Perceptions of neighborhood environments and childhood obesity: evidence of harmful gender inequities among Portuguese children

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Abstract

This study investigates the links between parents' perceptions of their social and built residential environment and obesity among Portuguese school boys and girls. A total of 1885 children, 952 girls and 933 boys, aged 3.0–10.0 years, were observed. The children's weight and height were measured, and their parents filled out the "Environmental Module" questionnaire of the International Physical Activity Prevalence Study. Age and sex-specific BMI cut-off points were used to define being overweight/obese. Environmental characteristics were combined into 2 composite neighborhood indices that were used as predictors in logistic regression models. Girls living in neighborhoods perceived as having poorly built environmental conditions had increased odds of being obese (OR = 1.47; $p<0.005$), and girls living in neighborhoods perceived as being unsafe and dangerous had also increased odds of being obese (OR = 1.339; $p<0.005$). These relationships were not evident for boys. Improvements in the neighborhood environment could be a strategy for tackling the growing epidemic of childhood obesity and can simultaneously contribute to reduce health iniquities across population subgroups.

Highlights

We analyzed the links between environmental perceptions and obesity in boys and girls.

We found associations between a poorly social (OR=1.339) and built (OR=1.47) environment and obesity in girls.

Girls are more obese, more sedentary, and more influenced by the environment than boys.

Differences can reflect perverse, harmful gender inequities in environmental adequacy.

Key-words: social and built neighborhood environment; perceptions; childhood obesity; gender inequities.

Introduction

Childhood obesity has become a worldwide epidemic in recent decades, and Portugal presents one of the most concerning situations in Europe. In a national study carried out between 2002 and 2003, Padez et al. (2004) found that Portuguese children aged 7–9 years showed a very high prevalence (31.5%) of being overweight or obese compared with other European countries. Moreover, authors found a higher prevalence of obesity among girls (17.0% in girls *vs.* 14.6% in boys). Some studies suggest that built and social environmental factors underlie this trend because these factors make it easy to take in excessive calories and/or discourage the expenditure of energy in daily life (Giles-Corti and Donovan, 2003, Portinga, 2006, Singh et al., 2010). Children's eating habits and physical activity behaviors are influenced by neighborhood features, including the following ones: access to healthy foods (Zenk and Powell, 2008); availability of parks, playgrounds and other recreational facilities (Burdette and Whitaker, 2003; Cradock et al., 2005; Brockman et al., 2010); access to public transportation; pedestrian and cycling conditions (Timperio et al., 2004; Pont et al., 2009); and crime rates (Burdette and Whitaker, 2003; Carver et al., 2010). Furthermore, when analyzing how environmental factors cause impact on the different genders, previous studies have highlighted the emergence of a sex-specific pattern of environmental influences. Nevertheless, this specificity was reported only for adolescents and adults and was not explicitly reported for children (Hume et al. 2005; Evenson et al., 2006; Santos et al., 2008; Santos et al., 2009; Singh et al., 2010). According to William et al. (2012), the associations between the built and social environment and obesity have been extensively researched in adults. However, no current consistent associations between key environmental features and obesity in children of all ages, gender, socioeconomic strata and locations have been identified.

A key question in the field of place effects on obesity is related to the measurement of environmental attributes. Features that make a neighborhood advantageous or disadvantageous can be directly or indirectly assessed via perceptions (Brownson et al., 2009). Tucker et al. (2009), who analyzed the relationship between the objectively measured presence of neighborhood recreational opportunities and parental perceptions of those opportunities, showed that both were positively associated with the physical activity of youth. Ding et al. (2011) argue that objective and perceived environments are related to active behaviors in different ways. Researching this same issue, McGinn et al. (2007) concluded that objective measures were not associated with physical activity, while several associations between perceived measures and physical activity were reported. Gebel et al. (2011) found that perceived neighborhood attributes had a more powerful influence on physical activity than objectively measured attributes. Studies focusing on childhood obesity must consider parents' opinions and perceptions of their residence, as they make the decisions for the family regarding what activities and spaces their children can develop and use (Gordon-Larsen et al., 2006; Frank et al., 2007).

