the categories presented by Finney to categorize the correlation and Cohen's k values [61]. The relationship between sociodemographic and lifestyle variables with anthropometric variables was analysed through weighted univariate analyses of variance through a general linear model (GLM). An initial exploratory study was carried out to know which variables had a significant effect on at least one of the anthropometric variables. The variables with significant effect in one model were used in all models. The z-score for BMI according to the WHO criteria was used to compare the prevalence of overweight (pre-obesity and obesity) with the z-score for WC and with WHtR, sociodemographic and lifestyle variables. A significance level of 5% was considered. Data processing was performed through the IBM SPSS® version 25 for Windows.

Results

Sociodemographic data

Table 1 presents the data of sociodemographic characterization of children. The sample of 483 children aged 3 to 9 years old, corresponded to 532465 children, when weighted for the Portuguese population. Of those, 48.3% were female and 51.7% were male, who had a mean age of 6 years old (95%CI:6.1;6.5).

Table 1- Sample sociodemographic and health characteristics; Portuguese children 3-9 years old, 2015-2016.

	n	Weighted n	Weighted %	95% CI
Age (years)				
3-5	202	233574	43.9	[37.4;50.5]
6-9	281	298890	56.1	[49.5;62.6]
Sex				
Female	245	257173	48.3	[43.7;52.9]
Male	238	275292	51.7	[47.1;56.3]
Geographical region				
North	91	187615	35.2	[30.2;40.6]
Centre	77	92525	17.4	[14.8;20.3]
Lisbon MA	75	168200	31.6	[26.9;36.7]
Alentejo	46	29225	5.5	[3.9;7.7]
Algarve	54	25926	4.9	[3.7;6.4]
Azores	77	17387	2.2	[1.5;3.1]
Madeira	63	11585	3.3	[1.6;6.5]
Diseases that require regular medical care				
Yes	69	68554	12.9	[9.6;17.0]
No	414	463910	87.1	[83.0;90.4]
Types of disease (the children that had diseases)				
Asthma	23	19285	28.1	[15.9;44.8]
Others	46	49269	71.9	[55.2;84.1]

Unweighted data (n), represents 483 children; weighted data (weighted n), represents 532464 children; CI: confidence intervals.

As for the distribution of the sample by regions, NUTs II, there were more children living in the North region, followed by the Lisbon metropolitan area; Madeira and Azores had a smaller population. The asthma was the most mentioned pathology to justify the need regular health care.

Table 2 and 3 shows the data of household composition and parents. In what considers children's household composition, the majority (57.9%) lived together with the father, mother and siblings. In relation to the educational level of the parents, the mothers had more commonly completed their higher education than the fathers. The mothers were more frequently unemployed than the fathers, however more than 83% of parents had a professional occupation and only 0.8% of the children had both parents without professional occupation.

Table 2- Household characteristics of the sample; Portuguese children 3-9 years old, 2015-2016.

	n	Weighted n	Weighted %	95% CI
Child lives with:				
Mother	478	530519	99.6	[98.7;99.9]
Father	444	497500	93.4	[90.2;95.6]
Siblings	328	355208	66.7	[60.1;72.7]
Grandparents	57	45813	8.6	[6.0;12.1]
Household composition- Child lives with:				
Mother and father	118	142895	26.8	[21.7;32.7]
Mother, father and siblings	272	308548	57.9	[51.0;64.6]
Mother, father, grandparents and with/no siblings	40	30291	5.7	[3.6;8.9]
Single parent family, with/no grandparents, with/no siblings	25	24042	4.5	[2.6;7.8]
Others	28	26688	5.0	[2.7;9.2]

Unweighted data (n) represents 483 children; weighted data (weighted n) represents 532464 children; CI: confidence intervals.

Table 3- Parents characteristics of the sample; Portuguese children 3-9 years old, 2015-2016.

	n	Weighted n	Weighted %	95% CI
Mother's education				
0 to 6 years	52	61632	11,6	[7.8;16,9]
7 to 9 years	112	100288	18.8	[13.9;25.0]
10 to 12 years	125	157124	29.5	[24.2;35.5]
Technical courses	11	4135	0.8	[0.3;1.8]
Higher education	183	209287	39.3	[21.0;47.1]
Father's education				
0 to 6 years	105	103498,3	19.4	[14.0;26.3]
7 to 9 years	136	145618	27.3	[22.3;33.1]
10 to 12 years	130	150202	28.2	[22.7;34.5]
Technical courses	9	7233	1.4	[0.6;3.3]
Higher education	103	125913	23.6	[17.8;30.8]
Mather's occupation				
Worker for remuneration or profit	401	446434	83.9	[78.6;88.0]
Unemployed	57	62281	11.7	[8.2;16.5]
Other	25	23749	4.5	[2.3;8.4]
Father's occupation				
Worker for remuneration or profit	444	506439	95.1	[91.4;97.3]
Unemployed	31	20518	3.9	[1.9;7.5]
Other	8	5507	1.0	[0.3;3.2]

Unweighted data (n) represents 483 children; weighted data (weighted n) represents 532464 children; CI: confidence intervals.

Lifestyle data

Table 4 shows the lifestyle characteristics of the sample. Relatively to food intake, this sample had a consumption of fruit or vegetable juices of less than one time per day and consumed twice per day of fruit or vegetables on plate or soup, which makes a total of about 4 portions of fruit and vegetables daily. In what concerns sedentary activities, children spent more time watching TV and playing EG during the weekend than during the week, about 1h more and 30min more, respectively. Sleep duration was slightly higher at the weekend. The time spent in sedentary activities is higher during the weekend. Per week, children under 6 years slept more than children over 6 years. The majority (57.5%) of the sample practiced regular structured physical activity. Appendix 1 presents more detailed data on food intake and sedentary activities.

Table 4- Sample lifestyles characterization; Portuguese children 3-9 years old, 2015-2016.

	n	Weighted n	Weighted Mean	95% CI
Food intake				
Consumption frequency per day				
Fruit	483	532464	1.91	[1.73;2.08]
Fruit or vegetable juice	483	532464	0.15	[0.11;0.18]
Vegetables soup	483	532464	1.29	[1.21;1.38]
Vegetables on plate	483	532464	0.89	[0.79;1.00]
Fruit + vegetables on soup or plate	483	532464	4.09	[3.83;4.35]
Vegetables soup or plate	483	532464	2.19	[2.04;2.33]
	n	**Weighted n**	**Weighted %**	**95% CI**
Fruit + vegetables on soup or plate				
Consumption <*5 portions*	326	340125	63,9%	[56.0;71,0]
Consumption ≥*5 portions*	157	192339	36,1%	[29.0;44.0]
	n	**Weighted n**	**Weighted Mean**	**95% CI**
Sedentary activities				
Spending time (h) per day				
TV Weekdays	483	532464	1.43	[1.23;1.63]
TV weekends	483	532464	2.45	[2.24;2.66]
EG weekdays	483	532464	0.46	[0.34;0.58]
EG weekends	483	532464	0.96	[0.81;1.12]
TV and EG weekdays	483	532464	1.89	[1.60;2.19]
TV and EG weekends	483	532464	3.41	[3.10;3.72]
Duration of sleep				
Hours of sleep per day				
Week	441	498290	9:49	[9:41;9:57]
Weekends	439	496871	10:08	[9:58;10:18]
Mean hours of sleep between the week and weekend by age				
<6 years	186	217833	10:10	[9:57;10:22]
≥6 years	253	279038	9:42	[9:33;9:51]
	n	**Weighted n**	**Weighted %**	**95% CI**
Physical activity				
Practice of regular structured physical activity				
yes	261	306262	57.5	[50.3;64.4]
No	222	226202	42.5	[35.6;49.7]

Unweighted data (n) represents 483 children; weighted data (weighted n) represents 532464 children; CI: confidence intervals.

