GROWING UP IN PORTUGAL: CAPE VERDEAN ANCESTRY CHILDREN EXHIBIT LOW OVERWEIGHT AND OBESITY COMPARED TO PORTUGUESE IN URBAN LISBON

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Authors' contributions

Ana Andre (AA) and Ines Varela Silva (IVS) agreed on the conception and design of the study and AA prepared the first manuscript. AA collected data referent to 2013 database. AA produced all statistical analysis and interpretation of the data. IVS, Paula Griffiths, Cristina Padez and Vítor Rosado Marques contributed to all sections of the manuscript, checked procedures and all authors read and approved final manuscript.

Acknowledgements

The authors would like to thank to all participants and institutions involved in the project. Even more to Carmen Garcia-Ruiz, Maria Dolores Marrodán and Joelma Almeida for sharing data from previous studies with Cape Verdean children and to V. Rosado Marques for providing all the support for fieldwork and the insight to the community. The 2013 project was part funded by a studentship awarded by Loughborough University.

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Summary. Portugal has one of the highest rates of childhood overweight and obesity (OW/OB) in Europe. However little is known about the health of ethnic minorities living in its capital city, Lisbon. The Cape Verdean community in Lisbon tend to have low educational levels, material deprivation and they struggle with discrimination and racism, factors that would likely be associated with a higher prevalence of OW/OB. Data for the Cape Verdean population were collected in three different time periods by three different research teams in 1993, 2009 and 2013 and included children from 6 to 12 years living in Cova da Moura neighbourhood, Great Lisbon Metro Area (GLMA). The Portuguese national survey was collected between 2009/2010 at public and private schools in mainland Portugal and included height, weight, skinfolds, arm, and waist circumferences. From these survey data body mass index (BMI) and the prevalence of stunting, (chronic malnutrition - low height-for-age) and underweight (low-weight-for-age) were calculated according to reference values proposed by Frisancho (2008). Overweight and obesity values were defined based on the references established by the International Obesity Task Force (IOTF). Results show that there are significant differences in height for boys and girls between Cape Verdean and Portuguese children. Generally, Cape Verdeans' growth falls within the healthy range of International growth references across all of the survey data collected. Cape Verdean rates for combined overnutrition (overweight and obesity) in 2013 (9.8% for boys and 16.7% for girls) are lower than the Portuguese (33% for boys and 31.7% for girls). Logistic regression models showed that Cape Verdean children have a lower risk of being OW/OB when accounting for breastfeeding,birthweight,maternal education and occupation. Despite living in a deprived neighbourhood these Cape Verdean children seem to have grown more healthily than Portuguese ancestry children. The challenge for policy makers will be to support improvement of the poverty related living conditions of this community without creating a risky environment for increasing prevalence of overweight and obesity.

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Introduction

Portugal, like many European countries, has registered a steep increase in overweight and obesity (OW/OB) prevalence over the last 30 years. These increases tend to be related to social disparities in which more deprived groups tend to show higher levels of OW/OB (Padez *et al.*, 2004; Padez *et al.*, 2005; Carvalhal *et al.*, 2007; Padez *et al.*, 2009; Valente, et *al.*, 2010) . In the last National Study of Childhood Obesity (2008) (Rito *et al.*, 2012) Portuguese school children aged 6-8 years old showed a prevalence of 16.8% for boys and 13.7% for girls for obesity (OB) when using (WHO) World Health Organization references (Onis *et al.*, 2007). These values place Portuguese children with one of the highest rates European prevalence of obesity with the European childhood surveillance initiative by the WHO (Wijnhoven *et al.*, 2012) revealing obesity prevalence of 6.0 to 26.6% for boys and 4.6 to 17.3% for girls (Onis *et al*., 2007).

Concomitantly, Portugal is still home for a considerable number of African migrants and their Portuguese-born offspring, mainly from Cape Verde, Angola and Mozambique. These communities live in adverse socioeconomic environments. Based on existing literature focusing on similar groups in other parts of the world, adverse living conditions tend to exacerbate poor health outcomes and predispose disadvantaged groups to specific health conditions like circulatory diseases, coronary heart disease and stroke (Harding *et al.*, 2008). The Cape Verdeans, as the second most numerous ethnic minority community in Portugal, are also the most affected by social inequalities and low educational levels (Gama, 2002; INE, 2011). According to the last census this group accounts for a third of the foreign citizens living in Portugal. Research has shown an increase of obesity among marginalised ethnic groups (Cole *et al.*, 2000; Hui & Bell, 2003; Moore *et al.*, 2003; Ulijaszek, 2003) in other settings. Data from 1983 showed growth impairment or prolonged moderate nutritional deficiency in Cape Verdean children attending pre-school in Cape Verde even with regional variations (Wennberg, 1988). However, more recent data, especially from Cape Verdean's most rural island, Fogo, suggest a nutritional transition is already underway (Abreu, 2011). Other research also supports the fact that Cape Verde is well into nutritional transition (Abrahams *et al.*, 2011; Bosu, 2014) and that overweight and chronic malnutrition coexist in Cape Verde (UNICEF & ICCA, 2011). Data from an inquest for the prevalence of anaemia and associated factors (IPAC) in Cape Verdean children from 2009 showed that 5% of the under five year olds were above their normal weight (Ministério da Saúde Cabo Verde, 2009).

