Pathways to childhood obesity: a deprivation amplification model and the overwhelming role of socioeconomic status

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Abstract

People of low socioeconomic status (SES) are more likely to live in disadvantaged neighbourhoods, where resources and facilities that might support healthy living are scarce, while harmful environmental aspects are abundant. Our aim was to analyse the associations between children’s body mass index (BMI), children’s sports activity (SA) and perceived environmental characteristics with the children’s SES. The sample included 1885 children, aged 3–10 years, living in Coimbra, Portugal. Overweight and obesity were defined using age and sex-specific BMI cut-off points, as defined by International Obesity Task Force (IOTF). SA levels, SES and parental neighbourhood perceptions were assessed through questionnaires. Environmental data were reduced through a Principal Component Analysis for Categorical Data (CATPCA), and two neighbourhood dimensions were achieved. The independent associations of SES, the main predictor, with BMI, SA and perceived neighbourhood dimensions was analysed using ordered logistic regressions. Our results showed that children of low and medium SES were more likely to be obese than their high-SES peers, children from low and medium SES groups were less likely to participate in SA; parents of children from low and medium SES groups were less likely to have positive
perceptions of their built environment. We concluded that low SES children are more obese, more sedentary and more likely to live in inadequate neighbourhoods, characterized by higher perceived risks. These findings show that the differential access to neighbourhood resources overlaps with familial socioeconomic disadvantage shaping patterns that are detrimental to children’s health and wellbeing. Childhood obesity also results from a model of deprivation amplification that penalizes the most vulnerable children.

*Keywords: childhood obesity, perceived neighborhood environment, deprivation amplification model.*

1 Introduction

The level of obesity has tripled in the last 25 years, becoming one of the leading causes of preventable death in the developed world. This trend of weight gain crosses all age ranges, affecting both adults and children alike. Among European adults, it has been estimated that excess weight gain accounts for 50% of hypertension, 33.3% of strokes, and 25% of osteoarthritis [1]. Consequences of childhood obesity are more insidious and difficult to assess; however, a number of studies has highlighted its diverse range of short- and long-term adverse health consequences (such as type II diabetes, hypertension and high cholesterol), as well as economic burdens [2].

Portugal represents one of the more severe cases of child obesity. A study conducted from 2002 to 2003 [3] concluded that among Portuguese children aged 7–9 years, the prevalence of being overweight or obese was notably high compared to the children’s counterparts in other European countries; on average, 31.5% of Portuguese children were considered overweight or obese, ranking second behind Italy (36%) and surpassing Greece (31%) and Spain (30%). There is general consensus among researchers that excess weight gain is caused by a number of factors. Although genetic factors play a significant role, they do not fully explain the dramatic increase in obesity rates in recent years. The studying of obesity, particularly childhood obesity leads researchers to pose the following questions; is this population trend of excess weight gain inevitable, perhaps as a sign of modernisation? Because of the multifactorial nature of obesity how can it be addressed most effectively? And finally is this upward trend of child obesity reversible?

1.1 The obesogenic environment

Environmental factors are increasingly considered as obesogenic (obesity promoting/favouring) by researchers because they facilitate the intake of excessive calories and/or reduce individual metabolism. Thus, overweight and obesity are not only avoidable but can probably be managed and controlled by environmental changes. Identifying manageable ways of changing the environment to address the issues of excess weight gain and obesity is of utmost importance and urgency. Research has pointed to the obesogenic potential of the physical infrastructure of the neighbourhood and social environment in several ways. Concerning the
physical environment, empirical evidence suggests that several factors are vital to the creation of healthy living environments, including concentrated development and highly connected road networks, as opposed to urban sprawl; mixed land usage, which ensures adequate access to residence, work, school, and retail shops related to food, leisure, sports and other amenities; high-quality pedestrian and cycling conditions with the presence of pavements, sidewalks, and cycle paths; and in general, pleasant and clean surroundings [4, 5]. In addition, the social environment can influence individual behaviours by “shaping norms, enforcing patterns of social control, (...), reducing or producing stress, and placing constraints on individual choices” [6]. Certainly, there is evidence for the association between the ‘social’ characteristics of neighbourhoods – such as crime, stressful environments, vandalism and other signs of social decay, the lack of social support and social capital among neighbours – with the prevalence of obese and overweight residents [7].

1.2 Childhood obesity: an issue of inequity

In the case of health and wellbeing, disadvantages are cumulative: less powerful individuals with low SES are more likely to live in relatively disadvantaged neighbourhoods. In these neighbourhoods, resources and facilities which might promote healthy lifestyles or mitigate poor health conditions among already unhealthy individuals are scarce, whereas environmental factors that are detrimental to one’s health are abundant [8, 9]. Therefore, the effects of individual and neighbourhood resources – or the lack thereof – on social and health disadvantages, which tend to cluster and overlap, can be characterised as additive, interactive or multiplicative.

