TITLEPAGE

Socio-demographic and behavioural risk factors associated with the high prevalence of overweight and obesity in Portuguese children

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Abstract

Objectives: Childhood obesity is a public health concern in Portugal. Socio-demographic and behavioural factors are highly associated with obesity but are not clearly understood. This paper aims to update the prevalence of overweight and obesity in Portuguese children and to explore the influence and risks of socio-demographic factors and behavioural factors.

Methods: A cross-sectional study of Portuguese children aged 3-10 years from all 18 mainland districts took place between March 2009 and January 2010. 17,136 (8455 boys; 8681 girls) Portuguese children age were observed. Height, weight and other anthropometric measurements were obtained by trained technicians. Body Mass Index (BMI) was calculated along with other anthropometric variables. Data analyses took place between April and September 2012. The overweight/obesity classification was established by age-and sex-specific BMI cut-off points as defined by the International Obesity Task Force (IOTF). Parents completed questionnaires about socio-demographic and behavioural characteristics of the family.

Results: Almost 28% of the Portuguese children were overweight or obese (19.7% overweight; 8.2 % obese). Prevalence was greater in girls than in boys. Logistic regression models found that the odds of childhood obesity were significantly affected by biological, socio-demographic and behavioural factors.

Conclusions: The protective factors against childhood overweight/obesity in this sample of Portuguese children are: i) being male; ii) having been breastfeed; iii) having been born from

mothers who did not smoke during pregnancy; iv) engaging in little sedentary behaviours (TV, PC and playing electronic games); iv) performing, at least, 1 hour of moderate physical activity every day; and vi) having parents with higher educational levels who also have their BMI within the healthy ranges.

Keywords: Portugal, children, obesity, risk factors, physical activity, sedentary behaviours

INTRODUCTION

Overweight and obesity (OW/OB) have been significantly increasing over the last 25 years and has been described as a public health epidemic (World Health Organisation, 1998). OW/OB are terms used to describe an excess of adiposity (fatness) above the ideal for good health (OW < OB) (Waters et al, 2011). Obesity increases the risk of a number of non-communicable diseases such as cardiovascular disease (CVD) (Mokdad et al, 2003), type II diabetes (Hirani et al, 2008), cancer (Calle et al, 2003), respiratory disease (Barranco et al, 2012), high cholesterol (Mokdad et al, 2003; Ko et al, 2001) and high blood pressure (Mokdad et al, 2003). Populations in developed and in many developing nations are increasingly becoming obese, particularly children. The seriousness of childhood obesity is increased by past evidence reporting that once obesity has been established, at a younger age, it is difficult to reverse later in life (Waters et al, 2011; Luttikhuis et al, 2009; Singh et al, 2008; Field et al, 2005). The problem is worsened due to the increasingly onset of type II diabetes *mellitus* to starting to occur in younger ages when compared to 25 years ago, and obesity is stated as a major determinant (Rosenbloom et al, 2000). Obese children are also likely to experience negative stereotyping such as perceptions of poor health, academic and social uselessness, poor hygiene and idleness (Hill & Silver, 1995; Thiel et al, 2008). Obese children may also experience negative emotional and psychological states such as nervousness, sadness and loneliness (Strauss. 2000). Finally, they are more likely to become victims of bullying and to engage in unhealthy behaviours such as smoking tobacco and/or cannabis (Farhat et al, 2010).

Overweight/obesity occurs when there is a consistent positive energy imbalance over a sustained period of time. A review by Lobstein et al (2004) describes that a variety of factors such as behavioural (physical activity, diet, sedentary lifestyle), cultural, genetic, environmental and economic have been associated in obesity's development. These factors are interchangeable and therefore complex. Like in most developed countries, childhood OW/OB is a public health concern in Portugal. A review study by Moreira (2007) found that the reported prevalence's of obesity would differ from one region to the other region. Also, Padez et al (2005) investigated the prevalence and risk factors for obesity of 7 to 9.5 year old children in a national representative sample and found alarming rates. It was found that parental obesity and educational levels were the most significant risk factors of children's obesity This finding is consistent with results from other studies in different ethnicities (Xi et al, 2009; Dannemann et al, 2011; Patterson et al, 1997). Padez et al (2005) concluded that maternal obesity had a stronger link to OW/OB compared to paternal obesity and suggested that this is unsurprising due to the cultural factor of Portuguese mothers being the parent who is usually responsible for important lifestyle factors such being the parent who buys, prepares and serves the food.

Sedentary behaviour is defined as any waking behaviour characterised by energy expenditure below 1.5 MET while sitting or reclining posture (Sedentary Behaviour Research Network, 2012). Padez et al (2005) reported that TV viewing was a risk factor of children's OW/OB. One reason is the low level of energy that is expended while watching TV (Hancox et al, 2004) however it has also be shown that engaging in TV viewing could lead to the increase behaviour of snacking of unhealthy foods while abstaining from healthy foods (i.e. fruit and vegetables) (Re-lopez et al, 2011; Liang et al, 2009). Another possible reason for the link between TV

viewing and obesity is that children could be subjected to the advertising of unhealthy products that could potentially impact upon obesity (Halford et al, 2008; Boyland et al, 2011). Sedentary behaviours of children are, however, more than just TV viewing. With the increase popularity of electronic games and personal computers and laptops these are behaviours that are important to explore. Carvalhal et al (2007) investigated the association between physical activity, TV, video games and obesity in 3365 Portuguese children. The study found similar results of TV viewing to that of Padez et al (2005) the longer children watched TV the greater the risk of obesity. Both boys and girls were found not to use computer's very often, however boys played electronic games for longer periods than girls and that there was a moderate relationship between electronic games and obesity levels.

