Socioeconomic status and biological factors on the nutritional health of an urban community of Cape Verdean children residing in Portugal

By

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Abstract

Background and aims

Southern European countries have been showing high overweight and obesity (OW/OB) rates especially among the younger generations (Cattaneo et al. 2010). Portugal is one of those countries with 37.9% overweight and 15.3% obesity in 6 to 8 year olds (Rito et al. 2012). However little is known about the health of ethnic minorities living in its capital city, Lisbon. The Cape Verdean community in Lisbon, the second largest group in Portugal, would be expected to be more affected by this epidemic due to social inequalities. This community also tend to have low educational levels, material deprivation and struggle with discrimination and racism, factors that would likely be associated with a higher prevalence of OW/OB. The aim of this study was to assess the nutritional status of Cape Verdean ancestry children aged 6 to 12 years old living in Lisbon according to their socioeconomic status, general living conditions, family composition, diet and physical activity levels. To compare the findings with previous projects conducted in 1993 and 2009 in the same location with Cape Verdean ancestry children and with Portuguese ancestry children (national study conducted in 2009). To determine what early life factors have significant effect on these children's nutritional health.

Methods

Physical measures and household information were collected from November 2013 to February 2014 in Cova da Moura Neighbourhood in Lisbon. Physical measures 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), CDC, and WHO depending on the specific aim or research question.

Results

Results show this is a very deprived community with low educational levels and mostly employed in the service sector. Maternal height and child birth order showed a significant association with child's height. Moreover maternal height and age are associated with child leg length. Living in a single parent family is associated with an increase in child BMI of 1.412 units when accounting for maternal waist circumference. Also significant differences in height for boys and girls were observed 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 over nutrition (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 compared to Portuguese children when accounting for breastfeeding,birth weight,maternal education and occupation.

Conclusions

Despite living in a deprived neighbourhood these Cape Verdean children seem to have grown healthier 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.

Key words: Cape Verdean; socioeconomic status, Portugal; nutritional status

Estatuto socioeconómico e factores biológicos na saúde nutricional de uma comunidade urbana de crianças cabo-verdianas a viver em Portugal

Resumo

Introdução e objectivos

Os países do sul da Europa têm vindo a apresentar elevadas taxas de sobrepeso e obesidade (SP/OB) especialmente entre as gerações mais jovens (Cattaneo et al. 2010). Portugal encontra-se entre esse grupo de países apresentando 37.9% de sobrepeso e 15.3% de obesidade em crianças entre os 6 e os 8 anos (Rito et al. 2012). No entanto muito pouco se sabe sobre o estatuto nutricional das minorias étnicas que vivem na capital do pais, Lisboa. Na comunidade Cabo-Verdiana a viver em Lisboa, o segundo maior grupo imigrante em Portugal, seria esperado um maior impacto desta epidemia devido às desigualdades sociais previamente observadas. Esta comunidade apresenta baixos níveis educacionais, privação material, discriminação e racismo, factores que seriam associados a elevadas taxas de sobrepeso e obesidade. O objetivo deste estudo foi determinar o estado nutricional das crianças de origem Cabo-verdiana com idades entre os 6 a 12 anos a viver em Lisboa de acordo com o seu estatuto socioeconómico, condições de habitabilidade, composição familiar, dieta e níveis de actividade física. Estes resultados serão comparados com projectos anteriores de 1993 e 2009 implementados no mesmo local com crianças de origem Cabo-verdiana e crianças de origem Portuguesa (estudo nacional de 2009). Pretende-se também determinar que factores pré-natais terão influência no estado nutricional destas crianças.

Métodos

Medidas antropométricas e informação relativa ao agregado familiar foram recolhidas entre Novembro 2013 e Fevereiro 2014 no bairro da Cova da Moura em Lisboa. As medidas antropométricas incluíram estatura, peso, pregas subcutâneas, perímetros da cintura e do braço. Destas medidas foram calculados o índice de massa corporal (IMC) e a prevalência de crescimento atrofiado (stunting) (malnutrição crónica-baixa estatura para a idade) e baixo peso (baixo-peso-para-a-idade) de acordo com os valores de referência propostos por Frisancho (2008). Os valores de sobrepeso e obesidade foram calculados com base nos valores de corte definidos pela International Obesity Task Force (IOTF), CDC, e OMS.

Resultados

Os resultados mostram que esta é uma comunidade pobre com baixos níveis educacionais, e onde a maioria da mães está empregada no sector dos serviços. A estatura materna e a ordem de nascimento das crianças participantes neste estudo revelaram-se significativamente associados à estatura da criança. Mais ainda a estatura e idade maternas estão associadas ao comprimento da perna da criança. Viver numa família monoparental está associado a um aumento de 1.412 unidades no

IMC tendo em conta o perímetro da cintura materna. Foram também encontradas diferenças na estatura de rapazes e raparigas de origem Cabo-verdiana e Portuguesa. As crianças de origem Cabo-verdiana apresentam um crescimento saudável dentro dos parâmetros internacionais e que se observa em toda a amostra. As taxas de sobrepeso e obesidade para os Cabo-verdianos em 2013 (9.8% rapazes e 16.7% para as raparigas) são inferiores às dos Portugueses (33% para os rapazes e 31.7% para as raparigas). Os modelos de regressão logística mostraram que as crianças de origem Cabo-verdiana têm baixo risco de sobrepeso/obesidade quando comparadas com as crianças Portuguesas tendo em conta o aleitamento materno, peso ao nascimento e a educação e ocupação maternas.

Conclusões

Apesar de viverem num bairro degradado com privação material as crianças de origem Cabo-verdiana apresentam um crescimento mais saudável que as crianças Portuguesas. O desafio para futuras políticas sociais será o de melhorar o nível sócio económico e as condições de habitabilidade desta comunidade sem criar um ambiente propício para o desenvolvimento de elevadas taxas de sobrepeso e obesidade.

Palavras-chave: Cabo-verdianos; estatuto socioeconómico; Portugal; estado nutricional

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Publications

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André, A. L., Padez, C., Rosado-Marques, V., Griffiths, P. L., Varela-Silva, M. I. (2016). Growing Up in Portugal: Cape Verdean Ancestry Children Exhibit Low Overweight and Obesity Compared With Portuguese in Urban Lisbon. Journal of Biosocial Science, 1–16. Https://doi.org/10.1017/S0021932016000699.

Conference contributions

Conference Oral presentations

European conference on African studies at the ISCTE, Lisbon, Portugal, 2013. *Migratory effects on the health status of African migrants living in Portugal*.

Seminar on physical activity, exercise and health at Coventry University, Coventry, United Kingdom. 2013. *Physical activity and obesity levels in Portugal*.

Society for the Study of Human Biology and Centre for Research in Anthropology, Lisbon, Portugal, 2015. *Maternal influences on Cape Verdean children living in Portugal*.

IUAES inter congress World anthropologies and privatization of knowledge: engaging anthropology in public, Dubrovnik, Croatia.2016. *Parental education, SES (socioeconomic status) and nutritional health in a Cape Verdean community living in Portugal*.

Conference Poster presentations

School of Health and Life Sciences- Research that matters Student Conference, 2013, Loughborough Poster winner: Obesity and Environmental factors among Cape Verdean migrants living in Portugal.

83rd annual meeting of the American Association of Physical Anthropologists in Calgary, Alberta Canada, April 2014. Scientific poster "Environmental factors affecting the health of the Cape Verdean community living in Portugal".

Awards

International Travel award given by the School of Sports, exercise and Health Sciences**,** Loughborough University to attend IUAES inter congress World anthropologies and privatization of knowledge: engaging anthropology in public in May 2016.

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List of Abbreviations

AA	Ana Andre (PhD student)
AML	Área Metropolitana de Lisboa I Lisbon Metropolitan Area
BMI	Body Mass Index
CDC	Centre for Disease Control and Prevention
CVDs	Cardiovascular diseases
COSI	Childhood Obesity Surveillance Initiative
DDS	Dietary Diversity Score
DRI	Dietary References Intakes
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
HDI	Human Development Index
ISCO	International Standard Classification of Occupations
IDDS	Individual Diet Diversity Score
INE	Instituto Nacional Estatística Portugal Portuguese National Institute of Statistics
IOTF	International Obesity Task Force
IPAC	Inquérito sobre Prevalência da Anemia e Factores Associados em Crianças Menores de 10 anos, Inquest for the Prevalence of Anaemia and associated factors in Children under 10 years in Cape Verde
LBW	Low Birth Weight
MDG	Millennium Development Goals
MIVS	Maria Inês Varela Silva (supervisor)
NHANES	National Health and Nutrition Examination Survey
OECD	Organization for Economic Cooperation and Development
PALOP	African Countries of Portuguese Official Language (Cape Verde, Angola, Guinea Bissau, Mozambique, São Tomé and Príncipe)
PT	Pre-term delivery
QUIBB	Questionário Unificado de Indicadores Básicos de Bem-estar Questionnaire for the basic welfare living indicators
SD	Standard Deviation
SGA	Small for gestational age
SEF	Serviços de Estrangeiros e Fronteiras Portuguese Foreign and Border Office
SES	Socioeconomic Status
UNICEF	United Nations Children's Fund
UNDP	United Nations Development Programme
WC	Waist circumference
WHO	World Health Organization
WHtR	Waist-to-height Ratio

Chapter 1. Introduction

Portugal is amongst the European countries with the highest rates of overweight and obesity (OW/OB) (Berghöfer et al. 2008) and the particular incidence of OW/OB in ethnic minorities (Berghöfer et al. 2008; Moreira 2007), affected by low educational levels and material and social deprivation, has not been widely studied (Harding et al. 2008).

The Cape Verdean community is the second major immigrant group living in Portugal. They have been migrating to Portugal since the beginning of XX century, especially occupying manual jobs in the building and service sectors. Little has changed and they still present low educational levels and suffer from discrimination (Mourão 2012; Almeida 2012). Cova da Moura neighbourhood is an example of one of those neighbourhoods. It is a very enclosed space with several houses with several floors built in a difficult and inclined terrain. The first settlers illegally built it in the 1950s. Since then it has seen changes and usually hosts the first newcomers from Cape Verde when they arrive to Portugal. Because of the organization of the space and due to the action of several local associations it has been providing support and helps maintain the connection to their home country by promoting festivities, social support and helping with legalization issues. The only primary school in the neighbourhood helps to maintain the enclosed space in which children move in and is also an important provider of knowledge, food and social support. When the fieldwork was conducted it hosted mostly children living in the neighbourhood. Life in the community is often tainted with police raids or drug related discussion that causes tension between its inhabitants. The neighbourhood is often visited by local sellers of vegetables and fish and also local businesses are active and help to make the community self-sufficient. Many children do not leave the neighbourhood during their first years.

According to the literature it would be expected for these children to show higher overweight and obesity values based on their levels of deprivation and low education status as generally lower socio-economic status individuals in high income countries have greater risk of overweight and obesity (Gama 2002; Instituto Nacional de Estatística (INE) (Portugal) 2011). However, previous studies from 1993 and 2009, showed that the percentage of OW/OB Cape Verdean children (4-12 years old) living in Lisbon´s deprived areas have remained constant and are lower than the Portuguese average (Gama 1993; Garcia-Ruiz & Marrodán 2000; Almeida 2012).

The current economic crisis in Portugal is affecting the quality of the health care assistance, the social support to the poorest (Leahy et al. 2013). This makes this an interesting time to assess the Cape Verdean community and the strategies to diminish the escalating values of overweight and obesity of Portuguese children overall.

This research project focuses on the particular incidence of OW/OB and under nutrition as well as biosocial variables among Cape Verdean ancestry children living in Portugal. It aims to:

i) Determine the influence of biocultural background (socioeconomic status, ancestry, diet and physical activity levels) on Cape Verdean ancestry children’s nutritional status;

ii) Assess the early life factors that are associated with Cape Verdean ancestry children’s nutritional health;

iii) Compare Cape Verdean children's nutritional health with other Cape Verdean data and with the general Portuguese population.

Thesis structure

- Chapter 2 provides an overview of Cape Verde and Portugal's history. Subsequently the literature review focuses on the assessment of children's nutritional health and associated intergenerational effects. Furthermore an account of the effect of environmental and living conditions on ethnic minorities’ nutritional health and physical activity assessment is explained. The review focuses on low- income communities living in developed countries like Portugal and includes a thorough consideration of previous studies of these population groups in Portugal.

- Chapter 3 includes all methods used in this research project. The first sub section includes the description of the study design and setting, Cova da Moura neighbourhood, while the following sections refer to the participants, inclusion criteria and recruitment process. Section 3.3 concerns data collection and includes all procedures applied. A brief mention is made to some amendments to initial procedures. The last 3 remaining sections refer to the ethical process, data handling and analysis, respectively.