Empirical studies found that children from low SES households exhibit higher levels of obesity [3, 10] Previous studies also show that children’s behaviours as related to diets and physical activity are by and large influenced by neighbourhood characteristics. Environmental factors that exacerbate unhealthy behaviours among children that can lead to weight gain include living in areas or studying in schools characterised by the scarcity of healthy foods [11]; the lack of parks, playgrounds and other facilities which may encourage physical activity [5]; poor access to public transport, unsafe pedestrian and cycling conditions [12]; and high crime rates [13]. Is childhood obesity, therefore, an issue of environmental injustice? Given that more obese children tend to have low-SES backgrounds and live in relatively disadvantaged neighbourhoods, it is important to recognise that the issue of childhood obesity is inextricably linked to environmental disparities that operate beyond individual disadvantages.

1.3 Research aims

This cross-sectional study investigates the associations between weight status, sports activity (SA), and parent’s environmental perceptions among children aged 3 to 10 years across SES backgrounds. We hypothesised that children from lower SES backgrounds are more obese, more sedentary, and more likely to live in disadvantaged, obesogenic environments, where opportunities to promote
children’s physical activity are scarce. Given that we hypothesise that children’s behaviours are directly related to neighbourhood factors, we argue that childhood obesity should be considered to be an issue of environmental injustice. While many studies have found empirical evidence confirming partial links of the obesity-environment model (e.g. links between the environment and individual behaviours, including diet and physical activity), few have tested the model and its multiple linkages in their entirety. In this study, we developed an integrative view of SES, weight status, physical activity and environmental features to understand the social and ecological pattern of childhood obesity.

2 Data and methods

Data for the present study were collected from 23 private and public schools in the Coimbra district, which is located in the central area of Portugal, between March 2009 and July 2010. The sample included 952 girls and 933 boys, aged 3 to 10 years, from preschool to grade 4 of primary school.

2.1 Children’s measures

The children’s SES was measured by the years of parental education. Parents were invited to complete a questionnaire concerning household characteristics and their children’s daily routine. We selected the father’s educational attainment as the main indicator of family SES [14]. SES was categorised into three groups based upon the Portuguese’s educational system: children whose fathers have fewer than 9 years of education (i.e. the first three cycles of compulsory schooling) are considered low-SES; those whose fathers have 10 to 12 years of education (i.e. secondary schooling) are considered middle-SES; and those whose fathers have more than 12 years of education (i.e. post-secondary schooling) are considered high-SES.

Regarding anthropometric measures, BMI was calculated from the children’s height and weight, as determined by standard anthropometric methods. All measurements were taken at their schools by the same person using the standard protocol and instruments. Internationally accepted cut-off points to categorise children’s BMI were used [15]. Participants were grouped into two categories: normal weight and overweight or obese.

Based on the same questionnaire, information about the children’s SA was measured using a single binary variable: participation in an extracurricular SA or not.

2.2 Neighbourhood environment

To assess the characteristics that determine neighbourhood advantage or disadvantage, researchers usually use objective measures that are systematic and direct, such as audits or Geographical Information Systems, and/or subjective measures, such as individual perceptions about their environment. Some authors, analysing the associations between objective and perceived measures of the natural environment and physical activity, concluded that objective environmental
measures were not associated with levels of physical activity, although perceptions about the natural environment were found to be associated with physical activity for certain measures [16].

Studies investigating the weight of children or youths and their related behavioural patterns tend to use subjective neighbourhood measures in their analyses [10, 14]. Despite their focus on children and youth, these studies must still consider parental opinions and perceptions because generally parents decide the neighbourhood in which the family resides [4]. Parental decisions also determine the kinds of activities and spaces in and with which their children can engage, depending on their perception regarding the quality and safety of neighbourhood amenities and spaces. For example, parents who are concerned about neighbourhood issues, such as traffic and crime, and their consequences for their children’s safety can restrict their children’s movements within the neighbourhood [17].

We argue that perceptions of neighbourhood features are based upon complex evaluations that arise from a multi-staged process involving the following criteria: (1) the objective qualities of the neighbourhood; (2) the psychosocial, biological and physical characteristics of the individual; and (3) the individual’s own subjective definition of neighbourhood and neighbouring. All of these aspects can influence behaviours and decisions; therefore, perceptions of the neighbourhood should be considered to be valid measures in themselves in analyses that study the link between neighbourhood and individual health.