Physical activity is defined as any bodily movement produced by skeletal muscles that result in energy expenditure (Caspersen et al, 1985). Low levels of physical activity have widely been documented as a major determinant of childhood OW/OB. Previous research including Portuguese studies have found evidence of an association between physical activity and obesity (Trost et al, 2001; Hernandez et al, 1999; Gonzalez-Suarez & Grimmer-Somers, 2011; Pereira et al, 2010). However other studies have found no association (Padez et al, 2005; Carvalhal et al, 2007; Martins et al, 2010). Past physical activity interventions have shown that although physical activity could possibly not reduce obesity levels, physical activity can maintain and prevent for longer the onset and/or increase of obesity occurring (Gonzalez-Saurez et al, 2009).The lack of clarity between the association of physical activity and obesity is that physical activity is a complex behaviour; that has many different determinants and correlates that vary from gender, to

age, to context and environmental (Sallis et al, 2000; Van der horst et al, 2007; Ferreira et al, 2007).

This study focuses on the impact of socio-demographic factors (age, sex, parental factors, parental behaviours, birthweight, and maternal smoking during pregnancy), and behavioural factors (physical activity/active play, TV viewing, electronic games use, computer use) during weekdays and weekends. The aims of this study are to 1) review and update the prevalence of OW/OB in Portuguese children nationally; and 2) to explore the influence and risk that socio-demographic factors and behavioural factors have upon OW/OB in Portuguese children.

METHODS

Participants and Settings

The total number of children was 17,509 but 373 did not fit the inclusion criteria for age, there the final sample was 17,136. The children were from all mainland Portuguese districts but not from the Portuguese Archipelagos (Madeira and Azores) were observed in March 2009 and January 2010 in public and private Portuguese schools. The studied population was selected by means of proportionate stratified random sampling taking into account the district and the number of children by age and sex in each district. Participation rate was 57.4% (49.3% in preschool children and 63.6% in school children). Due to insufficient number of participations for the ages of 2.5, 10.5, 11, 11.5, 12, 12.5, 13 years and missing body mass index (BMI) data, the final number of participations for data analyses was 17,136. The study protocol was approved by Direcção Geral de Inovação e Desenvolvimento Curricular (DGIDC) and written

informed consent was obtained from all the children's parents. Ethical approval was also granted for secondary data analyses by the Loughborough Universities Advisory Ethic Committee. Data analyses took place between May 2012 to September 2012

Measures

Trained technicians performed anthropometric measurements using standardised procedures within each of the schools (Lohman et al, 1988). Height was measured using a stadiometer with the head positioned according to the Frankfort plane and weight was measured via an electronic scale with a precision of 100g. BMI was calculated as weight/height^2 (kg/m^2). The definitions of OW/OB for children were based on average centiles in accordance to the IOTF's age and sex-specific BMI cut-off points which were the criterion applied (Cole et al, 2000). For the adults (parents), overweight was defined as a BMI's of 25.0-29.9 kg/m^2 (obesity as a BMI of 30 kg/m^2 (obese) (World Health Organisation, 1998).

Parents completed a mailed questionnaire about different characteristics of all members of the household including themselves. The questionnaire was designed and intended to collect information about factors that may have a potential influence on childhood OW/OB. Factors such as sex; birthweight; decimal age; breastfeeding (yes/no); district; parental occupation (professional & executives, management & technicians, administrative, service and sales, farmers, agricultural, skilled workers, unskilled workers); parental physical activity participation (yes/no); parental education (primary (4y), six years, nine years, twelve years, university (>12 years)); parents self-reported height and weight,; school conditions for physical activity classes (yes/no); mother smoked during pregnancy (yes/no); sport activity outside of school (yes/no);

urbanization (urban, semi-urban, and rural); electronic games weekdays/weekends (none, <1h, 1h, 2h, 3h, 4h, 5h <); personal computer (PC) use weekdays/weekends (none, <1h, 1h, 2h, 3h, 4h, 5h<); television (TV) weekdays/weekends (none, <1 h, 1 h, 2 h, 3 h, 4 h, 5h<); physical activity in school (0-30min, 30-60min, 60-90min, 90-120min, 120-150min, 150min <); watching TV during meal times (never, only at weekend, 1 to times/week, 2 to 3 times/week, every day); active play weekdays/weekends (none, <1h, 1h, 2h, 3h, 4h, 5h<). Active play was used as an umbrella term for all physical activity (self-reported) that parents believed that their child took part within.

Data Analyses

Pearson Chi-square χ^2 (β set at 0.05) difference tests were conducted to test the level of association between the different variables measured (birthweight, breastfeeding, district; parental occupation, parental physical activity participation, parental education, school physical activity, maternal smoking during pregnancy, sport activity outside of school, urbanization, active play weekdays/weekends, electronic games weekdays/weekends, personal computer use weekdays/weekends, television (TV) weekdays/weekends, watching TV during meal times) and children's overweight, obesity and OW/OB . Variables with a significant association with childhood overweight, obesity and OW/OB were further analysed by backward logistic regression models. Sex and age were adjusted and the odds ratio (OR) and 95% confidence interval were calculated for each of the categorical variables within the regression models. Categorical factors with an OR statistically significantly (p<0.05) and higher than 1.0 resulted as a risk factor and an increased likelihood of childhood OW/OB and an OR statistically

significantly *($p<0.05$)* with a value below than 1.0 was taken as a protective factor. Statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS/PC-)-, version 19.0; SPSS Inc., Chicago, IL, USA).

