

**Less obesity but higher inequalities in Portuguese children: trends of childhood obesity between 2002-2016**

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**Short title:** Social inequalities in childhood obesity

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**List of abbreviations:** socioeconomic position (SEP); gross domestic product (GDP); International Obesity Task Force (IOTF); physical activity (PA); television (TV)

## ABSTRACT

**Aim:** To observe the trends of overweight and obesity among Portuguese children from 2002 to 2016, before and during the years of the economic crisis, and compare these trends according to family's socioeconomic position (SEP). **Methods:** Prevalence rates were calculated using data from six studies providing comparable estimates from 2002, 2009, 2011, 2013 and 2016 for children aged 6-10-years living in the Portuguese Midlands (n=7192; 50.2% girls). Height and weight were objectively measured; children and family characteristics were collected by standard questionnaires. A logistic regression was used to test the association between variables. **Results:** Between 2002 and 2016, there was a decrease in the prevalence of overweight and obesity, which reached a statistical significance for girls. The prevalence of overweight, including obesity, was high (low-SEP=30.5%; high-SEP=20.5%) and a widening of socioeconomic inequalities was found. Socioeconomically disadvantaged children had more than 2 times the odds of having obesity than children from higher-SEP, even after adjusting for sex, physical activity and screen-time. **Conclusion:** While a decrease in overall rates of overweight and obesity was observed from 2002 to 2016, the social inequalities have been widened which suggest the need for public efforts to promote healthy weight at a population level, especially in lower socioeconomic classes. **Keywords:** Children; economic recession; obesity; socioeconomic inequalities; surveillance.

## KEY NOTES

- Prevalence of overweight and obesity in Portuguese children decreased from 2002 to 2016, particularly in girls;
- Socioeconomic inequalities in childhood obesity increased from 2002 to 2016, before and after the financial crisis, respectively;
- After adjusting for sex, physical and sedentary behaviors, socioeconomically disadvantaged children were 20-30% more probable to have obesity compared with children from higher socioeconomic position.

## INTRODUCTION

Childhood obesity rates are particularly alarming in Europe however, the problem varies across regions, with higher prevalence in southern countries such as Portugal (1,2). A plateau or decreased in overall prevalence of childhood obesity has been suggested in many developed countries (3,4). A surveillance study carried on Portuguese children, reported a decreased in overweight (8.3%) and obesity (3.3%) rates between 2008 and 2019 (3). Unfortunately, this optimistic picture may not be true for all children. In the

USA, Skinner et al (5) found that the obesity rates did not decrease for any age group (2 to 19 years old) and continued upward among socioeconomically disadvantaged subgroups between 1999 and 2016.

In high-income or industrialized populations, obesity tends to be more frequent among those classified with a low socioeconomic position (SEP); the inverse is true in low- and middle-income countries (6).

Also, low-SEP children may experience a greater increase in overweight risk during macroeconomic downturns, resulting in widening inequalities by social disadvantage in the face of economic crises (7).

The latest economic recession that started in 2008 and affected many European countries has hit hard Portugal (8). However, few studies have looked for the impact of the economic crisis in the childhood obesity rates and inequalities.

Currently, the Portuguese economy is suffering with the impact of the COVID-19 pandemic which is exerting a radical and abrupt effect on the country's gross domestic product (GDP) and unemployment rates. This context reinforces the need to have up to date information on levels and trends of overweight/obesity to quantify its health effects and to prompt decision-makers to prioritize action and evaluate where progress is, or is not, being made. The present study aimed to describe the prevalence of childhood obesity in Coimbra (Portugal) between 2002 and 2016, and observe how childhood overweight and obesity was associated with SEP in each observation period.

## **METHODS**

### ***Sample population and methodology***

The present study uses population-based data from multiple projects of the Research Centre for Anthropology and Health (CIAS) of the University of Coimbra, Portugal. CIAS has focused on the study of childhood obesity and related determinants and has carried a number of national surveys and cross-sectional studies in schools during the last two decades (Table 1). Data from the district of Coimbra (situated north-center in mainland Portugal) were retrieved from national surveys carried on in 2002-2003, 2009-2010 and 2016-2017; and local studies carried on in 2011-2012 and 2013-2014.

Primary schools were randomly selected from the list of public and private schools in the district and all the children (grade 1 to grade 4) were invited to participate. Questionnaires were delivered in the schools, sent home with the child and completed by the children's caregivers. The basis of the instrument was similar for all the studies and details can be found elsewhere (see Table 1).