- Chapter 4 presents general living conditions of the Cape Verdean families who participated in this research project collected in 2013/2014. All participants included in the analysis presented in this chapter are of Cape Verdean ancestry and they will be referred to as CVPT throughout. In total there is information on 62 households regarding: socio-demographic data, household income and expenditure, ethnic background (ancestry), descriptive information on nutritional status of Cape Verdean ancestry children, physical activity (PA) and dietary assessment.

- Chapter 5 first presents a general description of the background setting of this project. It was based on observations and thematic analysis from the household interviews. It provides a unique guide to the way this community is structured and will help understand the quantitative results. Subsequently results for the second research question, regarding maternal and intergenerational (mother to child) effects on the health and growth outcomes of the children are presented. All participants included in the analysis presented in this chapter are of Cape Verdean ancestry. For the first objective, maternal health history is analysed using parity, maternal diseases in adulthood, weight gain during the participant's pregnancy, time living in Portugal, current nutritional status and risk factors on cardiovascular diseases (CVDs). Descriptive information presented in this chapter refers to the maternal health history while descriptive data pertaining to the children has been detailed in the previous chapter (chapter 4). After the descriptive data the second objective on intergenerational effects associated with anthropometric outcomes is presented.

- Chapter 6 focuses on differences between children born in Portugal from Cape Verdean ancestry at different time frames (1992, 2009, and 2013). Participants included in the analysis are of Cape Verdean ancestry. Moreover these samples will be compared with a national study on the Portuguese population (PT2009). The Portuguese national study by Padez and collaborators (Padez et al. 2011; Padez et al. 2012) was a national survey that included several data regarding anthropometric profile for children, active and sedentary behaviours and characteristics of the built in environment collected by a questionnaire sent to parents. Firstly, descriptive data is presented on children's height, weight, BMI, sitting height, triceps and subscapular skinfolds. The respective Z-score values will also be analysed according to child's age and sex. Secondly, malnutrition rates are presented according to International references (WHO, CDC, IOTF) on the Portuguese (PT2009) and Cape Verdean databases (CVPT1992, CVPT 09, CVPT2013). Subsequently section 6.3 will show the multiple linear regression models on socioeconomic determinants for CVPT2013 nutritional health. The last section will present a logistic regression model that allowed differentiating the Portuguese and Cape Verdean databases (PT2009 and CVPT2013 respectively). Details of these analyses can be consulted in Appendix F.

- Chapter 7 puts together all of the findings from previous chapters and contextualizes these within the existing literature. It discusses the research questions and aims of the thesis as well as gaps and limitations of this research area. It ends with strengths and policy implications for future research.

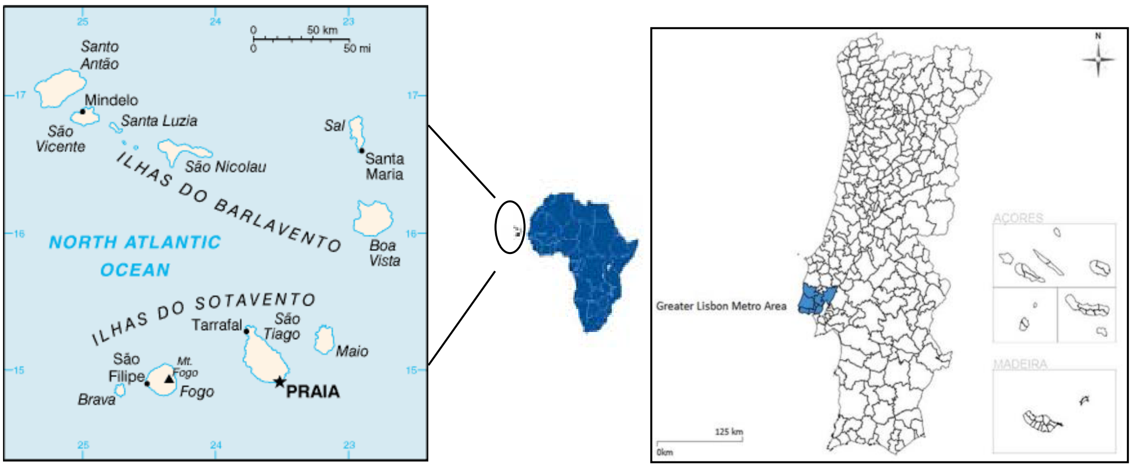
Chapter 2. Literature review

This chapter provides an overview of Cape Verde and Portugal's history. Subsequently the literature review focuses on the assessment of children's nutritional health and associated intergenerational effects. Subsequently an account of the effect of environmental and living conditions on ethnic minorities' nutritional health and physical activity assessment is explained. The review focuses on low- income communities living in developed countries like Portugal and includes a thorough consideration of previous studies of these population groups in Portugal.

2.1 The Cape Verdean Diaspora

2.1.1 Historical background

The Republic of Cape Verde is an archipelago of 10 islands situated in the Atlantic Ocean next to the African oriental coast (Senegal, Figure 2.1) (Marques 1999). It has the same name as the cape in Senegal. They were officially discovered by Portuguese sailors between 1460 and 1463 (Carvalho 2010) and in the past it was strategically used in the trade between Africa and South America. Its area is 4 033 km divided into two groups of islands (named by the direction of the winds). The country explores its 734 265 km^2 of sea.



Cape Verde Portugal

Figure 2. 1.The Cape Verde archipelago (downloaded http://www.mapcruzin.com) and Portuguese Territory (PORDATA)

These volcanic islands show several arid regions, irregular rains and the temperatures are quite elevated (above 21 and 22 centigrade). However from December to June a colder time is followed by a rainy season from August to October. The biggest island, Santiago, concentrates 50% of the population and the capital, Praia, was involved in the slave trade and transportation of resources on sailing ships in the XVI century. The Cape Verdeans share European and African origins with the first European being mostly Portuguese from the main land and the Madeira Islands. The African origin population of Cape Verde originated historically from the coast of Guinea, Senegal and Sierra Leone. Although Portuguese is the official language, *creole* is still used in everyday conversations. In Figure 2.2 a detailed description of the main historical events of the Cape Verde's Republic is presented. Cape Verdean migration started in the XVII century and is still going on today. The exact numbers are not known but they are considered high. The main destinations started out to be United States of America and São Tomé and Príncipe, (a small set of islands on the African coast)(Carling 1997; Carreira 1977). Emigration was driven by the difficult climate, job opportunities and the migration policies of the host country. On the other hand migration to European countries begun after the second world war to countries like Netherlands, Portugal, Italy and France. Portugal has been a transiting country where migrants stop to get documentation.

Figure 2. 2. Important milestones regarding Cape Verde's history (Carreira 1984).

2.1.2 Transition from Portuguese colony to independence

Cape Verde transitioned to independence peacefully in 1975. Sixteen years after a multiparty democracy was introduced. It is currently defined as a sovereign republic, unitary and democratic (Carvalho 2010). Independence consolidated language and Cape Verdean culture. It was a single party PAIGC that was responsible for the independence signed on 5th July 1975 and in 1991 the country opened to other political parties. This helped the country get to a system of market economy. In 2007 the country managed to be on the United Nations list for medium development countries (Carvalho 2010). Independence caused more migration. In the 1981 census more than half (53.5%) of Cape Verdeans had migrated between 1974 and 1981 (Saint-Maurice & Pires 1989). Independence also changed the nationality laws for Cape Verdean citizens living in Portugal. Until 1975 children born in the Portuguese territory or its colonies had Portuguese nationality (Portuguese law DL 2098/1959), July 29). A new law in 1975 denied the Portuguese nationality to those not born in Portugal (main land and islands) (dl NR 308-a/75, June 24). It was possible to obtain Portuguese nationality for many of those living in Portugal for at least 5 years.

2.1.3 Socioeconomic and political characterization of Cape Verde

The majority of the population lives in Cape Verde's urban centres (61.8%) a common tendency for medium income countries (Instituto Nacional de Estatística (INE) (Cabo verde) 2010). In 2000 urban residents were almost half (47.8%) of the total population and in 2010 they overtook (61.8%) the rural residents in numbers. However in 16 of the 22 counties, the rural population is greater than the urban population (UNCV), showing the urban population is concentrated in certain counties of the main island (Santiago). The country has a low urbanization rate with most of its population living from agriculture. According to the statistics institute in Cape Verde the population changed in the last 30 years in a different way. Annual growth rate was 1.5% in 1980 and went to 2.4% and reduced from 2000 to 2010 to 1.2% (Instituto Nacional de Estatística (INE) (Cabo verde) 2010). Also, improvements in social conditions mentioned in the last UNICEF report (UNICEF & ICCA 2011) contributed to a decrease of 9.7% in chronic malnutrition and 2.6% on malnutrition rates (UNICEF & ICCA 2011).

In the 2000 census 64% of the Cape Verdean women could not read and 62.5% had never been to school (Carvalho 2010). The vast majority of those women live in rural areas where their situation is more precarious. According to the last census (Instituto Nacional de Estatística (INE) (Cabo verde) 2010) the total population was estimated at 491,875 with 191,329 inhabitants within the age ranges of 0-17 years (39% population).Currently, Cape Verde shows one of the best performances on the Human Development Index (HDI) for the Sub-Saharan Africa area with marked improvements in literacy, reduced child mortality, higher life expectancy and improvements in health care (Fukuda-Parr 2003; International Food Policy Research Institute Intiative et al. 2004). Between 2000 and 2010 that value went from 0.500 to 0.534 (United Nations Development Programme 2011) (UNCV). Cape Verde has been fulfilling the millennium development goals (MDG monitor) despite differences between the islands. Great improvements have been observed in Cape Verde in reducing the maternal mortality rate and increasing primary education access compared to other African regions (UNDP et al. 2015). Marine resources, agriculture, industry and energy are the main economic sectors together with remittances and development aid. However unemployment is 10.7% and affects mostly women and young people and may lead to school dropout, social problems and migration (UNICEF & ICCA 2011). Life expectancy at birth is around 79.9 for women and 71.50 years for men, the majority of the adolescents are in school (> 15 years) and poverty rate is estimated to be 25% (United Nations 2014; United Nations 2015).

2.1.4 Cape Verdean migration (Diaspora)

The external migrations from Cape Verde to other countries (Figure 2.3) have been mainly driven by the harsh climate and bouts of famines. The first migratory waves during the XIX century occurred to the USA and focused mainly on the whale industry (Carreira 1984). When the USA imposed migratory restrictions the Cape Verdeans started migrating to Senegal, Angola and São Tomé e Príncipe until around the 1960s (Lopes Filho 1995). Migration to Portugal intensified around 1964 and continued into the 1980s with Cape Verdeans working in the construction, mining and other services. Historically Cape Verdean society is still female oriented and many women are the main providers of care and financial support (Drotbohm 2009). The adaptive characteristics of the society and the precarious situations have reinforced the absence of the male figure (Åkesson et al. 2012; Drotbohm 2009). The Cape Verdean concept of family resides in a household that relies on local help from other neighbourhood residents and this was determined by past migration patterns (Drotbohm 2009). Currently women only leave the country to migrate if they have family, relatives or they are enrolled in higher education in the host country (Carvalho 2010).

Cape Verdeans started migrating to Portugal mainly over the last 50 years with demands for the Portuguese job market in terms of services and construction workers. The absence of many Portuguese in military service in the colonial war generated this high demand (Machado 1994). In 2008 Cape Verdean residents in Portugal were estimated to be 50,887 mainly distributed around Lisbon metropolitan area (PORDATA website).