In Portugal, a study conducted in 1991 with low/medium socioeconomic status (SES) Portuguese and Cape Verdean children aged 7-10 years in the Great Lisbon Metro Area (GLMA) metropolitan area showed that there were no differences for height even though Cape Verdeans were born lighter (Gama, 1993). Cape Verdean children living in Portugal were taller than their counterparts from the islands but thinner and shorter than the US references (Frisancho, 1990; Gama, 2002). Biosocial factors influenced these children´s growth as shown by the positive effect of birth order and parental educational level (Varela-Silva, 2004) on children's weight and height respectively. In 2002 Gama revealed that Cape Verdean children living in Portugal were thinner than Portuguese children aged 6-11 years living in Lisbon (Gama, 2002). In comparison with Cape Verdean children from the islands, Cape Verdean children living in Portugal were taller and heavier which might have been due to favourable living conditions. Later on in 2004 the same trend was observed by Varela Silva who compared Portuguese children, Cape Verdean children born in Portugal and Cape Verdean children living in Cape Verde in 1993, 1999 and 2001(Varela-Silva, 2004).

The aim of this study is to assess the health and nutritional status indicators of Cape Verdean children aged 6 to 12 years old living in Great Lisbon Metro Area (GLMA) (urban setting) of Portugal in three databases from different time periods (1992, 2009, 2013) and to compare these with the health and nutritional status of a sample of Portuguese children (2009) of a similar age. This paper covers a period during which a European economic crisis occurred and fills an important gap in the literature over this time period in growth studies among ethnic minorities living in Portugal, enabling a comparison of the anthropometric status of Cape Verdean children living in Portugal with their Portuguese origin counterparts.

Methods

Study population

This paper focuses on the Cape Verdean community living in Cova da Moura neighbourhood of Great Lisbon Metro Area (GLMA) (figure 1). Cape Verdean children aged 6-12 years old were recruited if they had Cape Verdean ancestry and were attending public schools within the neighbourhood. Ancestry was assessed by semi-structured interview and included one grandparent on the paternal/ maternal side and parents born in Cape Verde (Cape Verdean ancestry). The majority of the children were born in Portugal (70-80%). Portuguese ancestry was assessed by a questionnaire mailed to parents. Portuguese ancestry children were selected if born from both Portuguese parents.

INSERT FIGURE 1

Study design and setting

The first dataset (CVPT92) was collected between 1992/1993 for a doctoral thesis and had a sample size of 164 Cape Verdean children (96 boys and 68 girls with mean age of 8.27± 1.41 years). Part of this dataset was previously published (Garcia-Ruiz & Marrodán, 2000). The second dataset (CVPT09) was collected between December 2008 and March 2009 and its sample size was 170 children (70 boys and 100 girls with mean age of 8.59 ± 1.65 years). The more recent database (CVPT13) was collected in 2013/14. This sample is comprised of 89 children (41 boys and 48 girls with mean age of 8.61 ± 1.4 3years). All projects on the Cape Verdean community were conducted in almost the same schools in Cova da Moura neighbourhood, meaning they cover the same area over time. The numbers are not known for the first dataset (CVPT1992) but for 2009 study all children from the school were recruited (226) and 221 were measured showing 98% participation rate. Also for the latter dataset (2013), 107 children were recruited and 101 were measured which shows a 94% participation rate.

These Cape Verdean samples will be compared to a nationally representative database (PT09) that includes 10619 Portuguese children from Portuguese parents (5153 boys and 5466 girls) measured between 2009 and 2010. For this paper only data from children residing in the Portuguese territory of Lisbon district and in an urban setting (n= 1648, 817 boys and 831 girls with mean age 7.85 ± 1.28 years) are analysed from the national database to ensure that children from the same area of Portugal are compared. With this national study (PT09) a final number of 17509 children were observed and the final participation rate was over 60 for school children (63.6%).

Cova da Moura neighbourhood

This neighbourhood is one of the oldest establishments for Cape Verdean migrants in Lisbon dating from the 1970s, with an estimated population in 2008 of approximately 4800 (INE, 2002). Recent data from a local socio-cultural association Moinho da Juventude estimates that about 6000 habitants live in the neighbourhood (Associação Cultural Moinho da Juventude, 2012). Sixty per cent are of African origin, mainly Cape Verdean, with half of the inhabitants under the age of 20 years. This neighbourhood tends to suffer from social and ethnic discrimination that is reinforced by a poor public image portrayed by the media. There are small shops within the physical space of the neighbourhood. Some children do not have many opportunities to leave the neighbourhood during their early years because of the long working hours of their parents and because they are looked after by relatives and friends that live in the neighbourhood (fieldwork observations). There are daily sellers that stop by the neighbourhood to sell fresh fish, fruit and many even sell ingredients used to prepare traditional Cape Verdean dishes. Local associations working in the neighbourhood have developed several support programs for local child-minders, professional development and help with documentation or revenue issues (Associação Cultural Moinho da Juventude, 2012).

Ethics approval

The first database on Cape Verdeans dates from 1992 and it was approved by the ethics committee of the San Carlos of the Clinical Hospital of Complutense University. Cape Verdean databases from 2009 and 2013 were firstly approved by Loughborough University's advisory Sub- Committee with research proposal Ref No: R13-P56. The 2013 database was also approved by Ethics Council of Instituto de Higiene e Medicina Tropical, Universidade Nova de Lisboa (Lisbon, Portugal). The study protocol and informed consent for Portuguese national database 2009 (Bingham *et al.*, 2013) was approved by Direcção Geral de Inovação e Desenvolvimento Curricular (DGIDC).

Variables

The anthropometric profile of each child included: height (cm), weight (kg), sitting height (cm), skinfolds (mm): triceps, subscapular, biceps and circumferences (cm): abdominal, arm and waist. Participants were measured lightly dressed and barefoot or with light socks. All measurements were performed following standardised procedures (Lohman, 1988).

Subsequently other parameters were calculated: Normal weight and over nutrition categories of overweight and obesity were matched with the International Obesity Task Force (IOTF) references (Wijnhoven *et al.*, 2012). Stunting, defined as low height-for-age was classified below -2 standard deviation for WHO (Frisancho, 2008). A semi-structured interview was conducted with children's parents/guardians in order to assess maternal and parental age, child's age, educational levels, occupational status and neighbourhood resources. When comparing the three databases common variables available in all databases were used for child anthropometry: height, weight, sitting height, arm circumference, triceps and subscapular skinfold. For socio demographic variables: parental education, occupation, ancestry, birth weight, and breastfeeding data were available in the PT09 and CVPT13 databases (see table 1).