The protocol for all studies was in accordance with the International Ethical Guidelines Involving Human Subjects and was approved by the Portuguese Data Protection Authority and the Portuguese Ministry of

Education. Parents were fully informed about all study procedures; informed written consent was obtained from the parents; children's consent was obtained prior to the anthropometric measurements. Children were included in this study if they were between 6 to 10 years old, had complete information on height and weight and were given parental consent.

### ***Anthropometry***

Height and weight were measured in schools by researchers who had been trained in standard anthropometric methods and using calibrated equipment (i.e., a portable stadiometer and a portable digital scale). Where possible, the same anthropometric equipment was used in all the studies. Body mass index (BMI) was calculated and the cut-off points from the International Obesity Task Force (IOTF) were used to classify children's nutritional status (15).

### ***Socioeconomic position***

SEP, a proxy variable of the socioeconomic inequalities, was defined by the parents' education level, which considered the highest level of education from mother or father. In mono-parental (single-parent) families, the parental education was based on the children's principal guardian. The variable was scored based upon the Portuguese Educational system and grouped into three categories: low (9 years or less), medium (10 to 12 year of education) and high (university degree). This has been done in previous studies in the Portuguese context since the country does not have an official measure for SEP (16).

### ***Sport activity and television viewing***

Parents reported their children's physical activity (PA) and television (TV) viewing. The same question was used in 5 studies: "Does your child practice any regular and organized physical activity outside school hours? If yes, how many minutes per weekdays, Saturdays and Sundays?". The total minutes per week were calculated by adding the answers for all days of the week. Parents also reported the time their children spent watching TV during Saturdays and the total minutes/day were classified as a categorical variable according to the recommendations of the American Academy of Pediatrics (17), such as, less than 2 hours/day and 2 or more hours/day. Data from 2011 were excluded since the criteria used to define active children and the time watching TV was not the same as in the other studies.

### ***Statistical analysis***

The prevalence of overweight and obesity among 6 to 10 years old children from Coimbra was examined in five different time periods: 2002, 2009, 2011, 2013, and 2016. The percentage and confidence interval for overweight, obesity, and overweight (including obesity) was calculated separately for boys and girls.

A chi-square test was run to test the differences between sample characteristics across the years. The data was divided according to the SEP and the percentage of overweight (including obesity) was calculated for the five time periods in order to observe the socioeconomic impact on children's nutritional status.

Finally, a logistic regression was used to examine the association between SEP and children's overweight and obesity, in the different time periods. Odds ratio (crude and adjusted for children's sex, PA and TV viewing), 95% confidence interval and p-values were reported. All analyses were conducted using SPSS v.23; statistical significance was set at 5%.

## RESULTS

The mean age of the 7192 children analyzed was 8.14 (SD=1.19) and 3610 (50.2%) were girls. Children's SEP, PA and TV viewing were statistically different across time periods ( $p<0.001$ ) (Table 2). Overall, between 2002 and 2016, there was an increase in the adoption of PA behaviors and more children spent 2 or more hours/day watching TV on Saturdays. Independently of the sex, most children were from a higher-SEP, particularly from 2009 onwards.

Figure 1 presents the change in the prevalence of overweight and obesity between 2002 and 2016 among 6 to 10 years old children in Coimbra, for boys and girls separately. The prevalence of overweight and obesity declined throughout the years but this trend was more evident for overweight than obesity.

Prevalence of both overweight and obesity was higher among girls than among boys. Among girls, the prevalence of obesity was higher in 2002 (9.5%; 1.9% [95% CI: 0.9-3.1] had morbid obesity) and lower in 2009 (5.2%; 0.8% [95% CI: 0.3-1.6] had morbid obesity). In boys, the lowest prevalence of obesity was found in 2011 (4.6%; 1.5% [95% CI: 0.4-2.6] had morbid obesity) and the highest was registered in 2002 (7.2%; 1.7% [95% CI: 0.7-2.9] had morbid obesity). The lowest prevalence of morbid obesity in boys was found in 2009 (1.0%; 95% CI: 0.3-1.8). From 2002 to 2016, the decline in overweight and obesity was higher among girls (2.1% and 2.6% respectively;  $p<0.001$ ) than boys (1.4% and 1.9% respectively;  $p=0.08$ ).

Figure 2 shows that the prevalence of overweight, including obesity, between 2002 and 2016, was continuously higher among children of lower- and medium-SEP, and lower among high-SEP children. A pattern of decline was observed across the years in children from higher-SEP (6.4%) but the inverse was found for medium- and low-SEP children (0.4% and 2.4%, respectively). The differences in children's overweight, including obesity, between SEP groups (higher to lower) increased from 5.9% in 2002 to 14.7% in 2016.