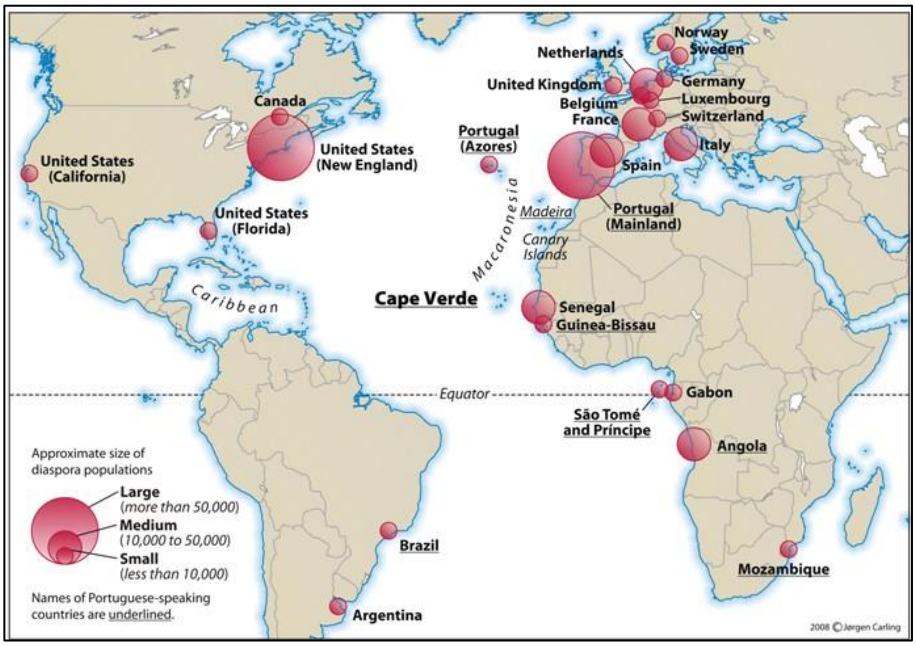


Figure 2. 3. Map of Cape Verdean Diaspora from (Batalha & Carling 2008) licensed under Creative Commons attribution by NC 3.0.

2.2 The Cape Verdean community living in Portugal

2.2.1 First settlements

Cape Verdeans started settling in Portugal and specifically in Lisbon during the 1930s. In 1936 they made 40% of total emigration from Cape Verde (Almeida 2012). Moreover from the 1940's Cape Verdean students started moving to Portugal not only to go to other European countries but also to get a degree (Almeida 2012). Further on in the 1980s more job opportunities arose in Portugal with its entrance in 1986 into the European Union. The Portuguese foreign office estimated that in 2002 Cape Verdeans were 52,454 making up 21.9% of foreign nationalities living in Portugal (Instituto Nacional de Estatística (INE) (Portugal) 2006b). Apart from the education cooperation there are also health agreements between Cape Verde and the Portuguese government affecting a small group of people (325 in 2002) (Direção-Geral da Saúde n.d.). Most of the Cape Verdean community in Portugal is settled in the great Lisbon's Metropolitan Area (Figure 2.4) (França 1992; Instituto Nacional de Estatística (INE) (Portugal) 2006b).

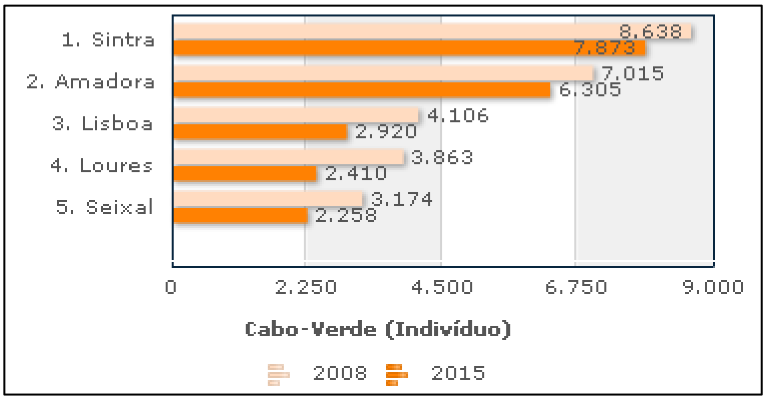


Figure 2. 4 Concentration of Cape Verdean communities (legal resident status) in Lisbon area, Portugal (PORDATA)

The community started as a small concentration of students and workers in a cheap area around Lisbon (Batalha 2008 in (Góis 2008)). Time and high demand of jobs lead to illegal housing to account for larger families and relatives but also to maintain culture and avoid discrimination (Almeida 2012). However after independence of Portuguese colonies in 1975 many settlements were distributed to the city into other municipalities like Amadora, Oeiras and Lisbon (CEPAC 1995). Amadora municipality was one of the first points of settlement due to the excellent location, good services and affordable housing (CESIS 2004). Cova da Moura neighbourhood is part of Amadora municipality and has been included in several refurbishment programs (Universidade Católica Portuguesa et al. 2008; CEPAC 1995). More recently the neighbourhood was also included in a pilot project of requalification due to its cultural value (Departamento de Programas de Reabilitação/ DHRU 2011). The Cape Verdean community is the main foreign group living in Cova da Moura neighbourhood geographically divided between Damaia and Buraca parishes.

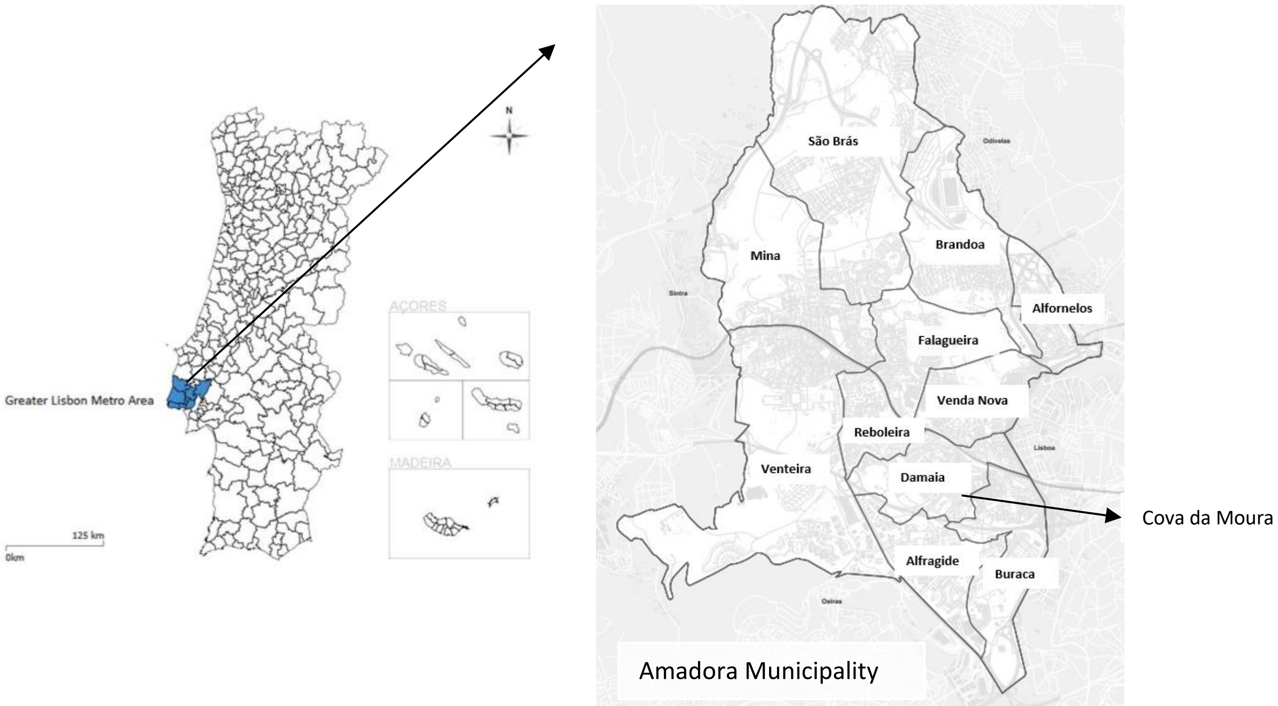


Figure 2. 5. The geographical position of Lisbon area and Amadora municipality (http://www.cm-amadora.pt/municipio).

The Amadora municipality (Figure 2.5) had in 2011 a total population of 175 136 inhabitants and was the 9th most populated municipality in Portugal (CMA. Câmara Municipal da Amadora 2014). It is currently the densest municipality in Portugal with 7 363 habitants/Km^2. Almost 4 % of its population (3.8 %) lives in slums. The infant mortality rate decreased but in 2008-2012 was 7.2 % still above Lisbon's average (3.7%). In 2011 the unemployment rate reached 15.0% (CMA. Câmara Municipal da

Amadora 2014) and since 2005 it has presented several fluctuations being the highest in December 2012 and affecting mostly men that had been unemployed less than a year (CMA. Câmara Municipal da Amadora 2011). The area is densely populated and due to the high demands in 2001 there was an increase in green space *per capita* as well as nurseries, public kindergartens and sports facilities that later in 2011 proved insufficient along with the number of global practitioners *per* 1000 habitants (CMA. Câmara Municipal da Amadora 2011). The school dropout for the primary level was also higher (16.2%) than Lisbon's average (11.3%) (CMA. Câmara Municipal da Amadora 2011).

2.2.1.1Cova da Moura neighbourhood

Figure 2. 6. Aerial View of Cova da Moura neighbourhood (www.ppl.com.pt)

Cova da Moura neighbourhood is considered by Amadora municipality as a deprived area (Figure 2.6). The total area is 16.3 hectares (http://www.aedamaia.pt/) divided between the southern region and slopes in the northern and eastern regions (Godinho 2010). It was one of the first points of settlement for Cape Verdean families that first arrived in Lisbon. The first migrants managed to build accommodations with the *djunta mon* (meaning putting hands together). From 1977 to 1987 other migrants from Portugal's ex colonies rose from 600 to 5000 (Almeida 2012). The current numbers of its inhabitants fluctuate due to the mobility of its population (Silva 2012) but in 2010 a local association estimated 7000 living in the neighbourhood (*Moinho da Juventude*). The residents are mainly Cape Verdeans from Santiago, Santo Antão and São Vicente islands (Góis 2006). The last houses were built on an horizontal plane in 1985/86

(Almeida 2012) and in 2001 there were 85 houses/ha and 306 inhabitants/ha, a much higher density than the mean values for the municipality (34 houses/ha)(Mendes 2008 cited in (Almeida 2012). This density/ overcrowding are explained by buildings with several levels that work as residencies but also shops and services. It would be common to have 4 people per household in different phases of life meaning different relations, reunion, new members or hosting relatives that recently migrated (Almeida 2012). The place is still in high demand and even though the rents are high many undocumented migrants reside there. Even if many utilities were installed in 1990s (electricity, sanitation, water, telephone lines) in 2008 several deficiencies were identified in the construction of buildings and problems of fire safety (Vilhena & Coelho 2008). Local associations like *Moinho da Juventude*, created in the early 1980s, currently provide childcare, education programs and administrative support. However drug related businesses located in specific areas of the neighbourhood contribute to the overall insecurity of the area. The local primary school was built in the 1980s and in 1996/97 a pre-school was added in the education area of Damaia parish. Later it was refurbished in 2001 and currently 13 teachers provide 4 levels of education to 204 students (Agrupamento de escolas da Damaia 2013).

The Cape Verdean community in Portugal registers high levels of unemployment, low educational status and deprived living conditions (Marques 1999; Embaixada Cabo Verde 1999).The working age population tend to have precarious and low paid jobs like domestic jobs for women and construction workers for men, many accumulating second jobs (Luz 2007; Departamento de Programas de Reabilitação/ DHRU 2011). These social problems are driven by unequal opportunities and social tensions deriving from the "illegal" housing in these neighbourhoods (Departamento de Programas de Reabilitação/ DHRU 2011). All of these problems impact this community's quality of life and more deeply the children's lives hence the pertinence of this study.

2.2.2 Qualitative studies conducted in the Cape Verdean community

Several themes have been explored on the social aspects of the Cape Verdean community in Portugal (Góis 2008; Bäckström 2009) and more specifically in Cova da Moura neighbourhood (Godinho, 2010; Ilheu & Silva, 1991). Some of this literature focused on migration process (Évora 2010; Évora 2011a; Batalha & Carling 2008), others on the subsequent acculturation process (Neto 2002; Pinto 2007), while some reflected on the role of women in migration (Grassi & Évora, 2007), transnational motherhood (Åkesson et al. 2012), parental investment (Almeida 2012), health access (Bäckström 2010; Masanet et al. 2014; Marques 1999; Machado et al. 2007), schooling in Portugal (Seabra, 2006; Seabra & Mateus, 2011), social insertion (Malheiros 1996; Machado & Abranches 2005), precarious job conditions (Pereira 2008), discrimination (Mourão 2012) and identity (Évora, 2011b; A de Saint-Maurice, 1997). Some of the methods used by these researchers were non-participant observation, thematic analysis, personal interviews with parents, key workers and informants and questionnaires.

The acculturation process of Cape Verdeans has been linked to the school and this has a way of changing views and multi ethnic societies. Neto used an International Comparative Study of Ethno cultural Youth (ICSEY)(Neto 2002) while Pinto used ethnicity scale and a demographic survey in Cape Verdeans in the USA and both confirmed cross generational transmission of parental values (Pinto 2007).

