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Research Article

Prevalence of Overweight and Obesity in Portuguese Adolescents: Association with Cardiovascular, Respiratory and Musculoskeletal Risk Factors

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Abstract

Introduction: Overweight and obesity in adolescents are major public health problems with particular interest because of their potential association with risk factors for development of diseases. The study aimed to determine the prevalence of overweight and obesity in adolescents in southern Portugal and investigate the association with risk factors for development of cardiovascular, respiratory and musculoskeletal diseases.

Materials and methods: The sample consisted of 966 adolescents aged 10 to 16 years. The calculation of Body Mass Index (BMI), evaluation of blood glucose, total cholesterol and triglycerides, blood pressure, spirometry and application of Low back pain (LBP) questionnaire were performed.

Results: 178 (18.4%) adolescents were overweight and 52 (5.4%) obese. 2 (0.2%) students presented hyperglycemia, 7 (0.8%) elevated total cholesterol and 6 (1.4%) showed high levels of triglycerides. The presence of LBP in the past year was reported by 456 (47.2%) students. None of the above variables revealed significantly associated with overweight and obesity. The presence of high pressure was observed in 200 (20.7%) individuals and hypertension in 158 (16.4%) adolescents. Adolescents with overweight and obesity have 2.3 times more likely to go on to developed signs of pre-hypertension and hypertension. 559 (57.9%) students had restrictive respiratory disorders and 23 (2.4%) obstructive disorders, and individuals who were overweight and obese had 0.64 probability of having restrictive respiratory disorders.

Conclusions: There was a high prevalence of overweight and obesity in Portuguese adolescents and these showed a statistically significant relationship with the development of pre-hypertension and hypertension and restrictive respiratory disorders.

INTRODUCTION

The prevalence of overweight and obesity increased in almost all countries, mainly in developed countries and in urbanized populations, indicating a growing global epidemic of childhood obesity, with a wide range of secular trends among countries [1].

At the level of the Organization for Economic Cooperation and Development (OECD) [2], one in each five children are affected by overweight across countries, and in Greece, the United States and Italy this relation is to 1/3. In Portugal, in 2007-2008 years, Ferreira [3] study found a prevalence of 22.6% of overweight and obesity in 7.8% of 5,708 students aged between 10 and 19 years.

It is estimated that about 10% of school-age children around the world presented excess of body fat with increased risk of developing of chronic diseases; these children, ¼ are obese, with a significant probability of developing multiple risk factors for diabetes type 2, heart disease and other co-morbidities before or during early adult [4].

Thus obesity is related, among other factors, the existence of chronic non-communicable diseases such as cardiovascular diseases, diabetes mellitus type 2, respiratory and musculoskeletal disorders [5-7].

According to the American Diabetes Association the incidence of diabetes type 2 in adolescents has also increased dramatically in the last decade, with approximately 206,000 individuals under 20 years of age diagnosed with diabetes [8].

Childhood obesity often presents insulin resistance a pathophysiological condition that is involved in the genesis of diabetes type 2, being present in 30% of children with obesity [9-11]. The results of the study by Sinaiko et al. [12] showed a significant association between insulin resistance and obesity and its interaction with cardiovascular risk factors during adolescence, however, only the presence of obesity does not explain fully the development of insulin resistance, since the relationship between obesity and insulin resistance is not present all obese subjects [13].

Besides obesity, hypertension is also a factor which characterizes the insulin resistance syndrome. However both are metabolic risk factors for developing of cardiovascular diseases as well as for diabetes type 2 [10].

Hypertension occurs with low frequency in children and adolescents however obese children and adolescents have more 9 chances to be present [14].

The study by Williams et al. [15] evaluated 3,320 subjects aged between 5 and 18 years to examine the association between body fat level with a high risk of developing hypertension and the data revealed that the fat levels equal to or exceeding 25% in boys and 30% among girls are indicators of an increased risk of elevated blood pressure in children and adolescents.

In addition to metabolic risk for developing cardiovascular diseases that may be associated with increased body weight factors, several studies have verified the possibility of obesity also increase the risk for development of asthma and other obstructive respiratory diseases obstrutivas [16-29]. The possible mechanisms for this relationship include airway inflammation produced by substances in adipose tissue, hormonal influences, the mechanical changes associated with obesity and changes in physical activity [16].

Obesity can also cause changes in lung function leading to restrictive respiratory disorders caused by parenchymal lung disease, disorders of the chest wall or neuromuscular conditions [30,31].