This cross-sectional study investigates the links between parents' perceptions of the local social and built environment and being overweight/obese among boys and girls aged 3–10 years. While some studies have found empirical evidence linking the environment and weight status, few have focused on children, and even fewer have systematically explored gender differences in children. As far as we know, this is the first study to analyze the influence of parental perceptions of neighborhoods on the weight status of young Portuguese boys and girls. Considering the high figures of childhood obesity in Portugal, this may be decisive, by giving opportunities for early and timely interventions.

Methods

Study design and setting

The data for the present study were collected at private and public schools located in the administrative division of the Coimbra district (equivalent to county) in Portugal, between March and July 2009. Twenty-three schools participated in this study, and 1885 children (933 boys and 952 girls) aged 3.0–10.0 years were included in the analysis. Coimbra is a district located in the central area of Portugal, extending from West to East (from the ocean to the largest mountain of Portugal), with an area of 4 679 Km^2 and a population of approximately 429987 inhabitants (INE, 2012). The capital of the administrative division is Coimbra, which is the larger city in the center of Portugal, and it has more than 100000 inhabitants. The area is comprised of 17 municipalities with population densities ranging from 448.9 inhabitants/Km^2 in the most central and compact municipality (Coimbra) to 11.3 inhabitants/Km^2 in the most inland

and rural municipality (Pampilhosa da Serra). The sampled schools were mainly located in urban areas (65.7%), followed by suburban areas (31.1%) and rural areas (3.2%).

Measures

Anthropometric measures

At each school, two trained technicians performed anthropometric measurements using a standardized procedure (WHO, 2005). These measurements were performed with the children lightly dressed and without shoes. The BMI (body mass index) (kg/m^2) was calculated from the children's height and weight. Using age and sex-specific BMI, the overweight and obesity cut-off points, as defined by the International Obesity Taskforce, were used (Cole et al., 2000). We also calculated the prevalence of underweight children in our sample. Due to the small number of cases, these children were considered as having a normal weight. For statistical analyses, participants were grouped into two categories: normal weight and overweight/obese.

Parents' education level

As it is usually performed in other studies on this subject, socioeconomic status (SES) was assessed by years of parental education (Timperio et al., 2005; Mota et al., 2011; Prins et al., 2011; Villanueva et al., 2012). Parents were invited to fill out a detailed questionnaire addressing household characteristics and the daily routines of their children. We selected the number of years of father and mother's education as main SES indicators because of two distinct trends: 1. the relevant scientific literature, which highlights the influence of mother's education as a proxy measure of SES (Rundle et al., 2009; Mota et al., 2011) and 2. men are the traditional heads of the household in Portuguese society, and their level of education typically determines family income and living conditions. The education variable was categorized into five groups: 4 years, 6 years, 9 years, secondary/professional, and university (graduate, master and PhD.).

Perceived neighborhood features

Parental perceptions of their local neighborhoods were assessed through a questionnaire using the Environmental Module of the International Physical Activity Prevalence Study (IPS, 2002). This questionnaire has been used previously, and it shows good test-retest reliability (De Bourdeaudhuij et al.; 2003, Mota et al, 2005; Alexander et al., 2006; Santos et al., 2009) with Intra-class correlation coefficients ranging from 0.36 to 0.79. From the whole questionnaire, we

selected 15 questions with a four-point Likert response scale, from strongly disagree to strongly agree, that address access to meaningful destinations, availability of local infrastructure, aesthetic qualities, street connectivity, access to public transportation, neighborhood safety and social environment.