Migration processes in women were studied by Akeson and collaborators who concluded that the duration of separation between children and mothers was accepted and was part of a difficult future. This finding was based on ethnographic fieldwork and interviews in 1998-2008 in Cape Verde and other Cape Verdean communities (Åkesson et al. 2012). To measure health and school access methods, interviews and participant observation were employed by Masanet (2014) showing the difficulty to access health services (Masanet et al. 2014). The findings from Seabra and Mateus (Seabra & Mateus 2011) showed that when socio-demographic variables are controlled, national origin had no greater impact than other variables on the school pathways of the pupils surveyed. On the other hand parental educational level and social position were important determinants in shaping school performance.

The biggest Cape Verdean communities in Portugal are located mainly in urban centres like Lisbon (Góis 2008). Cova da Moura is a unique setting and has been hosting the biggest Cape Verdean community in Portugal for some decades and has contributed to a stronger association between its residents (Carita & Rosendo 1993; Sardinha 2005)

On the other hand the confined physical space might have made it difficult for their integration in society (Góis 2008; Saint-Maurice 1997). Having a school inside the neighbourhood stops children engaging in multicultural integration (Gusmão 2004). The fact is that different waves of migration to Portugal have had different impacts on Portuguese society (Amaro 1986; Esteves & Caldeira 2000). Cape Verdean parents consider education as the most important factor on social differentiation (Góis 2008). School dropout is very high and many youngsters do not complete 9 years of education because they are too old to enrol again. In Portugal media has reported a negative image of Cape Verdean ancestry youth (Ferreira 2005). The main problems reported by the residents are marginality and exclusion (Braathen et al. 2008).The youngsters use that to create a contrary identity of the Portuguese mainstream, and identify themselves with the neighbourhood as a physical space (Góis 2008). There are still business opportunities because there is the concentration and need from the residents of the neighbourhood (eg remittances and sending packages)(Góis 2008). One of the most important assets is having a house as it is a sign of success and prestige (Weeks 2012). Many art and music expression activities are organised by local associations like *Moinho da Juventude* (Associação Cultural Moinho da Juventude 2012) as well as social support. Local child minders employ Cape Verdean women and also provide support for working mothers of the neighbourhood (Gusmão 2004). Cape Verdean women's power is enhanced as they need to provide for child care, household and economic stability (Weeks 2012; Pina-Cabral 1986). The main contributors to help Cape Verdean women and that include family and relatives, the neighbourhood and Lisbon periphery (Figure 2.7). The family dynamic is practical and adapts to different situations like long separation periods and different children from different relationships living in the same household (Weeks 2012). This is seen by the community as a strategy to overcome precarious labour conditions and remunerations.

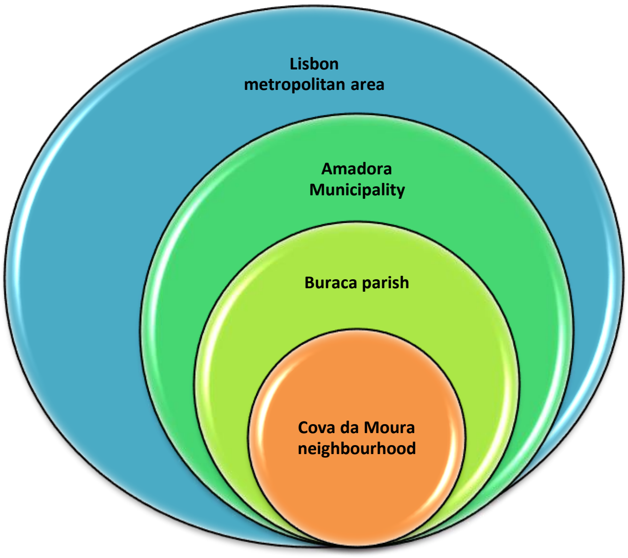


Figure 2. 7. Different ecologies in which the Cape Verdean community living in Lisbon.

2.2.3 Socioeconomic and political characterization of Portugal

Located in the southwest of Europe, Portugal (Figure 2.8) has a total population of 10,562178 million with almost 27% (2 830 867 habitants) concentrated in the capital, Lisbon (Instituto Nacional de Estatística (INE) (Portugal) 2011).

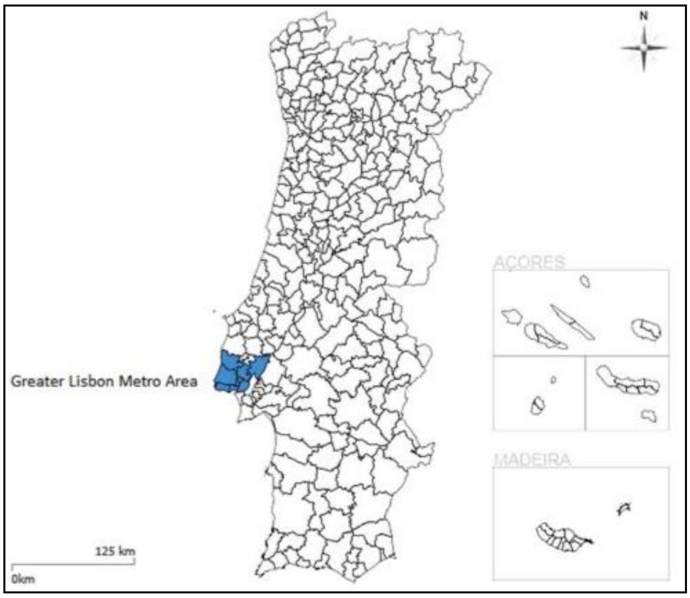


Figure 2. 8. Map of Portugal (reproduced with permission (PORDATA).

The first republican government in 1910 was followed in 1939 by a dictatorship instituted by the former finance minister, António de Oliveira Salazar, who brought severe socioeconomic changes to the Portuguese society. The authoritarian regime, along with the Spanish civil war (1936-1939) and the Portuguese colonial war (1961-1974) would only end in 1974 with the political revolution (Ramos & Sousa 2009). Over the period of 1971-1980 there was a massive increase of 7% of the Portuguese population (close to half million) returning from the previous African colonies (Veiga et al. 2004). Later on in the 80s and 90s several Portuguese migrants returned from France or Switzerland even if many emigrated after Portugal's entrance to the European Union (EU) in 1986 (Mateus 2013). In the 90s most of the population growth was only possible due to the migratory rates and for last years the European immigration has increased and the people from African countries accounted for 45% of them (14% from Cape Verde) (Veiga et al. 2004). Presently a terrible economic crisis (2008) is drastically changing the social scenario (Leahy et al. 2013). Figure 2.9 shows the major events that characterised Portugal during the 20th century.

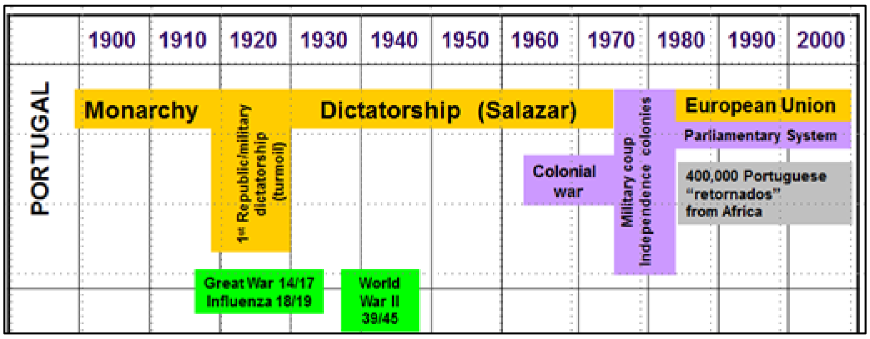


Figure 2. 9. Important events during the 20th century in Portugal (with permission of Varela Silva)

The 2011 census reported almost 400,000 foreigners living in Portugal (394.496), about 4% of the total population with 10% from Cape Verde (Instituto das Comunidades 2012; Instituto Nacional de Estatística (INE) (Portugal) 2011). Conversely, 1.5 million Portuguese left mainly for France, Angola, Mozambique and Germany. The current economic crisis is driving 100 000 to 120 000 Portuguese each year out of the country (Observatório da emigração 2013) and in 2011, 41,9998 Portuguese mostly 25-29 years of age left the country (Instituto Nacional de Estatística (INE) (Portugal) 2011). The Portuguese society experienced several changes to the migratory patterns, improvements to health care services and educational levels over the past 40 years. Presently the Portuguese earn more, have better living conditions, have less children (Veiga et al. 2004) and are more qualified than before the dictatorship but are currently struggling with a terrible economic crisis with several demographic variables deviating below European average references (Table 2.1). Also the Portuguese workers earn one of the lowest social wages in Europe that was further reduced in 2011 by 3.6 % (Eurostat). The current unemployment rate (17.8%) surpasses the European average (Eurostat 2013b) affecting particularly the younger aged 15-24 years.

The National Health System in Portugal was founded in 1971 providing primary health care first through district health centres by the National vaccination Programme and antenatal and child care and was then extended to cities (Branco & Branco 2001).This contribution was reflected by a drop in infant mortality rates even with the high rates for low birth weight (Barreto 2000; OECD 2010). However, Portugal still shows insufficient and unequal access to primary health care and in 2010 the expenditures on health services fell opposing the experience of previous years (OECD 2010; Pereira & Bugalho 2003). Moreover, over the last 30 years the fertility rate has been dropping (Barreto 2000) and since 1982 Portugal cannot maintain its population because most families have only one-child. Even though pre-school childcare enrolment in Portugal has tripled in the last decade, the country is spending less on children in their first years and in 2008 less was spent on social protection (OECD 2010). Despite the decrease in infectious diseases, the rising prevalence of cancers and vascular problems accounted for 59.8% of Portuguese deaths (Barreto 2000; Eurostat 2013b). Although Portuguese die mostly from circulatory diseases, cancers and respiratory diseases and suffer from respiratory conditions (Eurostat 2013a) they also live longer than before, the women more than men (OECD 2010). In Portugal death rates are mostly due to circulatory diseases (173.8) and cancers (156.5) similar to other European counterparts (circulatory diseases: 209 and cancers: 166.9 (Eurostat, 2010). When observing the health risk factors in European Union countries the Portuguese have lower rates for smoking, higher rates for alcohol consumption, higher diabetes rates and are less physically active (OECD 2010) also registering the highest OW/OB rates for European women (Berghöfer et al. 2008). More among younger generations one in every three Portuguese children aged 6 to 8 years are overweight (Rito et al. 2012).

Table 2. 1. Bio-demographic variables shaping the Portuguese society and health status compared to World and European averages (assembled by AA from various sources).

Variables	Statistics Portugal	Year	UE27/OECD
Health			
Life expectancy at birth[2]	80.9	2009/11	79.7(2009) [3]
Fertility index[2]	1.35	2011	1.57
Low birth weight[4]	7.7%	2010	6.4% OECD health
Alcohol consumption[5]	11.4%	2010	10.8%
Smoking rates [5]	19.6 %	2010	24.2 %
Obesity [6](18-90 years)	13.9%M 26.1%F	2008	16.2%M18.1%F
Diabetes adults (20-79y) [7]	9.6%	2012e	6.7%
Moderate Vig PA (15y) daily [8]	10%	2006	15.7%
Total health spending[5]	10.7% of GDP	2010	OECD 9.5%
Main death rates[3]	Circulatory diseases (173.8)	2010	Circulatory diseases (209)
Education			
Educational expenditure[2]	5.79%	2009	5.41%
Economy			
Minimum wage[1,3]	485€	2013	500-1000€
Population			
Foreign population[2]	4.2%	2011	
Foreign born [5]	7.3%	2010	
Unemployment [3]	17.8%	2013	12.2%
Social protection[1]	24.3%	2008	26.4%

Fertility index: number children per women; [1]Main death causes : standardised death rate for each 100 000 inhabitants[3]; Educational expenditure (% of GDP)[2] ; GDP : Gross Domestic Product[2] ; social protection (expenditure health) % of GDP[1] ; Household Average Income based on lower educational level[2]; Elderly people: aged 65 or above[3] ratio %; Educational level (secondary)[2]; Low birth weight (<2500gr)[4]

Sources:

1. Instituto Nacional Estatística Portugal I Portuguese National Institute of Statistics
2. FFMS (2008) PORDATA - base de dados Portugal contemporâneo. (http://www.pordata.pt/). Access 2013 March 6-13th
3. Eurostat, http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Main_Page
4. OECD Health Data: www.oecd.org/health/healthdata, OECD Health at a Glance 2011 and OECD Health Data 2012 (Statistics and Indicators);
5. OECD Health Data 2010; Eurostat Statistics Database; WHO (2010).
6. (Berghöfer et al. 2008)
7. (International Diabetes Federation 2012)
8. (WHO 2008a)

Literature review on nutritional health among ethnic minorities

A review of the literature identified a gap in the research focusing on the growth and nutritional health of ethnic minorities living in Portugal. AA analysed 42 papers written in English, Portuguese and Spanish retrieved from five international databases (Google scholar, Scopus, EBSCO, ProQuest- Health and Medicine, Web of Science, Sciencedirect) and 6 Portuguese-specific databases (Dialnet, Scielo, Porbase (National Library of Portugal), Docweb (IHMT), RCAAP (Open access scientific repository of Portugal), Dart Europe) with no restriction of year in November 2012. The key words for this review were "Cape Verde", "Cape Verdeans" and in Portuguese "Cabo Verde", "Cabo Verdeanos" with any study related to "growth", "nutritional health" and "socioeconomic studies".