RESULTS

Prevalence of overweight and obesity (OW/OB)

Table 1 presents the prevalence (%) of normal weight and OW/OB among a sample of 17,136 Portuguese children aged 3 to 10 year olds. As a whole, 72.1 % of children were classified as having a normal OW/OB status, 19.7% were classified as overweight and 8.2% were classified as obese. This means that, overall, more than a quarter (27.9%) of the children were either overweight or obese.

Biological Factors

Sex differences were found across all age groups, with girls being more OW/OB than boys. Chi-square (χ^2) difference tests shows that these sex differences were significant across the ages 3.5y, 4.0y, 4.5y, 5.0y, 5.5y, 6.5y and 7.5y. Tables 2-4 describe the logistic regression models. Table 2 outlines the biological risk factors that were significantly associated with OW/OB of Portuguese children. It was found that age and sex difference (male= reference)) were significant risks for

being overweight and obese. This was found across all three logistic regression models (Table 4, Table 5).

Two other biological factors- "maternal smoking during pregnancy" and "breastfeeding"- were also significant predictors of OW/OB. Maternal smoking during pregnancy increased the odds of obesity among the children (OR 1.52 95%CI 1.30-1.78) and, in a smaller degree, also increased the odds of child overweight (OR 1.31 95%CI 1.16-146). Table 2 outlines that being older, female, with a mother who smoked during pregnancy, and not being breastfed increased the odds of being OW/OB.

Socio-Demographic Factors

Chi-square difference results of parental factors (father and mother) by weight status and sex found that normal weight (boys and girls) had parents with higher paid occupations. This was also found to be evident for educational level for parents. It was also clearly found that children who were OW/OB had parents with higher BMI's compared to normal BMI-children (Mother BMI: Boys OW/OB: $\chi^2 = 186.94$, $p \leq 0.01$; Girls OW/OB: $\chi^2 = 194.99$, $p \leq 0.01$; Father BMI: Boys OW/OB: $\chi^2 = 182.92$, $p \leq 0.05$; Girls OW/OB: $\chi^2 = 174.44$, $p \leq 0.05$).

Mother's education was a risk factor for childhood obesity with less educated mothers having an increased risk of having an obese child, but not in all children's age-groups. Significant odds ratios were found for 6 years (OR 1.34 95%CI 1.03-1.74); 9 years (OR 1.49 95%CI 1.29-248) and 12 years (OR 1.81 95%CI 1.04-2.40); Fathers' education was also associated with an

increased likelihood for childhood obesity. Odds Ratios ranged from 1.35 to 1.79. Mothers education had no found increase likelihood for children being overweight, however fathers education did, with those with lower education levels having the likelihood (6 years = OR 1.20 95%CI 1.02-1.42, 4 years 1.25 95%CI 1.06-1.49).

Portuguese children are also at greater risk of being overweight or obese if their mothers and/or fathers are OW/OB themselves. This likelihood increased as the weight of the parents increased, with the greater likelihood found within obese fathers (OR 4.50 95%CI 3.51-5.77) compared to obese mothers (OR 4.10 95%CI 3.19-5.25). Table 3 outlines that there was a found increased likelihood of obesity if mothers did not take part in regular physical activity (OR 1.30 95%CI 1.04-1.61).

Behavioural Factors

Differences between levels of active play during weekdays were found to be significant ($p \leq 0.01$) in overweight and obese girls compared to normal-BMI girls (OW: $\chi^2 = 28.09$; OB: $\chi^2 = 26.63$; OW/OB: $\chi^2 = 39.80$) ($p \leq 0.01$). When viewing the chi-square differences of all the selected sedentary behaviour variables the differences were all found to be statistically significant for obese boys but only significant *p*-values were only found for TV viewing for girls ($\chi^2 = 15.17$, $p \leq 0.05$). Although not all differences between overweight and normal weight boys were found significant across sedentary behaviours, a significant difference was found across all sedentary behaviours for obese boys. It was found that overweight and obese boys engaged in larger periods of time playing electronic games compared to girls during weekdays (39.7% vs.

14.4%). Boys were found to play more electronic games than girls across all weight categories. Weekends were also found to be periods of the week where more active play, TV viewing, PC viewing and electronic games took place for both sexes. It was found that 70.6% of OW/OB boys played some kind of electronic games compared to their normal weight peers (62%) (χ^2 = 26.79, $p \leq 0.01$). Obese girls played more electronic games than overweight and normal weighted girls; however it was clear that overweight and obese boys played with electronic games for greater of quantities time than girls. Watching TV during meals times was found to occur most frequent for obese boys than overweight and normal weight boys and girls.

Table 4 outlines the statistically significant odds ratios for the logistic models conducted for overweight, obesity and OW/OB and the behavioural factors of physical activity and sedentary behaviours. Key findings were that the likelihood of childhood obesity was significantly increased (OR 3.81 95%CI 1.15-12.66) if the children played on electronic games for more than 4 hours during weekdays, however within this statistic there were only 13 children within the category so this result should be interpreted with prudence. This was also found to be true for electronic games during weekends but the increased likelihood was significant for overweight only, not obesity (OR 1.32 95%CI 1.06-1.64). Watching TV during weekdays was found to have a greater likelihood for children to be overweight and the likelihood increased as daily hours watching TV increased (1hours, OR 1.43 95%CI 1.05-1.96; 2 hours, OR 1.60 95%CI 1.16-2.20). This was evident for the group category of OW/OB but with the added significant likelihood factor of watching TV for 3 hours during a weekdays (OR 1.52 95%CI 1.06-2.16). Obesity had an increased risk to occur when children watched TV while eating meals. This was found for all

number of times a child watched TV while eating, but significant values were found for two meals (OR 1.47 95%CI 1.07-2.01) and four meals (OR 1.41 95%CI 1.04-1.91).