Statistical procedures

Data were analysed with Statistical Package for Social Sciences version 22.0 (SPSS). Descriptive statistics included a Chi-square analysis to compare prevalence of under and over nutrition between the samples. Analysis of variance (ANOVAs) allowed the comparison of anthropometric scale measures between the samples. Appropriate post-hoc statistics were calculated to identify which differences were significant in this analysis. The Portuguese (PT09) and Cape Verdean database (CVPT13) were used in a subsequent analysis

because they shared common variables like parental education, occupation and breastfeeding time that allowed factors associated with overweight and obesity to be identified. The CVPT09 and CVPT92 databases did not include the same level of detail regarding socio-demographic factors meaning they were excluded from the analysis of the factors associated with overweight and obesity. Logistic regression was performed between PT 09 and CVPT 13 for comparison and permitted determining the biological (birth weight and breastfeeding status) and socio-demographic (maternal education and occupation) factors associated with OW/OB to assess differences in nutritional status between the two ethnic groups. Only models for overweight and obesity are presented because of the low prevalence of under nutrition across all of the samples. Odds ratios and 95% CIs are presented. Model fit is demonstrated using Hosmer Lemeshow statistics. Models were built by entering age, sex, and ancestry (PT as reference) at step 1. Subsequently on step 2 significant socio-demographic variables from an unadjusted analysis were included. This strategy allows identifying differences between the samples explained by the biological and socio demographic factors entered into this step of the model building process.

Results

Table 1 shows that there are significant differences for height and height Z-scores, Z-score sitting height, triceps and subscapular skinfolds and Z-scores for these measures between Cape Verdean and Portuguese boys aged 6 to 12 years between the four databases. There were fewer differences for Cape Verdean girls (table 2), with only height and triceps skinfolds/triceps Z-score revealing significant differences compared to the Portuguese sample ($p<0.05$).

INSERT TABLE 1 and 2

An analysis of variance showed that there were differences for height among boys $F(3)=6.160$, $p=0.007$. Gabriel's *pos-hoc* test (ANOVA) used for unequal group sizes showed that there were significant differences between Portuguese (PT09) (M=129.63, SD=8.54) and two of the Cape Verdean datasets (CVPT09 (M=132.75, SD=10.67; CVPT13 (M=134.25, SD=9.76). Z-score height (F (3) =3.652, $p=0.012$) was significantly higher for Cape Verdean measured in 2013 (CVPT13 (M=0.58, SD=1.05)) than the Portuguese (M=0.16, SD=0.88) and the Cape Verdean measured in 1992 (CVPT92 M=0.05, SD=0.82). On the other hand Cape Verdean measured in 2009 had a lower Z-score sitting height mean (M =-0.47, SD= 0.95) compared to the Portuguese (M =-0.07, SD= 0.92) and the 1992 Cape Verdean database (CVPT92 M = 0.14, SD=1.09), $F(3)=5.751$, $p=0.001$.

A Kruskal-Wallis rank sum test using a Chi-square statistic of independence was performed to determine the association between variables with a non-parametric distribution. Subsequently, Mann Whitney tests were performed for associations labeled as significant from the Kruskal-Wallis test to determine which groups were significantly different. Results are shown accounting for Bonferroni adjustment for the final p-value. For boys Z-Score triceps (X^2 (3, 1020) = 17.341, p≤0.01) was significantly lower for CVPT13 (Median=-0.42 interquartile (25-75%) =-0.82 to 0.34), compared with the Portuguese (Median=-0.13, interquartile =-0.55 to 0.40) and the Cape Verdean 1992 database (CVPT92 Median=0.06, interquartile=-0.29 to 0.85). For Z-score subscapular (X^2 (3, 1020) = 19.133, p≤0.01) CVPT92 (Median=-0.08 interquartile =-0.33 to 0.73) had significantly higher means than CVPT13 (Median=-0.50 interquartile =-0.72 to 0.16) and PT (Median=-0.04 interquartile=-0.40 to 0.50).

The girl's height from the CVPT09 database (Median=132.7, interquartile=122.6 to 139.2) was significantly higher (X^2 (3, 1041) = 11.458, p≤0.01) compared to the Portuguese (Median=128.9, interquartile=122.4 to 135.1) and to their counterparts measured in 1992, CVPT92 (Median=128.1 interquartile=120.1 to 133.5). However, we did not find any significant differences in Z-scores for height for girls suggesting that age differences in the sample may have been responsible for the significant differences in the raw height data observed. For the skinfolds, Z-score triceps (X^2 (3, 1041) = 22.089, p≤0.01)) was higher for CVPT09 (Median=0.13, interquartile=-0.52 to 0.67,) compared to the Portuguese (Median=-0.23, interquartile = -0.68 to 0.37) and lower than CVPT92 (Median=- 0.01, interquartile= -0.43 to 0.56).

Cape Verdean children's nutritional status

Nutritional status was assessed using under-and-overweight prevalence. No significant differences were found in nutritional status between Cape Verdean ancestry children in the three different databases. Overweight prevalence is lower in the 2013 sample compared to the 1992 sample for boys (22.9% in 1992 and 9.8% in 2013) and girls (19.1% in 1992 and 12.5% in 2013). None of the Cape Verdean boys measured in 2013 was considered obese while 4.2% of the girls were. In 1992 the scenario was different and there were 11.5% obese boys and 11.8% obese girls.

