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

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1 **TITLE PAGE**

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

4

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29 None

30

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32 DDB did the statistical analyses and data cleaning supervised by MIVS and wrote the first draft.

33 All authors contributed to the interpreting the results, and to the discussion. All authors revised  
34 the article and approved the final manuscript.

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47 **Abstract**

48  
49 **Objectives:** Childhood obesity is a public health concern in Portugal. Socio-demographic and  
50 behavioural factors are highly associated with obesity but are not clearly understood. This paper  
51 aims to update the prevalence of overweight and obesity in Portuguese children and to explore  
52 the influence and risks of socio-demographic factors and behavioural factors.

53  
54 **Methods:** A cross-sectional study of Portuguese children aged 3-10 years from all 18 mainland  
55 districts took place between March 2009 and January 2010. 17,136 (8455 boys; 8681 girls).  
56 Height, weight and other anthropometric measurements were obtained by trained technicians.  
57 Body Mass Index (BMI) was calculated along with other anthropometric variables. Data  
58 analyses took place between April and September 2012. The overweight/obesity classification  
59 was established by age-and sex-specific BMI cut-off points as defined by the International  
60 Obesity Task Force (IOTF). Parents completed questionnaires about socio-demographic and  
61 behavioural characteristics of the family.

62  
63 **Results:** Almost 28% of the Portuguese children were overweight or obese (19.7% overweight;  
64 8.2% obese). Prevalence was greater in girls than in boys. Logistic regression models found that  
65 the odds of childhood obesity were significantly affected by biological, socio-demographic and  
66 behavioural factors.

67  
68 **Conclusions:** The protective factors against childhood overweight/obesity in this sample of  
69 Portuguese children are: i) being male; ii) having been breastfeed; iii) having been born from

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

74

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

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93 **INTRODUCTION**

94

95 Overweight and obesity (OW/OB) have significantly increased over the last 25 years and have  
96 been described as a public health epidemic (World Health Organisation, 1998). OW/OB are  
97 terms used to describe an excess of adiposity (fatness) above the ideal for good health (Waters et  
98 al, 2011). Obesity increases the risk of a number of non-communicable diseases such as  
99 cardiovascular disease (CVD) (Mokdad et al, 2003), type II diabetes (Hirani et al, 2008), cancer  
100 (Calle et al, 2003), respiratory disease (Barranco et al, 2012), high cholesterol (Mokdad et al,  
101 2003; Ko et al, 2001) and high blood pressure (Mokdad et al, 2003). Populations in developed  
102 and in many developing nations are increasingly becoming obese, particularly children. The  
103 seriousness of childhood obesity is increased by past evidence reporting that once obesity has  
104 been established, at a younger age, it is difficult to be reversed later in life (Waters et al, 2011;  
105 Luttikhuis et al, 2009; Singh et al, 2008; Field et al, 2005). The problem is aggravated due to the  
106 increasingly onset of type II diabetes *mellitus* occurring in younger ages when compared to 25  
107 years ago, and obesity is stated as a major determinant (Rosenbloom et al, 2000). Obese children  
108 are also likely to experience negative stereotyping such as perceptions of poor health, academic  
109 and social uselessness, poor hygiene and idleness (Hill & Silver, 1995; Thiel et al, 2008). Obese  
110 children may also experience negative emotional and psychological states such as nervousness,  
111 sadness and loneliness (Strauss, 2000). Finally, they are more likely to become victims of  
112 bullying and to engage in unhealthy behaviours such as smoking tobacco and/or cannabis (Farhat  
113 et al, 2010).