Table 4 presents that the likelihood of obesity is reduced if a child takes part in more active play during weekdays the (< 1hr = OR 0.70 95%CI 0.54-0.90; 1hr = OR 0.68 95%CI 0.51-0.90; 2hr = OR 0.67 95%CI 0.49-0.91; 3hr = 0.39 95%CI 0.23-0.66). The protective effect of 1hr of active play was found to be greater at weekends compared to weekdays for obese children (1hr = 0.51 95%CI 0.30-0.86). Three hours of active play at weekends was also found not to have a higher significant protection to obesity than 3hr in weekdays (3hr = OR 0.40 95%CI 0.21-0.76).

DISCUSSION

The results of this Portuguese national representative study show that the prevalence of OW/OB children was high (27.9%), with girls having greater prevalence of OW/OB than boys (30.6 % vs 25.2%). However, the prevalence changed slightly when compared with the values obtained in 2004 (31.6%; boys 29.3%, girls 33.8%) (Padez et al (2005). Socio-demographic variables (i.e. parents BMI and education level) have a significant risk upon childhood OW/OB. Fathers have as just an important role in a child's likelihood of OW/OB as mothers. Sedentary behaviours, such as screen time viewing and the amount of time children spend engaging in these behaviours, and while eating meals are significant factors. Physical activity during weekdays and weekends were significant protective factors of obesity.

Prevalence of overweight and obesity

Comparing this statistic to other previous measurements it is difficult to state with confidence whether childhood OW/OB levels have changed in Portugal over the last decade. The international association for the study of obesity (IASO, 2013) reports that 28.1% of Portuguese children aged 6-8 years are OW/OB; the organisation for economic co-operation and development (OECD, 2011) concluded that 22.6% of children aged 5-17 years were OW/OB; and Padez *et al* (2005) showed that 31.6% of children aged 7-9.5 years were OW/OB. Reasons for this variance could be inconsistent age ranges of previous statistics in which results in this study are logically comparable to national sample sizes. Despite the discrepancy of findings it is clear that OW/OB is high in Portugal and across Europe particularly in other Mediterranean countries (Italy, Spain and Greece). Children's OW/OB levels of Italy (31.7%), Spain (24.8-27.9%) and Greece (41.1%) along with Portugal are all consistently found to be among the highest of childhood obese nations in Europe and globally (IASO, 2013; OECD, 2011).

Biological Factors

We found statistically significant sex differences for OW/OB. Girls across all ages (3-10 years) were more overweight than boys and generally found to be more obese than boys. This finding is interesting when comparing to other national data sets, with some reports stating that Portuguese boys have greater prevalence of OW/OB than girls (IASO, 2013; OECD, 2011). However sex differences between previous published Portuguese works have shown to differ between studies (Moreira et al, 2007). The findings of the current study are in agreement with Wiisneieski et al (2009) who concluded that sex difference existed between boys and girls' rates of OW/OB (Girls OW/OB > Boys OW/OB). Reasons for this could be due to girls biologically having greater fat

mass, fat distribution and being found to be less physically active than boys. However the relationship between other moderators of OW/OB such as ethnicity and culture being investigated alongside gender are small in study numbers (Owen et al, 2005). Another well-established risk factor of OW/OB that this study found was age which is a well-documented factor across the literature with higher OW/OB being more likely as age increases (Hernandez et al, 1999; Gonzalez-Suarez, 2011; Pereira et al, 2010).

Behaviours of mothers and the choice to smoke during pregnancy and to breastfeed or not, were clearly significant risk factors of childhood obesity. These finding has been documented elsewhere (Owen et al, 2005). This study only included a two choice answer to breastfeeding (yes/no) so therefore a more detailed description and risk association on duration of breastfeeding could not be found like in previous studies (Padez et al, 2005; Ryan, 2007). Clear guidance and promotion of anti-smoking and the encouragement of breastfeeding should be implemented by health professionals to mothers in order to combat many health outcomes associated including childhood obesity.

Socio-Demographic Factors

This study found that OW/OB was associated with parental obesity and educational levels. An obese child was more likely to have parents who were obese and had a lower level of education. This finding has been found previously (Xi et al, 2009; Dannemann et al, 2011; Patterson et al, 1997) however Padez et al (2005) concluded that although parental obesity and educational levels were important associations of Portuguese children's OW/OB, mother's obesity and

educational levels had a greater risk on children's OW/OB than fathers. This conclusion of maternal superiority has previously been well documented in previous work (Whitaker et al, 2010) but this study found that fathers with high BMI and low education had a greater risk upon children's OW/OB than mothers BMI and education. The importance of parental demographics (BMI and educational level) and their risk association to children's OW/OB, reinforces the idea of future interventions targeting the whole family. Previous lifestyle interventions targeted within a family environment have found positive results (Luttikhuis et al, 2009). A major conclusion of this study is that although mothers in Portuguese families are culturally seen to be the parent who takes the role for buying, preparing and serving the food (Padez et al, 2005) fathers have a significant link to childhood obesity and future interventions and research should document and seek the inclusion of fathers, however more research is needed.

