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The economic crisis impact in the BMI of children living in distinct urban environments. *Public Health*, 196.

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Abstract

Objectives: Little is known about the impact of the 2008 global economic recession in childhood obesity in Portugal. Thus, this study goals were to compare children weight status during and after the economic crisis according to their neighbourhood environment features and to assess changes in specific dietary habits during the economic crisis. **Study design:** Cross-sectional study. **Methods:** Data from children living in Lisbon municipality was collected in 2009 (N=929) and in 2016 (N=1751) namely, weight, height, residence address to allow its geocoding and dietary habits changes during the crisis. A multidimensional environment index, with data of both built and socioeconomic nature collected at the statistical section level (areas comprised by 300 dwellers) in the 2011 census, was used to characterize neighbourhoods. **Results:** Overall, the proportion of children with overweight or obesity living in the socioeconomically vulnerable areas decreased in 2016. Families living in the latter areas stopped buying some food items, started to buy cheaper food items, cooked more meals at home and eat less in restaurants. In 2016 the risk for overweight and obesity increased in children who lived in the least advantageous areas. Living in areas with high socioeconomic status or most advantageous areas, no longer represented a decreased risk of having overweight or obesity in children in 2016 as it did in 2009. **Conclusions:** This study suggest that the economic crisis enhanced the social inequalities regarding childhood obesity. These results aid the development of evidence-based strategies to lessen the social inequities in health outcomes created by the crisis.

Keywords: multidimensional environment index; childhood obesity; global economic crisis

Introduction

Childhood obesity prevalence has been consistently high in the last two decades in Portugal ^{1,2}, a country severely affected by the 2008 global economic recession. During the economic crisis, many European countries' governments were obliged to reduce the health budget, which affected population health ³. Overall, during economic recessions, there is an increase in health inequalities ⁴ but, the social and economic effects of the 2008 economic crisis, such as the increase in the unemployment rate or the decrease in salaries ³, were more strongly felt in the years after ^{3,5}. For example, evidence shows that experiencing deprivation during infancy has negative effects on children's health, both in short and long-term ⁶.

The 2008 economic crisis produced different, and even contradictory health outcomes in children between countries namely because of how each country experienced and responded

to the crisis ^{3, 4, 7}. Some studies suggest that childhood obesity tend to increase during economic recessions while others show the opposite ⁸. In countries like Greece, Spain and Portugal ⁹, where households with children had the highest income inequality, thus more economically fragile, more austere measures were implemented ³ such as the increase of taxes and the price of basic needs items amongst which the better-quality food products ¹⁰. Studies performed in Spain ⁷ and Greece ¹⁰ have attempted to identify how the economic crisis impacted children's health, specifically weight status but, very little is known about the Portuguese children health outcomes during or after this period.

It is known that people living in urban environments, especially the more socioeconomically disadvantaged elders and children suffer the most with such economic recessions ^{6, 7, 10, 11}. Urban poorer individuals are highly vulnerable to economic downfalls and face higher risks of food insecurity and malnutrition ¹¹ among other aspects. Within a particular urbanized area however, there are different realities or distinct contexts that might produce different impacts on the individuals' weight status ¹². Therefore, this study aims to compare the weight status of children living in Lisbon municipality, during and after the economic crisis, according to the neighbourhood characteristics as well as to assess changes in some dietary habits during the crisis.

Methods

According to the socioecological model, childhood obesity determinants encompasses individual, interpersonal, community, environmental and state level dimensions ¹³. In turn, the environmental level determinants include both built and social features. Research about the impact of environment in children weight status usually focuses in either the built or the social features, independently. However, the environment surrounding us daily is the product of a complex interaction between different nature aspects thus, it should not be analysed resorting to a single characteristic ¹².

In this study three indexes were used to classify Lisbon municipality. The first according to its built environment features; the second regarding the socioeconomic environment aspects and a third one which combines both the built and socioeconomic environment dimensions designated as Multidimensional Environment Index (MEI). The methods to compute these indexes have been previously published elsewhere ¹². In short, data on built and socioeconomic features of the environment at the statistical section level (areas of more or less 300 dwellers), was retrieved from Census 2011. Then, principal component analysis was used to reduce data dimension, followed by a cluster analysis. Finally, MEI was computed and is the result of a cluster analysis using the outcomes from the principal component analysis of

both the built and socioeconomic environmental features. MEI has four classes: (1) Socioeconomic vulnerable areas which is comprised by houses with poor materials, old buildings with small and empty houses as well as older residents, (2) Least advantageous areas integrates family buildings, large houses with parking and low socioeconomic residents, (3) Mixed land use areas, has sections with large houses and non-residential buildings and (4) Most advantageous areas, are sections with family buildings, large houses with parking and high socioeconomic residents ¹².