Anthropometric data

Table 5 shows the anthropometric characterization of the sample: height and weight z-scores according to WHO and CDC criteria; BMI z-score according to WHO, CDC and IOTF criteria; WC z-score according to McCarthy criteria and WHtR.

Table 5- Sample anthropometric characterization; Portuguese children 3-9 years old, 2015-2016.

	Unweighted Mean	Weighted Mean	95% CI
zHeight			
WHO	0.02	0.02	[-0.12;0.16]
CDC	0.15	0.16	[0.03;0.29]
zWeight			
WHO	0.47	0.54	[0.40;0.68]
CDC	0.40	0.46	[0.34;0.59]
zBMI			
WHO	0.65	0.74	[0.61;0.88]
CDC	0.47	0.57	[0.45;0.69]
IOTF	0.58	0.67	[0.54;0.81]
Waist circumference			
zWaist	0.84	0.88	[0.74;1.02]
Waist-to-height ratio			
WHtR	0.49	0.49	[0.48;0.49]

Unweighted mean: n=483; Weighted mean: n=532464; CI: confidence intervals for weighted mean, height- for- age z- score (zHeight), weight-for-age z-score (zWeight), BMI-for-age z-score (zBMI) according to WHO, CDC and IOTF critera; waist circumference z-score (zWaist) according to McCarthy criteria; and waist-to-height ratio (WHtR).

There were significant differences between z-scores for height, weight and BMI, when comparing the different criteria. The CDC z-score for height was significantly higher than the WHO z-score (p<0.001), whereas the CDC z-score for weight and BMI was significantly lower than the WHO z-score (p<0.001). The IOTF z-score for BMI was significantly lower than the WHO z-score (p<0.001) but significantly higher than the CDC z-score (p<0.001). There was a very strong correlation (unweighted r≥0.98; p<0.001) between the WHO z-scores and the CDC z-scores for weight and height, as well as between WHO, CDC and IOTF z-scores for BMI.

Table 6 shows the prevalence of general and abdominal adiposity. Comparing the prevalence of overweight defined by the WHO criteria with other criteria, there were the CDC criteria overestimated overweight, and the IOTF criteria underestimated overweight. As for the differences between sex, girls had a higher prevalence of overweight than boys, although the differences weren't significant. Analysing the differences between sexes relatively to the pre-obesity and obesity for the different criteria, it was observed that according to CDC and WHO criteria boys presented a lower prevalence of pre-obesity and a higher prevalence of obesity. According to IOTF criteria, boys presented lower prevalence of pre-obesity and obesity than girls. However, there was a strong agreement between WHO, CDC and IOTF criteria (unweighted $k \geq 0.78$; $p < 0.001$). The prevalence of abdominal adiposity was similar when comparing WC with WHtR and was higher in boys.

Table 7 shows the prevalence of general and abdominal adiposity by geographical regions. Although the differences between regions weren't significant, it was observed that general adiposity (pre-obesity + obesity) was higher in the Algarve and North and lower in the Alentejo and Azores. As for abdominal adiposity, according to the WC, it was higher in the Centre and Algarve and lower in the Alentejo and North. Regarding WHtR, it was higher in the Algarve and Azores and lower in Alentejo and Madeira.

Table 6- Prevalence of general and abdominal adiposity by sex. General adiposity defined according to BMI by the WHO, CDC and IOTF criteria and abdominal adiposity defined according to WC and WHtR; Portuguese children 3-9 years old, 2015-2016.

Anthropometry										
	Total				Female			Male		
	n	Weighted n	Weighted %	95% CI	Weighted n	Weighted %	95% CI	Weighted n	Weighted %	95% CI
WHO										
Underweight	2	319	0.1	[0.0;0.3]	319	0.1	[0.0;0.5]	-	-	-
Normal weight	345	364680	68.4	[62.0;74.3]	171117	66.5	[58.2;74.0]	193562	70.3	[62.0;77.5]
Pre-obesity	87	114356	21.5	[16.6;27.4]	61697	24.0	[16.9;32.8]	52659	19.1	[13.5;26.4]
Obesity	49	53109	10.0	[6.2;15.6]	24039	9.3	[4.9;17.0]	29070	10.6	[6.2;17.4]
CDC										
Underweight	10	3361	0.6	[0.3;1.3]	3001	1.2	[0.5;2.7]	360	0.1	[0.0;0.5]
Normal weight	332	352594	66.2	[59.8;72.1]	167823	65.3	[55.1;74.2]	184771	67.1	[59.2;74.2]
Pre-obesity	88	120965	22.7	[17.5;28.9]	56576	22.0	[13.5;33.7]	64388	23.4	[17.3;30.8]
Obesity	53	55544	10.4	[6.7;16.0]	29771	11.6	[6.5;19.7]	25773	9.4	[5.5;15.5]
IOTF										
Underweight	20	14103	2.6	[1.4;4.9]	9846	3.8	[1.7;8.6]	4257	1.5	[0.6;4.0]
Normal weight	347	375456	70.5	[64.3;76.0]	164668	64.0	[54.1;72.9]	210787	76.6	[68.4;83.1]
Pre-obesity	83	105154	19.7	[14.9;25.7]	62140	24.2	[15.6;35.4]	43014	15.6	[10.2;23.2]
Obesity	33	37751	7.1	[3.8;12.9]	20518	8.0	[3.8;16.0]	17234	6.3	[3.1;12.4]
Waist circumference										
WC< $P_{90\%}$	318	356967	67.0	[62.0;71.7]	173886	67.6	[60.0;74.4]	183081	66.5	[59.4;72.9]
WC≥ $P_{90\%}$	165	175497	33.0	[28.3;38.0]	83287	32.4	[25.6;40.0]	92211	33.5	[27.1;40.6]
Waist-to-height ratio										
WHtR<0.5	320	353893	66.5	[59.8;72.5]	178605	69.4	[60.6;77.1]	175288	63.7	[54.1;78.2]
WHtR ≥0.5	163	178571	33.5	[27.5;40.2]	78568	30.6	[22.9;39.4]	100003	36.3	[27.8;45.9]

Unweighted data (n) represents 483 children; weighted data (weighted n) represents 532464 children; CI: confidence intervals.

Table 7- Prevalence of general and abdominal adiposity by regions. General adiposity defined according to BMI by the WHO criteria and abdominal adiposity defined according WC and WHtR; Portuguese children 3-9 years old, 2015-2016.