Behavioural Factors

Portuguese children watching 1hr and 2hr of TV during weekdays were found to have an increased risk of being overweight. This finding is similar to previous Portuguese research (Padez et al, 2005). This study did not find the same effects for obesity, which is not in accordance with previous Portuguese work which concluded that an increase of TV viewing equals a greater effect upon children's OW/OB (Carvalhal et al, 2007; Hernandez et al, 1999). Much of previous research has mainly concentrated upon TV viewing. This study furthered the scope of sedentary behaviours within a Portuguese sample by measuring personal computer use and electronic games use over weekdays and weekends. Playing electronic games for long periods of time during weekdays (3hr) was associated to childhood obesity, and playing on

electronic games for long periods of time (4hr<) during the weekend was associated to children being overweight. Previous research found similar results (Boyland et al, 2011; IASO, 2013) TV viewing during meal times is reportedly a common behaviour among Portuguese families (Carvalhal et al, 2007). Therefore possible reasons for the link between TV (screen) viewing and obesity such as low levels of energy expenditure (Hancox et al, 2004) increase snacking of unhealthy foods (Rey-Lopez et al, 2011; Liang et al, 2009) and children being subjected to advertising of unhealthy products (Halford et al, 2008; Boyland et al, 2011) could well be factors especially as this study adds strength to the argument as watching TV while consuming food during meal times was also a significant factor to childhood obesity.

Physical activity in the form of active play was found to protective behaviour against childhood obesity. The more active the child the greater the protection against obesity. Similar findings, have previously reported Trost et al, 2001; Hernandez et al, 1999; Gonzalez-Suarez & Grimmer-Somers, 2011; Pereira et al, 2010). Taking part in 1 hour of active play at weekends had a greater protective effect than 1hr of active play during weekdays. This finding is of interest as the current international physical activity guidelines for children is to take part in 1 hour of moderate to vigorous physical activity every day (World Health Organisation, 2010). With the added protection of physical activity taking place during weekends, which do not have time restraints for physical activity found during weekdays (school), along with the found increase prevalence of sedentary behaviours during weekends, this study supports the view of past research that weekends offer an opportunity for future physical activity promotions/interventions to take place (Aznar et al, 2010). This will help combat the epidemic of childhood obesity while also

providing the health benefits that regular physical activity independently of reducing obesity can provide (World Health Organisation, 2010).

Like all investigations this study has limitations. Self-reported data is well established to have problems of bias, reliability and validity especially within complex behaviours such as physical activity and sedentary behaviour (Shephard, 2003).The nature of the questionnaire being sent home and filled out by parents could lead to one parent completing the questionnaire on behalf of both parents. The questionnaire also asked about individual screen time behaviour therefore multi-screen use data was not available, such as using a laptop or games device while watching the television (Jago et al, 2012). A final limitation is the term "active play". Active play has no standard definition across academics (Brockman et al, 2011) therefore it could be suggested that parents who completed the questionnaires and reported the level of active play for children, could well have a different definition of active play to another parent and family, therefore results of active play/physical activity should be viewed with caution. Even with the discussed limitations, this study has strong statistical strength because it is a nationally stratified representative study of Portugal with large numbers of children within all 18 districts of mainland Portugal.

In conclusion, this study found that childhood OW/OB in Portugal is high, with the prevalence being higher in girls than in boys. Child's age, maternal smoking during pregnancy and no breastfeeding are significant biological risk factors. Both mothers and fathers education level and BMI are risk factors for childhood OW/OB along with sedentary behaviours such as TV, PC use and, especially for boys playing electronic games. Physical activity (active play) was found to

have a protective dose response to obesity, with greater protection found during weekends. Future research should investigate the sex differences between different districts, look to implement the use of objective measures of physical activity and sedentary behaviours, and future interventions should take note of the importance of breastfeeding, mothers not smoking during pregnancy, maternal and paternal weight status, education level, physical activity levels and the importance of sedentary behaviours especially while eating meals and the increase use during weekends, particularly in boys.

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Table 1: Prevalence of normal, overweight and obese Portuguese children by age and sex.