114

115 Overweight/obesity occurs when there is a consistent positive energy imbalance over a sustained  
116 period of time. A review by Lobstein et al (2004) describes that a variety of factors such as  
117 behavioural (physical activity, diet, sedentary lifestyle), cultural, genetic, environmental and  
118 economic have been associated in obesity's development. These factors are interchangeable and  
119 therefore complex. Like in most developed countries, childhood OW/OB is a public health  
120 concern in Portugal. Padez et al (2005) investigated the prevalence and risk factors for obesity  
121 of 7 to 9.5 year old children in a national representative sample and found alarming rates. More  
122 specifically, the prevalence of overweight, obesity and combined overweight+obesity were,  
123 respectively, 20,3%, 11,3% and 31,6%. It was found that parental obesity and educational levels  
124 were the most significant risk factors of children's obesity. In the same study, it was concluded  
125 that maternal obesity had a stronger link to OW/OB compared to paternal obesity and suggested  
126 that this is unsurprising due to the cultural factor of Portuguese mothers being the parent who is  
127 usually responsible for important lifestyle factors such as buying, preparing, and serving food for  
128 the family. Also, a review by Moreira (2007) found that the reported prevalences of obesity  
129 would differ from one region of the country to another. , These findings are consistent with  
130 results from other studies in different ethnicities (Xi et al, 2009; Dannemann et al, 2011;  
131 Patterson et al, 1997).

132  
133 Sedentary behaviour is defined as any waking behaviour characterised by energy expenditure  
134 below 1.5 MET while sitting or reclining posture (Sedentary Behaviour Research Network,  
135 2012). Padez et al (2005) reported that TV viewing was a risk factor OW/OB in children. One  
136 reason is the low level of energy that is expended while watching TV (Hancox et al, 2004).  
137 However, it has also been shown that engaging in TV viewing could lead to increased snacking

138 on unhealthy foods while abstaining from healthy foods (i.e. fruit and vegetables) (Re-lopez et  
139 al, 2011; Liang et al, 2009). Another possible reason for the link between TV viewing and  
140 obesity is that children could be subjected to the advertising of unhealthy products that could  
141 potentially lead to obesity (Halford et al, 2008; Boyland et al, 2011). Sedentary behaviours of  
142 children are, however, more than just TV viewing. With the increase popularity of electronic  
143 games and personal computers and laptops these are behaviours that are important to explore.  
144 Carvalhal et al (2007) investigated the association between physical activity, TV, video games  
145 and obesity in 3365 Portuguese children. The study found similar results of TV viewing to that  
146 of Padez et al (2005), indicating that the longer children watched TV the greater the risk of  
147 obesity. Both boys and girls were found not to use computers very often. However, boys played  
148 electronic games for longer periods than girls and there was a moderate relationship between  
149 electronic games and obesity levels.

150  
151 Physical activity is defined as any bodily movement produced by skeletal muscles that results in  
152 energy expenditure (Caspersen et al, 1985). Low levels of physical activity have widely been  
153 documented as a major determinant of childhood OW/OB. Previous research including  
154 Portuguese studies have found evidence of an association between physical activity and obesity  
155 (Troost et al, 2001; Hernandez et al, 1999; Gonzalez-Suarez & Grimmer-Somers, 2011; Pereira et  
156 al, 2010; Guerra et al, 2006). However, other studies have found no association (Padez et al,  
157 2005; Carvalhal et al, 2007; Martins et al, 2010). Past physical activity interventions have shown  
158 that although physical activity could possibly not reduce obesity levels, physical activity can  
159 maintain and delay the onset of obesity (Gonzalez-Saurez et al, 2009).The lack of clarity  
160 between the association of physical activity and obesity is that physical activity is a complex



161 behaviour; that has many different determinants and correlates that vary from gender, to age, to  
162 context and environmental (Sallis et al, 2000; Van der horst et al, 2007; Ferreira et al, 2007;  
163 Mota et al, 2002).

164  
165 This study builds upon the study published by Padez et al (2005). It adds subjective  
166 measurements of activity and it covers a statistically representative sample of the Portuguese  
167 population stratified by sex, age and districts. Therefore, the impact of socio-demographic  
168 factors (age, sex, parental factors, parental behaviours, birthweight, and maternal smoking during  
169 pregnancy), and behavioural factors (physical activity/active play, TV viewing, electronic games  
170 use, computer use) can be better contextualised.

171  
172 This study has two short-term aims and one long-term aim.

173 The two short-term aims are:

- 174 a) To review and update the prevalence of OW/OB in Portuguese children nationally;
- 175 b) to explore the influence and risk that socio-demographic factors and behavioural factors  
176 have upon OW/OB in Portuguese children.