Anthropometry							
	North	**Centre**	**Lisbon MA**	**Alentejo**	**Algarve**	**Madeira**	**Azores**
BMI							
Underweight							
Weighted n	--	--	--	--	--	192	126
Weighted %	--	--	--	--	--	1.7	0.7
95% IC	--	--	--	--	--	[0.2;10.5]	[0.1;6.3]
Normal weight							
Weighted n	122922	62568	118084	23135	16479	8157	13335
Weighted %	65.5	67.6	70.2	79.2	63.6	70.4	76.7
95% IC	[54.2;75.3]	[55.2;78.0]	[55.8;81.5]	[61.6;90.0]	[47.4;77.1]	[59.6;79.3]	[51.7;91.0]
Pre-obesity							
Weighted n	51610	16328	35351	2806	4022	1256	2983
Weighted %	27.5	17.6	21.0	9.6	15.5	10.8	17.2
95% IC	[18.0;39.6]	[11.4;26.3]	[12.6;32.8]	[3.8;22.4]	[7.5;29.4]	[5.6;19.9]	[7.1;35.9]
Obesity							
Weighted n	13082	13629	14764	3284	5425	1980	944
Weighted %	7.0	14.7	8.8	11.2	20.9	17.1	5.4
95% IC	[3.4;13.8]	[7.9;25.9]	[2.1;29.7]	[3.8;29.0]	[7.4;46.7]	[10.8;26.0]	[1.4;18.5]
Waist circumference							
WC≤ $P_{90\%}$							
Weighted n	133672	53163	115190	21471	15123	7824	10523
Weighted %	71.2	57.5	68.5	73.5	58.3	67.5	60.5
95% IC	[64.1;77.5]	[45.4;68.7]	[56.0;78.7]	[61.1;83.0]	[42.8;72.3]	[56.4;77.0]	[41.9;76.5]
WC≥ $P_{90\%}$							
Weighted n	53943	39362	53010	7754	10803	3761	6864
Weighted %	28.8	42.5	31.5	26.5	41.7	32.5	39.5
95% IC	[22.5;35.9]	[31.3;54.6]	[21.3;44.0]	[17.0;38.9]	[27.7;57.2]	[23.0;43.6]	[23.5;58.1]
Waist-to-height ratio							
WHtR≤0.5							
Weighted n	123080	59473	114875	21706	16078	7640	11041
Weighted %	65.6	64.3	68.3	74.3	62.0	65.9	63.5
95% IC	[52.5;76.7]	[49.7;76.6]	[55.8;78.6]	[59.7;84.9]	[36.0;82.6]	[51.6;77.9]	[39.6;82.2]
WHtR ≥0.5							
Weighted n	64535	33053	53325	7519	9848	3945	6346
Weighted %	34.4	35.7	31.7	25.7	38.0	34.1	36.5
95% IC	[23.3;47.5]	[23.4;50.3]	[21.4;44.2]	[15.1;40.3]	[17.4;64.0]	[22.1;48.4]	[17.8;60.4]

Unweighted data (n) represents 483 children; weighted data (weighted n) represents 532464 children; CI: confidence intervals.

Adiposity measures, sociodemographic and lifestyles variables

Tables 8 and 9 represent the association of sociodemographic and lifestyle characteristics with the anthropometric variables, WHO z-scores for BMI, weight and height, WC z-score and WHtR. In a preliminary analysis we considered the following variables: sociodemographic data (sex, age, geographical region, child lives with: mother, father, siblings, grandparents; parent’s maximum education, mother’s occupation, father’s occupation, regular health care, having asthma, having other diseases) and lifestyles data (practice of regular structured physical activity; food intake frequency; sedentary activities; duration of sleep). The final model for each anthropometric parameter only included the variables that had presented a significant association with, at least, one of the anthropometric variables. The univariate analysis of variance, using a GLM procedure, identified some statistically significant associations, although most of the effect sizes were small. It was found that children with higher BMI z-score were the ones: who practiced regular physical activity; with parents with lower education; and who ate vegetables less frequently. Children living with their mothers and older children had higher weight z-score. Children with higher height z-score didn’t have siblings and were older. Children with higher WC z-score were older. Children with higher WHtR lived with their fathers and grandparents, were younger and ate vegetables less frequently.

Table 8 - Association of sociodemographic and lifestyles characteristics with anthropometric variables (WHO z-score for BMI, weight and height); Portuguese children 3-9 years old, 2015-2016.

		zBMI (R^2=0.076)			**zWeight** (R^2= 0.088)			**zHeight** (R^2 =0.110)		
Geographic region		**Weighted Mean**	**95% CI**	***p***	**Weighted Mean**	**95% CI**	***p***	**Weighted Mean**	**95% CI**	***p***
North		0.64	[0.28;0.99]	0.286	0.27	[-0.08;0.61]	0.385	-0.31	[-0.81;0.18]	0.090
Centre		0.50	[0.06;0.94]		0.14	[-0.27;0.54]		-0.40	[-0.89;0.09]	
Lisbon MA		0.65	[0.30;1.00]		0.93	[0.04;0.74]		-0.09	[-0.59;0.40]	
Alentejo		0.27	[-0.11;0.65]		0.13	[-0.20;0.46]		-0.10	[-0.58;0.38]	
Algarve		0.65	[0.20;1.11]		0.44	[0.06;0.82]		-0.12	[-0.67;0.44]	
Azores		0.14	[-0.50;0.79]		-0.20	[-0.78;0.39]		-0.51	[-1.04;0.009]	
Madeira		0.52	[0.22;0.83]		0.27	[-0.06;0.60]		-0.19	[-0.72;0.33]	
Child lives with:										
Mother	yes	0.58	[0.33;0.83]	0.392	0.49	[0.26;0.73]	0.003	0.11	[-0.11;0.32]	0.095
	no	0.38	[-0.08;0.85]		-0.08	[-0.48;0.32]		-0.60	[-1.43;0.23]	
Father	yes	0.63	[0.32;0.94]	0.118	0.40	[0.12;0.67]	0.082	-0.10	[-0.53;0.34]	0.179
	no	0.33	[-0.06;0.72]		0.02	[-0.38;0.42]		-0.40	[-0.94;0.14]	
Siblings	yes	0.52	[0.19;0.84]	0.620	0.09	[-0.23;0.41]	0.148	-0.48	[-0.95;0.0002]	0.002
	no	0.44	[0.10;0.78]		0.32	[0.02;0.63]		-0.020	[-0.46;0.42]	
Grandparents	yes	0.60	[0.15;1.05]	0.346	0.39	[-0.03;0.81]	0.138	-0.09	[-0.60;0.43]	0.137
	no	0.36	[0.06;0.67]		0.02	[-0.27;0.31]		-0.41	[-0.87;0.05]	
Practice of regular structured physical activity	yes	0.64	[0.32;0.96]	0.046	0.29	[-0.01;0.59]	0.314	-0.30	[-0.75;0.15]	0.484
	no	0.32	[-0.02;0.67]		0.12	[-0.21;0.46]		-0.20	[-0.67;0.27]	
		Parameter	**95% IC**	***p***	**Parameter**	**95% IC**	***p***	**Parameter**	**95% IC**	***p***
Age (years)		0.022	[-0.046;0.090]	0.520	0.11	[0.05;0.18]	0.001	0.14	[0.08;0.20]	<0.001
Maximum education of parents		-0.113	[-0.211;-0.015]	0.024	-0.10	[-0.21;0.01]	0.067	-0.04	[-0.14;0.06]	0.475
Total Vegetable intake frequency		-0.152	[-0.301;-0.002]	0.047	-0.11	[-0.27;0.07]	0.222	0.004	[-0.14;0.15]	0.959

Weighted n: 496871; CI: confidence intervals; zBMI: BMI-for-age z-score according WHO criteria; height- for- age z- score (zHeight), weight-for-age z-score (zWeight); Variables considered in initial study: Sociodemographic data (sex, age, geographical region, child lives with: mother, father, siblings, grandparents; parent's maximum education, mother's occupation , father's occupation, regular health care, having asthma, having other diseases) and lifestyles data (practice of regular structured physical activity; food intake frequency; sedentary activities; duration of sleep).