Age(y)	n	Normal %(n)	Overweight %(n)	Obese %(n)	Overweight + Obese (n)
3					
Boys	256	83.2 (213)	13.3 (34)	3.5 (9)	16.8 (43)
Girls	247	82.2 (203)	15 (37)	2.8 (7)	17.8 (44)
Total	503	82.7 (416)	14.1 (71)	3.2 (16)	17.3 (87)
			$\chi^2 = 0.267$, $p = 0.61$	$\chi^2 = 0.190$, $p = 0.66$	$\chi^2 = 0.91$, $p = 0.76$
3.5					
Boys	427	54.1 (372)	9.6 (41)	3.3 (14)	12.9 (55)
Girls	406	77.6 (315)	16.3 (66)	6.2 (25)	22.6 (91)
Total	833	82.5 (687)	12.8 (107)	4.7 (39)	17.5 (146)
			$\chi^2 = 9.296$, $\mathbf{p \leq 0.05}$	$\chi^2 = 3.865$, $p \leq 0.05$	$\chi^2 = 13.085$, $p \leq 0.01$
4					
Boys	510	82.2 (419)	14.3 (73)	3.5 (18)	17.8 (91)
Girls	504	73.8 (372)	19.4 (98)	6.7 (34)	26.2 (131)
Total	1014	78(791)	16.9 (171)	5.1 (52)	22.0 (223)
			$\chi^2 = 5.948$, $p \leq 0.05$	$\chi^2 = 5.391$, $p \leq 0.05$	$\chi^2 = 10.296$, $p \leq 0.01$
4.5					
Boys	546	81.9 (447)	12.6 (69)	5.5 (30)	18.1 (99)
Girls	510	71.4 (364)	22.7 (116)	5.9 (30)	28.6 (146)
Total	1056	76.8 (811)	17.5 (185)	5.7 (60)	23.2 (245)
			$\chi^2 = 19.159$, $p \leq 0.01$	$\chi^2 = 0.074$, $p = 0.79$	$\chi^2 = 16.302$, $p \leq 0.01$
5					
Boys	570	77.9 (444)	14.9 (85)	7.2 (41)	22.1 (126)
Girls	587	69.7(409)	20.3 (119)	10.1 (59)	30.3 (178)
Total	1157	73.7 (853)	17.6 (204)	8.6 (100)	26.3 (304)
			$\chi^2 = 7.102$, $p \leq 0.01$	$\chi^2 = 2.992$, $p = 0.08$	$\chi^2 = 10.083$, $p \leq 0.01$
5.5 years					
Boys	586	77.0 (451)	16.6 (97)	6.5 (38)	23.1 (135)
Girls	610	70.7 (431)	18.2 (111)	11.1 (68)	29.3 (179)
Total	1196	73.7 (882)	17.4 (208)	8.9 (106)	26.3 (314)
			$\chi^2 = 1.363$, $p = 0.24$	$\chi^2 = 8.045$, $p \leq 0.01$	$\chi^2 = 6.140$, $p \leq 0.05$
6					
Boys	528	76.3 (403)	15.3 (81)	8.3 (44)	23.7 (125)
Girls	493	71.0 (350)	20.1 (99)	8.9 (44)	29.0 (143)
Total	1021	73.8 (753)	17.6(180)	8.6 (88)	26.2 (268)
			$\chi^2 = 4.223$, $p \leq 0.05$	$\chi^2 = 0.113$, $p = 0.74$	$\chi^2 = 3.744$, $p = 0.53$
6.5 years					
Boys	603	75.8 (457)	16.7 (101)	7.5 (45)	24.1 (146)
Girls	700	67.9 (475)	21.6 (151)	10.6 (74)	32.2 (225)
Total	1303	71.5 (932)	19.3 (252)	9.1 (119)	28.5 (371)
			$\chi^2 = 6.384$, $p \leq 0.05$	$\chi^2 = 3.773$, $p = 0.052$	$\chi^2 = 10.004$, $p \leq 0.01$
7					
Boys	708	73.3 (519)	18.6 (132)	8.1 (57)	26.7 (189)
Girls	696	70 (487)	20.3 (141)	9.8 (68)	30.0 (209)
Total	1404	71.7 (1006)	19.4 (273)	8.9 (125)	28.3 (398)
			$\chi^2 = 0.901$, $p = 0.34$	$\chi^2 = 1.279$, $p = 0.26$	$\chi^2 = 1.920$, $p = 0.17$
7.5 years					
Boys	676	73.7 (498)	17.5 (118)	8.9 (60)	26.4 (178)
Girls	659	66.5 (438)	22.8 (150)	10.8 (71)	33.5 (221)
Total	1335	70.1 (936)	20.1 (268)	9.8 (131)	25.4 (339)
			$\chi^2 = 7.020$, $p \leq 0.01$	$\chi^2 = 1.359$, $p = 0.24$	$\chi^2 = 8.265$, $p \leq 0.01$
8					
Boys	643	70.5 (453)	19.9 (128)	9.6 (62)	29.5 (190)
Girls	650	67.5 (439)	23.8 (155)	8.6 (56)	32.5 (211)
Total	1293	69 (892)	21.9 (283)	9.1 (118)	31.0 (401)
			$\chi^2 = 2.652$, $p = 0.10$	$\chi^2 = 0.411$, $p = 0.52$	$\chi^2 = 1.282$, $p = 0.26$
8.5 years					
Boys	717	66.8 (479)	25.2 (181)	7.9 (57)	33.2 (238)
Girls	720	63.1 (454)	26.9 (194)	10 (72)	36.9 (268)
Total	1437	64.9 (933)	26.1 (375)	9 (129)	35.1 (504)
			$\chi^2 = 1.011$, $p = 0.32$	$\chi^2 = 1.848$, $p = 0.17$	c2 = 2.219, $p = 0.14$
9					
Boys	705	67.9 (479)	22.8 (161)	9.2 (65)	32.1 (226)
Girls	817	65.0 (531)	26.2 (214)	8.8 (72)	35.0 (286)
Total	1522	66.4 (1010)	24.6 (375)	9 (137)	33.6 (512)
			$\chi^2 = 2.220$, $p = 0.136$	$\chi^2 = 0.077$, $p = 0.78$	$\chi^2 = 1.475$, $p = 0.23$
9.5					
Boys	597	69.7 (416)	19.9 (119)	10.4 (62)	30.3 (181)
Girls	709	69.3 (491)	21.3 (151)	9.4 (67)	30.7 (218)
Total	1306	69.4 (907)	20.7 (270)	9.9 (129)	30.5 (399)
			$\chi^2 = 0.269$, $p = 0.60$	$\chi^2 = 0.319$, $p = 0.57$	$\chi^2 = 0.28$, $p = 0.87$
10					
Boys	383	72.1 (276)	20.4 (78)	7.6 (29)	27.9 (107)
Girls	373	71 (265)	22 (82)	7 (26)	29.0 (108)
Total	756	71.6 (541)	21.2 (160)	7.3 (55)	28.4 (215)
			$\chi^2 = 0.269$, $p = 0.61$	$\chi^2 = 0.101$, $p = 0.75$	$\chi^2 = 0.096$, $p = 0.76$
Boys Total	8455	74.8 (6326)	17.7 (1498)	7.5 (631)	25.2 (2129)
Girls Total	8681	69.4 (6024)	21.7 (1884)	8.9 (773)	30.6 (2657)
TOTAL	17136	72.1 (12350)	19.7 (3382)	8.2 (1404)	27.9 (4786)

Table 2: Biological predictors of overweight and obesity of Portuguese children aged 3-10 years.