The considerable increase in the obesity prevalence has coincided with a major change in how children spend their time, which results in a decrease in physical activity and an increase in sedentary behaviors [32-34]. The increase in sedentary behavior is associated with increased time spent watching television, playing computer games, internet and phone use [33,35].

In addition to the factors mentioned above, it is believed that overweight and obesity are variables that may be associated with musculoskeletal disorders, or it may aggravate them less likely due to the increased stress applied to the bone structures of sustaining higher load requirement [36]. The increased body fat, particularly in the abdominal region, it promotes the modification of the body center of gravity forward, so as to cause postural changes in the pelvic region such as the anteversion of the pelvic girdle, which can result in lumbar hyperlordosis [36,37].

The change in lumbar curvature can cause pain, which are very common in children and adolescents with a prevalence that is between 30% to 51% [38].

The aim of this study was to determine the prevalence of overweight and obesity in adolescents in southern Portugal and investigate the association with risk factors for developing chronic conditions such as hyperglycemia, dyslipidemia, hypertension, restrictive and obstructive respiratory disease and musculoskeletal disorders such as low back pain (LBP).

MATERIALS AND METHODS

The design of this epidemiological study was observational, analytical, and cross-sectional.

For develop of study we was done a request for informed consent to parents and guardians were informed about the objectives of studies and evaluations to be conducted, all guaranteed fundamental rights or principles applicable to humans by certain codes of ethics. The study was approved by the Ethics Committee of the Regional Health Administration of the Algarve, the Regional Directorate of Education of the Algarve, the Directorate General for Innovation and Curriculum Development, the Ministry of Education and Science and the directors of Schools that participated in the project.

Population and sample

The population involved students enrolled in public schools from all municipalities of the Algarve, from both sexes, aged between 10 and 16 years. Considering as an estimative of population dimension the number of students between the fifth and ninth grades (26,217 students), the minimum sample size was defined as 948, considering an estimate of the annual prevalence of overweight of 20% reported national studies [3,39,40] and assuming an error margin of 2.5% with a confidence level of 95% [41]. We opted for the use of prevalence of overweight, since the values of the prevalence of thinness and obesity are lower than these.

Considering the existence of non-response, logistical reasons and to facilitate the division of students by schools, we proposed a sample size of approximately 1,000 elementary students (2nd and 3rd cycles) from the Algarve region which has 16 counties.

Inclusion criteria involved the students who were present on the data collection days, who had brought the parental or guardian consent and who wanted to participate.

It was used a stratified random sample defined by different phases: first it was considered the county level, assuming that we can have geographical heterogeneities (within each county schools were selected randomly, if there was more than one school in the county), and then within each school classes were randomly selected, until the desired number of students per school was obtained. The dimension of samples by counties took were proportional to the number of students enrolled in each county in public school, considering three classes of counties:

small (<1,000 students), medium (1,001-2,000 students) and large (>2,000 students). Different dimension samples were required for each one (40, 70 and 100 students, respectively).

Measurements

Data collection occurred in the period between April 2011 and February 2012. Measurements were always performed in the morning.

Body mass index (BMI): Body Mass Index for the body weight measurement, we used a SECA 780 digital scale with a 150 kg capacity and 100 g precision. Weight measurements were performed using a 200 cm stadiometer. In both measurements, students were standing upright, without shoes. For height measurement, students had their backs turned to the instrument, and their heads were positioned in the Frankfurt horizontal plane according to standard procedures [42].

BMI was calculated and the adolescents were classified as underweight, normal weight, overweight and obese, according to the limits proposed by Cole et al. [6,43] values greater than or equal to 25kg/m^2 indicated overweight and values equal to or greater than 30kg/m^2 indicated the presence of obesity. The thinness was defined for values less or equal to 18,5 kg/m^2.

Glucose, total cholesterol and triglycerides: Glucose, total cholesterol and triglycerides for the determination of capillary blood glucose, total cholesterol and triglycerides the following instruments were used: FreeStyle Freedom Lite and Accutrend GCT (Roche).

This blood collection was performed in the morning with students in fasting period of at least 8 hours.

Blood glucose values followed the standards established by the American Diabetes Association for adolescents in the fasting state, where the values of appropriate blood glucose were between 90 mg/dl to 180 mg/dl for ages between 6 and 12 years and between 90 mg/dl 130 mg/dl for ages 13 to 18 years [8].