177  
178 The long-term aim is:

- 179 a) to provide an accurate record of the basic health, nutritional status and living conditions  
180 of the Portuguese children and their children as of the beginning of 2010. The year of  
181 2010 is of crucial importance because it marks the onset of the socio-economic and  
182 political crisis that has hit Portugal. According to PORDATA (The National Database of  
183 Portugal - <http://www.pordata.pt/en/Home>), most of the indicators on basic demography,

184 health, living conditions and unemployment rates have been declining steeply since 2010.  
185 These changes are expected to intensify and linger for the next decade. This fact makes  
186 this survey a reference that shows the biosocial status of the Portuguese population before  
187 the sociopolitical and economical changes start being reflected on the health of the  
188 people. Any survey conducted after this one should take this paper in consideration and  
189 use the results presented here as the baseline results gathered at the beginning of a crisis  
190 that will have countless effects on the health and living conditions of the Portuguese  
191 people for decades to come. A personal observation by one of the co-authors shows the  
192 multiplication of “soup/kitchens” all over Portugal during 2012-2013. By mid-2013,  
193 several primary schools are starting to supply one hot/meal per day during the weekends.

194

## 195 **METHODS**

196

### 197 Participants and Settings

198 The total number of children was 17,509. The children were from all mainland Portuguese  
199 districts but not from the Portuguese Archipelagos (Madeira and Azores). Data were collected  
200 between March 2009 and January 2010 in public and private Portuguese schools. The studied  
201 population was selected by means of proportionate stratified random sampling taking into  
202 account the district and the number of children by age and sex in each district. Participation rate  
203 was 57.4% (49.3% in preschool children and 63.6% in school children). Due to insufficient  
204 number of participations younger than 3 and older than 10 years, and for those missing data on  
205 body mass index (BMI) data, the final number of participations for data analyses was 17,136.  
206 The study protocol was approved by Direcção Geral de Inovação e Desenvolvimento Curricular

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

210

## 211 Measures

212 Trained technicians performed anthropometric measurements using standardised procedures  
213 (Lohman et al, 1988) within each of the schools. Height was measured using a stadiometer with  
214 the head positioned according to the Frankfort plane and weight was measured via an electronic  
215 scale with a precision of 100g. BMI was calculated as  $\text{weight}/\text{height}^2$  ( $\text{kg}/\text{m}^2$ ). The definitions of  
216 OW/OB for children were based on average centiles in accordance to the IOTF's age specific  
217 BMI cut-off points (Cole et al, 2000). For the adults (parents), overweight was defined as a  
218 BMI's of 25.0-29.9  $\text{kg}/\text{m}^2$  (obesity as a BMI of 30  $\text{kg}/\text{m}^2$  (obese) (World Health Organisation,  
219 1998).

220

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

230 urbanization (urban, semi-urban, and rural); electronic games weekdays/weekends (none, <1h,  
231 1h, 2h, 3h, 4h, 5h <); personal computer (PC) use weekdays/weekends (none, <1h, 1h, 2h, 3h,  
232 4h, 5h<); television (TV) weekdays/weekends (none, <1 h, 1 h, 2 h, 3 h, 4 h, 5h<); physical  
233 activity in school (0-30min, 30-60min, 60-90min, 90-120min, 120-150min, 150min <); watching  
234 TV during meal times (never, only at weekend, 1 to times/week, 2 to 3 times/week, every day);  
235 active play weekdays/weekends (none, <1h, 1h, 2h, 3h, 4h, 5h<). Active play was used as an  
236 umbrella term for all physical activity done by the child as reported by the parents.

237

### 238 Data Analyses

239

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

253 analyses were performed using the Statistical Package for the Social Sciences (SPSS/PC-),  
254 version 19.0; SPSS Inc., Chicago, IL, USA).