MODEL 1	Overweight			Obese			OW/OB		
Factors	OR	95%CI	*p*	OR	95%CI	*P*	OR	95%CI	*P*
Decimal Age	1.11	1.10-1.13	$p \leq 0.01$	1.10	1.07-1.14	$p \leq 0.01$	1.10	1.08-1.13	$p \leq 0.01$
Sex									
Male (Reference)	1.00			1.00			1.00		
Female	1.32	1.22-1.43	$p \leq 0.01$	1.40	1.24-1.58	$p \leq 0.01$	1.35	1.25-1.45	$p \leq 0.01$
Smoke									
No (Reference)	1.00			1.00			1.00		
Yes	1.31	1.16-1.46	$p \leq 0.01$	1.52	1.30-1.78	$p \leq 0.01$	1.36	1.23-1.51	$p \leq 0.01$
Breastfeed									
Yes (Reference)	1.00			1.00			1.00		
No	1.06	0.94-1.20	ns	1.49	1.27-1.75	$p \leq 0.01$	1.18	1.06-1.31	$p \leq 0.01$

Table 3: Parental predictors of overweight and obesity of Portuguese Children aged 3-10 years.

MODEL 2	Overweight			Obese			OW/OB		
Factors	OR	95%CI	*P*	OR	95%CI	*P*	OR	95%CI	*P*
Decimal Age	1.12	1.10-1.16	$p \leq 0.01$	1.11	1.07-1.16	$p \leq 0.01$	1.12	1.10-1.15	$p \leq 0.01$
Sex									
Male (Reference)	1.00			1.00			1.00		
Female	1.27	1.14-1.41	$p \leq 0.01$	1.28	1.09-1.52	$p \leq 0.01$	1.28	1.16-1.41	$p \leq 0.01$
Mother Education									
University (Reference)	1.00			1.00			1.00		
12 Years	1.03	0.69-1.53	ns	1.81	1.15-2.84	$p \leq 0.01$	1.20	0.85-1.69	ns
9 Years	0.93	0.6-1.25	ns	1.49	1.08-2.07	$p \leq 0.05$	1.60	0.81-1.37	ns
6 Years	0.94	0.74-1.20	ns	1.34	1.03-1.74	$p \leq 0.05$	1.02	0.82-1.26	ns
4 Years (Primary)	0.91	0.73-1.13	ns	1.22	0.94-1.59	ns	0.97	0.80-1.17	ns
Father Education									
University (Reference)	1.00			1.00			1.00		
12 Years	1.26	0.95-1.67	ns	1.58	1.04-2.40	$p \leq 0.05$	1.43	1.11-1.83	$p \leq 0.01$
9 Years	1.08	0.87-1.33	ns	1.79	1.29-2.48	$p \leq 0.01$	1.29	1.07-1.55	$p \leq 0.01$
6 Years	1.20	1.02-1.42	$p \leq 0.01$	1.35	1.1-1.79	$p \leq 0.05$	1.24	1.07-1.44	$p \leq 0.01$
4 Years (Primary)	1.25	1.06-1.49	$p \leq 0.01$	1.51	1.13-2.02	$p \leq 0.01$	1.31	1.12-1.52	$p \leq 0.01$
Mother Obesity (BMI)									
Normal (Reference)	1.00			1.00			1.00		
Underweight	0.44	0.28-0.70	$p \leq 0.01$	0.62	0.30-1.28	ns	0.48	0.32-0.71	$p \leq 0.01$
Overweight	1.43	1.26-1.62	$p \leq 0.01$	1.93	1.60-2.34	$p \leq 0.01$	1.54	1.38-1.73	$p \leq 0.01$
Obese	1.65	1.33-20.5	$p \leq 0.01$	4.10	3.19-5.25	$p \leq 0.01$	2.24	1.87-2.69	$p \leq 0.01$
Father Obesity (BMI)									
Normal (Reference)	1.00			1.00			1.00		
Underweight	1.32	0.43-4.01	ns	na	na	na	1.04	0.34-3.17	ns
Overweight	1.53	1.36-1.72	$p \leq 0.01$	2.17	1.76-2.66	$p \leq 0.01$	1.65	1.49-1.84	$p \leq 0.01$
Obese	2.02	1.69-2.41	$p \leq 0.01$	4.50	3.51-5.77	$p \leq 0.01$	2.55	2.19-2.98	$p \leq 0.01$
Mother Physical Activity									
Yes (Reference)	1.00			1.00			1.00		
No	1.08	0.95-1.23	ns	1.30	1.04-1.61	$p \leq 0.05$	1.12	0.10-1.26	ns

Table 4: Behavioural predictors of overweight and obesity of Portuguese Children aged 3-10 years.