Ethical issues

The study protocol was approved by Direção Geral de Inovação e Desenvolvimento Curricular, Direção Geral da Educação (Ministry of Education) and data collection procedures was revised and approved by the Portuguese Commission for Data Protection. Schools' directors gave permission to collect data and parents signed the informed consent as well as a permission to allow the collection of their children anthropometric data.

Study design and setting

This is a cross-sectional study developed in Lisbon municipality, the capital of Portugal. Lisbon is the most urbanized area in the country with the highest population density according to the 2011 Census (6444 individuals per square kilometre).

Environmental data used in this study was collected in the 2011 Census at the statistical section level and the epidemiologic data was collected in 24 private and public schools within Lisbon municipality area in two moments, 2009 and 2016. In both moments of data collection the procedures to obtain data were the same and the same schools were used as sampling frame. In 2009, the sampling procedure was based on a stratified random design that accounted for the number of children by age group and sex in each district, to provide a nationally representative survey of children aged 3 to 10 years. In each district, schools were randomly selected and then year groups were selected within schools. In 2016, schools participating in the 2009 survey from three districts (Lisbon, Coimbra and Porto), were selected and invitations sent to pre-primary and primary school-aged children. Parents who accepted to participate, signed a permission and an informed consent allowing the anthropological assessment of their children. The participation rate for the overall sample in 2009 was 57.4% and in 2016 it was 61.4%. For the current study, we used the samples collected within the Lisbon area (Lisbon municipality) in both moments. Although the sample size is slightly different in the two moments, they remain representative for school-aged children from the study area (Lisbon municipality) and thus the results are reliable for

comparison with results from other studies with similar samples. _ Children's parents provided their residence postal code which allowed for the residence geocoding. In 2016, parents also filled a questionnaire concerning dietary habits changes during the economic crisis. For this study purposes the following "yes or no" questions were analysed: "Did you have to stop buying some food items that you usually consumed?", "Did you start buying cheaper food items?" and "Did you cook more at home and go to restaurants less often?".

Anthropometric data

Anthropometric data from children was collected in two moments, one in 2009 (N=929) and the other in 2016 (N=1751). In both moments, height and weight of each child was objectively measured by trained people. Using this information, children's Body Mass Index (BMI) was computed and categorized into normal and overweight/obese according to the International Obesity Taskforce cut-offs points for children ¹⁴.

Statistical analysis

Chi-square was used to compare proportions of children with normal weight and overweight/obesity by the built, socioeconomic and MEI classes and to compare the proportion of families that changed their eating behaviours during the crisis also by classes of built, socioeconomic and MEI. Logistic regression was computed to measure the magnitude of association between the built, socioeconomic and MEI classes of the residence and children weight status expressed as odds ratio (OR) and the respective 95% confidence intervals (CI). All statistical analysis was performed using SPSS (v.22) and findings at $p < 0.05$ were considered significant.

Results

In 2009 children had an average age of 7,45 years ($\pm 1,8$) and in 2016 the mean age was 6,90 years ($\pm 1,8$). In both years the proportion of girls and boys was similar, in 2009 the sample was comprised by 49,9% of girls and in 2016 by 49,6% of girls.

As seen in Table I, no differences were found between the proportion of children with normal weight or overweight/obesity in none of the built, socioeconomic and MEI classes, in 2016. Similar results were found in 2009, according to Pereira, Nogueira (2018).

[Table I Proportion of children with normal and overweight/obesity per built, social and MEI, in 2016]

However, when comparing the proportion of children with normal weight and overweight or obesity within each of the built, socioeconomic and MEI classes it is possible to identify some differences (Table II). In the built environment clusters, the proportion of children with overweight or obesity decreased from 2009 to 2016 in the older and empty areas (from 30.7% to 16.7%, $p<0.01$) as well as in the commerce and service areas (from 27.4% to 15.2%, $p<0.05$). This proportion also decreased between 2009 and 2016, in the older residents' areas of the socioeconomic environment clusters (from 28.1% to 20.2%, $p<0.001$). The majority of families that lived in the latter areas stopped buying some food items (68.5%), started to buy cheaper food items (68.9%) and cooked more at home and had less meals in restaurants (74.1%) (Table III).