255

## 256 **RESULTS**

257

### 258 Prevalence of overweight and obesity (OW/OB)

259

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

264

265

### 266 Biological Factors

267

268 Sex differences were found across all age groups, with girls being more OW/OB than boys. Chi-  
269 square ( $\chi^2$ ) difference tests shows that these sex differences were significant across the ages 3.5y,  
270 4.0y, 4.5y, 5.0y, 5.5y, 6.5y and 7.5y. Tables 2-4 present results of the logistic regression models.  
271 Table 2 outlines the biological risk factors that were significantly associated with OW/OB of  
272 Portuguese children. It was found that age and sex (male= reference) were significant risks for  
273 being overweight and obese. This was found across all three logistic regression models (Table 4,  
274 Table 5).

275

276 Two other biological factors- “maternal smoking during pregnancy” and “breastfeeding”- were  
277 also significant predictors of OW/OB. Maternal smoking during pregnancy increased the odds of  
278 obesity among the children (OR 1.52 95%CI 1.30-1.78) and, in a smaller degree, also increased  
279 the odds of child overweight (OR 1.31 95%CI 1.16-1.46). Table 2 outlines that being older,  
280 female, with a mother who smoked during pregnancy, and not being breastfed increased the odds  
281 of being OW/OB.

282

### 283 Socio-Demographic Factors

284

285 Chi-square difference results of parental factors (father and mother) by weight status and sex  
286 found that normal weight (boys and girls) had parents with higher paid occupations. This was  
287 also found to be evident for educational level for parents. It was also clearly found that children  
288 who were OW/OB had parents with higher BMI’s compared to normal BMI-children (Mother  
289 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:  
290 Boys OW/OB:  $\chi^2 = 182.92, p \leq 0.05$ ; Girls OW/OB:  $\chi^2 = 174.44, p \leq 0.05$ ).

291

292 Mother’s education was a risk factor for childhood obesity with less educated mothers having an  
293 increased risk of having an obese child, but not in all children’s age-groups. Significant odds  
294 ratios were found for 6 years (OR 1.34 95%CI 1.03-1.74); 9 years (OR 1.49 95%CI 1.29-2.48)  
295 and 12 years (OR 1.81 95%CI 1.04-2.40); Fathers’ education was also associated with an  
296 increased likelihood for childhood obesity. Odds Ratios ranged from 1.35 to 1.79. Mother  
297 education was not associated with an increased likelihood for children being overweight,

298 however fathers education did, with those with lower education levels having the likelihood (6  
299 years = OR 1.20 95%CI 1.02-1.42, 4 years 1.25 95%CI 1.06-1.49).

300  
301 Portuguese children are also at greater risk of being overweight or obese if their mothers and/or  
302 fathers are OW/OB themselves. This likelihood increased as the weight of the parents increased,  
303 with the greater likelihood found within obese fathers (OR 4.50 95%CI 3.51-5.77) compared to  
304 obese mothers (OR 4.10 95%CI 3.19-5.25). Table 3 outlines that there was an increased  
305 likelihood of childhood obesity if mothers did not take part in regular physical activity (OR 1.30  
306 95%CI 1.04-1.61).

307  
308 Behavioural Factors

309  
310 Differences between levels of active play during weekdays were found to be significant ( $p \leq$   
311 0.01) in overweight and obese girls compared to normal-BMI girls (OW:  $\chi^2 = 28.09$ ; OB:  $\chi^2 =$   
312 26.63; OW/OB:  $\chi^2 = 39.80$ ) ( $p \leq 0.01$ ). When viewing the chi-square differences of all the  
313 selected sedentary behaviour variables the differences were all found to be statistically  
314 significant for obese boys; the only significant p-values for girls were for TV viewing ( $\chi^2 =$   
315 15.17,  $p \leq 0.05$ ). Although not all differences between overweight and normal weight boys were  
316 significant across sedentary behaviours and a significant difference was found across all  
317 sedentary behaviours for obese boys. It was found that overweight and obese boys engaged in  
318 larger periods of time playing electronic games compared to girls during weekdays (39.7% vs.  
319 14.4%). Boys were found to play more electronic games than girls across all weight categories.  
320 Weekends were also found to be periods of the week where more active play, TV viewing, PC

321 viewing and electronic games took place for both sexes. It was found that 70.6% of OW/OB  
322 boys played some kind of electronic games compared to 62% of their normal weight peers ( $\chi^2 =$   
323 26.79,  $p \leq 0.01$ ). Obese girls played more electronic games than overweight and normal  
324 weighted girls; however it was clear that overweight and obese boys played with electronic  
325 games for greater quantities of time than girls. Watching TV during mealtimes was found to  
326 occur most frequently for obese boys than overweight and normal weight boys and girls.