Factors	OR	95%CI	*p*	OR	95%CI	*p*	OR	95%CI	*p*
Decimal Age	1.12	1.08-1.16	$p \leq 0.01$	1.12	1.06-1.16	$p \leq 0.01$	1.13	1.09-1.16	$p \leq 0.01$
Sex									
Male (Reference)	1.00			1.00			1.00		
Female	1.30	1.14-1.47	$p \leq 0.01$	1.10	0.91-1.33	ns	1.25	1.12-1.39	$p \leq 0.01$
Electronic Weekdays									
None (Reference)	1.00			1.00			1.00		
<1hr	1.06	0.88-1.28	ns	1.09	0.87-1.37	ns	1.14	0.96-1.35	ns
1hr	1.05	0.74-1.49	ns	1.22	0.81-1.83	ns	1.20	0.88-1.63	ns
2hr	0.83	0.41-1.67	ns	1.79	0.89-3.63	ns	1.21	0.68-2.14	ns
3hr	1.38	0.39-4.85	ns	3.81	1.15-12.66	$p \leq 0.05$	2.11	0.75-5.93	ns
4hr <	1.83	0.17-20.20	ns	na	na	na	2.40	0.24-24.28	ns
Electronic Weekends									
None (Reference)	1.00			1.00			1.00		
<1hr	0.97	0.73-1.29	ns	0.67	0.41-1.10	ns	0.89	0.68-1.15	ns
1hr	1.07	0.92-1.25	ns	0.83	0.64-1.07	ns	1.05	0.91-1.20	ns
2hr	0.86	0.70-1.07	ns	0.70	0.50-0.98	ns	0.88	0.72-1.06	ns
3hr	1.48	0.97-2.27	ns	0.55	0.25-1.24	ns	1.29	0.87-1.92	ns
4hr <	1.32	1.06-1.64	$p \leq 0.05$	0.71	0.48-1.05	ns	1.26	1.03-1.53	$p \leq 0.05$
TV Weekdays									
None (Reference)	1.00			1.00			1.00		
<1hr	1.27	0.93-1.72	ns	1.01	0.61-1.67	ns	1.22	0.93-1.60	ns
1hr	1.43	1.05-1.96	$p \leq 0.05$	1.24	0.73-2.11	ns	1.46	1.10-1.92	$p \leq 0.05$
2hr	1.60	1.16-2.20	$p \leq 0.01$	1.34	0.77-2.32	ns	1.67	1.26-2.21	$p \leq 0.01$
3hr	1.43	0.96-2.14	ns	1.18	0.61-2.28	ns	1.52	1.06-2.16	$p \leq 0.05$
4hr	1.03	0.50-2.13	ns	1.58	0.63-3.95	ns	1.42	0.79-2.57	ns
5hr <	0.86	0.27-2.74	ns	1.85	0.51-6.71	ns	1.31	0.54-3.21	ns
TV Meal Time									
Never (Reference)	1.00			1.00			1.00		
One Meal	1.07	0.86-1.33	ns	1.33	0.94-1.89	ns	1.13	0.93-1.37	ns
Two Meal	1.07	0.88-1.30	ns	1.47	1.07-2.01	$p \leq 0.05$	1.16	0.97-1.38	ns
Three Meal	1.13	0.93-1.39	ns	1.20	0.86-1.67	ns	1.15	0.96-1.38	ns
Four Meal	1.07	0.88-1.30	ns	1.41	1.04-1.91	$p \leq 0.05$	1.15	1.36	ns
PC Weekdays									
None (Reference)	1.00			1.00			1.00		
< 1hr	0.90	0.80-1.03	ns	0.78	0.63-0.97	ns	0.89	0.79-1.00	ns
1hr	0.67	0.52-0.88	$p \leq 0.01$	0.77	0.52-1.22	ns	0.73	0.58-0.92	$p \leq 0.01$
2hr	0.76	0.48-1.21	ns	0.64	0.32-1.27	ns	0.80	0.53-1.20	ns
3hr	0.75	0.16-3.63	ns	1.47	0.33-6.54	ns	1.24	0.39-3.92	ns
4hr <	2.04	0.55-7.57	ns	na	na	na	1.27	0.35-4.68	ns
Active Play Weekdays									
None (Reference)	1.00			1.00			1.00		
<1hr	0.9	0.75-1.08	ns	0.70	0.54-0.90	$p \leq 0.01$	0.83	0.72-0.96	$p \leq 0.01$
1hr	0.84	0.69-1.03	ns	0.68	0.51-0.90	$p \leq 0.01$	0.77	0.66-0.90	$p \leq 0.01$
2hr	0.95	0.77-1.17	ns	0.67	0.49-0.91	$p \leq 0.05$	0.85	0.72-1.00	$p \leq 0.05$
3hr	0.76	0.56-1.04	ns	0.39	0.23-0.66	$p \leq 0.01$	0.63	0.49-0.80	$p \leq 0.01$
4hr	0.71	0.41-1.12	ns	0.71	0.33-1.52	ns	0.62	0.42-0.93	$p \leq 0.05$
5hr <	0.91	0.58-1.42	ns	0.95	0.53-1.69	ns	0.91	0.65-1.38	ns
Active Play Weekends									
None (Reference)	1.00			1.00			1.00		
<1hr	1.15	0.60-2.19	ns	0.80	0.36-1.78	ns	0.79	0.49-1.29	ns

1hr	1.19	0.76-1.88	ns	0.51	0.30-0.86	$p \leq 0.01$	0.81	0.59-1.11	ns
2hr	1.25	0.79-1.97	ns	0.71	0.42-1.20	ns	0.96	0.70-1.31	ns
3hr	1.33	0.81-2.16	ns	0.40	0.21-0.76	$p \leq 0.01$	0.83	0.58-1.19	ns
4hr	1.23	0.79-1.93	ns	0.65	0.39-1.07	ns	0.88	0.65-1.20	ns
5hr <	1.37	0.88-2.12	ns	0.65	0.39-1.06	ns	0.92	0.68-1.25	ns

ns = non-significant ($p > 0.05$); na = not available (small frequency of variable)