A decrease in the proportion of children with overweight or obesity was also found in the socioeconomic vulnerable areas of the MEI (from 28.5% to 19.4%), in which 43.3% of families stopped buying certain food items, 45.3% started to buy cheaper food items and 46.5% cooked more at home and had less meals in restaurants (Table III).

[**Table II** Comparison of the proportion of children with normal and overweight/obesity by built, socioeconomic and MEI clusters, in 2009 and 2016]

[**Table III** Comparison of the proportion of families that changed their eating behaviours during the crisis by built, socioeconomic and MEI clusters]

The results of the binary logistic regression crude models computed for 2016 are presented in Table IV. According to Pereira, Nogueira (2018), in 2009 children living in higher socioeconomic areas, of the socioeconomic environment clusters, had a decreased risk of being overweight or obese when compared with children living in older residents' areas. In the same year, children living in the most advantageous areas of MEI were less likely to be classified as overweight/obese children comparing with children living in socioeconomic vulnerable areas, as well as in 2016, although in the latter year, it was not statistically significant (OR=0.88, 95%CI=0.55-1.39).

In 2016, children living in commerce and service areas of the built environment clusters had a decreased risk of being overweight or obese when compared with children living in residential areas (OR=0.63, 95%CI=0.43-0.93). Furthermore, children living in the least advantageous areas of MEI were more likely overweight/obese (OR=1.46, 95%CI=1.03-2.05) comparing with children living in socioeconomic vulnerable areas.

[Table IV Association between children weight status and built, socioeconomic and MEI clusters, in 2016]

Discussion

This study results suggest that the trends of childhood obesity rates at local level might be determined by global economic conjuncture. Besides, this study goes in line with other studies and highlights that childhood obesity is susceptible to social inequities at the environmental level ^{9, 15}. Within children that lived in the socioeconomically vulnerable areas there was a decrease in the proportion of children with overweight or obesity from 2009 to 2016, and families that lived in those areas changed their eating habits during the crisis. Despite it, in 2016 the risk for overweight and obesity increased in children that lived in the least advantageous areas when compared with results from 2009. Also, unlike what was observed in 2009, living in areas with high SES or most advantageous areas, did not represent a decreased risk of having overweight or obesity in children in 2016.

The consequences of the 2008 economic crisis in children's health was not homogenous between countries namely because each country experienced and responded differently to that economic recession ^{3, 7}. Spain, Greece and Portugal were severely affected by the crisis and had to implement harsher measures, once these countries' economies were more fragile ⁹. Hence, it was expected similar consequences of the crisis in the Portuguese, Spanish and Greek children's weight status.

In Spain, between 2005 and 2012, the percentage of children living below the poverty line increased by 15%, which, among other aspects, meant that many families could not afford the school meal, affecting children nutritional status ⁷. According to a study from Catalonia (Spain) that measured the associations between the family living conditions from 2006 and 2010-12 and child health outcomes, there was an increase in childhood overweight and obesity, during this period ¹⁶. This increase was mostly because the most disadvantaged families changed their diet patterns due to the lack of financial resources, leading to a higher consumption of junk food and also not eating breakfast ¹⁶. It is known that, families that go through adverse events, such as a decrease in the family budget imposed by the economic crisis, might also have a lesser consumption of fruits and vegetables ¹⁷.

In this study, results suggest that the risk for overweight and obesity increased in children from the least advantageous areas which goes in line with the results from Spain and two cohort studies, one performed in Japan ¹⁷ and other in Ireland ⁵. In Japan the results showed that children from lower income households were at higher risk of overweight and obesity after the onset of the 2008 economic crisis ¹⁷. In Ireland, researchers found that the prevalence of

overweight and obesity increased during the economic crisis ⁵. In both studies researchers discuss several potential explanations for such findings but, like the Spanish, they point out the lack of resources to get healthier food and the adoption of poorer and unhealthier diets during economic recessions, as a major risk factors for obesity ^{5, 16, 17}. Overall, during the economic crisis, children are usually given lower quality meals as well as cheaper food items namely, carbohydrates-based ¹⁸.