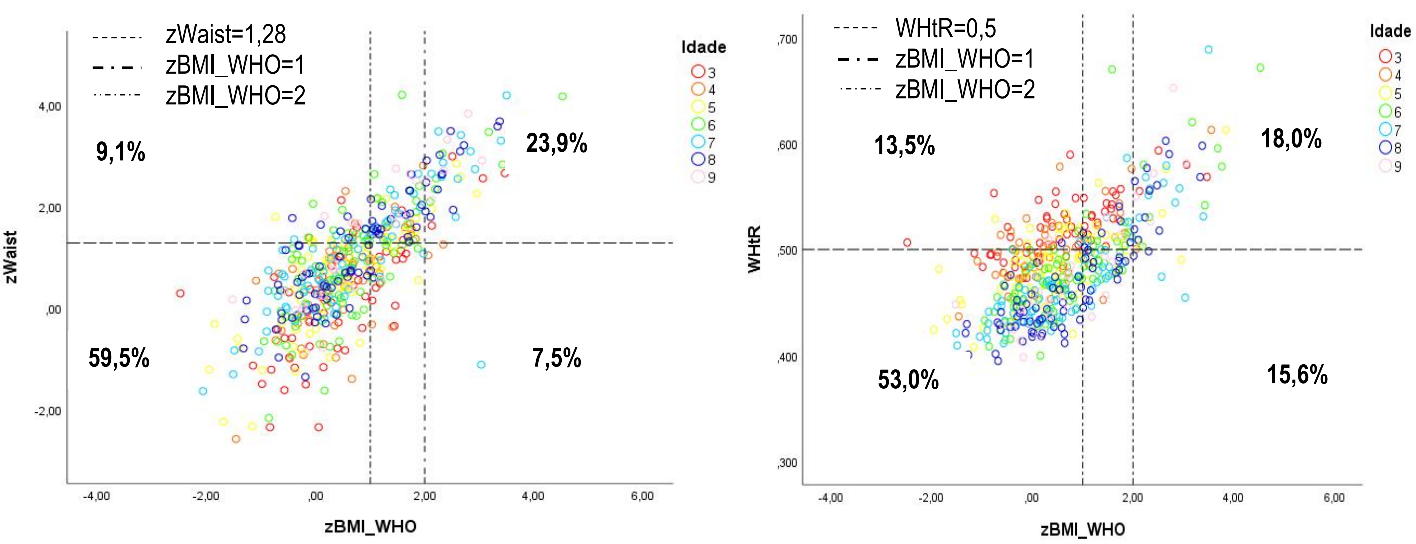
Table 9- Association of sociodemographic and lifestyle characteristics with anthropometric variables (WC z-score and WHtR); Portuguese children 3-9 years old, 2015-2016.

		zWaist **(R^2=0.093)**			WHtR **(R^2=0.228)**		
Geographic region		**Weighted Mean**	**95% CI**	***p***	**Weighted Mean**	**95% CI**	***p***
North		0.64	[0.24;1.04]	0.119	0.478	[0.461;0.495]	0.066
Centre		0.77	[0.33;1.22]		0.491	[0.472;0.509]	
Lisbon MA		0.69	[0.32;1.06]		0.477	[0.462;0.493]	
Alentejo		0.34	[-0.03;0.72]		0.465	[0.449;0.481]	
Algarve		0.87	[0.43;1.32]		0.490	[0.467;0.512]	
Azores		0.49	[-0.23;1.21]		0.482	[0.452;0.511]	
Madeira		0.48	[0.14;0.83]		0.477	[0.465;0.489]	
Child lives with:							
Mother	yes	0.79	[0.53;1.06]	0.129	0.485	[0.474;0.496]	0.377
	no	0.44	[-0.06;0.93]		0.475	[0.451;0.499]	
Father	yes	0.86	[0.54;1.18]	0.059	0.489	[0.474;0.504]	0.046
	no	0.37	[-0.13;0.86]		0.471	[0.452;0.490]	
Siblings	yes	0.58	[0.23;0.93]	0.663	0.483	[0.468;0.497]	0.284
	no	0.64	[0.29;0.99]		0.478	[0.462;0.493]	
Grandparents	yes	0.84	[0.40;1.28]	0.064	0.491	[0.471;0.511]	0.033
	no	0.39	[0.03;0.74]		0.469	[0.454;0.484]	
Practice of regular structured physical activity	yes	0.75	[0.41;1.08]	0.130	0.485	[0.470;0.501]	0.056
	no	0.48	[0.09;0.87]		0.475	[0.459;0.491]	
		Parameter	**95% CI**	***p***	**Parameter**	**95% CI**	***p***
Age(years)		0.12	[0.04;0.20]	0.003	-0.011	[-0.01;-0.008]	<0.001
Maximum education of parents		-0.04	[-0.152;0.066]	0.434	-0.001	[-0.005;0.003]	0.528
Total Vegetable intake frequency		-0.12	[-0.29;0.05]	0.165	-0.006	[-0.011;0.000]	0.045

Weighted n: 496871; CI: confidence intervals; zWaist: WC-for-age z-score according to McCarthy criteria; WHtR: Waist-to-height ratio; Variables considered in initial study: Sociodemographic data (sex, age, geographical region, child lives with: mother, father, siblings, grandparents; parent's maximum education, mother's occupation , father's occupation, regular health care, having asthma, having other diseases) and lifestyles data (practice of regular structured physical activity; food intake frequency; sedentary activities; duration of sleep)