The reference values for total cholesterol and triglyceride levels showed an adequate level when presented below 200 mg/dl, with a high risk threshold with values were between 200 mg/dl and 239 mg/dl for cholesterol and between 200 mg/dl and 399 mg/dl for triglycerides. The high values of cholesterol were at or above 240 mg/dl and equal to or higher than 400 mg/dl for triglycerides [44].

Systemic blood pressure: Systemic blood pressure was measured through the use of a stethoscope and a calibrated sphygmomanometer. As a sample of adolescents, pediatric blood pressure cuff was used and where there is a need for greater clamp, because the diameter of the individual being assessed arm, adult pressure cuff was used.

Before the measurement, the students were seated five minutes with the spine supported, feet flat on the floor and right arm supported to obtain baseline values. The evaluations were performed in the right upper limb due to the possibility of coarctation of the aorta that could cause false readings in the left arm [10].

The determination of arterial pressure was applied through two measurements with two-minute intervals, by the same evaluator. For the analysis we considered the mean values. On all days of evaluations, the value of systemic arterial pressure obtained by manual sphygmomanometer in a chosen individual was confirmed with the results obtained from the use of a digital sphygmomanometer.

The first and fifth phase Korotkoff sounds were used to identify the values of systolic and diastolic blood pressure [45].

The normal value of blood pressure in children and adolescents was based on percentiles, which took into account height and gender of the individual [46]. Thus, there was not a single limit of normal blood pressure in the age group of children and adolescentes [8,45].

Hypertension in childhood was defined when the systolic or diastolic blood pressure were located above the 95th percentile and the pre-hypertension values were higher than 90 and lower than 95th percentile [8,47].

Spirometry: For spirometry was used the Spirodoc (MIR) equipment thta evaluated FEV1 (forced expiratory volume in 1 second), the FEV1/FVC (forced vital capacity) ratio and FEF 25-75% (flow measured between 25% and 75% of the total expired volume).

Students held a deep inspiration, followed by a brief period of apnea and immediately (with her/his mouth on the mouthpiece of the equipment) were made a rapid and forced expiration. In this evaluation was given the opportunity to the student who exhibits some alteration in the test to perform it again, since this test needs encouragement by the evaluator and understanding to be well executed.

Prior to testing, the students could not smoke within 4-6 hours.

The airway obstruction was characterized by a reduction in FEV1 less than 80%, FEV1/FVC ratio less than 75%, FEF 25-75% less than 70% and FVC may be normal or reduced [44,48].

Restrictive respiratory disorders of the airways were characterized by a reduction in FEV1 less than 80%, the FEV1/FVC ratio could be normal or above 70% and FVC showed values lower than 80% [44,48].

Low back pain questionnaire: Low Back Pain Questionnaire this Questionnaire involved questions about the sociodemographic characteristics of the population, physical activities at school and outside, the weekly time spent with electronic games and watching TV and the presence of LBP in the last year. This questionnaire has been validated and used in the study by Oliveira et al [49].

LBP was characterized by the presence of symptoms in the lumbar region that included pain, muscle tension or rigidez [50].

The application of Low Back Pain Questionnaire was always done in the presence of the reviewer who clarified any questions during your fill.

Data analysis

The first approach was taken through a statistical description of the usual techniques of descriptive and analytical statistics for all variables of this study, with particular emphasis on identifying outliers.

After this initial approach, the various associations between variables were analyzed using the statistical inference, namely the Chi-square Independency test.

The influence of variables pre-hypertension and hypertension, restrictive and obstructive respiratory disorders, gender and age group in individuals with overweight and obesity was assessed using binary logistic regression models. The models Enter e Forward LR and the Omnibus, Hosmer, Lemeshow and Nagelkerke tests were used, and Odds Ratios (OR) crude and adjusted and respective confidence intervals were presented.

Due to some small numbers and in order to satisfy the requirements of applicability of Chi-square Independency test, the variables BMI classification, ethnicity, glucose, cholesterol, triglycerides, blood pressure and weekly hours to playing games and watching television were grouped.

In the case of BMI classification were considered 1 group included individuals classified as thinness and normal weight and another group with overweight and obesity.

The ethnicity variable was grouped into students of Caucasian origin and the other group included the remaining races.

The blood glucose values were grouped in normal values and hypoglycemia and other group with hyperglycemia. The cholesterol and triglyceride values were grouped in adequate and the other group included high risk threshold and high level.

For the classification of systemic blood pressure one group included students who had hypotension and normal blood pressure values and the other group with pre-hypertension and hypertension.