Contrary from the latter studies results, in a study from Greece, conducted between November of 2009 and May of 2012, a statistically significant decrease in the prevalence of overweight and obesity was documented. Besides, a slight increase in normal and underweight prevalence was found, although not significant ¹⁰. The authors state that the harsh conditions dictated by the economic crisis namely the increase of food price, might have led to the reduction of the number of meals once there were no interventions targeted at decreasing childhood obesity in Greece during the study period ¹⁰.

Despite the increased risk for obesity mentioned above, likewise in Greece, this study results show that the proportion of children with overweight and obesity decreased in 2016 specifically in children from the socioeconomically vulnerable areas, when compared with results from 2009 ¹². According to the present results, families that lived in the most deprived areas changed their eating habits – stopped buying certain food items, started to buy cheaper food items and cooked more at home and eat less often in restaurants. Besides, during the economic crisis years in Portugal, the perception of food-insecurity (a proxy to evaluate the household access to food) was very high when compared with other countries ¹⁹ which might also explain the overweight and obesity decrease.

In sum, in Spain the risk for overweight and obesity in children increased during the crisis, in Greece the prevalence of childhood overweight/obesity decreased and in Portugal although the overall proportion of overweight and obese children decreased, the risk for obesity increased in children living in the least advantageous areas. This heterogeneity of results between countries, even within countries that were similarly affected by the economic crisis, highlight the complexity underneath childhood obesity trends, determinants and evolution as well as the important role of cultural factors. So far, it remains unclear what are the reasons for the higher susceptibility of some populations to obesity than others ²⁰.

Childhood obesity has been high for some decades worldwide and, although it seems that it levelled off in some countries ¹⁵, there are predictions of increases in other countries namely, Eastern European countries, more specifically countries that belonged to the former Soviet Union ²¹. In Romania, for example, until very recently only the higher socioeconomic classes had access and ownership of computers, televisions, cars and certain high caloric foods which

explains the higher risk of obesity in children from higher socioeconomic status ²². However, Eastern European countries are currently going through an economic transition which, despite of its benefits, is changing all individuals' habits and diets towards healthier lifestyles so, it is expected that the prevalence of obesity increases in most Eastern European countries until 2050 ²¹.

Strengths and limitations

The cluster analysis applied to the urban context is a reliable measure of the environment as whole or as the product of the complex interaction between built and social features that naturally coexist ¹². Therefore, the use of such analysis is an added value in the assessment of the impact of urban environment on children weight status.

However, the fact that this is a cross-sectional study does not allow for inferring a causality effect. In fact, our findings could be partially explained by factors of the individual or interpersonal level of determinants that were not included in our analysis since the focus of the present study was on the environmental and state level factors.

Another limitation of this study is that we did not design the study to have a representative sample of children in each of the territorial subsections therefore our results are prone to the ecological bias, that is, the misleading interpretation of results by attributing the environmental features to the individuals assessed.

Conclusions

This study suggests that the economic crisis that erupted in 2008 globally, had an impact on children's weight status in Portugal. Overall there was a decrease in the proportion of overweight and obese children in 2016 but, the risk for overweight and obesity increased in children living in the least advantageous areas of Lisbon municipality when compared with results from 2009. Thus, one might state that the economic crisis enhanced the social inequalities regarding childhood obesity.

During the economic crisis, families living in the least advantageous areas changed their eating habits. Not only the families did not afford some food items but also started to eat cheaper food items and cooked more at home. Hence, children might have been exposed to higher risks of food insecurity or even malnutrition leading to the changes verified in their weight status between 2009 and 2016.

The environmental classification used in this study is a valuable tool when assessing the effect of neighbourhood environment in children's weight status, specifically in a densely urbanized area, during and after the economic crisis. This classification allows the identification of

priority areas to tackle obesity, that is, the most sensitive areas to economic oscillations thus aiding the creation of evidence-based strategies seeking to lessen the social inequities in health outcomes, created by the crisis.

Ethical approval

The study protocol was approved by the relevant authority from the Portuguese Ministry of Education (Direção Geral do Ensino) and by the Portuguese Data Protection Authority (Comissão Nacional de Protecção de Dados).

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Declarations of interest: none.

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