Comparing the nutritional status of Cape Verdean and Portuguese children residing in Lisbon

When comparing Cape Verdean children with the Portuguese national study (figure 2), significant differences were found only for over nutrition among boys ($X^2(3) = 16.827$, n=1022, $p \leq 0.001$) (data not shown). There is more overweight and obesity among Portuguese boys (20.3% and 12.7%, respectively) when compared to Cape Verdean in 2013 (9.8% and 0%, respectively for 2013 database) ($p \leq 0.001$) and even when comparing with the Cape Verdean children in the same year 2009 (11.4% OW, 7.1% OB) $p<0.05$. However, more stunting is also observed in Portuguese boys even if the percentage is small (4 cases) and non-significant.
For girls no statistically significant differences in overweight and obesity or under nutrition were found for any of the references used between the samples (figure 3). However some trends can be observed. For example, more Portuguese girls were classified as overweight (22%) or obese (9.7%) in comparison with the Cape Verdean girls (12.5% and 4.2%, respectively, non-significant).
Results of the logistic regression showed the Hosmer-Lemeshow test revealing that the model fitted the data well (model 6: X^2 =1.440, p=0.994). Breastfeeding (yes/no), birth weight (kg), maternal education and occupation were significantly associated with overweight and obesity. However age and sex were not statistically significantly associated with overweight and obesity in these Portuguese children (ns).

The variables entered in the model did not fully explain the difference between the Portuguese and the Cape Verdean samples (Table 3). A lower risk of overweight and obesity was identified for the Cape Verdean sample compared to the Portuguese children with an odds ratio of 0.403 (95% CI 0.186-0.876) in the last model which adjusted for the potentially confounding effects of age, sex, maternal age, maternal education, maternal occupation, birth weight and whether the child was breastfed on this association (6). Further, in addition to being Cape Verdean other significant protective factors for overweight and obesity are identified in the final step of the model: being breastfed, lower birth weight, having a mother with more years of education, and having a mother with an occupation that results in her spending more time at home such as unemployed or housewife. Maternal occupation is also related with lower risk when the mother stays at home.

INSERT FIGURES 2 and 3
INSERT TABLE 3

Discussion

In comparing the Cape Verdean ancestry populations with the nationally representative Portuguese dataset during the economic crisis we have revealed that linear growth among Cape Verdean samples (heights) has increased over time, especially for the boys. In contrast there have not been significant increases in weight over the same period for the Cape Verdean samples. This has resulted in good outcomes for BMI and adiposity indicators (subscapular and triceps skinfolds) for this population during this difficult time period. This pattern of change in height was only statistically significant for the male sample although the direction of the trend was similar but not statistically significant for females with an increase between 1992 and the 2009/2013 samples in height. Findings further reveal a lower risk of OW/OB of Cape Verdean ancestry children compared

to the Portuguese even after adjusting for potentially confounding factors (age, sex, maternal age, birth weight, whether the child was breastfed, maternal education and occupation). In addition to being Cape Verdean other significant protective factors for overweight and obesity identified in the model were being breastfed, being of lower birth weight, having a mother with more years of education, and having a mother spending more time at home such as being unemployed or a housewife.

Favourable changes might be observed in linear growth following the fast development of some countries' economy (Martorell & Zongrone, 2012) and that seems to have happened to the Cape Verdean children living in Portugal. Even though living in a "deprived" neighbourhood in the Portuguese context they seem to have benefited from positive environmental conditions Portugal experienced over the past 40 years compared to their country of origin. Entrance in the EU (1986) brought rising wages, better infrastructures and higher household income. Moreover there were important improvements in Portuguese society in health care services, educational levels and socioeconomic status (Veiga *et al.*, 2004;OECD, 2011;). Cape Verdeans living in Portugal currently have better access to health services and school nutritional programs than they would have had in Cape Verde (UNICEF, 2015). This finding is not unique to this population, for example the American-Maya children after migrating from Mexico to Florida experienced an improvement in their growth and living conditions (Smith *et al.*, 2002; Bogin, 2012). Moreover there is also the "healthy immigrant effect" in which the population that migrates is usually in better health condition due to younger age and working status (DesMeules *et al.*, 2004; Ronellenfitsch & Razum, 2004; Buron *et al.* , 2008;Garcia-Gomez & Oliva, 2009).

However in earlier studies (1989, 1992) no differences in height were found between Portuguese and Cape Verdean children (Garcia-Ruiz & Marrodán, 2000; Gama, 2002). On the other hand Varela Silva found in 2004 a negative trend in height and weight on Portuguese and Cape Verdean for boys between 1993, 1999 and 2001.This is consistent with our results and the author explained that it might be because boys are more susceptible to adverse conditions from the environment. This was studied by Stinson (Stinson, 1985) who found that differences in growth among boys and girls were reflected first in boy's physical growth and development. The same author (Varela-Silva, 2004) suggests that it might also be that the pace of development process makes boys more vulnerable to environmental inequalities. Girls have been shown to experience the effects of nutritional transition in other societies as well. For example, South African adolescent girls have experienced nutrition transition earlier than boys and show more risk for over than under nutrition whilst boys still show a higher risk of under than over nutrition (Pradeilles *et al.*, 2015). Furthermore sub-Saharan African boys have been shown to be more affected by stunting related to socio-economic deprivation (Wamani *et al.*, 2007).

Furthermore living conditions in Portugal have been translated into height increases for Cape Verdeans compared to the ones born in Cape Verde (Gama, 2002). The current study findings show that Cape Verdean children are not disadvantaged in linear growth compared to other Portuguese children of similar age living in a similar environment or compared to the international growth references. It appears there have been further improvements in the linear growth of Cape Verdean children since 2002 despite the difficult economic climate in Portugal in the later part of this period. Further there is an almost absence of stunting (low height-for-age) among this population.