For the variables weekly hours for playing games and watching television were considered a group with those students who did up to 10 hours per week and the other group who adopted these habits for more than 10 hours per week.

Spirometry values were divided into 3 groups, involving the values of adequate, restrictive and obstructive disorders.

Based on the definition of two different phases of growth period, two age groups were considered in analyses: age group 1 - students with age between 10 and 12 years; age group 2 - students between 13 and 16 years. It is assumed that individuals from age group 1 aren't yet in the period of pronounced growth, primarily boys, and between 13 and 16 years the adolescents are in the period of accelerated pubertal growth [51,52].

The statistical analysis was performed with the Statistical Package for Social Sciences (SPSS) version 19.0. Statistical significance was set at 0.05.

RESULTS

The minimum number set to the sample to a precision error of 2.5% was exceeded, with a sample of 966 students aged between 10 and 16 years (12.24 ± 1.53 years), where 437 (45 2%) were male and 529 patients (54.8%) were female.

Table 1 presents the results of the associations between nutritional status and the variables analyzed in this study.

On the analysis of blood glucose 2 students (0.2%) refused to participate at this evaluation because of fear of the sting. For logistical reasons the capillaries levels of total cholesterol and triglycerides were not assessed in the whole sample. The total cholesterol levels were evaluated in 929 students. The assessment of the capillary triglyceride levels was performed in 432 adolescents.

Spirometry results revealed that 400 (41.4%) students had mild restrictive respiratory disorders, 134 (13.9%) moderate and 25 (2.6%) severe degree. The mild obstructive disorders were observed in 19 (2%) students and moderate in 4 (0.4%) students. The most adolescents classified as overweight and obese had respiratory disorders (p=0.018).

Table 2 shows the results obtained for the event of excess weight and obesity, based on logistic binary regression models. In the adjusted model, the values obtained in Omnibus, Hosmer and Lemeshow and Nagelkerke tests for the characteristics of the sub-sample overweight and obesity adjusted for the variables of blood pressure, values of spirometry, age group and gender were respectively: $p<0.001$, $p=0.114$ and $R^2=0.86$, being considered mathematically valid models for the realization of analysis.

It was observed that the variable high blood pressure levels was correlated with overweight and obesity, where adolescents classified with overweight and obesity had 2.3 times (95% CI: 1.72-3.18, $p<0.001$) more probability of developing signs of pre-hypertension and hypertension and 0.64 times (95% CI: 0.47-0.87, $p<0.001$) more chances to have restrictive respiratory disorders.

DISCUSSION

This study revealed a high prevalence of overweight and obesity (23.8%) of a representative sample of 966 adolescents living in the south of Portugal in the years 2011-2012. Compared to a national study, the research of Sardinha et al. [39], which evaluated 22,048 individuals aged 10 to 18 years in 2008, found a prevalence of overweight and obesity of 22.6%. The national study by Ferreira [3], realized in 2007-2008, obtained higher values than this study, being 30.4% with overweight and obesity in 5,708 students aged 10 to 18 years and the study of Marques-Vidal et al. [53] held in Lisbon between the years 2000 and 2002, evaluated 5,013 individuals aged 10 to 18 years and obtained a prevalence of overweight and obesity of 46.9%.

The study Minghelli et al. [40] revealed a 37.4% prevalence of overweight and obesity in 364 students from two counties in the Algarve region, aged between 10 and 18 years in 2008. In the study by Sardinha et al. [39], mentioned earlier, the prevalence of overweight and obesity in the Algarve region was 21% in a sample of 823 adolescents. The differences in the results of these recent studies may be attributed to differences between the counties of the Algarve region.

Regarding data from studies of other countries, the study Kovalskys et al. [54] evaluated 1,588 adolescents from 10 to 11 years in Argentina and obtained values of prevalence of overweight and obesity of 27.9%. Similar results were obtained by

Table 1: Associations between nutritional status and the study variables.