Parental perceptions of their local neighbourhood were assessed based on items in a questionnaire using the Environmental Module of the International Physical Activity Prevalence Study [18]. Out of 17 questions from the entire questionnaire, we select 15 questions related to parental perceptions that have responses based on a four-point Likert scale, ranging from strongly disagree to strongly agree with statements that ask about the importance of the following neighbourhood characteristics: access to meaningful destinations; the availability of local infrastructures; aesthetic qualities; street connectivity; access to public transport; neighbourhood safety; and levels of social support.

2.3 Statistical procedure

With list-wise deletion of questionnaires with missing information, the analytical sample comprised of 1889 individuals. Chi-square difference test was used to determine significant differences (p ≤ 0.05) in the children respondents’ demographic, physical and behavioural characteristics by their family’s SES. Spearman correlations were calculated to explore the relationship between the perceived environmental variables. In general, significant associations among the environmental variables were found (results not shown). Therefore, to render the original contextual data more parsimonious and intelligible without losing important data, we conducted a Categorical Principal Component Analysis (CATPCA). CATPCA produces a small number of uncorrelated dimensions (or components) that represent most of the information found in the original data. CATPCA use an optimal-scaling approach, allowing variables to be scaled at different levels and optimally quantified in the specific dimension. Dimensions
were rejected when considered irrelevant using the Kaiser’s criterion (eigenvalue < 1). Five dimensions satisfied this initial criterion, but only the first two met the threshold value for reliability, showing adequate internal consistency (Cronbach’s Alpha scores > 0.5). Thus, to generate two stronger dimensions, variables with a low loading in both dimensions were discarded [19]. A final model based on two main neighbourhood dimensions, which was composed of 13 variables and explaining approximately 55% of the total variance was retained:

First Dimension: composed of variables related to infrastructures (chiefly, those related to sport and recreation), access to amenities (e.g. shops, markets and general destinations of interest), the availability and quality of maintenance of infrastructures (e.g. cycle paths and sidewalks), and the general neighbourhood aesthetics (Cronbach’s Alpha = 0.8). This dimension represents the neighbourhood’s built and physical environment, clearly in relation to its land-use and urban design.

Second Dimension: comprised of variables related to the social environment and neighbourhood safety, including perceptions of disorder, crime, violence, and safety, including road safety (Cronbach’s Alpha = 0.6).

In the statistical analysis, these two dimensions were transformed into dichotomous variables based on a median split between negative and positive overall perceptions.

The independent association of SES with BMI, SA and perceived neighbourhood dimensions as dependent variables was analysed using ordered logistic regressions. Models were adjusted for age and gender. Adjusted odds ratios (OR) and 95% confidence intervals (CI) were calculated, and in these calculations, robust standard errors were used to account for the clustering of participants in schools. The statistical analysis was performed using SPSS 19.0. Pseudo-R², and likelihood ratio statistics were also performed.

4 Results

The prevalence of overweight and obese children in our sample was 21.5% and 5.3%, respectively. Greater proportions of girls were overweight and obese (12.5% and 2.8%, respectively) than those of boys (9% overweight and 2.5% obese) (results not shown).

Analyzing children’s weight status by SES, a clear social gradient emerges. Levels of obesity increase as fathers’ levels of education decrease (p < 0.01). The difference between the percentage of overweight/obese children from the lowest (33.3%) versus the highest (20.3%) SES households peaked at a ratio of 1.64. A similar pattern emerges in terms of the social gradient on SA: children from higher SES backgrounds were significantly more active than their lower SES peers (p < 0.01), and the ratio between active children from the highest versus the lowest SES groups peaks at 2.45 (results not shown).

Our logistic models, adjusted for the child’s gender, age and clustering effect of children within schools (table 1), showed that children from low and medium SES backgrounds were more likely to be overweight and obese than their high SES peers (i.e. OR = 1.767 and OR = 1.574, respectively).
Table 1: Logistic regression analysis showing estimating results of BMI, physical activity and neighbourhood perceptions with SES as independent variable.