Consequently the fact that 2013 Cape Verdean ancestry children are protected from overweight and obesity in comparison to Portuguese children living in similar environments suggests even after controlling for a range of socio-demographic and biological factors that this Cape Verdean community have currently experienced the positive aspects of nutritional transition in relation to linear growth without the negative aspects associated with becoming overweight or obese. Despite relative deprivation compared to the Portuguese, this Cape Verdean community appears to have reaped the benefits of the Portuguese social system as it settled. This is much like the Maya experience in Florida (Bogin, 2012). It is possible that cultural factors might explain improvements in linear growth without associated changes in weight. In Portugal 40% of the babies are

breastfeed (OECD, 2009) while in Cape Verde 60% are exclusively breastfeed until 6 months (UNICEF, 2015). There is mixed evidence in the literature surrounding the association between breastfeeding and risk for overweight and obesity, although others do document a similar relationship to this study in Portugal. For example a study with Portuguese mothers has shown that breastfeeding a child for 3 to 6 months or more than 6 months was associated with a decreased risk in OW (Padez *et al.*, 2005). Findings of the logistic regression reveal that breastfeeding behaviour explains some of the difference in risk for overweight and obesity between Cape Verdean ancestry children and other Portuguese children. After including the breastfeeding variable into the model there was a change in the ancestry parameter effect of close to 18%. We have therefore been able to reveal that this is one important cultural factor that might be influencing the differences in ancestry risk for overweight and obesity. Observations from fieldwork show that this community is still following a fairly traditional diet assured by the local businesses who supply food and a wide range of services. Moreover social support systems in place at the neighbourhood have helped in protecting the children from westernized influences by keeping them in the physical space and also watching out for them. Children can safely "play" outside despite the sometime unsafe episodes that happen in this space. This might result in more physically active children when compared to the Portuguese whose viewing time, for example, has been linked to higher obesity rates (Carvalhal *et al.*, 2007).

The limitations of the study are the small sample size of the Cape Verdean samples that could limit the representation of these samples at the different time points. Moreover the Portuguese sample is only restricted to Lisbon district and might mask people from different socioeconomic status. More because of the missing information from 1992 representation of the sample, one of the authors (Rosado-Marques, V) has been present in all of the data collection of all of the datasets referred in this paper and he can assure that similar strategies have been followed for recruitment of participants and data collection.

Conclusions

Cape Verdean children seem to have benefitted from the better living conditions experienced in Portugal. This trend is more pronounced for the 2013 sample is positive and significant for boys in height. Even though coming from a deprived neighbourhood these children have a better nutritional status than Portuguese. The next task for policy makers should be to improve socioeconomic status of these households while preserving cultural practices protecting against westernized influences.

Subsequent studies should focus on more objective measurements of environmental variables (Harding *et al.*, 2006) such as diet, social support, physical activity and disease among ethnic minorities like the Cape Verdean (Nogueira & Santana, 2005).

Competing interests

The authors declare that they have no competing interests.

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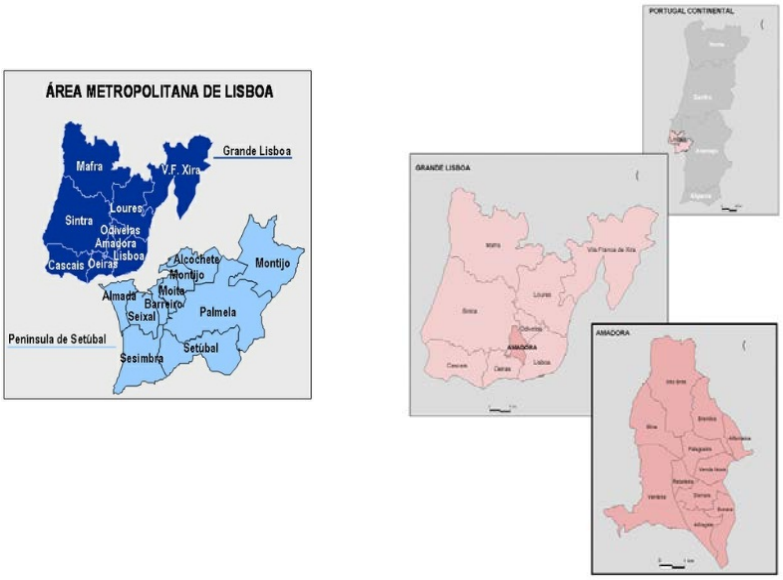
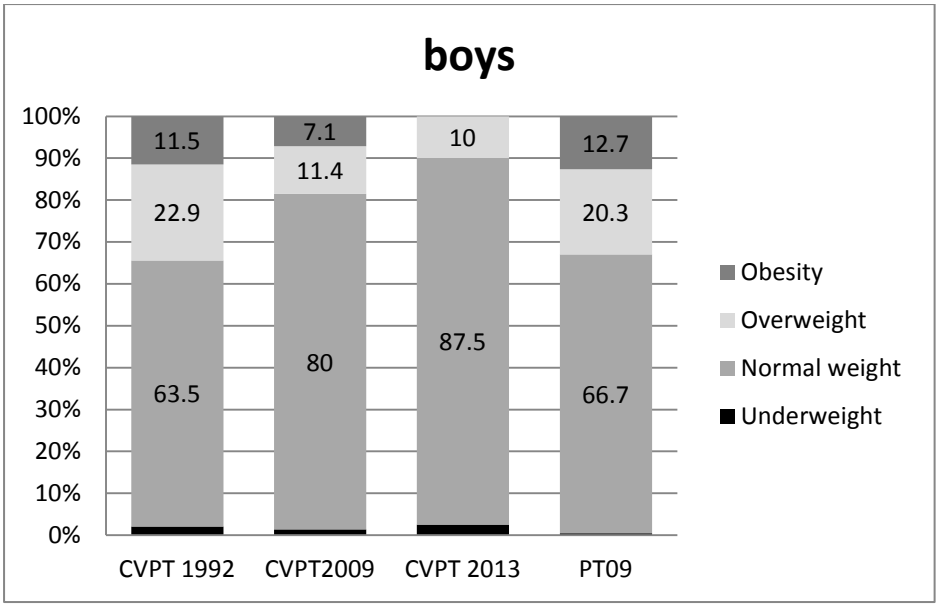
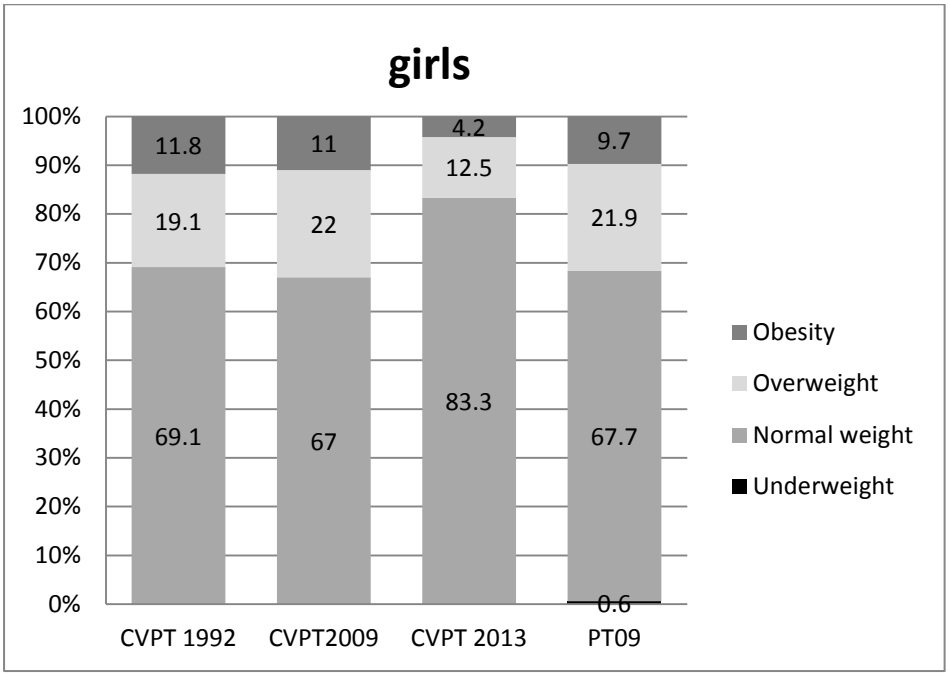