Variables		Thinness (28, 2.9%)	Adequate (708, 73.3%)	Overweight (178, 18.4%)	Obesity (52, 5.4%)	p-value
Gender	Male (437, 45.2%)	7 (1.6%)	340 (77.8%)	73 (16.7%)	17 (3.9%)	0.01
	Female (529, 54.8%)	21 (4%)	368 (69.6%)	105 (19.8%)	35 (6.6%)	
Age group	10-12 years (574, 59.4%)	20 (3.5%)	391 (68.1%)	122 (21.3%)	41 (7.1%)	<0.01
	13-16 years (392, 40.6%)	8 (2%)	317 (80.9%)	56 (14.3%)	11 (2.8%)	
Ethnicity	Caucasians (894, 92.5%)	24 (2.7%)	654 (73.2%)	167 (18.7%)	49 (5.5%)	0.223
	Black (68, 7%)	3 (4.4%)	53 (77.9%)	9 (13.2%)	3 (4.4%)	
	Asian origin (4, 0.4%)	1 (25%)	1 (25%)	2 (50%)	0	
Glycemia	Hypoglycemia (647, 67%)	20 (3.1%)	480 (74.2%)	113 (17.5%)	34 (5.3%)	0.428
	Adequate (315, 32.8%)	8 (2.5%)	224 (71.1%)	65 (20.6%)	(18, 5.7%)	
	Hyperglycemia (2, 0.2%)	0	2 (100%)	0	0	
Total cholesterol	Adequate (877, 94.4%)	22 (2.5%)	648 (73.9)	160 (18.2%)	47 (5.4%)	0.137
	Threshold high risk (45, 4.8%)	3 (6.7%)	26 (57.8%)	12 (26.7%)	4 (8.9%)	
	High (7, 0.8%)	1 (14.3%)	5 (71.4%)	1 (14.3%)	0	
Triglycerides	Adequate (414, 95.9%)	4 (1%)	304 (73.4%)	82 (19.8%)	24 (5.8%)	0.836
	Threshold high risk (12, 2.7%)	0	7 (58.3%)	5 (41.7%)	0	
	High (6, 1.4%)	0	6 (100%)	0	0	
Blood presssure	Hypotension (87, 9%)	3 (3.4%)	72 (82.8%)	11 (12.6%)	1 (1.1%)	0.001
	Adequado (521, 53.9%)	21 (4%)	401 (77%)	81 (15.5%)	18 (3.5%)	
	Pre-hypertension (200, 20.7%)	1 (0.5%)	142 (71%)	44 (22%)	13 (6.5%)	
	Hipertension (158, 16.4%)	3 (1.9%)	93 (58.9%)	42 (26.6%)	20 (12.7%)	
Spirometry	Adequate (384, 39.8%)	2 (0.5%)	273 (71.1%)	83 (21.6%)	26 (6.8%)	0.018
	Restrictive (559, 57.9%)	2 (8.7%)	422 (75.5%)	89 (15.9%)	24 (4.3%)	
	Obstructive (23, 2.4%)	2 (8.7%)	13 (56.5%)	6 (26.1%)	2 (8.7%)	
Time watching TV (per week)	up to 5 hours (446, 46.2%)	12 (2.7%)	315 (70.6%)	88 (19.7%)	31 (7%)	0.809
	between 6 to 10 hours (303, 31.4%)	9 (3%)	236 (77.9%)	49 (16.2%)	9 (3%)	
	between 11 to 15 hours (127, 13.1%)	4 (3.1%)	91 (71.7%)	22 (17.3%)	10 (7.9%)	
	More than 15 hours (90, 9.3%)	3 (3.3%)	66 (73.3%)	19 (21.1%)	2 (2.2%)	
Time playing games/ computer (per week)	up to 5 hours (649, 67.2%)	21 (3.2%)	465 (71.6%)	122 (18.8%)	41 (6.3%)	0.342
	between 6 to 10 hours (184, 19%)	3 (1.6%)	150 (81.5%)	26 (14.1%)	5 (2.7%)	
	between 11 to 15 hours (73, 7.6%)	3 (4.1%)	50 (68.5%)	15 (20.5%)	5 (6.8%)	
	More than 15 hours (60, 6.2%)	1 (1.7%)	43 (71.7%)	15 (25%)	1 (1.7%)	
Physical activity (outside of school)	Yes (627, 64.9%)	17 (2.7%)	468 (74.6%)	112 (17.9%)	30 (4.8%)	0.249
	No (339, 35.1%)	11 (3.2%)	240 (70.8%)	66 (19.5%)	22 (6.5%)	
Low back pain	Absence (510, 52.8%)	16 (3.1%)	376 (73.7%)	94 (18.4%)	24 (4.7%)	0.604
	Presence (456, 47.2%)	12 (2.6%)	332 (72.8%)	84 (18.4%)	28 (6.1%)	

* Chi-square Independency tests were applied using the grouped classes defined in Data Analyses

Table 2: Results of binary logistic regression for the event excess weight and obesity.