2.3 Nutritional health and intergenerational effects

2.3.1 Growth and nutritional health

Human growth is a mirror of environmental variables acting on the genetic background (Tanner 1986). However environmental variables may have different impacts on different phases of life. When individuals are growing up there are some periods when they are more susceptible to environmental causes (Cameron & Demerath 2002). These are rapid growths periods that occur at different phases: prenatal, infancy, childhood and adolescence. For example, diet quality and growth rate in infancy and early stages of childhood can be associated with adult mortality (Barker et al. 2011; Ness et al. 2005).

During infancy there is an acceleration of growth and there are several important physiologic, behavioural and cognitive achievements. This stage goes until 36 months (Bogin 2012a). Subsequently childhood starts at 3 and goes to 7 years with moderate growth. The juvenile phase is next and is marked by sex differences: girls from 7 to 10 years and boys from 7 to 12 years. In this phase the growth rate is slower because of the learning process of social skills. Puberty follows this stage and is characterized by secretion of sexual hormones and sexual development. In the last stage, adolescence, there is a greater increment in height and weight, permanent teeth erupt and socio-sexual maturation (Bogin 2012a).

The human body is composed of different parts that grow at different stages in the lifetime (Lejarraga 2012). Lejarraga shows the variation of anthropometric measures like height, weight and head circumference during infancy and childhood. During the first year of infancy the growth rate is very fast and even more on the first part of the first year. However velocity of growth is slower in childhood and continues to decrease until adolescence. Three major phases of growth can be observed during the first years: decelerating stage from birth to 2-3 years, slowly decelerating from 3 years to onset of adolescence and the adolescent growth spurt. The author defined height as a linear growth measurement while weight a combination of lean body mass and body fat (Lejarraga 2012).

Anthropometry can be used as a growth indicator (Gorstein & Akré 1988). It can be used to assess linear measures like height and leg length and it may reflect on the quality of the environment (Bogin et al. 2002). For example boys have shown to be more affected by the quality of their environment as observed through leg length measures (Stinson 1985). Other body anthropometric measurement methods include weight (Frisancho 2008a), skinfold thickness (Wells & Fewtrell 2006), waist circumference (Wells & Fewtrell 2006), body mass index (Bogin 2012a; Zemel 2012) and bioelectrical impedance (Wells & Fewtrell 2006; Ackland et al. 2012). For body mass composition, skinfold measurements is a fast method that can detect risk of central obesity (triceps and subscapular skinfold) and the location of body fat mass. Also waist circumference measuring central fat tissue can determine the risk of abdominal obesity and subsequent health related conditions. It is important to use it according to the different ethnic, age and sex specific cut off points (WHO 2008c). Body mass index (BMI) is calculated as the ratio of body weight to height squared (WHO). It has been used in several studies because of its simplicity and different cut offs available. It permits an inference about population health and risk of obesity but it does not account for sex differences, short people and a relationship to visceral fat

(Bogin 2012a; Zemel 2012). On a par with anthropometric measures bioelectrical impedance is also a common method to assess body composition due to its portability and easiness (Heyward & Wagner 2004; Ackland et al. 2012). However, it depends on several environmental conditions like the hydration status of the individual to provide reliable and accurate measurements. Wells (2003) cited Roland-Carrera et al (1984) to show a U shaped curve for BMI between 2 and 16 years. BMI is lowest between 4 years and 6 years and then increases until the child gets to the juvenile stage. This was named by Wells as BMI rebound (Wells 2003). However BMI relates height to weight and during a lifetime several changes may be translated into alterations of fat, body mass or bone density. A higher BMI can also mean more weight to height which would include more fat, muscle or water (Bogin 2012a; Zemel 2012; Doak et al. 2013). Nevertheless BMI is commonly used across the world to determine overweight and obesity rates in different populations (Centers of disease control 2011). Nutritional health incorporates malnutrition, which is related to over nutrition, overweight and obesity, and under nutrition measured as stunting, wasting and underweight rates. The problem of over nutrition is the excessive consumption of nutrients and calories that compromise an individual's health that leads to non-communicable health conditions such as cardiovascular disease (CVD), hypertension and diabetes (Popkin 2001). On the other hand, under nutrition as defined by UNICEF refers to insufficient food ingestion and may be associated to a depressed immune system leading to subsequent infections (UNICEF 2016). This classification includes children who are short-for-age (stunting, or chronic malnutrition), show lower weight-for-height (wasting, or acute malnutrition) and with lower weight-for age (underweight). The described conditions undermine and reduce growth rates, decrease average values for subcutaneous fat (skinfolds), arm and head diameters, and tend to slow sexual maturation in both sexes (Cameron 1991; Spurr et al. 1983). Furthermore these conditions have been associated with an increase in infant mortality (Pelletier et al. 1993; Pelletier et al. 1995; Van der Mei et al. 2007; Van den Broeck et al. 1993). The prevalence of under and over nutrition varies around the world (De Onis et al. 2000). Even with a decrease of 40 million on stunting in under 5 year old children in developing countries child malnutrition is still an urgent public health concern (De Onis et al. 2000). If some rates are slowly increasing others maintain high values. The World Health Organization (WHO) suggests malnutrition is responsible for one third of child deaths even if it has not been faced as a direct cause. Among other factors, the WHO refers to the lack of specific nutrients, poor feeding practises like inadequate breastfeeding, not ensuring the child gets the most nutritious food and early weaning as contributing to malnutrition and increasing infection rates endangering children's growth (WHO 2014a).

Childhood OW/OB rates are especially concerning due to their subsequent tracking to adulthood and their connection to several states of comorbidity (Kuczmarski et al. 2002) as well as the difficulty of reversing these conditions later in life (Waters et al. 2011; Singh et al. 2008). Childhood obesity independent of adult obese status has serious consequences for outcomes like hypertension, dyslipidaemia and hyperinsulinemia (Freedman et al. 1999; Srinivasan et al. 2002; Tounian et al. 2001).

Furthermore there has been an increase of obesity among ethnic groups (Cole et al. 2000; Hui & Bell 2003; Moore et al. 2003; Ulijaszek 2003). Labree and collaborators reported in a review paper in 2011 (Labree et al. 2011) that some non-European migrant children are more prone to overweight and obesity. The most common growth reference used to assess overweight and obesity in migrant children in 6 countries were the International obesity task force (IOTF) cut off points. Studies like the ones conducted by Dawson and collaborators, Gilbert and collaborators and Roville-Suasse and collaborators attributed higher overweight and obesity rates to lower physical activity levels and dietary changes among these children (Dawson et al. 2005; Gilbert & Khokhar 2008; Rovillé-Sausse 2005).

In this dissertation we are focusing on children of Cape Verdean ancestry living in Lisbon, Portugal. Therefore the following parts of the chapter will be focusing on the literature specific to Portugal and Cape Verde.

2.3.1.1 Portugal - growth studies and health of the population

In Portugal some studies have shown trends in growth, under and over nutrition during the second half of the XX century (Gama 2002; De Castro et al. 1998; Meira 1953;

Meira 1956; Wennberg 1988). The secular trend observed in Portugal showed significant socioeconomic changes that improved quality of life reflected into decreasing of menarche age and increasing average height (Barreto 2000; Padez & Rocha 2003; Padez 2003b). While both changes are the result of genetic and environmental variables (Padez & Rocha 2003; Tanner 1992), the increment on the average height was not sufficient and the Portuguese are still the shortest Europeans (Garcia & Quintana-Domeque 2007; Padez 2002). A positive pattern in the Portuguese Lisbon male population (Lacerda 1904; Padez & Johnson 1999) showed increments of 1.8 cm and 1.5 cm respectively (De Castro et al. 1998; Sobral 1988). Consequently children from higher SES and urban settings were taller and heavier (Caninas 2002; Carmona da Mota 1990) while adults from poorer regions of Portugal were shorter (Sobral 1988). The same was observed in conscripts living in the dictatorship period (Sobral 1990) and more recently children from Madeira island (Freitas et al. 2007). The period of 1961-1966 was especially favourable for economic, political and social conditions allowing the Portuguese to grow more in length. Moreover, the entry to the European Union (1986) and the democratic period increased the average height by 2.9 cm/decade (Padez & Johnson 1999; Padez 2002). While rising height was associated with better living conditions regional differences became less expressive in 1996 (Padez & Johnson 1999). In the 1990's father's higher educational level was positively related with their children's height followed by maternal academic level and area (Fragoso 1998). Simultaneously a marked positive trend in weight (Padez & Johnson 1999)(Cardoso & Padez 2009) was also found. Portuguese adolescents grew 1.8cm/decade (boys) and 2.1 cm (females) but also gained 6 kg (Coelho-e-Silva & Malina 2003) in Portugal and the Azores islands (Sobral & Coelho-e-Silva 2001). In spite of significant socioeconomic changes the country has the highest European obesity rates (Lobstein & Frelut 2003; Cattaneo et al. 2010) exceeding 30% and 31.8% in OW/OB along with deep social disparities (Padez et al. 2004; Padez et al. 2005; Padez 2003a; Branca et al. 2007; Ferrão et al. 2013). Moreover the last National Study of Childhood Obesity conducted in 2009, showed a prevalence of 37.9% for overweight (OW) and 15.3% for obesity (OB) in 6-8 year old school children (Rito et al. 2012). A study showed that 20. 1% of under 6 year old boys were OW/OB and 27.3% of the girls

(Rito 2006). In the older children (6-10 years) the percentages for OW/OB ranged from 5.3 to 13.2% in boys and 6.4 to 12.6% for girls. The adolescents born in the 90s presented with 11.3% boys and 9.2% girls being obese, according to CDC references (Centre for Disease Control,(Kuczmarski et al. 2002)). Recently, in 2008, 1 in 3 Portuguese children aged 6 to 8 years was overweight showing a similar trend of southern European countries (Rito et al. 2012). The findings quantified the underweight, overweight and obesity according to the IOTF standards, as 4.8%, 28.1% and 8.9% respectively. Interestingly the islands, Azores and Madeira, show a higher concentration of OW/OB children while the south of Portugal exhibits lower rates. Furthermore in 2012 rising excessive weight among pre-schoolers marked a north-south pattern (Wijnhoven et al. 2013) and showed the highest European values (26.8% and 28.5% for Portuguese boys and girls, respectively) for overweight and obesity (7.9% and 9.3%). Back in 2007, Moreira presented a review on OW/OB prevalence rates in Portuguese children. The paper covered studies from 1999 to 2006, different regions of the country, different age ranges with only one presenting national data (Padez et al. 2004). Table 2.2 summarises some of the main conclusions. Starting from 2 to 6 years (Mira 2006) and going to 10-15 years (Sardinha et al. 1999) the common standard used was the IOTF criteria (International Obesity Task Force). On the following age range (6-10 years) obesity rates showed variations from 5.3 to 13.2% in boys and 6.4 to 12.6% for girls. Nevertheless the single study with a pubertal population (Ramos & Barros 2005) born in the 90s showed incidences of obesity of 11.3% in boys and 9.2% in girls, even though using a different growth standard (CDC, Centre for Disease Control, (Kuczmarski et al. 2002)). Despite the difficulties to compare data from different age ranges, locations and different criteria, the main conclusion of the paper was that OW/OB represented more than a third of the young population (30%), an altogether alarming fact.

Consequently the same tendency was observed by Padez and collaborators in a national study of 7 to 9 years old attending public teaching Institutions (4511 in total)(Padez et al. 2009). Similar to other southwest European countries these are only exceeded by Italian children (Binkin et al. 2010).

Table 2. 2. Summary of studies on over nutrition in children and adolescents conducted in Portugal.