Figure 1. Geographical position of Lisbon area and Amadora council. (http://www.cm-amadora.pt).





Figures 2 and 3. Over and under nutrition rates for boys and girls respectively using IOTF and WHO cut off points on Cape Verdean ancestry and Portuguese databases.

Table 1. Descriptive values (Mean/median[2] ±SD/IQR[2]) and ANOVA for Portuguese and Cape Verdean boys							
Variables					Diff[a,b]		
	1992 CVPT N=96	2009 CVPT N= 70	2013 CVPT N= 41	2009 PT N= 815	X^2	*F*	*p-value*
[b]Age decimal (years)	8.17 7.31-9.47	8.84 6.91-9.95	8.54 7.34-9.59	8.34 7.23-9.29	5.432		*ns*
[a]Height(cm)	*129.35±8.71*	*132.75±10.67*	*134.25± 9.76*	*129.63 ± 8.54*		6.160	*p<0.001*
[a]Zscore height	*0.05±0.82*	*0.22±0.89*	*0.58±1.05*	*0.16 ± 0.88*		3.652	*0.012*
[a]Sitting height(cm)	69.41±4.43	68.22±4.22	69.55± 4.85	68.48± 4.11		2.302	*ns*
[a]Zscore SH	*0.14±1.09*	*-0.47±0.95*	*-0.04±1.05*	*-0.07±0.92*		5.751	*0.001*
[b]Weight(kg)	28.10 24.72 to 32.56	28.10 24.68 to 35.08	28.60 24.95 to 31.80	28.10 24.43 to 33.30	0.324		*ns*
[b]Zscore weight	-0.24 -0.66 to 0.32	-0.35 -0.78 to 0.23	-0.22 -0.71 to 0.19	-0.16 -0.65 to 0.36	2.549		*ns*
[b]BMI	16.57 15.47 to 18.64	16.09 15.37 to 17.46	15.73 15.06 to 17.28	16.66 15.52 to 18.60	12.648		*ns*
[b]Triceps SK (mm)	*8.85 7.22 to 14.15*	*8.70 6.95 to11.60*	*7.10 6.15 to 10.50*	*8.00 6.60 to 10.42*	*17.655*		*0.001*
[b]Zscore Ts sk	*0.06 -0.29* to *0.85*	*-0.05 -0.43to 0.51*	*-0.42 -0.82* to *0.34*	*-0.13 -0.55* to *0.40*	*17.341*		*p<0.001*
[b]Subscapular SK (mm)	*5.50 4.90 to 8.78*	*5.20 4.60 to 6.60*	*4.60 4.05 to 6.25*	*5.60 4.72 to 7.20*	*16.199*		*0.001*
[b]Zscore subcapular	*-0.08 -0.33* to *0.73*	*-0.19 -0.55 to 0.31*	*-0.50 -0.72* to *0.16*	*-0.04 -0.40* to *0.50*	*19.133*		*p<0.001*