Variables	Odds Ratio$_{crude}$ (CI 95%); p	Odds Ratio$_{Adj**}$ (CI 95%); p
Systemic blood pressure (hypotension and appropriate*) Pre-hypertension and hypertension	2.23 (1.65-3.01); p<0.001	2.34 (1.72-3.18); p<0,001
Spirometry (adequate*) Obstructive respiratory disorder Restrictive respiratory disorder	1.35 (0.56-3.26); p=0.512 0.64 (0.47-0.87); p<0.001	1.19 (0.48-2.96); p=0.706 0.67 (0.47-0.87); p=0.005
Age group (13-16 years*) 10-12 years	1.92 (1.39-2.65); p<0.001	-----
Gender (Male*) Female	1.39 (1.03-1.88); p>0.033	-----

*Class Reference; **Adjusted to sex and age

Shields et al. [55] who evaluated 8,661 children and adolescents Canadians, age between 2 and 17 years, in 2004, and found a prevalence of 26%. The study of Pellegrini et al. [56] obtained a lower prevalence of 15.3% in 33,728 Brazilian adolescents aged between 11 and 17 years and the results of Stigler et al. [57], who assessed 1,818 individuals from India with mean ages between 13.9 and 15.8 years revealed a prevalence of overweight and obesity of only 13.7%.

All the above studies used BMI to assess weight status according to the criteria established by International Obesity Task Force (IOTF) [5], the same used in the present study. The reasons for the observed differences between the values of the prevalence of overweight and obesity can be explained by virtue of the populations that have been evaluated and the socio-economic context; however this variable was not analyzed in this study.

The higher prevalence of overweight and obesity was observed among girls (60.9%), which differ from the data obtained in the study of Ferreira [3] where prevalence of overweight and obesity were almost similar between the sexes, with a slight descent in boys (50.2%). In the study by Marques-Vidal et al. [53] only overweight was more prevalent among girls, being the most prevalent obesity among boys. The possible explanation for obtaining a higher prevalence of adiposity in girls may be due to higher amount of fat mass shown in adolescent girls compared to boys. In girls, regardless of chronological age, pubertal development and early menarche is associated with increased fat corporal [34,58]. In the adolescent boys the characteristic pattern of body composition is to decrease body fat, associate with increased of speed growth in altura [58].

Regarding ethnicity, the majority of the sample consisted of Caucasian students, where a high percentage (24.2%) was classified as overweight and obesity. A lower prevalence of overweight and obesity was seen in black adolescents (17.6%), data that are consistent with the literature that shows that the percentage of body fat as well as the levels of abdominal fat is more prevalent in Caucasian children compared to black [59].

Another variable analyzed in this study was the glucose, where prevalence of reduced hyperglycemia in students evaluated (0.2%) was observed. The study by Adams et al. [60] showed mean values of blood glucose similar to the present study. The study by Ekelund et al. [61] verified the presence of metabolic syndrome in European children, including the Portuguese, and revealed a prevalence of 0.2% in individuals aged 10 years and 1.4% in those who were 15 years of age. As insulin resistance, this is probably caused by changes in total body fat, body fat distribution and release of hormones related to the period of puberty [62]. However, this study found no significant association between blood glucose values with overweight and obesity, possibly due to low prevalence of elevated blood glucose levels.

This study revealed a high prevalence of hypoglycemia, which in children can lead to impaired of cognitive function, affecting brain development. However, the impairment of cognitive function is more affected when blood glucose levels are higher [63].

As for the capillary levels of total cholesterol and triglycerides, although we have not seen a statistically significant association with overweight and obesity, a high prevalence of students classified as overweight and obese had high levels of cholesterol and triglycerides (32.7% and 27.8%, respectively). The excess subcutaneous fat is associated with risk of developing cardiovascular diseases, including hypercholesterolemia factors, elevated plasma concentrations of lipoproteins and arterial hypertension [64].

The results obtained in this study revealed a high prevalence of elevated blood pressure and hypertension (37.1%) where overweight and obesity consisted of a risk factor for its development. Similar results were obtained in the investigation of Aounallah-Skhiri et al. [65], where the values of high blood pressure were observed in 35.1% of 2,870 individuals in the sample; however the age group differed from the present study and included individuals with aged between 15 and 19 years of the North African region.