<table>
<thead>
<tr>
<th></th>
<th>Obesity Sports activity besides school</th>
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<tr>
<td></td>
<td>Adjusted OR 95% IC</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td>** adjusted OR ** 95% IC</td>
</tr>
<tr>
<td>(girl)</td>
<td>1.426** 1.182–1.720</td>
</tr>
<tr>
<td><strong>age</strong></td>
<td>1.094* 1.036–1.156</td>
</tr>
<tr>
<td><strong>SES</strong></td>
<td><strong>High</strong> ref (1) 1.574** 1.34–2.33</td>
</tr>
<tr>
<td></td>
<td><strong>Low</strong> 1.767** 1.248–1.985</td>
</tr>
<tr>
<td>Perceived a convenient built environment</td>
<td>Perceived a convenient social environment and safety</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td>** adjusted OR ** 95% IC</td>
</tr>
<tr>
<td>(girl)</td>
<td>0.934 0.759–1.15 ws</td>
</tr>
<tr>
<td><strong>age</strong></td>
<td>1.033 0.92–1.094 ws</td>
</tr>
<tr>
<td><strong>SES</strong></td>
<td><strong>High</strong> ref (1)</td>
</tr>
<tr>
<td></td>
<td><strong>Low</strong> 0.516** 0.379–0.703</td>
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** p < 0.001; * p < 0.05, ws (without significance).

Furthermore, our data showed that low- and medium-SES children were significantly more likely to engage in greater time spent being sedentary compared to their high-SES counterparts, even after accounting for gender and age differences. The odds ratios of children from low and medium SES backgrounds practicing extracurricular SA were 0.177 and 0.357, respectively, compared to their high SES peers. Put differently, low-SES children are 82.3% less likely than high SES children to participate in SA, whereas medium SES children are 64.3% less likely. In subsequent models that account for neighbourhood characteristics (neighbourhood dimensions determined by CATPCA), children’s demographic characteristics (i.e. gender and age) do not appear to be significantly associated with parental perceptions about the neighbourhood. In terms of perceptions about the built environment by SES, results showed that parents from low- (OR=0.516) and medium- (OR = 0.565) SES backgrounds were less likely than parents from high SES background to perceive their built environment as convenient. In the adjusted models, children from low- and medium-SES backgrounds were 48.4% and 43.4% less likely than their high-SES peers to live in neighbourhoods that their parents perceived to have convenient built environments. Most of the predictors in the model are not significantly associated with the social environment and neighbourhood safety. However, results showed that children of medium and
low SES were 6.6% and 15.2% (i.e. OR = 0.934 and OR = 0.848, without statistical significance), respectively, less likely than their high-SES peers to live in neighbourhoods with positive social environments based on parental perceptions.

5 Discussion

This study is among the first to take an integrative perspective in analysing the social patterns of childhood obesity, participation in SA and both physical and social perceived neighbourhood characteristics. Our main findings confirm linear socioeconomic gradients in childhood obesity and physical activity: compared to their peers from low and medium SES backgrounds, high SES children were more likely to have a normal BMI and to participate in extracurricular SA. We also tested for significant associations between SES and two composite measures of perceived environmental characteristics, of which only one produced statistically significant results: the composite dimension related with the physical or built environment, including its land-use patterns and urban design. Lower-SES children tend to live in neighbourhoods characterised by their scarcity of public spaces (e.g. parks, recreation centres, playgrounds, public swimming pools), poor access to amenities (e.g. shops, stores, markets), lack of infrastructures (e.g. walking trails and bike paths) and their poor maintenance and generally poor aesthetics. The other composite measure of parental perceptions of the neighbourhood was related to its social environment and safety, as operationalised by variables that include perceptions of disorder, violence, crime, and fear of crime and safety, including road safety. Our results showed that low-SES children tend to live in neighbourhoods characterised by a lack of social support and safety, but the association does not appear to be statistically significant. This finding is perhaps due to the unique neighbourhood characteristics of the area from which our sample is taken: Coimbra is a small–medium city, without major problems of crime and social disorder.

As previously mentioned, most extant studies have taken a narrow approach in studying the issue of child obesity. In a study carried out among Portuguese girls aged 13 to 17 years old, authors concluded that girls from higher-SES backgrounds were more likely to be active and to have more positive perceptions about their neighbourhoods (e.g. well-connected street networks and better neighbourhood aesthetics) than their lower-SES counterparts [14]. Similar to the results of our study, they also found no significant SES gradient in terms of perceptions of the social environment and neighbourhood safety. However, these researchers do not study issues of weight gain and obesity in relation to these neighbourhood characteristics. Other study found a significant positive association between SES and levels of physical activity, arguing that psychosocial pathways related to the increased capacity of higher SES families to transport their children to SA and the greater valuation of physical activity as a form of leisure explain the SES gradient in physical activities [20].