Statistical procedures

A chi-squared test was used to compare age and socioeconomic differences in children who were normal weight and overweight/obese. Spearman correlations between the children's BMI and each environmental variable were performed, and in general, significant associations between BMI and the environmental variables were found. Therefore, to reduce the original contextual data set into a more parsimonious intelligible data set without losing information, a Categorical Principal Component Analysis (CATPCA) was performed. The main output of a CATPCA is a small number of uncorrelated dimensions (statistical indices) that represent most of the information found in the original data. CATPCA uses an optimal scaling approach that allows variables to be scaled at different levels and optimally quantified in the specific dimension (Meulman and Heiser, 2005; Santos et al., 2008). Dimensions were rejected when they were considered irrelevant using Kaiser's criterion (eigenvalue <1). Five indices satisfied this initial criterion, but only the first two had the premise of reliability, which shows adequate internal consistency (Cronbach's alpha scores above 0.5) (Santos, 1999). To generate two strong dimensions, variables with a low loading in both indices were discarded (Cummins, 2005; Nogueira, 2009). A final solution of two dimensions and 13 variables, explaining approximately 55% of the total variance, was retained:

> *First Index* - Neighborhood built environment (land use and urban design): availability and proximity of infrastructure and facilities (retail, leisure and sports), access to destinations, physical feature availability and maintenance of features, such as cycle paths and sidewalks, and general aesthetics (Cronbach's $\alpha = 0.8$).
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> *Second Index* - Neighborhood social environment and safety: perceptions of disorder, crime, violence and safety, including road safety (Cronbach's $\alpha = 0.6$).

For the statistical analysis, indices were dichotomized based on a median split into negative overall perception *vs.* positive overall perception.

To examine the association between children being overweight/obese and the parental neighborhood perceptions, binary logistic regression analyses were performed. Unadjusted logistic regression analyses were carried out separately for each sex, with age, maternal and paternal education and residential area (urban, suburban, rural) as independent variables. Final

adjusted models were child sex-specific and included variables with a statistically significant relationship with the dependent variable in the previously unadjusted analyses, which were individual age and maternal and paternal education. Adjusted odds ratios (OR) and 95% confidence intervals (CI) were calculated, and Huber-White estimates were used to account for the clustering of participants in schools. Potential clustering of participants according to school can happen if the sample is based on randomized schools, not on randomized children, though the effects were measured for individuals. In this situation, the assumption of i.i.d. (independently and identically distributed measurements) might be violated, since children of a particular school are most likely more similar to each other than to children from other schools. Statistical analyses were performed using SPSS 17.0.

Results

Sample characteristics

The prevalence of being overweight and obese in our sample was 21.5% and 5.3%, respectively. Based on international age and sex-specific thresholds used to define overweight and obesity (Cole et al.), girls had higher values for being overweight and obese than boys (30.2% in girls and 23.2% in boys). Age influences weight, as there was a higher prevalence of being overweight and obese in older ages. The prevalence of underweight children by age ranges from 4.7% (6 children at 3 years of age) to 1.3% (4 children at 7 years of age) (results not shown).

Table 1. Participants' characteristics

	Normal (%)	Overweight/Obese (%)
Total sample	73.3	26.8
Male (n= 933)	76.8	23.2
Female (n= 952)	69.8	30.2
X^2 = 11,9; p = 0.001		
3 years (n=126)	77.8	22.2
4 years (n=185)	81.1	18.9
5 years (n=190)	76.3	23.7
6 years (n=259)	72.2	27.8
7 years (n=300)	75.7	24.3
8 years (n=316)	69.0	31.0
9 years (n=346)	72.8	27.2
10 years (n=163)	64.4	35.6
X^2 = 18,6; p = 0.01		
Fathers' education		
1–4 yrs	65.2	34.8
5–6 yrs	71.2	28.8
7–9 yrs	69.3	30.7
10–12 yrs	73.0	17.0
>12 yrs	80.0	20.0
X^2 = 18,4; p = 0.001		
Mothers' education		
1–4 yrs	66.2	33.9
5–6 yrs	67.4	32.6
7–9 yrs	69.5	30.5
10–12 yrs	75.0	25.0
>12 yrs	76.8	23.2
X^2 = 27,09; p = 0.000		