Table 3 shows crude and adjusted associations between parental SEP and children's overweight and obesity. Low-SEP was associated with increased odds of overweight (odds ratio [OR] between 1.40 and 2.04) and obesity (OR between 1.85 and 3.30) but the association was attenuated after adjustment for children's sex, PA and TV viewing. The association between SEP and childhood obesity was weaker in 2002 and stronger in 2013 and 2016.

## **DISCUSSION**

To our knowledge the present study is the first to analyze the trends and socioeconomic inequalities in the prevalence of overweight and obesity among Portuguese children between 2002 and 2016. Using a large sample of data and a repeated cross-sectional design, it was shown that, since 2009, the prevalence of overweight/obesity seems to have linearly decreased in Portuguese boys and girls living in the Midlands. This can be considered a positive change and may reflect a trend also reported in other developed countries (1). The literature has supported the notion that in countries facing the childhood obesity epidemic over several years, the plateau can be partly attributed to the initiated public health programs focused on the lifestyle of children (4). In the last years, the Portuguese government implemented several actions including the creation of a sugar tax on sweetened beverages (18) that led to an 11% reduction of total energy intake through sweetened beverages consumption by the population (19).

Results from the present study are in line with those reported in other Portuguese studies (3) and in others countries such as Greece, reflecting a trend for decrease prevalence of childhood obesity during the economic crisis from 2009 to 2012 (20). Temporary economic slowdowns may lead to an increase in parental engagement in health promoting activities when working hour's decrease or a decrease in total caloric intake when households face extreme hardship (21). However, increasing levels of childhood obesity were observed in times of economic slowdowns in countries such as Ireland (22). These discrepancies indicate that changes might differ for overweight and obese children according to their age and the context they live in and the role of cultural characteristics in each country. Moreover, the suggested decrease may not be shared equally across all the socioeconomic groups.

We found that while the prevalence of overweight and obesity is declining among children from higher-SEP, the inverse is seen for their counterparts of lower-SEP. Between 2002 and 2016, socioeconomically disadvantaged children were more overweight or obese than their counterparts of higher-SEP and the magnitude of that inequality grew within those years, which is in line with previous studies (23,24).

Growing disparities in socioeconomic health inequalities during the last years were reported for English

school-aged children (23) and preschool children from the USA (25). While the peak of the recession is over, financial situation have not returned to the levels seen prior to the crisis, potentially contributing to the continue widening socio-economic disparities found in the present study.

The 2008 economic recession, due to deterioration of socioeconomic and living conditions had a major contribution to the widening of inequalities in childhood obesity according to SEP. From 2011 to 2013, Portugal lost approximately 7% of the GDP and the recession period was characterized by rising deficits and high unemployment rate (26). Since 2008, the percentage of households with children that have been unable to buy meat or fish every second day has more than doubled during the economic crisis in countries such as Estonia, Greece, Italy and Portugal (27), and data from the Portuguese National Health Surveys revealed that the consumption of soup, fish and meat significantly decreased between 2005 and 2014 (28). The economic crisis may have reinforced the socioeconomic disparities in obesity related behaviors previously reported for Portuguese children, namely that children from lower-SEP had higher odds of consuming saturated and fat diets (29) and less probability of participating in extracurricular sport activities (30).

This study has several strengths. First, to our knowledge, it is the first to examine changes in the prevalence of overweight and obesity in Portuguese children according to the SEP throughout the last decade, including the years of the economic crisis; second, the measures were objectively collected using trained researchers and standardized methods, thus reducing the risk of misclassification of weight status; and third, the study's large sample size provided robust data to study different socioeconomic levels.

However, these were cross-sectional studies based on different independent samples which does not allow to suggest the causality and 'period effects' could not be rule out. Furthermore, while the socioeconomic disparities in obesity widened over the time period that included the recession, it is not possible to conclude that the recession caused this tendency. More studies are needed regarding the direct impact of the recession on individuals' households in the above-mentioned period and also in the post COVID-19 era.

In conclusion, childhood obesity remains a challenge for public health and there is a need to promote more daily PA and less sedentary time since we showed that those behaviors may attenuate the association between SEP and overweight or obesity. Reducing inequalities may require a proportionate universal approach, where the receipt of an intervention is proportionate to the degree of disadvantage, such that more children in deprived groups would receive programs to prevent obesity.