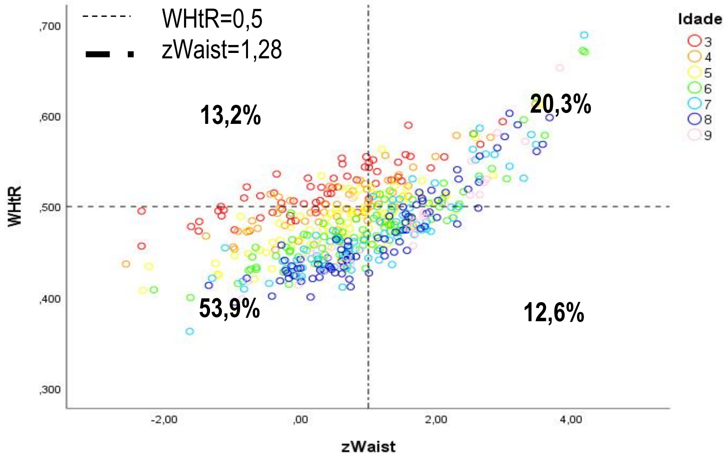
Figures 2 and 3 present the relationship between WC z-score, WHtR and BMI z-score according to WHO criteria. The WHO z-score for BMI presented a strong correlation (unweighted r=0.78; p<0.001) with the WC z-score and a moderate correlation (unweighted r=0.68; p<0.001) with WHtR. WC z-score showed a moderate correlation (unweighted r=0.69; p<0.001) with WHtR. Furthermore, the discrepancies in the classification of general and abdominal adiposity among these measures were analysed. It was analysed the discrepancies between the different anthropometric measures: being overweight (pre-obese or obese) from BMI z-score according to the age-dependent WHO criteria; having excessive WC according to the 90th percentile by McCarthy; and having excessive WHtR, above 0.5 according to criterion by Ashwell. BMI showed a classification discrepancy of 16.6% with WC and of 29.1% with WHtR, respectively, a moderate agreement (unweighted k=0.649; *p*<0.001) and a weak agreement (unweighted k=0.358; *p*<0.001). Between WC and WHtR, 25.8% of children were differently classified and a week agreement (unweighted k=0.418; *p*<0.001) was found.

Figure 2- Association among WC z-score, WHtR with BMI z-score according to WHO criteria by age; Portuguese children 3-9 years old, 2015-2016.



zBMI_WHO: BMI z score for WHO criteria; zWaist: WC-for-age z-score; WHtR: Waist-to-height ratio. The vertical dashed lines correspond to the WHO cut-off of BMI=1. The Horizontal dashed lines correspond to the *McCarthy* cut off for the 90th percentile (zWaist=1.28) and to the WHtR=0.5 cut-off.

Figure 3 - Association between WC z-score and WHtR by age; Portuguese children 3-9 years old, 2015-2016



zWaist:WC-for-age z-score; WHtR: Waist-to-height ratio. The vertical dashed lines correspond, to the WHtR=0.5 cut-off. The Horizontal dashed lines correspond to the McCarthy cut off for the 90th percentile (zWaist=1.28).

In order to study how the deviations in the risk classification between the anthropometric variables were influenced by the sociodemographic and lifestyle characteristics included in the models in the tables 7 and 8, three different univariate analysis of variance models were performed (Table 10). One had as dependent variable the WC z-score and independent variables the BMI z-score, sociodemographic and lifestyle characteristics. In this model it was verified that children with similar BMI z-score values had higher WC z-scores if their parents had higher education, were older and lived in the Azores, while those that lived in the Madeira had lower WC z-score. Another model considered as dependent variable the WHtR and independent variables the BMI z-score, sociodemographic and lifestyle characteristics. In this model it was verified that children with similar BMI z-score values had higher WHtR if they were younger, lived with their grandparents, and lived in the Azores, while those living in Alentejo had lower WHtR. Finally, considering as dependent variable the WC z-score and as independent variables WHtR, sociodemographic and lifestyle characteristics, it was concluded that children with similar WHtR values had higher WC z-score if they were older, didn't have siblings and lived in Lisbon, WC z-score was lower in the Azores.

Table 10- Relationship among discrepancies in the risk classification of general and abdominal adiposity with sociodemographic and lifestyle characteristics; Portuguese children 3-9 years old, 2015-2016.

		zWaist (zBMI) R^2 = 0.693			**WHtR (zBMI)** R^2 =0.696			**zWaist (WHtR)** R^2=0.713		
Geographic region		**Weighted Mean**	**95% CI**	***p***	**Weighted Mean**	**95% CI**	***p***	**Weighted Mean**	**95% CI**	***p***
North		0.73	[0.39;1.06]	0.046	0.482	[0.470;0.493]	<0.001	0.81	[0.53;1.08]	0.021
Centre		0.98	[0.63;1.33]		0.498	[0.486;0.511]		0.66	[0.36;0.95]	
Lisbon MA		0.77	[0.46;1.09]		0.481	[0.469;0.491]		0.87	[0.61;1.14]	
Alentejo		0.74	[0.37;1.11]		0.479	[0.466;0.493]		0.80	[0.53;1.07]	
Algarve		0.95	[0.58;1.32]		0.492	[0.478;0.507]		0.78	[0.43;1.14]	
Azores		0.99	[0.63;1.35]		0.499	[0.484;0.515]		0.57	[0.31;0.84]	
Madeira		0.67	[0.28;1.06]		0.484	[0.471;0.49]		0.68	[0.39;0.97]	
Child lives with:										
Mother	yes	0.93	[0.77;1.09]	0.508	0.490	[0.483;0.497]	0.605	0.80	[0.66;0.95]	0.582
	No	0.74	[0.15;1.32]		0.486	[0.467;0.504]		0.68	[0.23;1.12]	
Father	yes	0.95	[0.64;1.27]	0.095	0.493	[0.482;0.502]	0.106	0.78	[0.56;1.01]	0.539
	No	0.71	[0.33;1.09]		0.483	[0.469;0.497]		0.70	[0.37;1.02]	
Siblings	yes	0.77	[0.45;1.09]	0.105	0.489	[0.478;0.500]	0.287	0.65	[0.38;0.92]	0.027
	No	0.89	[0.56;1.23]		0.486	[0.475;0.497]		0.83	[0.58;1.08]	
Grandparents	yes	0.96	[0.58;1.35]	0.117	0.496	[0.482;0.509]	0.012	0.72	[0.43;1.01]	0.726
	No	0.70	[0.37;1.03]		0.480	[0.469;0.491]		0.76	[0.51;1.01]	
Practice of regular structured physical activity	yes	0.84	[0.52;1.15]	0.978	0.487	[0.478;0.499]	0.695	0.76	[0.50;1.01]	0.744
	No	0.83	[0.49;1.18]		0.488	[0.476;0.499]		0.72	[0.45;1.00]	

Weighted n: 496871; CI: confidence intervals; zWaist:WC-for-age z-score according to McCarthy criteria; WHtR: Waist-to-height ratio; zBMI_WHO: BMI-for-age z-score according WHO criteria; Variables considered in initial study: Sociodemographic data (sex, age, geographical region, child lives with: mother, father, siblings, grandparents; parent's maximum education, mother's occupation , father's occupation, regular health care, having asthma, having other diseases) and lifestyles data (practice of regular structured physical activity; food intake frequency; sedentary activities; duration of sleep).