Table 2. Descriptive values (Mean/median[2] ±SD/IQR[2]) and ANOVA for Portuguese and Cape Verdean girls							
Variables					Diff[a,b]		
	1992 CVPT N=68	2009 CVPT N= 100	2013 CVPT N= 48	2009 PT N= 827	X^2	*F*	*p-value*
[b]Age decimal (years)	7.82 6.84-9.48	8.46 6.99-9.98	8.48 7.61-9.59	8.35 7.23-9.33	3.586		*ns*
[b]Height(cm)	*128.05 120.1* to *133.5*	*132.70 122.6* to *139.2*	*130.85 123.60* to 139.4	*128.90 122.4* to *135.1*	*11.458*		*0.01*
[a]Zscore height	-0.03±0.78	0.31±0.91	0.12±0.90	0.08±0.92		2.337	*ns*
[a]sitting height(cm)	68.39±4.48	68.09±4.74	69.00± 5.09	68.33± 4.38		0.462	*ns*
[a]Zscore SH	0.62±0.96	0.25±1.73	0.38±0.94	0.44±0.94		1.721	*ns*
[b]Weight(kg)	26.80 22.78 to 32.45	29.80 24.70 to 36.05	26.95 23.83 to 35.30	27.80 24.1 to 33.7	5.022		*ns*
[b]Zscore weight	-0.01 -0.32 to 0.60	0.20 -0.38 to 0.89	-0.05 -0.45 to 0.41	0.11 -0.42 to 0.73	3.501		*ns*
[b]BMI	16.39 15.38 to 18.69	16.89 15.03 to 19.43	16.22 15.37 to 17.81	16.72 15.49 to 18.98	2.378		*ns*
[b]Triceps SK (mm)	*10.40 8.43-14.55*	*11.00 8.25-14.00*	*10.30 8.20-13.84*	*9.20 7.52-12.00*	*23.172*		*p<0.001*
[b]Zscore Ts sk	*0.14 -0.34* to *0.88*	*0.13 -0.52* to *0.67*	*-0.01 -0.42* to 0.56	*-0.23 -0.68* to *0.37*	*22.089*		*p<0.001*
[b]Subscapular SK (mm)	6.65 5.22 to 8.23	6.50 5.20 to 8.95	6.30 5.10 to 8.95	6.56 5.20 to 9.20	0.745		*ns*
[b]Zscore subcapular	-0.05 -0.38 to 0.40	-0.20 -0.42 to 0.98	-0.19 -0.49 to 0.28	-0.09 -0.42 to 0.51	2.478		*ns*

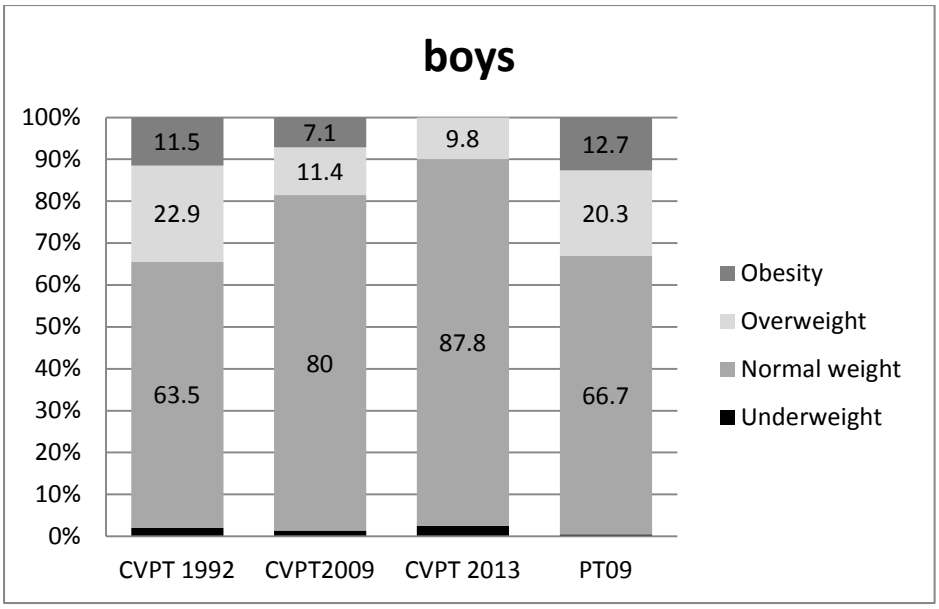
2 Median/ IQR are presented where the data were non-normally distributed and the Kruskal-Wallis rank sum test was applied and mean/ SD are presented where the data were normally distributed and ANOVA applied. Ns: non-significant values;

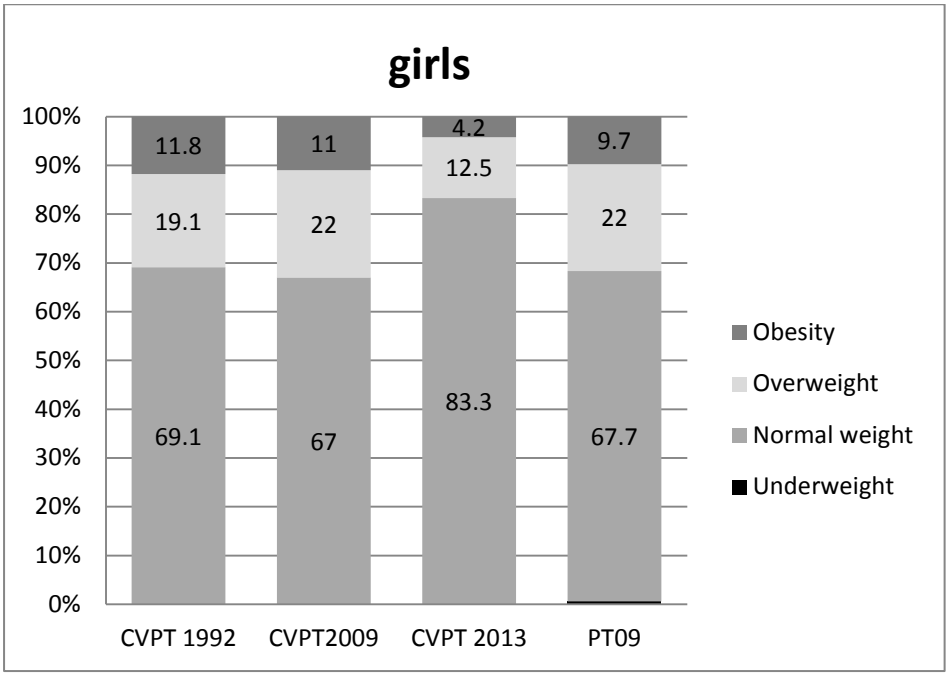
Table 3. Odds ratios and 95% confidence intervals from a logistic regression model of socio demographic and biological predictors of children's OW/OB between Portuguese and Cape Verdean ancestry (PT09, CVPT13)