However, this study did not examine the role of environmental factors. Analysing parental perceptions of the neighbourhood by SES, one study found certain differences among parents of children aged 10–12 years but not among
parents of children aged 5–6 years [21]. The authors concluded that high-SES parents reported more sports venues, well-lit areas, crosswalks, and public transport in their neighbourhoods than did low-SES parents. In the same study, the authors reported an association between children’s SES and their own neighbourhood perceptions, with low SES children expressing more concerns about heavy traffic than did their high SES peers. Moreover, the authors reported that high SES children were more likely to walk and cycle to local destinations, suggesting that these children may live in neighbourhoods with better-built environments and better infrastructure, as corroborated by their parents’ positive neighbourhood perceptions.

Our findings contribute an additional insight. Based on a sample of children aged 3 to 10 years old, we argue that low-SES children are more likely to be overweight and obese. Likewise, these children tend not to participate in as many extracurricular SA as their higher SES counterparts. Furthermore, these children tend to live in neighbourhoods perceived by their parents as both physically and socially disadvantaged. We argue that this chain of detrimental conditions constitutes a problem of environmental justice, or a deprivation amplification model [9].

Low-SES families tend to have lower income and poorer access to information, which, in turn, restrict their spending on health-related products and services; in general, their consumption patterns and lifestyles are less conducive to good health. As a result, children of lower-SES backgrounds are more likely to consume unhealthy and relatively inexpensive food, while they are simultaneously less likely to engage in extracurricular SA, given the hefty participation fees and expensive equipment associated with sports. The propensity for low-SES children to be overweight or obese is thus clearly due to an imbalance between their diet and exercise. However, beyond that, they tend to live in poor, disadvantaged areas, where resources – both tangible and intangible – and facilities that promote health and wellbeing are scarce. Parents from lower socioeconomic ranking reported negative perceptions about their neighbourhoods, concerning issues of land use, urban design, social organisation and safety (even without significance to social resources). Those negative perceptions reflect the challenges facing the residents of these neighbourhoods, including poor access to a wide range of amenities, a lack of public spaces, poor quality of infrastructures, including sidewalks and cycle paths, fear of crime, heavy traffic, unsafe roads, and generally unattractive surroundings. Given that these parents live in perceptibly stressful, unpleasant and dangerous neighbourhoods, where opportunities are scarce, they restrict and discourage their children from engaging in outdoor activities, including sports. Ultimately, this discouragement leads to detrimental consequences for their children’s health and wellbeing, particularly their tendency for weight gain [17]. Therefore, we suggest that there is a clear socioeconomic gradient in the degree of access to both physical and social neighbourhood resources, which, in turn, leads to distinct socioeconomic patterns in child health and wellbeing, particularly issues related to obesity. Environmental risks magnify individual vulnerability, thereby creating an environmental injustice issue [8, 9].
6 Conclusions

Even though we cannot establish causality, given the cross-sectional nature of this study, this study presents certain important findings. Low SES children are more likely to engage in sedentary behaviours, due to their greater likelihood of living in disadvantaged areas, which leads to their excess weight gain. This chain of conditions is not merely a coincidence but is evidence for the powerful role of SES in linking environmental factors, individual behaviour and weight gain. Is there a solution for this problem? We argue that improving the local environment is the key solution for breaking this chain.

The local neighbourhood environment broadly comprises of a set of diverse and interdependent factors, including the density of resources and facilities, the availability and maintenance of public infrastructures, such as sidewalks and bike paths, land use diversity, and crime rates. Local environments are dynamic places that can undergo downward spirals of decay or, conversely, upward spirals of improvement and enrichment [19]. A decaying environment is characterised by processes of physical and structural degradation, resulting in a greater sense of anomie among its residents, as well as facilitating sedentary lifestyles; regarding the degree of social cohesion decreases, crime rates and rates of traffic-related injuries are also likely to increase. Neighbourhoods become less attractive, less safe and less pleasant for people to walk outside. The more affluent residents leave the area, while the less affluent are compelled to stay, given their lack of financial discretion. With minimal disposable income, less affluent residents do not invest in maintaining the external appearance of their houses, and at the same time, there is a diminished sense of collective responsibility in maintaining the general aesthetics of public spaces. Therefore, structural degradation and urban deterioration ensue. Together, health promotion agents, local authorities, urban planners and policy-makers can put a halt to this cycle of deterioration by designing interventions that involve the redesign of the built environment and its land use, the improvement of neighbourhood safety, access to opportunities, the maintenance and improvement of overall aesthetics, and assistance to low-SES households aimed at improving health and wellbeing, particularly those of children. Promoting an active, healthy neighbourhood environment can be a promising, efficient, and enduring strategy for improving individual and collective health because the environment is a holistic resource that influences all of its residents and the entire community. Investing in the environment is also an ethical and moral duty, given that the issue of environmental disadvantage undermines the ideals of social justice and social equity, which are the foundational principles of modern societies.

References