Reference	Region	Sample	Age range (years)	Prevalence girls (%)	Prevalence boys (%)	Standards used
(Vaz de Almeida et al. 1999)	Continent	1000	>= 15	BMI≤19.9: 8% 20≥BMI≤24.9: 50% 25≥BMI≤29.9: 33% BMI≥30:9%		Garrow 1981
Castro et al.(1996;1998)	Continent	2383	20	BMI>25kg/m^2: 18% BMI>27kg/m^2: 6.4%		
Mira 2006	Coimbra	408	2-6	------	OW: 20.6 % OB: 7.8 %	IOTF
Rito 2006 (Rito 2006)	Coimbra	2361	3-5	OW: 20.4% OB: 6.9%	OW: 13.6% OB: 6.5%	IOTF
Sardinha 1999	Lisbon	328	10-15	44.8	27.3	BF
Padez et al 2004	Continent	4511	7-9	OW: 19.1% OB: 10.3%	OW: 21.4% OB: 12.3%	IOTF
Ramos and Barros 2005	Porto	2023	13-14	OW: 16.9% OB: 11.3%	OW: 16% OB: 9.2%	CDC
Bingham et al 2013	Continent	17136	3-10	OW: 17.7% OB: 7.5%	OW: 21.7% OB: 8.9%	IOTF

Notes: OW: overweight; OB: Obesity; IOTF: International obesity task force; CDC : Centre for Disease Control, BF: body fat % defined in Sardinha et al 1999 for obesity BF >25% in boys and >30% in girls citing Williams et al 1992; Garrow 1981

The actual values presented are that 31.5% of the children are OW/OB and 11.3% obese (using IOTF standards). As expected girls presented higher values (33.7%) while boys accounted for almost a third (29.4%).

In Table 2.3 overweight and obesity classification are presented according to the two different cut off points. Values are slightly higher for IOTF cut off points on overweight for boys and girls.

Table 2. 3. Values found for over nutrition in a review paper in Portuguese children 2-10 years (Antunes & Moreira 2011).

	Overweight		Obesity	
Standards	Boys	Girls	Boys	Girls
CDC	9.1-27.4%	13.4-26.5 %	5.9-19.8%	6.1-21.3%
IOTF	29.6%	31.4%	10.6%	13.1%

However for obesity, on the higher end of the spectrum, IOTF cut off points show lower rates for boys and girls. One of the recent review studies on over nutrition in Portugal (Antunes & Moreira 2011), as shown in Table 2.3, reports higher overweight for IOTF on both sexes and lower rates for obesity. The CDC standards were commonly used in studies with children younger than 10 years.

2.3.1.2 Cape Verde - growth studies and health of the population

Health studies are sparse in Cape Verde and only a small account is possible from some of the projects conducted in the archipelago during and after its independence in 1975. The first health status account on the Cape Verdean population dates from 1953, when Meira (Meira 1953) noted that children born in the 1940s and 1950s from Sal island grew up to be lean and thin adults with boys being shorter than girls', a fact the author related to a possible selective social protection or lower levels of physical activity (Meira 1953). Later in 1956 in São Nicolau island, boys and girls showed lower and slower increments in weight and height especially for girls and starting at 9 years (Barbosa 1956). Even with improvements from 1970-73 the Cape Verdean population continued to show lower height and weight compared to international growth standards and an observed catch-up around 17 years was associated by the author with environmental factors or maturity timing (Rocha 1987). By the end of the 80s growth retardation or chronic, moderate nutritional deprivation was detected with interregional variations in Cape Verdean preschool-age children (Wennberg 1988). Table 2.4 shows under nutrition rates found on studies conducted in Cape Verde. On one study next to 14 670 children attending health services were identified and 26% of them classified as stunted. Only small percentages were found to be wasted or both stunted and wasted (3 and 1% respectively) (Reitmaier et al. 1987). Recently the Cape Verdeans present normal values and females show higher values in relation to the males according to the World Health organization (WHO) and National Centre for Health Statistics (NCHS) growth references (Abreu 2011).

Table 2. 4. Nutritional status of Cape Verdean children living in Cape Verde in past studies (Reitmaier et al. 1987; Wennberg 1988) .

Country	Sample	Age range	Results	Authors
Cape Verde	14670	Lower 5 years	HFA <-2SD (stunting): 26% WFA <-2SD (stunting): 3.0% Stunted and wasted: 1%	Reitmaier et al (1987)
Cape Verde	17017	0-6 years	WFA <-2SD (underweight): 17.2% HFA <-2SD (stunting): 13.1% Stunted and wasted: 1% WFH<-2SD (wasting): 2.5% WFA <-3SD (underweight): 6.1% HFA <-3SD (stunting): 2.3% WFH<-3SD (wasting): 0.6%	Wennberg (1988)
HFA: Height-for-age, WFA: Weight-for-age, WFH : Weight-for-height				

Nevertheless (UNICEF & ICCA 2011) UNICEF stated that in 2011 chronic malnutrition in Cape Verde was paired with another problem characteristic of developing countries: overweight. Data from IPAC (Inquest for the prevalence of anaemia and associated factors in children under 10 years) from 2009 show that 5% of the under five year olds were above the normal weight in a country undergoing nutritional transition (Ministério da Saúde de Cabo Verde (DSSA,MSaude 2009). The 2011 report from UNICEF calls for measures to be taken to address the main nutritional problems of the country (UNICEF & ICCA 2011).

2.3.1.3 Cape Verdean children living in Portugal - growth studies and health of the population

There are only a few health studies conducted with Cape Verdean migrant populations living in Portugal. The first one was a cross -sectional study conducted in 1989 in Buraca parish, Amadora municipality (Gama 1993; Gama 2002). Gama collected anthropometric and sociodemographic data on Cape Verdean ancestry children. The sample included Cape Verdean ancestry children living in Portugal (CVPT) and Portuguese ancestry children (PT). CVPT were thinner than PT children aged 6-11 years living in Lisbon. In comparison with Cape Verdean children (CV) from the islands ((citing (Rocha 1987)) CVPT were taller and heavier which was attributed by the author to favourable living conditions. Portuguese children 6 to 11 years living in 1989 were heavier (Z-scores) than Cape Verdean ancestry born in Portugal. Height values compared to NHANES III reference data show lower values among Cape Verdean ancestry children compared to the Portuguese. Differences were found for height for an only child and first born with the Portuguese girls being taller. Households lower than 5 members had children with higher weight values. Among Cape Verdean ancestry children the ones from medium SES (4 years of education) were taller and heavier than the ones of lower socio-economic status.

Subsequently another study in 1992 by Garcia-Ruiz (Garcia-Ruiz & Marrodán 2000) collected data in several neighbourhoods of Buraca parish, municipality. While comparing children from Cape Verdean ancestry children living in Portugal (CVPT) with Portuguese (PT) the authors found that there were small but not significant differences for height and weight. Most of the differences found were for body composition in girls (higher triceps skinfold). In 1992/93 Portuguese children aged 6-7 years were significantly heavier and fatter (triceps skinfold) than Cape Verdean ancestry boys and Cape Verdean ancestry girls and more significantly at 8-9 years. Later on in 2004 Varela Silva compared PT, CVPT and CV from Cape Verde along three periods (1993, 1999 and 2001). Effectively both PT and CVPT boys had negative trends in height, weight and upper muscular area (UMA) while CV boys had the lowest measures in all variables. In addition PT boys showed increases in low weight-for-age (WFA) demonstrating that the biocultural situation got worse and boys were more sensitive to environmental changes (Stinson 1985). In CVPT girls low WFA diminished since 1993 and differences in stunting between PT and CV born in Portugal increased in 1993 but diminished between 1999 and 2001. It seems that the better energetic balance in Portugal could be reflected in height and weight increases for Cape Verdean children born in Portugal (CVPT).

Even if Cape Verdean ancestry children experience difficult situations in Portugal in deprived neighbourhoods they also seem to have better access to health services and school nutritional programs than when residing in Cape Verde (Smith et al. 2002). This situation is similar to the American-Maya children that after migrating experienced an improvement in their growth and living conditions. Over nutrition rates (OW/OB) increased for Portuguese boys while it stabilized for Cape Verdean ancestry boys since 1993. The Cape Verdean ancestry girls showed an increase on OW/OB while for Portuguese girls it stabilized.

In 2009 a study showed that Cape Verdean ancestry children´s linear growth was in the healthy range of the NHANES growth reference and that this was probably derived from better living situations (Almeida 2012). Despite living in a "deprived" neighbourhood Cape Verdean ancestry children measured in 2009 were lighter (lower OW/OB) than Portuguese children in 2008 (Almeida 2012). Cape Verdean ancestry children also had higher sitting height ratio that shows a healthier status than Portuguese children measured in 2001. Children measured in 2009 were born in 1997-

2002 after Portugal's accession to the European Union (1986) and benefitted from a wealthy economy.

In summary nutritional health can be measured in terms of malnutrition rates. Several international growth references (WHO, CDC, IOTF) have been used for the Portuguese and the Cape Verdean population. Despite the different time frames several studies highlight the low under and over nutrition rates for Cape Verdean ancestry children and the rising values for over nutrition among the Portuguese. The better living conditions in Portugal have benefited the Cape Verdean generations that grew taller and heavier than their counterparts in Cape Verde without showing large proportions of overweight and obesity rates. On the other hand the difficult economic conditions in Portugal may have been negatively affecting boys (1993-2009).

The difficult history of Cape Verde marked by famine and diseases may indicate some burden of disease affecting Cape Verdean mothers. Hence significant intergenerational effects may be observed in this ethnic group. The worse maternal growing conditions in Cape Verde may affect their current nutritional health and that of their descendants.

2.3.2 Intergenerational effects

Emmanuel proposed in 1986 that current conditions of one generation may have an impact on the health, growth and development of the subsequent generation (Emanuel 1986). Moreover other researchers have postulated how child growth can be influenced by maternal and ancestral nutritional health like prenatal and post-natal nutrition (Kuzawa 2005). It is important to understand child growth in several stages of life: prenatal, infant and childhood and how it will affect adult outcomes. For that we need to look at maternal and early life factors and understand how they affect children.

2.3.2.1 Early life review

The health status of an individual depends on the conditions in which he/she is born and the intra-uterine life is important for that outcome (Gluckman & Hanson 2008). Moreover the study of the first years of a child’s life provides an important indicator for their health, nutritional status and wellbeing of the population. Maternal nutritional status at the time of the pregnancy as well as her health history have proven to be determinants for their children's health in many studies (Moreira et al. 2007; Varela-Silva et al. 2009; Marques 1999; Baker et al. 2004; Poston 2012; Harding, Boroujerdi, et al. 2006; Reilly et al. 2005).

If poor nutrition (Thame et al. 1997) was associated with smaller and shorter babies, overweight/obese mothers were more likely to have children suffering from over nutrition at 5 years (Janjua et al. 2012). Moreover an incorrect diet (FFQ) based on low intake of fibre and high intake of fat and carbohydrates and low birth weight were shown to increase the chance of developing childhood obesity and later metabolic syndrome and diabetes in a review paper (Misra et al. 2009).

Actually a wide variety of different risk factors at different stages might influence children's nutritional status. For example, maternal weight gain is a good indicator of the nutrient availability for the *fetus* and can be influenced by several variables like age, ethnicity, parity, lifestyle, socioeconomic status, drug, alcohol and tobacco use (Marques 1999). A higher weight gain during pregnancy was associated with a higher offspring's adult BMI but was not associated with adiposity outcome (skinfolds) in adulthood. In 2006 Moreira and Padrão (Moreira & Padrão 2006) showed that among Portuguese mothers a maternal weight gain during pregnancy higher or equal to 16Kg represented an increased OW/OB risk in the offspring. Furthermore Moreira (Moreira 2007) also presented an important relationship between maternal excessive weight gain and her obese offspring. In a cross-sectional study, Portuguese researchers demonstrated that the probability of a child having increased risk of OW/OB was greater in mothers with considerable weight gain in pregnancy (Padez et al. 2009).

Also the World Health Organization (WHO), defends exclusive breastfeeding should be continued for the first 6 months of age (Saadeh 2003) to have a protective effect against obesity in all world populations (Kries et al. 1999; Bosnjak & Grgurić 2013). However, breastfeeding length and its effect on OW/OB outcomes do not show consensus among researchers. Some indicate that breastfeeding (Arenz et al. 2004) has an inverse relation with childhood obesity. If some studies validate this relation (Moschonis et al. 2008) others could not find significant relationships (Davis et al.

2007). Another study identifies the importance of breastfeeding in reducing the probability of becoming OW/OB (Horta et al. 2007). In addition other researchers also found that breastfeeding protected against overweight, high blood cholesterol, high blood pressure and type II diabetes (Plagemann & Harder 2005). The fact that breastfeeding shows a different type of association might be related to study designs and type of measures collected (Davis et al. 2007; Arenz et al. 2004). It might also be due to the different characteristics of the populations studied and age range selected (Davis et al. 2007). The protective effect of breastfeeding may also depend on the ethnic group studied (Grummer-Strawn & Mei 2004; Hediger et al. 2001).