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## AUTHOR DISCLOSURE STATEMENT

The authors declare that there are no competing financial interests.

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Figure 1. Change in the prevalence of overweight and obesity among children aged 6 to 10 years living in Coimbra between 2002 and 2016. Mean percentage values for overweight and obese girls (a) and boys (b) and 95% confidence intervals.

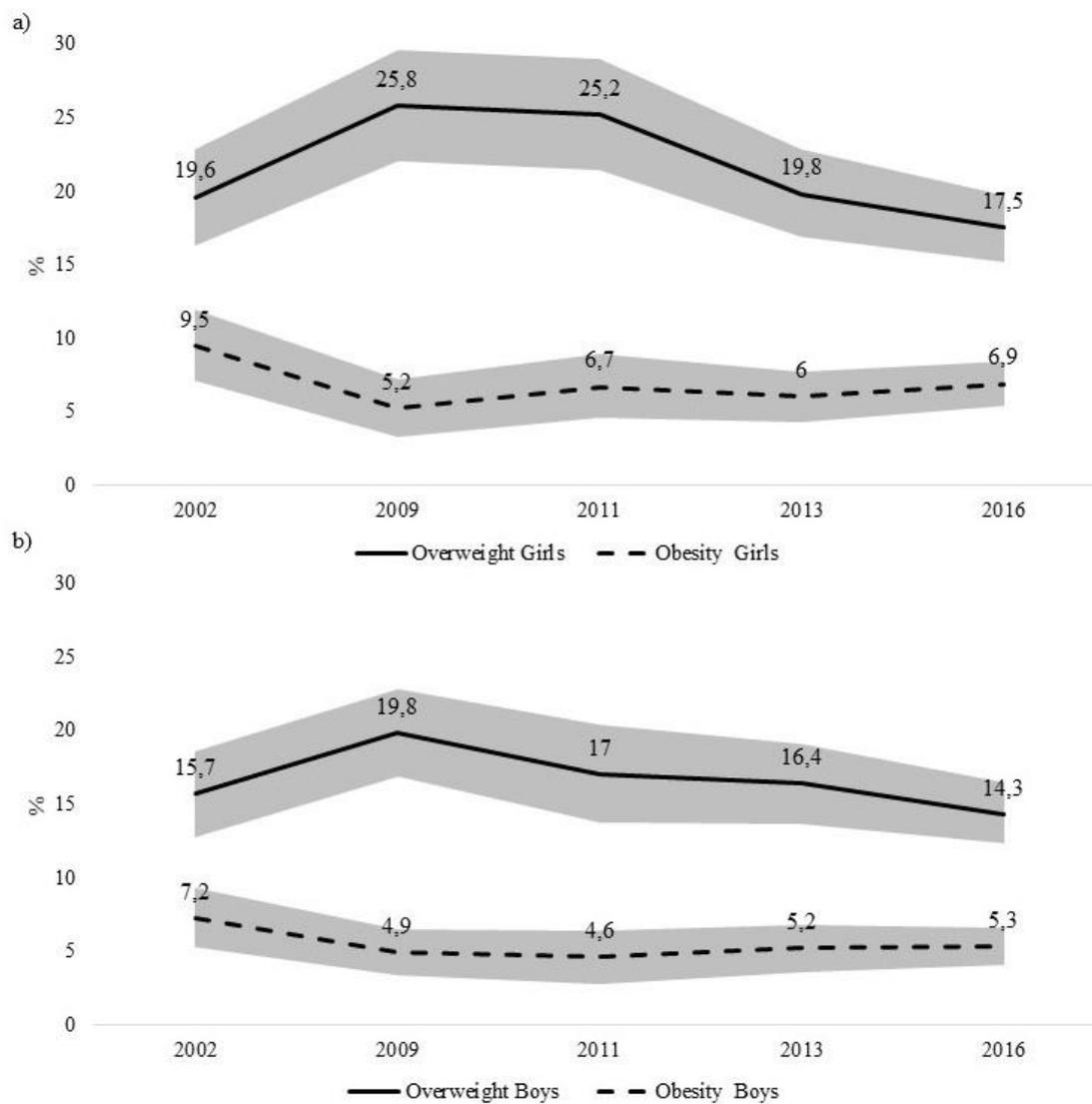


Figure 2. Prevalence (and 95% confidence intervals) of overweight (including obesity), in children living in Coimbra (aged 6 to 10 years) according to SEP from 2002 to 2016.