When analyzing the children's weight status by level of parental education, a significant social gradient emerged: the levels of childhood obesity increased as the years of parental education decreased. Considering the mothers' education level, a linear social gradient and a ratio of 1.46 between overweight/obese children of the lower *vs.* more educated households (33.9% *vs.* 23.2% prevalence) was found. Considering the fathers' education level, the ratio reached 1.74 (34.8% prevalence for the low SES children *vs.* 20% for the highest group) (table 1).

Neighborhood perceptions

The influence of parental perceptions about the local environment on children's weight, as assessed through logistic models, was significant for girls for both the built and social neighborhood dimensions. However, no statistical associations were found for boys.

Table 2. Odds ratios and 95% CI from binary logistic regression models predicting overweight and obesity in girls and boys

	Boys		**Girls**	
	Adjusted OR[b]	**95% CI**	**Adjusted OR[b]**	**95% CI**
Built environment (land use and urban design)				
Positive overall perception [a]	1		1	
Negative overall perception	0.839	0.543-1.318 (n.s.)	1,47	1.026-2.105*
Social environment and safety				
Positive overall perception [a]	1		1	
Negative overall perception	1.004	0.812-1.243 (n.s.)	1.339	1.035-1.732

[a] Reference category
[b] Adjusted for age, father's and mother's educational level and school clustering
*p<0.05

Table 2 shows that adjusting for age, maternal and paternal education and accounting for the clustering of children in schools, girls whose parents had a negative perception of the built and physical neighborhood environment (infrastructures, access to destinations, physical feature availability and maintenance, and general aesthetics) were more likely to be overweight or obese (OR = 1.47; $p<0.05$). Considering the neighborhood social environment (perceptions of disorder, crime, violence and safety, including road safety), results show that girls living in areas perceived by their parents as unsafe and potentially dangerous had a 34% higher probability of being obese or overweight than their counterparts living in areas perceived as safe, convenient and socially organized (OR = 1.339) ($p<0.005$) (table 2). In terms of boys, no significant effects of parental neighborhood perceptions on weight status were found.

Discussion

We found that parental perceptions of built and social environments were predictive of weight status in girls, but not in boys. As far as we are aware, few studies similar to this have been published. Other studies on this topic were concerned with older children (Hume et al. 2005; Evenson et al., 2006; Santos et al., 2009; Singh et al., 2010; Rodríguez et al., 2012) or, if concerned with younger children, no gender distinctions were found (Timperio et al., 2004, 2005; Burdette et al, 2003; Carver et al., 2010). Only some studies considering adolescents have pointed to a sex-specific influence of neighborhood features on physical activity behaviors. Adolescent girls seem to be more sensitive to some features of the built environment, while adolescent boys showed a particular sensitivity to the social environment, chiefly peer influences (Hume et al. 2005; Evenson et al., 2006; Santos et al., 2009; Rodríguez et al., 2012).

We may suggest several explanations to explain our findings. Firstly, parents with positive perceptions concerning land use and urban design (including access to a range of destinations and the provision and quality of infrastructure, including sidewalks and cycle paths), as well as social organization (being perceived as peaceful and safe) most likely believe that their children live in a “convenient”, pleasant neighborhood, with good, safe opportunities, which allows them to be active outdoors and to reach their local destinations actively. It is likely that children, especially the older ones, who feel safer and positively perceive their daily living space, are more prone to enjoy open and public spaces, thus developing several outdoor activities (e.g., transportation, active play) that have positive impacts on weight status.