Table 10- Relationship among discrepancies in the classification of general and abdominal adiposity with sociodemographic and lifestyle characteristics; Portuguese children 3-9 years old, 2015-2016 (continued).

	zWaist (zBMI) $R^2 = 0.693$			**WHtR (zBMI)** $R^2 = 0.696$			**zWaist (WHtR)** $R^2 = 0.713$		
	Parameter	**95% CI**	***p***	**Parameter**	**95% CI**	***p***	**Parameter**	**95% CI**	***p***
Age(years)	0.10	[0.06;0.14]	<0.001	-0.011	[-0.013;-0.010]	<0.001	0.359	[0.312;0.406]	<0.001
Maximum education of parents	0.05	[0.01;0.10]	0.032	0.002	[-0.000;0.004]	0.053	-0.016	[-0.072;0.041]	0.584
Total Vegetable intake frequency	0.009	[-0.075;0.093]	0.838	-0.001	[-0.004;0.002]	0.455	0.009	[-0.064;0.082]	0.807
zBMI	0.84	[0.76;0.91]	<0.001	0.030	[0.027;0.032]	<0.001	-----	-----	-----
WHtR	-----	-----	-----	-----	-----	-----	22.42	[20.54;24.31]	<0.001

Weighted n: 496871; CI: confidence intervals; zWaist:WC-for-age z-score according to McCarthy criteria; WHtR: Waist-to-height ratio; zBMI_WHO: BMI-for-age z-score according WHO criteria; Variables considered in initial study: Sociodemographic data (sex, age, geographical region, child lives with: mother, father, siblings, grandparents; parent’s maximum education, mother’s occupation , father’s occupation, regular health care, having asthma, having other diseases) and lifestyles data (practice of regular structured physical activity; food intake frequency; sedentary activities; duration of sleep).

Discussion

Considering the high prevalence of childhood obesity in Portugal, the purpose of this dissertation was to explore the risk discrepancies of adiposity classifications, and this association with sociodemographic and lifestyle characteristics. This study included a sample of 483 children, representative of the Portuguese population, corresponding to approximately 532465 children aged 3 to 9 years.

In the present study, nearly 1/3 of the children presented general or abdominal adiposity. The prevalence of overweight (pre-obesity +obesity) according to WHO was 31.5%. When compared to this organization, the CDC (33.1%) overestimates the prevalence of overweight, whereas the IOTF (26.8%) underestimates this prevalence. Nevertheless, the agreement is strong between these classifications. The z score of BMI, weight and height for the 3 criteria presented a strong correlation between them, however there were significant differences. These differences explain the disparities between the classification of each criteria. The use of different criteria, WHO, CDC and IOTF, to estimate general adiposity according to BMI (table 11) allows comparability between studies [28, 62, 63]. However, there are few studies that compare the 3 criteria in this age group, usually reporting higher prevalence of overweight by the WHO and lower prevalence by the IOTF [29-31, 64]. Camarinha *et al,* assessed children from the municipality of Gaia, in comparison to the present study, they found a higher prevalence of overweight. The prevalence of overweight according the IOTF was lower than the WHO, while the CDC was considerably close [28]. According to Bingham *et al*, whose study considered a representative sample of continental Portugal, the prevalence of overweight among children aged 3 to 10 years, was 27.9%, using the IOTF criteria[48]. The IDEFICS study (Identification and prevention of Dietary-and lifestyle-induced health Effects in Children and infants) gathered data from children aged 2 to 9 years from 8 European countries between 2007 and 2010. They found a greater prevalence of overweight in southern Europe, where Italy (42.4%) showed the highest rates, followed by Cyprus (23.3%) and Spain (21.2%), according to the IOTF cut-offs [32]. These results corroborate data from the latest COSI report comparing the results of Round 1 (2007/2008) and Round 2 (2009/2010) in Europe among children between the ages of 6 and 9. COSI has found a decrease in the prevalence of obesity between the two Rounds in countries such as Portugal, Spain and Italy, but the prevalence in southern Europe remains high [65]. Data from the COSI- Portugal 2016 study, revealed a decrease in the prevalence of childhood obesity in Portugal. Between 2008 and 2016, they found a reduction of 7.2% (37.9% to 30.7%) for pre-obesity and of 3.6% (15.3% to 11.7%) for obesity[66].

In this study, the prevalence of abdominal adiposity according to the WC and WHtR were similar. The prevalence of abdominal adiposity for WC was determined according to the British reference of McCarthy *et al*. from 1990, however it would be interesting to analyse in the future the prevalence of abdominal adiposity according to Fernandez *et al*, since they considered the European-American population in the development of cut-off points for WC [37]. Albuquerque *et al.* analysed the prevalence of abdominal adiposity according to the WC 90th percentile cut-off by Cook [67] and the WHtR cut-off (table 11). When compared with our study, they found a lower prevalence of abdominal adiposity, according to the WC and WHtR cut-off, with a smaller prevalence found for WC [68]. A recent study analysed the prevalence of abdominal adiposity according WHtR cut-off, in the same region, and concluded that the prevalence of abdominal adiposity decreased compared to the previous study [68, 69]. A study conducted between 1998 and 2000 in Spain concluded that the prevalence of abdominal adiposity according to the WC 90th percentile cut-off by Taylor et al.[70] and WHtR cut-off, was 13.0% and 21.3%, respectively [71]. In Greece a study conducted with data from the second round of the COSI (2010-2011) revealed that the prevalence of abdominal adiposity, according to WHtR cut-off was 28,0% [72]. Compared to the results obtained in the studies previously mentioned with our study revealed a higher prevalence of abdominal adiposity.

Table 11- Prevalence of general and abdominal adiposity, comparison between studies.

Authors	Year	Region	Age (years)	n	Prevalence of overweight according the BMI			WC	WHtR
					WHO	CDC	IOTF		
Bingham, *et al* (48)	2009-2010	Portugal	3-10	17 136	--	--	27.9%	--	--
Camarinha, *et al* (28)	2013-2014	Portugal, Gaia	3-13	8 974	37.4%	37.5%	31.9%	--	--
Albuquerque, *et al.* (68)	2011	Portugal, Centre	6-12	1 433	--	--	33.0%	7.8%	23.6%
Rodrigues, *et al.* (69)	2013-2014	Portugal, Centre	6-10	793	--	--	21.9%	--	21.9%
Schroder, *et al.* (71)	1998-2000	Spain	6-11	1 521	--	--	28.1%	13.0%	21.3%
Hassapidou, *et al.* (72)	2010-2011	Greece	7-9	5 231	49.5%	--	42.4%	--	28.0%
Ahrens, *et al.* (32)	2007-2010	Italy	2-9	2 424	--	--	42.4%	--	--
	2007-2010	Spain	2-9	1 539	--	--	21.2%	--	--
	2007-2010	Cyprus	2-9	2 942	--	--	23.3%	--	--
This work	2015-2016	Portugal	3-9	483	31.5%	33.1%	26.8%	33.0%	33.5%

The present study analysed the association between the sociodemographic and lifestyle characteristics, and the anthropometric variables, for which the associations found were very weak, similarly to what was reported by others [73].

Age had a significant effect on height, weight, WC and WHtR. It was verified that older children had higher weight, height and WC, and younger children had higher WHtR. According to Cole *et al*. height increases with age continuously throughout time during childhood and adolescence, and the secular trend of weight gain is a result of the combination of height and adiposity tendencies [74]. McCarthy *et al.* found that WC and height are correlated, suggesting that the WC increase during infancy is due to linear growth. This may explain the relationship found for age and anthropometric variables.

In this work there were no significant differences between sexes regarding general and abdominal adiposity. In other studies, the difference in the prevalence of general adiposity by BMI between sexes wasn't consistent, either boys or girls could have higher prevalence [28, 48, 69, 72, 75, 76]. Regarding abdominal adiposity, previous studies showed that the prevalence was higher for boys, but without statistical significance, as in our study [68, 71].