327 Table 4 outlines the statistically significant odds ratios for the logistic models conducted for  
328 overweight, obesity and OW/OB and the influence of physical activity and sedentary behaviours.  
329 Key findings were that the likelihood of childhood obesity was significantly increased (OR 3.81  
330 95%CI 1.15-12.66) if the children played on electronic games for more than 4 hours during  
331 weekdays, however within this statistic there were only 13 children within the category so this  
332 result should be interpreted with caution. This was also found to be true for electronic games  
333 during weekends but the increased likelihood was significant for overweight only, not obesity  
334 (OR 1.32 95%CI 1.06-1.64). Watching TV during the weekdays was associated with a greater  
335 likelihood for children to be overweight and the likelihood increased as daily hours watching  
336 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  
337 evident for the group category of OW/OB and there was additional significance for watching TV  
338 for 3 hours during a weekday (OR 1.52 95%CI 1.06-2.16). Obesity had an increased risk to  
339 occur when children watched TV while eating meals. This was found for all number of times a  
340 child watched TV while eating, but significant values were found for two meals (OR 1.47 95%CI  
341 1.07-2.01) and four meals (OR 1.41 95%CI 1.04-1.91).

342



343 Table 4 illustrates the reduced likelihood of obesity if a child takes part in more active play  
344 during weekdays (< 1hr = OR 0.70 95%CI 0.54-0.90; 1hr = OR 0.68 95%CI 0.51-0.90; 2hr = OR  
345 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  
346 was found to be greater on weekends compared to weekdays for obese children (1hr = 0.51  
347 95%CI 0.30-0.86). Three hours of active play at weekends was also found not to have a higher  
348 significant protection from obesity than 3hr in weekdays (3hr = OR 0.40 95%CI 0.21-0.76).

349

## 350 DISCUSSION

351

352 There are very few national surveys about the health and nutritional status of children in  
353 Portugal. The previous survey by Padez et al (2004) showed an alarming trend on OW/OB of  
354 Portuguese children that will have heavy health and economic repercussions. The importance  
355 and novelty of this current study, is that it was conducted immediately before the  
356 economic/financial crisis hit Portugal and most of Europe which has affected the lives of  
357 thousands of Portuguese families. This fact makes this study a reference that show biological and  
358 social changes reflected on the health of the Portuguese people. Any survey conducted after this  
359 one should take this paper in consideration and use this studies results as the baseline gathered at  
360 the beginning of a crisis that will have countless effects on the health and living conditions of the  
361 Portuguese people for decades to come.

362

363 The results of this Portuguese national representative study show that the prevalence of OW/OB  
364 children was high (27.9%), with girls having greater prevalence of OW/OB than boys (30.6 % vs

365 25.2%). However, the prevalence changed slightly when compared with the values obtained in  
366 2004 (31.6%; boys 29.3%, girls 33.8%) (Padez et al (2005). Socio-demographic variables (i.e.  
367 parents BMI and education level) have a significant risk upon childhood OW/OB. Fathers have  
368 as just an important role in a child's likelihood of OW/OB as mothers. Sedentary behaviours,  
369 such as screen time viewing and the amount of time children spend engaging in these  
370 behaviours, and while eating meals are significant factors. Physical activity during weekdays and  
371 weekends were significant protective factors of obesity.