Why is this not clear for both sexes? This question may be due to the different interactions and use of space by girls and boys. “Living and lived-space” is certainly different for both genders. An example is the type of contextual, active behaviors performed by boys and girls. Boys traditionally like contact, team sports better, such as football, and may be less influenced by the availability of infrastructure and sport facilities, the maintenance of sidewalks or even aesthetics. Girls, however, prefer non contact and recreational activities, like walking, tennis, volleyball, dancing or ballet (Darst, 2002; Grieser at al., 2006), and will be more influenced by the provision of such equipment and general aesthetics.

On the other hand, our results may suggest that parental attitudes vary according to their children’s gender, which may reflect societal standards and cultural norms. The stereotype of femininity (it may not appear to be feminine for girls to play football), the lack of available female role models for girls in some physical activities and the greater vulnerability attributed to girls, can lead to greater parental restrictions; however, conceiving boys activities as competitive and aggressive (Hill and Cleven, 2005), and considering them less vulnerable than girls, parents may give more freedom to boys, encouraging them to practice some physical activities. Even in areas considered to be less suitable, parental restrictions may differ depending on their children’s gender, with greater restrictions for girls. This explanation seems to be supported by the distinctive behavioral patterns of the genders, as some studies consistently point to the lower levels of physical activity in girls, (Sallis et al. 2000; Santos et al., 2009) which may be the result of a mismatch between the suitability of the environment and their needs.

Study strengths and limitations

A major strength of our study is the measurement of two composite environmental indices and their relationship with childhood obesity. Although the literature on neighborhood effects on adult obesity and obesity-related risks is substantial, such research on childhood obesity is quite limited, especially when gender differences are highlighted. We also underline our findings about increased risks of obesity and overweight associated with unfavorable built and social environments, particularly among vulnerable groups, such as girls and low SES children.

As for limitations, firstly we must be aware that the assessment of causality was limited by the cross-sectional nature of this study; indeed, notwithstanding the statistical models applied and the statistical significance they reached, we can only argue that results show a joint variation of children’s weight and built and social environments.

Secondly, beyond our partial, dichotomized view, the local environment is a single entity, which we subdivided to address multidimensionally. Physical and social environments make up the

neighborhood environment. This broad, holistic, local environment puts many complex challenges to researchers. In fact, conceptualizing and operationalizing this broad influence remains a theoretical and empirical challenge, which stresses the need for future research on this topic.

Thirdly, the lack of statistical significance achieved for boys should lead us to critically examine the methodological procedures applied for the environmental measurement up to the statistical models.

Lastly, our study was based only on subjective environmental measures, and future work to clarify the connections of the built and social environment and weight should also include objective neighborhood measures. Even if some authors argue that perceived measures are closely related with weight status (see introduction), it's not yet been determined how close one's perception reflects reality and how objective and perceived environments may affect weight status differently.

Conclusions

This research presents several important findings because it suggests that neighborhood, community-based approaches could be a strategy for childhood weight control. The evidence presented here suggests that tackling the increasing trend of childhood obesity is both a health and planning issue. Therefore, the epidemic may be controlled and mitigated through interventions that address the local environment, making it more adequate to children's needs. These interventions include improving the urban design (e.g., availability and maintenance of sidewalks and cycle paths, traffic calming measures, and lighting) and promoting mixed land uses, as well as the social environment, especially safety. Neighborhood safety is crucial to children being able to play, walk and cycle outdoors and depends on social features such as social control and collective efficacy. Social features depend, in turn, on physical characteristics, such as the presence of public meeting places (e.g., streets, parks, squares), that promote social interactions.

Finally, the peculiar interaction found between girls and their environment makes the mentioned local environmental interventions even more relevant, given the known pattern of a higher prevalence of girls being overweight and obese and having lower levels of physical activity. Above all, our results underscore the importance of engaging in preventive gender-sensitive efforts, both to promote health and as an opportunity to decrease iniquities between girls and boys. As girls are more obese, less active and more influenced by the environment, perhaps we can suspect that they are facing a subtle, insidious process of environmental discrimination over their male counterparts. This is, in itself, an unjust, unbearable situation.

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