The present study didn't find differences in the prevalence of general and abdominal adiposity among regions. However, the COSI study- Portugal 2016, not only reported differences between regions, regarding the prevalence of overweight, but also a decrease in all Portuguese regions between 2008 and 2016, more pronounced in the Azores (46.6% in 2008 to 31.0% in 2016), Lisbon and Tagus Valley (2008: 38.3% and 2016: 29.3%) and Centre (2008: 38.1% and 2016: 30.0%) [66]. In the APCOI study, the prevalence of overweight was higher in the Azores (36.6%) and lower in the Alentejo and Algarve (23.4%) [8]. Studies that assess the prevalence of abdominal adiposity nationwide weren't found in children. However, the IAN-AF assessed the prevalence of abdominal obesity in adults and concluded that it was higher in the Azores (61.7%) and in the Centre region (59.8%), and lower in the Lisbon Metropolitan Area (45.5%) and in the North (47.9%)[77].

In Portugal, in 2017, asthma affected about 6.8% of the population and has an impact on the quality of life [78]. Children with obesity are at higher risk of developing asthma [79, 80]. Among the reported pathologies that conditioned children to regular healthcare, asthma was the most mentioned in the present study (3.6%). Such result is in accordance with the one found in the second national health survey 2005-2006, where 4.9% Portuguese children aged less than 15 years had asthma [81]. Nevertheless, there wasn't an association between asthma or other diseases and anthropometric variables.

Regarding the household composition, there were different associations between the members of the household and anthropometric variables. Living with the mother was associated with higher weight and living with the father was related with higher values of WHtR. Formisano, *et al.* verified that children living with a single parent can gain more weight than children living with both parents [82]. Another study found that children who lived with a single mother were at the greatest risk of childhood obesity[83]. These studies explain that the relationship between the development of obesity in children living in a single-parent family may be due to the parents' lack of time that can compromise their eating choices and playtime with their children [82, 83]. In our study, children living with their grandparent had higher WHtR. Living with their grandparents was associated with being an overweight children [82], nevertheless no data on this association with the development of abdominal adiposity was reported. According to our results, not having siblings was associated with greater height. Savage, *et al.* found that first-born children were approximately 2 to 5 cm taller than later-borns, thus birth order also has an effect on height, showing a gradual decrease in height from the first birth to the third one [(84)]. Therefore, the set of single children (that are necessarily the oldest child) should be, on average, taller than the set of children that have siblings (that has from the oldest child to the youngest), as revealed in the present study. Furthermore, being an only child or being the youngest has been considered a risk factor for overweight [(83, 85)], however, this dissertation does not present this association.

Regarding parents' characteristics, it was also verified that parents' low education levels were associated with high BMI. In agreement with the results obtained by other studies [(47, 48, 86)] parents' occupation didn't have a significant effect on the anthropometric variables. According to a review, both parents being unemployed was a risk factor for childhood obesity compared to one or both parents being employed [(87)]. In our study the percentage of parents who didn't work is very small (0.8%) which may explain the lack of association between parental occupation and anthropometric variables.

Regarding the data on food intake, the WHO recommends a minimum of 400g of fruit and vegetables per day, the equivalent of 5 portions, since daily consumption of fruit and vegetables can help prevent noncommunicable diseases such as obesity[(88)]. In the present study, a daily intake of approximately 4 portions of fruit and vegetables, was reported. The consumption of 5 portions of fruits and vegetables per day was less than 40%. Only lower consumption of vegetables was associated with higher BMI and WHtR. APCOI, as in our study, verified that obese children were the ones who ate less vegetables[(8)].

Concerning sedentary activities, the obesity prevention guidelines recommend "limit screen time to no more than 2 h per day" [(89)]. In the present study the average time spent in sedentary activities during weekdays was less than 2 hours and during weekends was more than 2 hours but didn't find association between sedentary activities and anthropometric variables.

However, other studies with children found association between sedentary activities and general and abdominal adiposity. Machado *et al.* found that watching TV for more than 2 hours was related to abdominal adiposity in boys and girls, however when adjusted to the parents' level of education, this association wasn't found in boys [90]. In our study, no significant differences were found between sexes, therefore no distinction was made. TV viewing time and playing EG were related to general adiposity, according to Bingham *et al.* and Ortega *et al.* [48, 91].

As for the duration of sleep, according to the American Academy of Sleep Medicine, to promote good health, children aged 3 to 5 years should sleep 10 to 13 hours per day and children aged 6 to 12 years should sleep 9 to 12 hours per day [58]. Sleeping more or less hours than what is recommended can lead to health problems, such as obesity [58, 92]. According to the results found, children under the age of 6 sleep an average of 10h10 and children over the age of 6 sleep an average of 9h42, values within the American Academy of Sleep Medicine recommendations. Hense *et al*. used data from the IDEFICS study and found no relation between the duration of sleep and overweight, as in our study [94].

In this study, those who practiced regular physical activity had higher BMI. Studies with children and adolescents reported that reduced physical activity leads to obesity [46, 48, 74, 93]. Yet, Mitchell *et al.* found that vigorous physical activity in both age groups was positively associated with BMI, similar to results in our study [73]. This opposite association may be attributed to reverse causality [73], that is, children may be practicing more physical activity because they have a high BMI.

In our study sample, there were children with normal weight or overweight classified with abdominal adiposity, such discrepancies were also found in Spain and Greece [71, 94]. These results are of great clinical importance, since children with abdominal adiposity and normal weight seem to have a more adverse metabolic profile when compared to children with overweight and without abdominal adiposity [71, 94]. Analysing, table 11, Spain, Greece and Portugal present a prevalence of abdominal adiposity lower than the prevalence of general adiposity [68, 71, 72]. However, in a study conducted by Machado *et al*, similar prevalence rates of abdominal and general adiposity were obtained. Contrary to other studies, a prevalence of abdominal adiposity higher than the prevalence of general adiposity was found. A study in Poland on secular changes of WC and BMI between 1996 and 2012 in children and adolescents found a mean BMI and WC increase, but WC had a higher increase when compared to BMI. These changes reflect the effect of improvement or deterioration in living conditions within the historical context, as well as differences in sensitivity to environmental influences related to children's developmental period[95]. The differences found when comparing studies with

Portuguese children may also reflect the country's economic context, and the changes in the household composition in the past few years.

In accordance to what was found by Brannsether *et al.* in Norwegian children aged 4 to 18 years [96], a strong correlation between BMI and WC and a moderate correlation between BMI and WHtR, were observed in the present study. The agreement between these measures was moderate and weak, respectively. WC had a moderate correlation and a weak agreement with WHtR. Both BMI and WC are age dependent, which doesn't happen with WHtR, this fact may explain the lower correlation and agreement of the WHtR with other measures. Considering height with abdominal obesity, WHtR becomes a better predictor of abdominal obesity, since it is less related to age than WC [97]. Due to the clinical relevance of the discrepancies found among the anthropometric measures, it was decided to study how these measures were related to each other and to the sociodemographic and lifestyle characteristics. In this analysis there were significant differences between regions. Children living in the Azores have a greater prevalence of abdominal obesity, according to WC and WHtR, within similar BMI values. Children living in Lisbon had higher WC for similar WHtR values. The regions with the highest prevalence of general and abdominal adiposity don't coincide with the regions where greater discrepancies between measurements were found. Children with similar BMI value and higher WC were older and their parents had higher education level; children with higher WHtR were younger, ate less frequently vegetables and lived with their grandparents. Apart from the parental level of education, these associations coincide with the associations found in the analysis from table 8 and 9. For similar values of WHtR, children who presented greater WC were older and had no siblings. Therefore, the association found may be related to the influence of height in determining the abdominal adiposity, since that was the association found with height.