Overweight or obesity could be associated with pre-gestational and gestational diabetes (Huang et al. 2007). The prevalence for this condition is widely known (Hunt & Schuller 2007; Vibeke Anna et al. 2008; Lawrence et al. 2008; Dabelea et al. 2005) and has been observed in Portugal (Sociedade Portuguesa de Diabetologia 2013). While some authors suggest it's prevalence to be independent of maternal BMI, age and parity in immigrant populations (Savitz et al. 2008; Caughey et al. 2010) it's metabolic control throughout pregnancy seems to be influenced by ethnicity/birth place (culture, diet) (Caughey et al. 2010; Torres et al. 2011). In a Norwegian population, Vangen and collaborators (Vangen et al. 2003) concluded that maternal diabetes could be associated with perinatal death. Also a diabetic mother could influence diabetes and obesity in her children (Dabelea et al. 2000). Consequently evidence suggests that even modest increases in maternal BMI could be linked to foetal death, stillbirth, neonatal, perinatal, and infant death (Aune et al. 2014).

Moreover, another study showed that probable early markers of obesity included maternal body mass index, childhood growth patterns (early rapid growth and early adiposity rebound), childhood obesity and father's employment (a proxy measure for socioeconomic status in many studies) (Brisbois et al. 2012).

Furthermore risk factors for obesity also included obese parents, restricted growth, low/high birth weight (BW) and low socioeconomic status even though their effect is difficult to assess (Monasta et al. 2010). A review paper considered obesity to be favoured by rapid growth, maternal diabetes, short sleep hours, lower physical activity

levels (less than daily 30 min) and sugar sweetened beverages consumption (Monasta et al. 2010). The strongest predictors were breastfeeding length, infant dimensions, short sleep hours and TV viewing. For breastfeeding length it was associated with lower overweight prevalence. The higher odds ratio were found for babies only breastfed for 1 month and lower when breastfed between 7-9 months (Harder et al. 2005).
On the other hand maternal obesity may be related with low socioeconomic status and educational level potentially prompting an obese offspring (Monasta et al. 2010). Moreover paternal BMI has also been positively associated with waist circumference in their descendants (Labayen et al. 2010).

There is research on the effect of birth weight (BW) (Brisbois et al. 2012) and infant size on a child's risk of OW/OB. Some researchers found a significant relationship between birth weight and obesity in the early life course stages (infancy and childhood) (Martins & Carvalho 2006) and for different countries (Reilly et al. 2005; Mamun et al. 2005; Jones-Smith et al. 2007). Nevertheless, there might be some inconsistencies. When growth is restrained during gestation it is reflected in a child's birth weight and may condition higher fat deposition and insulin resistance (Ibáñez et al. 2006). A review paper showed the relationship between infant size/ growth and subsequent OW/OB (Baird et al. 2005). Values falling on each end of birth weight, both low and high, could be predisposing factors for later development of obesity. Some researchers found increased risk of obesity (Guo et al. 2000) or abdominal obesity (check waist to hip ratio) (Laitinen et al. 2004) with low birth weight and a higher birth weight was positively associated with increased adult BMI or OW/OB rates. There seems to be a positive association between birth weight with waist circumference in men (Kuh et al. 2002), a negative association with waist-hip-ratio but not with waist circumference in women.

The review of the biological literature combined concepts and theories derived from other approaches and disciplines. The analytical model presented shows how the accumulation of disadvantages during the life course point to subsequent intergenerational effects.

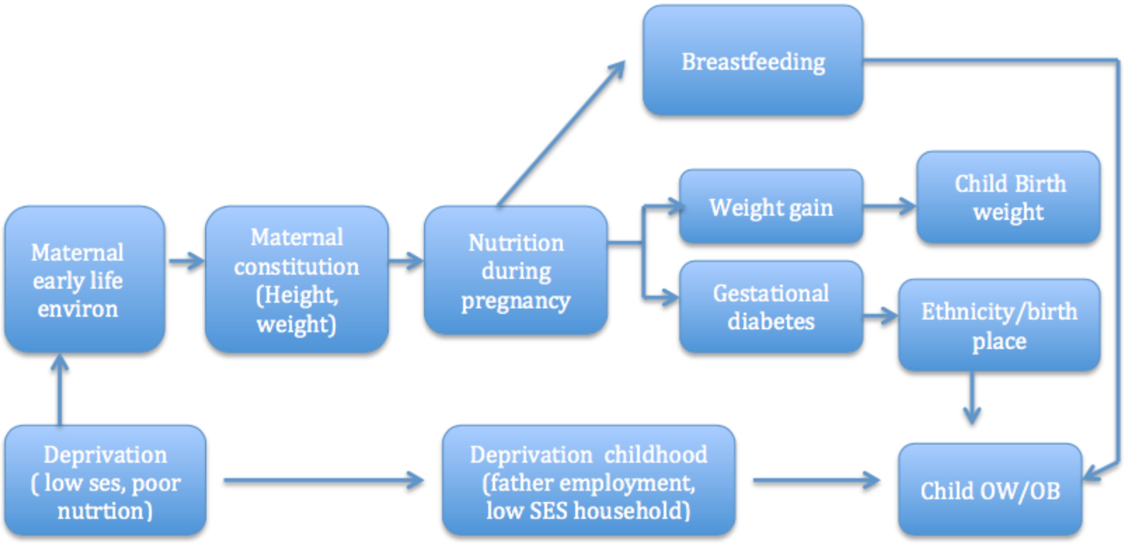


Figure 2. 10. Analytical model on theories explored to determine intergenerational influences on child nutrition.

2.3.2.2 Early life factors in Portugal

In a cross-sectional study (Cunha et al. 2013) with preschool Portuguese children, maternal BMI was related with their children's overweight especially for girls. Subsequently, birth weight was found to be independent of maternal age and parity (Harding, Boroujerdi, et al. 2006) when comparing Portuguese and African mothers. In contrast, Portuguese children born weighing more than 4000 grams had an increased probability to become obese adults (Padez et al. 2005). In addition, children's birth order, parental BMI and family size were significantly related with excessive weight in children (Padez et al. 2005). The same was observed for Portuguese mothers who showed an inverse relationship between breastfeeding length and risk of obesity (Padez et al. 2005).

On the other hand data from Portuguese health services shows that for those under 6 years more than 10% (15.1%) are not breastfed while just over a half (53.6%) stop breastfeeding in the first three months (Ministério da Saúde 2001). As shown by Padez and collaborators (Padez et al. 2005) breastfeeding a child for 3 to 6 months or more than 6 months would represent a decrease in overweight. Nevertheless maternity leave in Portugal is only 4 months and that might be related to the fact that many mothers cannot keep breastfeeding after getting back to work (Portal do cidadão 2013). Furthermore, there is added evidence that (Moreira et al. 2007) birth weight, breastfeeding, smoking, and maternal parity showed an influence on weight gain during childhood and on long term obesity (Dunger et al. 2006; Gale et al. 2001; Ong et al. 2002; Von Kries et al. 2002). Padez and collaborators in 2005 showed how parental OW/OB influenced their children's OW/OB status with the mother being particularly more influential (Padez et al. 2005). Maternal biological factors are important especially in migrant women as some suffer health problems aggravated when moving to a host country (Carballo & Nerukar 2001; Lewis 2007; Gissler et al. 2003; Temmerman et al. 2004; Waterstone et al. 2001). It has been observed that miscarriage and prematurity indicators may in the long term represent worst health outcomes in immigrant populations (Machado et al. 2009). Consequently because parity is usually higher for immigrant women as observed in Spain (Domingo et al. 2008; Panagopoulos 2005; Vahratian & Buekens 2004), and taking into account their length of stay, higher proportions of preterm deliveries have been observed in a study conducted in Italy with immigrants from African ancestry (Sosta et al. 2008). Moreover as a country with high levels of migrants, Switzerland, showed that for 37 332 mother-child pairs from various nationalities delivering in a hospital from 2000 to 2002 some inequalities in reproductive health outcomes were found. Even though controlling for regular gestational age and immigrant/national groups, average birth weight was significantly higher in immigrant women's new-borns. In this study conducted in Spain in 2004, Moroccan mothers had children with higher birth weight while Sub-Saharan Africa mothers had lower birth weight babies (Domingo et al. 2008). In fact, maternal country of origin might also influence low birth weight new-borns (Carballo & Nerukar 2001; Mosher et al. 2004; Urquia et al. 2007). Moreover breastfeeding and it's improved health outcomes for infants in a migrant context has been discussed (Neault et al. 2007). Some studies showed higher adherence to breastfeeding initiation and longer duration in immigrant mothers (Merten et al. 2007; Singh et al. 2007) and that it might have been positively influenced by cultural beliefs (Ergenekon-Ozelci et al. 2006). On the other hand an inadequate calcium and vitamin D intake (7 day diet diary) was found among migrant women (Caucasian, black African, black African-Caribbean and Asian) with low birth weight babies (Rees et al. 2005). It was especially concerning that all ethnic groups had low intakes of folic acid and iron and that meant vitamin D and calcium intakes were different between the groups (Rees et al. 2005). A considerable proportion (31%) of African women did have low RNI of calcium intake (Reference Nutrient Intake) (Rees et al. 2005).

In addition to health constraints, migrant women might suffer with low wages and social support (Machado et al. 2009; Sword et al. 2006). It was shown in previous studies how the socioeconomic environment and access to health care services (Carballo & Nerukar 2001) might affect these women. This might be associated with age at which they migrated as shown in the Netherlands where the younger the Dutch, Turkish and Surinamese women the higher the probability of infant death (Troe et al. 2007).

Even though Portugal has a strong tradition of receiving migrants there are just a few studies about health in migrant groups (Instituto Nacional de Saúde Dr. Ricardo Jorge & Departamento de Epidemiologia 2008). Furthermore with the increasing rates of immigrants arriving to Europe new challenges are posed as women are primarily migrating (United Nations 2006). In Portugal the main immigrants are women from Brazil and Portuguese speaking countries (Servicos de estrangeiros e fronteiras 2008). Female's health status is also important for their offspring outcomes in the host country where there might be many risk factors for their health (Dias et al. 2008). A group studied in the 4th national survey showed that the health status for migrants was similar to the Portuguese population and some immigrants showed even better health indicators than the Portuguese (Instituto Nacional de Estatística (INE) (Portugal) 2014). In contrast another review article (Almeida et al. 2013) concluded that immigrants had an increased level of comorbidity, reduced access to health services, poor communication skills, more stillbirth and early neonatal death. Further work has shown that more foetal deaths were identified during pregnancy and post-natal mortalities in immigrants living in a more socio-materially deprived area (Machado et al. 2007). Cape Verdean adult migrants living in Portugal have also been shown to be more affected by cardiovascular diseases (Harding et al. 2008). The Cape Verdean community living in generally poor conditions (Instituto Nacional de Estatística (INE) (Portugal) 2011) are affected by social inequalities and low educational levels (Gama 2002). In a host country where social protection is sparse, long maternal working hours and low pay are common and derived from Portugal's economic crisis increased difficulties may be expected for these children's health and growth.

In summary maternal health is vital for their offspring birth, growth and subsequent health outcomes. As a result poor nutrition and low birth weight might be related with overweight/obese status or diabetes rates. For the Portuguese population maternal weight gain, breastfeeding duration, birth weight higher than 4000 grams, birth order, parental BMI and family size have been correlated with increased OW/OB in children. An African immigrant group living in a socially deprived urban area in Lisbon has shown higher neonatal death and stillbirth. Moreover Cape Verdean migrants living in Portugal seem to be experiencing burden of cardiovascular diseases. Different environmental effects may be at work and together with ancestry may be having a significant impact on Cape Verdean ancestry children's growth.

2.4 Socio-demographic factors among ethnic minorities

Socio-economic measures combine both economic and social dimensions. They are difficult to assess and may vary within a specific setting (Sheppard et al. 2009). The physical and social features of the neighbourhoods are connected and are important for their health outcomes (Kjellstrom & Mercado 2008; Barten et al. 2007). For some ethnic minorities that might mean better social cohesion, the preservation of cultural practises and social protection. However neighbourhood inequalities in living conditions and health might propagate the "poverty trap" and prevent these groups from benefiting from positive environmental changes (Barrett & Carter 2013). To measure that inequality it is important to determine its correlation with health measures by using adequate tools (Wagstaff & Watanabe 2003). One way of doing it in low socioeconomic status populations is to determine their assets as a proxy of household wealth (Mckay 2009; Sheppard et al. 2009). Furthermore parental occupation, maternal education, (Huntsman & White 2007),income and housing were also used in the Portuguese context (Freitas et al. 2007) as an approximate measure of socioeconomic status. Another study has also shown that single parent families have a higher risk of long term poverty (Santana 2002). Poor housing (Wagstaff et al. 2004; Dear & McMichael 2011), unemployment (Santana 2002), living in a deprived area (Marmot & Bell 2012), low income(Haddad et al. 2002), multiple deprivation and absence of resources (Lavy et al. 1996) have also proved to influence child's health.