372

### 373 Prevalence of overweight and obesity

374

375 Comparing the results of this study with others outlines a clear consensus that the prevalence of  
376 OW/OB of Portuguese children is clearly high. The international association for the study of  
377 obesity (IASO, 2013) reports that 28.1% of Portuguese children aged 6-8 years are OW/OB. The  
378 finding of the IASO (2013) is similar to the prevalence found within this study, 27.9%. Results  
379 from the previous survey by Padez *et al* (2005) (31.6%) could suggest that OW/OB prevalence is  
380 lowering or possibility stabilising. However discrepancy occurs when viewing results of the  
381 organisation for economic co-operation and development (OECD, 2011) of who reported a  
382 prevalence of 22.6% of children aged 5-17 years were OW/OB. Reasons for difference could be  
383 the different age ranges of surveyed of previous studies in comparison to this study. However, it  
384 is clear that OW/OB is high in Portugal and across Europe particularly in other Mediterranean  
385 countries (Italy, Spain and Greece). Children's OW/OB levels of Italy (31.7%), Spain (24.8-  
386 27.9%) and Greece (41.1%) along with Portugal are all consistently found to be among the  
387 highest of childhood obese nations in Europe and globally (IASO, 2013; OECD, 2011).

388

389 Biological Factors

390

391 We found statistically significant sex differences for OW/OB. Girls across all ages (3-10 years)

392 were more overweight than boys and generally found to be more obese than boys. This finding is

393 interesting when comparing to other national data sets, with some reports stating that Portuguese

394 boys have greater prevalence of OW/OB than girls (IASO, 2013; OECD, 2011). However, sex

395 differences between previously published Portuguese works have shown to differ between

396 studies (Moreira et al, 2007). The findings of the current study are in agreement with Wiisneieski

397 et al (2009) who concluded that sex difference existed between boys and girls' rates of OW/OB

398 (Girls OW/OB > Boys OW/OB). Reasons for this could be due to girls biologically having

399 greater fat mass, fat distribution and being found to be less physically active than boys (Mota et

400 al, 2002; Baptista et al, 2012). However, Guerra and colleagues found no significant

401 relationships between Portuguese Girls physical activity and obesity, but did find that inactive

402 Portuguese boys had twice the likelihood of being obese than active Portuguese boys (Guerra et

403 al, 2006). Therefore more research is required to understand in more depth sex differences of risk

404 factors of OW/OB in Portuguese children. The relationship between other moderators of OW/OB

405 such as ethnicity and culture should also be investigated in greater depth and frequency as

406 studies are small in numbers (Owen et al, 2005). Another well-established risk factor of OW/OB

407 that this study found was age which is a well-documented factor across the literature with higher

408 OW/OB being more likely as age increases (Hernandez et al, 1999; Gonzalez-Suarez, 2011;

409 Pereira et al, 2010).

410

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

419

#### 420 Socio-Demographic Factors

421

422 This study found that OW/OB was associated with parental obesity and educational levels. An  
423 obese child was more likely to have parents who were obese and had a lower level of education.  
424 This finding has been found previously (Xi et al, 2009; Dannemann et al, 2011; Patterson et al,  
425 1997) however; Padez et al (2005) concluded that although parental obesity and educational  
426 levels were important associations of Portuguese childrens OW/OB, mother's obesity and  
427 educational levels had a greater risk on children's OW/OB than fathers. This conclusion of  
428 maternal superiority has previously been well documented in previous work (Whitaker et al,  
429 2010) but this study found that fathers with high BMI and low education had a greater risk upon  
430 children's OW/OB than mothers BMI and education. The importance of parental demographics  
431 (BMI and educational level) and their risk association to children's OW/OB, reinforces the idea  
432 of future interventions targeting the whole family. Previous lifestyle interventions targeted  
433 within a family environment have found positive results (Luttikhuis et al, 2009). A major

434 conclusion of this study is that although mothers in Portuguese families are culturally seen to be  
435 the parent who takes the role for buying, preparing and serving the food, (Padez et al, 2005)  
436 fathers have a significant link to childhood obesity. Future research should seek to confirm this  
437 finding, and fathers may need to be included in future interventions.