The results of the prevalence of pre-hypertension and hypertension obtained in this study differ from other studies in Portugal [66-68] and of other countries [69-71].The study of Monego and Jardim [72] revealed a prevalence of hypertension in only 5% of sample consists of 3,169 Brazilian children and adolescents aged 7 to 14 years. The difference between studies may possibly be attributed to the different method of collection of these values and the characteristics of the study area. For example, in the study by Santiago et al. [66] the individual living in rural and suburban areas not being subjected to daily stress of an urban environment, which could influence the values of blood pressure. In addition, the sample used in the study may differ in other aspects such as the study by Maldonado et al. [16] who found a prevalence of 28% of pre-hypertension and hypertension in children and adolescents aged 5 to 18 years, lower values those obtained in this study, however the subjects in the sample had a level of physical activity rated as above average, once initiated its federated sport practice at evaluation and a prevalence of obesity less than the estimate for the population.

This study also demonstrated an association between high BMI and high blood pressure, where individuals with overweight and obese had 2.3 more likely to develop high blood pressure levels. This relationship between the presence of overweight and hypertension can be justified according to the study Kotsis et al. [73] who reported that there are three main mechanisms that explain this relationship: the activation of the sympathetic nervous system, renal and hormonal dysfunctions.

Similar results were obtained by Rebelo et al. [74], where BMI was positively related to systolic and diastolic blood pressure in both genders, and Santiago et al. [66] and Monego and Jardim [72] who found that obesity is a factor risk for development of hypertension. The study by Maldonado et al. [68] found that individuals with adequate weight had a prevalence of hypertension of 8%, the overweight individuals of 14% and with obesity of 23%. The same association was obtained in the study by Hirschler et al. [75] where the blood pressure values were higher in the obese group compared with the non-obese group, where the hypertension was present in 25% of obese patients, and absent in the non-obese group, however this last study BMI was not used for classification of body mass, but waist circumference. The investigation of Katzmarzyk et al. [76] found a significant clinical utility of assessing BMI in predicting risk of developing hypertension in children and adolescents, measuring instrument used in this study.

The high prevalence of pre-hypertension and hypertension in the present study and the results obtained in other studies may suggest an increased prevalence of pre-hypertension and hypertension in adolescents over the years, as has been observed with the prevalence of overweight and obesity. That is, since overweight and obesity are increasing worldwide [5,7,35], and these are related to increased levels of blood pressure, it is estimated that an increase in individuals who are may develop high blood pressure in adolescence. However, the association between obesity and hypertension is not yet fully explained, being necessary new studies to explore the cause-effect relationship, through, for example, of cohort studies.

This considerable increase in the prevalence of obesity has coincided with a major change in how adolescents spend their time, which results in a decrease in both the level of physical activity and an increase in sedentary behaviors [32-34]. The causes of these changes in lifestyles are complex and cumulative. For many, there has been a general reduction in daily activity (eg, walking less, greater use of cars, stairs escalators and elevators), and also a reduction in the value of the importance of physical education and sport practice at school and performed in house. However the data from this study revealed that most of the students assessed practiced some kind of physical activity outside of school, not being found a statistically significant relationship between lack of physical activity and obesity.

The increase in sedentary behavior is associated with increased time spent watching television, playing computer games, use the internet and phone [33,35]. The data from this study revealed a prevalence of 13.8% and 22.4% of individuals who adopted sedentary habits, such as playing computer games or watching television, respectively, and of these 27% and 24% were classified as overweight and obesity. Studies show that the obesity rate is 8.3 times higher in children who watch more than 5 hours of television per day compared to those who watch less than 2 hours per day [35].

The effect of television viewing on the risk of development of obesity is twofold: watching television promotes weight gain not only by physical inactivity, but also by increasing energy intake, since children and adolescents consume excessive amounts of food while watching television. In addition, television advertising may adversely affect the healthy eating patterns [32].

Regarding to respiratory disorders assessed by spirometry, most individuals classified as overweight showed abnormalities in spirometric evaluation and as the obese individuals half also showed some change. Most student evaluated respiratory disorders in overweight and obesity were classified as obstructive character, such as asthma and chronic bronchitis.

The study of Bertolace et al. [17] found no statistically significant association between increased BMI and the presence of asthma, despite having found a higher value of BMI in asthmatic patients compared with non-asthmatics. The study by Cassol et al. [18] found a positive association between obesity and the prevalence of asthma symptoms in 4,010 adolescents in southern Brazil. Vlaski et al. [29] found that being overweight was significantly associated with an increased risk of having asthma (OR adjusted: 2.36, 95% CI: 1.02-5.44, p=0.04).

Although a large number of studies have found an association between obesity and asthma, it cannot establish a cause-effect relationship in most of these studies, it is confirmed that obesity precedes the development of bronchial activity, furthermore, most studies defined the presence of asthma using a questionnaire assessing self-reported symptoms and not by a definite diagnosis by other suitable clinical criteria.