With this study it was possible to characterize anthropometrically a representative sample of Portuguese children between the ages of 3 and 9. The methods to collect data nationwide were standardized and data collection was performed by trained interviewers.

Since this is a cross-sectional study we couldn't assess the causal effect, that is, it wasn't possible to relate our results with previous events. The use of references developed according different population bases, for both BMI and WC was another limitation of the present study.

Since there are very few studies on the subject among children within this age range, and some of the similar studies that exist follow different methodological procedures or study distinct age grows, it would be interesting to conduct further research since early intervention may improve children's health and quality of life.

In the future, it would be interesting to carry out similar analysis on a longitudinal study in this age group, since it would allow to correlate anthropometric variables, sociodemographic and lifestyle characteristics with changes in body composition that occur during growth and to better understand causality effects.

Conclusion

About 1/3 of the Portuguese children aged 3-9 years old presented general or abdominal adiposity. When compared with the WHO criteria, the CDC overestimated overweight while the IOTF underestimated it.

It was found that children more prone to general or abdominal adiposity were more likely to practice physical activity, had parents with lower levels of education, ate vegetables less frequently and lived with their parents or grandparents. Younger children had higher WHtR and lower WC. Children with lower height for age were younger or had siblings. Those with higher weight for age were older or lived with their mothers.

BMI classification showed higher agreement with WC than with WHtR, while WC and WHtR had a weak agreement. Discrepancies between these 3 measures of adiposity varied differently with the geographic region.

The present study may contribute to a better understanding of pediatric obesity and sociodemographic factors associated to it. Hopefully, this study may contribute to sharper prevention strategies and treatments that will be more effective in the fight of childhood obesity. Never the less, more studies in this age group should be conducted to allow early clinical and public health interventions.

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Appendix- Supplementary information

Table I- Characterization of food intake (fruit, fruit juice, vegetable soup, vegetable on plate); Portuguese children 3-9 years old, 2015-2016

	Food intake															
	Fruit				**Fruit or vegetables juice**				**Vegetables soup**				**Vegetables on plate**			
	n	**Weighted n**	**Weighted %**	**95% CI**	**n**	**Weighted n**	**Weighted %**	**95% CI**	**n**	**Weighted n**	**Weighted %**	**95% CI**	**n**	**Weighted n**	**Weighted %**	**95% CI**
Never	1	1275	0.2	[0.0;1,7]	169	181553	34.1	[27.7;41.1]	5	8295	1.6	[0.5;4.7]	39	35580	6.7	[3.8;11.5]
<1 per month		--	--	--	69	76966	14.5	[9.9;20.6]	3	793	0.1	[0.0;0.5]	6	7226	1.4	[0.5;3.4]
1-3 per month	6	10615	2.0	[0.7;5.3]	77	100278	18.8	[13.3;25.9]	2	1146	0.2	[0.1;0.8]	16	18164	3.4	[1.8;6.3]
1 per week	4	751	0.1	[0.1;0,4]	68	70537	13.2	[9.5;18.3]	8	6303	1.2	[0.4;3.5]	20	18872	3.5	[1.8;6.9]
2-3 per week	27	24832	4.7	[2.8;7.8]	60	64806	12.2	[8.7;16.7]	30	22979	4.3	[2.4;7.5]	81	96673	18.2	[14.0;23.2]
4-6 per week	55	54879	10.3	[7,1;14.8]	12	8446	1.6	[0.7;3.8]	71	65200	12.2	[8.9;16.6]	81	99855	18.8	[14.6;23.7]
1 per day	124	129699	24.4	[19.0;30.7]	21	27848	5.2	[2.8;9.5]	187	224647	42.2	[35.6;49.0]	138	146372	27.5	[22.7;32.8]
2 per day	184	202913	38.1	[31.2;45.5]	6	1859	0.3	[0.1;1.1]	175	202409	38.0	[31.5;45.0]	101	109491	20.6	[15.2;27.1]
≥3 per day	82	107501	20.2	[15.0;26.6]	1	171	0.0	[0.0;0.2]	2	692	0.1	[0.0;0.6]	1	231	0.0	[0.0;0.3]

Unweighted data (n) represents 483 children; weighted data (weighted n) represents 532464 children; CI: confidence intervals.

Table II- Characterization of sedentary activities (TV viewing and playing EG, on weekdays on the weekend); Portuguese children 3-9 years old, 2015-2016

	Sedentary activities															
	TV Weekdays				**TV Weekends**				**Electronic games weekdays**				**Electronic games Weekends**			
	n	**Weighted n**	**Weighted %**	**95% CI**	**n**	**Weighted n**	**Weighted %**	**95% CI**	**n**	**Weighted n**	**Weighted %**	**95% CI**	**n**	**Weighted n**	**Weight ed %**	**95% CI**
Never	41	34035	6.4	[3.9;10.3]	44	34669	6.5	[4.0;10.4]	201	221717	41.6	[36.2;47.3]	159	157520	29.6	[24.5;35.3]
≤15min	21	20667	3.9	[2.2;6.9]	10	6817	1.3	[0.5;3.3]	77	83905	15.8	[11.8;20.7]	34	32131	6.0	[3.6;10.0]
30min	87	97885	18.4	[13.7;24.2]	28	35815	6.7	[4.1;10.9]	108	103881	19.5	[15.1;24.8]	68	78691	14.8	[10.8;19.9]
1h	167	188730	35.4	[29.4;42.0]	67	76639	14.4	[10.4;19.6]	64	79744	15.0	[11.1;19.9]	113	121087	22.7	[17.0;29.8]
2h	113	123736	23.2	[18.4;28.9]	129	140237	26.3	[20.7;32.9]	26	34505	6.5	[2.9;13.7]	73	101813	19.1	[13.8;25.9]
3h	29	29755	5.6	[3.5;8.9]	114	136807	25.7	[20.3;31.9]	2	2089	0.4	[0.1;2.4]	24	25725	4.8	[2.5;9.0]
4h	15	21467	4.0	[1.9;8.2]	50	47261	8.9	[6.4;12.2]	2	4553	0.9	[0.2;4.5]	8	9358	1.8	[0.6;5.2]
5h	6	6593	1.2	[0.3;4.9]	20	25093	4.7	[2.6;8.3]	2	1905	0.4	[0.1;2.1]	3	5975	1.1	[0.3;3.6]
≥6h	4	9596	1.8	[0.6;5.7]	21	29126	5.5	[2.9;10.1]	1	164	0.0	[0.0;0.2]	1	165	0.0	[0.0;0.2]

Unweighted data (n) represents 483 children; weighted data (weighted n) represents 532464 children; CI: confidence intervals.

Risk classification discrepancies in general and abdominal adiposity measures within Portuguese children

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