438

#### 439 Behavioural Factors

440

441 Portuguese children watching 1hr and 2hr of TV during weekdays were found to have an  
442 increased risk of being overweight. This finding is similar to previous Portuguese research  
443 (Padez et al, 2005). This study did not find the same effects for childhood obesity, which is  
444 indifferent to previous Portuguese studies which concluded that an increase of TV viewing leads  
445 to a greater likelihood of obesity (Carvalho et al, 2007; Hernandez et al, 1999). Much of  
446 previous research has mainly concentrated upon TV viewing. This study furthered the scope of  
447 sedentary behaviours within a Portuguese sample by measuring personal computer use and  
448 electronic games use over weekdays and weekends. Playing electronic games for long periods of  
449 time during weekdays (3hr) was associated to childhood obesity, and playing on electronic  
450 games for long periods of time (4hr<) during the weekend was associated with childhood obesity  
451 being overweight. Previous research found similar results (Boyland et al, 2011; IASO, 2013). TV  
452 viewing during meal times is reportedly a common behaviour among Portuguese families  
453 (Carvalho et al, 2007). Possible reasons for the link between TV (screen) viewing and obesity  
454 are low levels of energy expenditure (Hancox et al, 2004), along with an increase snacking of  
455 unhealthy foods (Rey-Lopez et al, 2011; Liang et al, 2009). Children also being subjected to  
456 advertising of unhealthy products while TV (Halford et al, 2008; Boyland et al, 2011) could well

457 be factors especially as this findings of this study adds strength to the argument as watching TV  
458 while consuming food during meal times was a significant factor to childhood obesity.

459  
460 Physical activity in the form of active play was found to be a protective behavior against  
461 childhood obesity. The more active the child, the greater the protection against obesity. Similar  
462 findings have been previously reported (Trost et al, 2001; Hernandez et al, 1999; Gonzalez-  
463 Suarez & Grimmer-Somers, 2011; Pereira et al, 2010; Guerra et al, 2006). Taking part in 1 hour  
464 of active play at weekends had a greater protective effect than 1hr of active play during  
465 weekdays. This finding is of interest as the current international physical activity guidelines for  
466 children is to take part in 1 hour of moderate to vigorous physical activity every day (World  
467 Health Organisation, 2010). With the added protection of physical activity taking place during  
468 weekends, which do not have time restraints for physical activity found during weekdays  
469 (school), along with the observed increase in prevalence of sedentary behaviours during  
470 weekends, this study supports the view of past research. For example, weekends offer an  
471 opportunity for future physical activity promotions/interventions to take place (Aznar et al,  
472 2010). Engaging in active play will help combat the epidemic of childhood obesity while also  
473 providing other health benefits (World Health Organisation, 2010).

474  
475 Like all investigations this study has limitations, self-reported data is well established to have  
476 problems of bias, reliability and validity especially within complex behaviours such as physical  
477 activity and sedentary behaviour (Shephard, 2003).The nature of the questionnaire being sent  
478 home and filled out by parents could lead to one parent completing the questionnaire on behalf  
479 of both parents, this could well lead to bias and inaccuracies. The questionnaire also asked about

480 individual screen time behaviour therefore multi-screen use data was not available, such as using  
481 a laptop or games device while watching the television (Jago et al, 2012). A final limitation is the  
482 term “active play”. Active play has no standard definition across academics (Brockman et al,  
483 2011) therefore it could be suggested that parents who completed the questionnaires and reported  
484 the level of active play for children, could well have a different definition of active play to  
485 another parent and family, therefore results of active play/physical activity should be viewed  
486 with caution. Even with the discussed limitations, this study has strong statistical strength  
487 because it is a nationally stratified representative study of Portugal with large numbers of  
488 children within all 18 districts of mainland Portugal.

489  
490 In conclusion, this study found that childhood OW/OB in Portugal is high, with the prevalence  
491 being higher in girls than in boys. Child’s age, maternal smoking during pregnancy and no  
492 breastfeeding are significant biological risk factors. Both mothers and fathers education level and  
493 BMI are risk factors for childhood OW/OB along with sedentary behaviours such as TV, PC use  
494 and, especially for boys playing electronic games. Physical activity (active play) was found to  
495 have a protective dose response to obesity, with greater protection found during weekends.  
496 Future research should investigate the sex differences between different districts and look to  
497 implement the use of objective measures of physical activity and sedentary behaviors. Future  
498 interventions should take note of the importance of breastfeeding, mothers not smoking during  
499 pregnancy, maternal and paternal weight status, education level, physical activity levels and the  
500 importance of sedentary behaviours especially while eating meals and the increase use of  
501 electronic games during weekends, particularly in boys.

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