Respiratory changes associated with obesity include from a simple change in lung function, with no effect on gas exchange, to severe conditions such as respiratory failure, characteristic of obesity hypoventilation syndrome [30].

The most students assessed by spirometry showed restrictive respiratory disorder, being included in this classification many students with overweight and obesity. Although the majority of individuals classified as overweight and obesity present obstructive respiratory disorder (34.8%), a large proportion of these also revealed restrictive respiratory disorder (28.4%). However, since the proportion of subjects with obstructive respiratory disorder was reduced, no statistical significance was obtained in the application of logistic regression. The opposite occurred with obese individuals who had restrictive respiratory disorders, once constituted a large part of the study sample.

The restrictive respiratory disorder presents as characteristics decreased lung compliance, which causes a decrease in ventilation. Alveolar hypoventilation is present in approximately 10%-20% of obese individuals, having a multifactorial cause and that includes a variety of mechanisms [31]. However the exact mechanism that some obese presented hypoventilation and others is still unknown there is a chance of mechanical overload, which shows that hypoventilation is secondary to mechanical limitation resulting from a decrease in the thoraco-pulmonary distensibility, fatigue and respiratory muscle weakness, or obesity may be a factor leading to decreased lung compliance to promote changes in respiratory diaphragm and rib cage [30,31].

In relation to musculoskeletal disorders, the presence of LBP in the year before the study was reported by approximately half of the students assessed (47.2%). Spinal pain is very common in children and adolescents and the prevalence of these pains is between 30% to 51% [38]. Skaggs et al. [77] evaluated 1,540 students aged between 11 and 14 years and found a prevalence of 37% of reported LBP. Data referring to Portugal, particularly in Lisbon, point to an annual prevalence of LBP of 39.4% in 208 adolescents aged between 11 and 15 years, between 2002 and 2003 [78].

Several factors such as age, gender, BMI, heredity, psychological and behavioral factors may contribute to the development of LBP [79]. The data from this study revealed that approximately 25% of students with LBP were classified as overweight and obesity, but this association did not reach statistical significance. The study of Kovacs et al. [80] also did not find an association between BMI and the presence of LBP. This fact can be explained by the influence of other risk factors mentioned above, since besides the change in lumbar curvature, which may be caused by the change of center of gravity by virtue of increased abdominal circumference and the weakness of the abdominal muscles (both factors that may be a result of excess weight) [36], several other factors have been considered to predispose the presence of LBP. Thus, LBP in adolescent and adult depends on multiple risk factors, being necessary the identification, interpretation and understanding [79].

This study examined several factors that could be associated with overweight and obesity, however only the variables hypertension and respiratory disorders showed statistical significance values. The influence of overweight and obesity in the development of hypertension and respiratory disorders becomes very important from the point of view of public health, since these factors may be amenable to change, making it important to identify the actual number of cases in terms of incidence and prevalence, these changes in weight status and verify the associated risk factors present in the adolescent population in the Algarve region.

Further investigations which can be determined the factors of cardiovascular and respiratory risk associated with overweight and obesity through analysis of cohort studies is suggested.

This study had limitations as a performance of only a moment of evaluation, consisting of a cross-sectional study. Thus the blood pressure measurement was performed only once, on the day of the evaluations, it was not possible to obtain confirmation of an accurate diagnosis. The diagnosis of hypertension is made by repeated blood pressure measurements, clinical history, physical examination and laboratory tests. Blood pressure is characterized by variations during the day and between several days. Thus, the diagnosis of hypertension should be based on multiple blood pressure measurements performed at different times. If blood pressure is elevated during an assessment should be carried out repeated measurements over months to confirm this fact [47]. However the investigation of McNiece et al. [71] found that the number of individuals with blood pressure above the limits normal is unchanged between the first and the third evaluation. Performing only one assessment point was given to the fact that the difficulty of performing measurements on different days may compromise the educational performance of schools. The same procedure should have been done to assess spirometry, which should be performed at another time to confirm the change, since the technique requires cooperation between the subject and the evaluator, and the results depend on both the technique is as well as personal factors [81].

CONCLUSION

The data from this study revealed a high prevalence of overweight and obesity in a representative and stratified sample of 966 adolescents living in the south of Portugal, and these showed a statistically significant relationship with the development of pre-hypertension and hypertension and with restrictive respiratory disorders.

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