	N	model 1	model 2	model 3	model 4	model 5	model 6
Child decimal age	1718	1.065 (0.981-1.157)	1.080 (0.992-1.177)	1.081 (0.992-1.178)	1.079 (0.987-1.180)	1.079 (0.985-1.182)	1.080 (0.979-1.191)
Ancestry Portugal (reference)	1631	1.00	1.00	1.00	1.00	1.00	1.00
Cape Verdean	87	0.327** (0.176-0.607)	0.359* (0.174-0.741)	0.422* (0.203-0.879)	0.468* (0.223-0.981)	0.413* (0.191-0.891)	0.403* (0.186-0.876)
Sex male (reference)	850	1.00	1.00	1.00	1.00	1.00	1.00
Female	868	0.963 (0.785-1.182)	0.910 (0.738-1.122)	0.916 (0.743-1.131)	0.931 (0.749-1.159)	0.938 (0.752-1.169)	0.933 (0.732-1.188)
Maternal age (years)			0.980* (0.962-0.998)	0.979* (0.961-0.998)	0.979* (0.960-0.998)	0.979* (0.960-0.999)	0.983 (0.962-1.004)
Breastfeeding Yes (reference)				1.00	1.00	1.00	1.00
No	1263			1.322* (1.008-1.734)	1.481* (1.119-1.959)	1.406* (1.058-1.869)	1.398* (1.023-1.911)
Birth weight (kg)					1.590** (1.268-1.995)	1.571** (1.249-1.975)	1.614** (1.259-2.06)
Maternal education							
primary (4y or none)(reference)	111					1.00	1.00
6 years	142					0.724 (0.429-1.222)	0.755 (0.561-1.015)
9-12 years	1259					0.570** (0.377-0.862)	0.609* (0.380-0.976)
Maternal occupation							
Manual (reference)	424						1.00
Non-manual	629						0.755 (0.561-1.015)
retired	22						0.569 (0.215-1.503)
unemployed/housewife	173						0.583** (0.392-0.865)

Odds ratio (OR)and 95% confidence intervals (CI) for the significant predictors of children being OW/OB (IOTF) vs normal weight ;the model excludes 546 cases because of missing data, asterisks denote the probability of being OW/OB in Portuguese database is significantly different from that in the reference category at the following levels,p< 0.01 and * p< 0.05;**

Figure 1. Geographical position of great Lisbon metropolitan area and Amadora council (www.pordata.pt)





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[b]Subscapular SK (mm)	*5.50 4.90 to 8.78*	*5.20 4.60 to 6.60*	*4.60 4.05 to 6.25*	*5.60 4.72 to 7.20*	*16.199*		*0.001*
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[a]Zscore SH	0.62±0.96	0.25±1.73	0.38±0.94	0.44±0.94		1.721	*ns*
[b]Weight(kg)	26.80 22.78 to 32.45	29.80 24.70 to 36.05	26.95 23.83 to 35.30	27.80 24.1 to 33.7	5.022		*ns*
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[b]Zscore Ts sk	*0.14 -0.34* to *0.88*	*0.13 -0.52* to *0.67*	*-0.01 -0.42* to 0.56	*-0.23 -0.68* to *0.37*	*22.089*		*p<0.001*
[b]Subscapular SK (mm)	6.65 5.22 to 8.23	6.50 5.20 to 8.95	6.30 5.10 to 8.95	6.56 5.20 to 9.20	0.745		*ns*
[b]Zscore subcapular	-0.05 -0.38 to 0.40	-0.20 -0.42 to 0.98	-0.19 -0.49 to 0.28	-0.09 -0.42 to 0.51	2.478		*ns*

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Sex male (reference)	850	1.00	1.00	1.00	1.00	1.00	1.00
Female	868	0.963 (0.785-1.182)	0.910 (0.738-1.122)	0.916 (0.743-1.131)	0.931 (0.749-1.159)	0.938 (0.752-1.169)	0.933 (0.732-1.188)
Maternal age (years)			0.980* (0.962-0.998)	0.979* (0.961-0.998)	0.979* (0.960-0.998)	0.979* (0.960-0.999)	0.983 (0.962-1.004)
Breastfeeding Yes (reference)				1.00	1.00	1.00	1.00
No	1263			1.322* (1.008-1.734)	1.481* (1.119-1.959)	1.406* (1.058-1.869)	1.398* (1.023-1.911)
Birth weight (kg)					1.590** (1.268-1.995)	1.571** (1.249-1.975)	1.614** (1.259-2.06)
Maternal education							
primary (4y or none)(reference)	111					1.00	1.00
6 years	142					0.724 (0.429-1.222)	0.755 (0.561-1.015)
9-12 years	1259					0.570** (0.377-0.862)	0.609* (0.380-0.976)
Maternal occupation							
Manual (reference)	424						1.00
Non-manual	629						0.755 (0.561-1.015)
retired	22						0.569 (0.215-1.503)
unemployed/housewife	173						0.583** (0.392-0.865)

Odds ratio (OR)and 95% confidence intervals (CI) for the significant predictors of children being OW/OB (IOTF) vs normal weight ;the model excludes 546 cases because of missing data, asterisks denote the probability of being OW/OB in Portuguese database is significantly different from that in the reference category at the following levels,p< 0.01 and * p< 0.05;**