2.4.1 Living conditions and family structure

In measuring the number of assets it is possible to assess the household power to increase education and income of its members. To assess poverty it is important to determine the status in terms of expenditure and income (Barrett & Carter 2013). Household wealth measured through assets and child school enrolment have been previously observed in Indian children to be related (Filmer & Pritchett 2001). In this case there was a difference between rich and poor children and the first had a higher attendance rate at school. However those differences were small and varied with geography. Moreover the absence of data in poor communities might veil the social disparity existent (WHO 2008b).

Deprived communities with high inequity in a physical space (built environment) are affected by several non-communicable diseases (NCDS) like obesity (Durand, Andalib, Dunton, Wolch, & Pentz, 2011) and cardiovascular diseases. Moreover they tend to present low physical activity levels (Sallis et al. 2012). Crime and discrimination contribute to chronic stress that ultimately negatively affects health (Baum et al. 1999). Also the built environment may be related to obesity rates (Papas et al. 2007) and with walkability (Saelens & Handy 2010). The inequality found in a study conducted with USA adolescents was explained by ethnic and socioeconomic differences in physical activity and overweight rates (Gordon-Larsen et al. 2006). Consequently low socioeconomic status groups and minority adolescents had less physical activity facilities available.

2.4.2 Socioeconomic status (SES) and Health

A paper published in 2009 showed that environmental factors were influencing weight gain in Portuguese adults as well as deprivation, urban mass, social capital and safety

(Santana et al. 2009). The study conducted in Lisbon Metropolitan Area (LMA) with 7669 adults living in 143 neighbourhoods reported the relationship between physical and social environments with physical activity and consequently body mass index (BMI). Effectively BMI and both socio-demographic and behaviour characteristics were connected with the environment showing a significant association with overweight and obesity. Similarly, a large body of literature has established links between neighbourhood environment and adult BMI. A greater prevalence of obesity (adults) in more deprived neighbourhoods was reported by a number of studies (Ellaway et al. 1997; Van Lenthe & Mackenbach 2002). Lower socioeconomic status housewives and retired people were more influenced by the physical environment as they spend more time in their neighbourhoods (Van Lenthe & Mackenbach 2002). Moreover living in these disadvantageous environments makes it easier to engage in less healthy behaviours like inactivity or social problems (McNeill et al. 2006; Stafford et al. 2007). Similarly in these places the facilitated access to fast food outlets and fast food restaurants increases its inhabitants propensity for obesity (Kim et al. 2006; Poortinga 2006; Cummins et al. 2005; Macdonald et al. 2007). This “obesogenic” environment is frequently associated with poorer places provoking changes in diets (easy available and low cost) and sedentary behaviours (Schoeppe & Braubach 2007). The effect of this setting can be observed at both individual and neighbourhood level. While at individual level it includes demographic variables like marital status, economic activity, education, occupation, income and health behaviours, at neighbourhood level it measures resources, social capital, available health services and deprivation. It might be considered that vulnerability caused by urban sprawl, long distances to facilities, unsafe and unpleasant environments, poor housing conditions and socio-material deprivation, could create communities with unhealthy behaviours as they make it difficult to walk in discouraging planned physical activity, promoting unhealthy diets and higher obesity rates. Contrary to this, results found for the study conducted by Santana and collaborators (Santana et al. 2009) showed that people from deprived neighbourhoods walked more. Results also attributed it to an interaction between higher deprivation and population density showing increased moderate physical activity in dense and poor areas even though its residents were less prone to engage in physical activity. The reasons for that were their propensity to be more affected by neighbourhood (if they spend more time there), limited incomes and lack of transport options (Stafford et al. 2007; Van Lenthe & Mackenbach 2002). Household earnings, parental educational levels and unemployment also affect diet (Bammann et al. 2013). Families of lower SES present more sedentary behaviours and greater risk of obesity (Tandon et al. 2012). In addition to that parental education also has influence on their offspring's obesity rates. According to the Centre for disease control (CDC) higher obesity rates were found for children in families with lower educational levels (Bammann et al. 2013). The difference would be from 21.1% obesity for children from medium educational level households to 11.8% obesity on a household with a degree in boys from different ethnic backgrounds living in the USA (Ogden et al. 2010). When relating environmental causes responsible for excess of weight (OW/OB) a review study identified income, education and employment (Brisbois et al. 2012). Consequently for a lower father's employment status, higher adult obesity would be found for their children. Manual occupation was associated with higher adult WC (waist circumference) and WHtR (waist-to-height ratio). On the other hand household income, maternal education, parental employment (head of the household), ethnicity, birthplace (country comparisons), birth order and number siblings did not have any significant associations. Effectively excessive body weight measured by obesity during adult life was negatively associated with childhood socioeconomic status' (Brisbois et al. 2012). A low socioeconomic status during childhood prolongs poor health and extends social inequalities related with obesity (Hardy et al. 2000). If father's employment measured by prestige and years studied, can serve as a measure for SES and an indicator of obesity for their offspring (Laitinen et al. 2001) then maternal low income and extensive work hours might determine their children's healthy diet and physical activity levels (Hawkins et al. 2008). A report from Eurothine (2004-2007), a funded project from the European commission health and consumer protection directorate, provided important insights on health inequalities. Researchers from the Netherlands, United Kingdom and Spain who analysed equity of morbidity from 26 European countries concluded that there was inequity in disease in relation to educational level and earnings. Therefore higher prevalence of diabetes, obesity and sedentary behaviour were found for lower earnings and educational level (Mackenbach et al. 2007).

The literature review has shown how adult health status relates with socioeconomic and cultural characteristics in the area of residence of immigrants (Macintyre et al. 1993; Reijneveld 1998). In general these groups might be living in worst conditions in host countries. Living in shantytowns might mean having weaker social and health services as well as bad housing conditions.

2.4.2 Socioeconomic status (SES) and Health in Portugal

Health inequalities have been increasing in almost all developed countries including Portugal. There is little information about studies on socioeconomic status in Portugal and even less on its relation with health outcomes. Even with improvements in social and health conditions since launching its National Health Service in 1974, Portugal still presents deep social problems (Correia & Barros 2015).

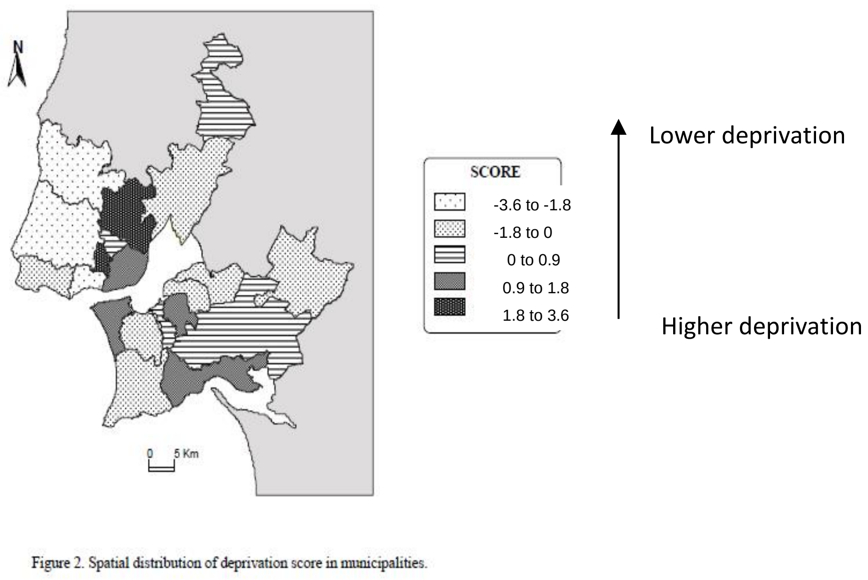


Figure 2. 11. Map of deprivation scores found on Lisbon municipalities (reproduced with permission from (Nogueira & Santana 2005).

In addition the country occupies one of the first places in European poverty statistics (Santana 2002) and as several studies have shown, health and poverty (also accounted as deprivation) are related. In a recent report its poverty levels were shown to have gone back 10 years (Sanches et al. 2015). Among the more deprived are elderly people and children, single parents (mainly single mothers), unemployed and immigrants who represent about 98% of disadvantaged Portuguese people. Moreover low incomes have direct consequences on poverty and indirect effects on social exclusion of some groups. Also unemployment has both direct and indirect detrimental effects on health (Santana 2002). Despite the fact that the Portuguese general population now has a longer life expectancy than ever before, this trend is less significant among disadvantaged people. For example manual workers have higher premature mortality rates than non-manual workers and such inequality will continue to increase (Mackenbach 2000; Kunst et al. 2001).

The few studies in the Portuguese population on the health of migrants or ethnic minorities were based on their access to health services. Reports are only based in a small percentage of maternal and infant health and the migration movement has not been totally grasped by health research (Harding, Santana, et al. 2006), (Machado et al. 2007). A study conducted in 2006 in Portugal concluded that the social background influenced the neighbourhood perception and that it was probably due to inequalities found by its inhabitants on a certain environment (Mota et al. 2011).

In addition, a study has shown that inequalities in earnings or in educational level were responsible for inequalities in health among the Portuguese population (Simões et al. 2006). It has also been shown that socioeconomic inequalities contribute to health inequalities in ethnic minorities (Krieger et al. 2005). Effectively Nogueira and Santana found in 2005 a strong association between socioeconomic variables and health outcomes (Nogueira & Santana 2005) (Figure 2.10). The authors devised a context-specific deprivation score based on 3 selected census variables compared to their mean for Lisbon Metropolitan area. For Nogueira and Santana occupation (men's unemployment and people with non-qualified jobs) and living conditions (percentage of people living in shanties) were collected during the 2001 Census along with mortality rates, (males and females under 64 years old, between 1998 and 2002 (Deaths registration)(Nogueira & Santana 2005). The results point to a strong relationship between multiple deprivation and premature mortality. Furthermore, Figure 2.10 shows that deprivation scores were higher in metropolitan areas showing associations with recent urbanization, ethnic diversity, urban tensions and social conflicts.

More the authors reflect on the specificity of areas like African communities that combine both high deprivation and premature mortality. Consequently the influence of biological factors and behaviours on weight of babies born at Amadora-Sintra hospital was observed. The hospital is one of the health institutions serving a densely populated parish with immigrant groups. Effectively there was a greater risk of being born with low birth weight if coming from African immigrant families (Harding, Santana, et al. 2006) even if the differences were weaker than with immigrant groups from other geographies (England) (Harding, Santana, et al. 2006). Furthermore birth weight was independent of Portuguese maternal age and parity while socioeconomic factors seemed more important for the African group (Harding, Boroujerdi, et al. 2006). Even though being one of the least educated countries in Europe (Albert & Davia 2011) Portugal shows similar or better health indicators (life expectancy, infant mortality) than most European countries (Barreto 2011). A study focused on the association of social conditions with pregnancy outcomes that reflect on childhood environment (Correia & Barros 2015). Correia and Barros used grandparents' highest education, childhood social class and family structure as proxies of childhood social environment. The social class was defined as grandparents' education and 11 family resources (house ownership, household heating, washing machine, television, telephone, housemaid, family car, bicycle, annual holidays, club membership and association affiliation) (Teixeira 2013). Correia and Barros concluded that for a higher maternal educational level there was protection from SGA (small-for-gestational age) in deprived neighbourhoods (childhood social environment). An increase in maternal education seemed to be enough to diminish disadvantages of earlier life.

One of the few studies on overweight among immigrants in Portugal showed that in 2007 African immigrants living in Portugal, Men and Women had higher obesity rates when comparing with Brazilian immigrants based on self-reported data (Goulão et al.

2015). Overweight in Brazilians was 13% and 30.9% and obesity 7.1% and 7.8% for female and male according to WHO health cut off points. For African migrants overweight ranged from 32.8% to 26% and obesity from 17.8% and 9.1% (female and male respectively). Differences between ethnic groups show that African men have higher OW compared to women of same ancestry. The inverse is found for obesity categories. For Brazilian migrants there are similar percentages for both men and women. Brazilian women have lower OW and OB compared to African women. For men the same effect as a marginal significance. Body Mass Index (BMI) was shown to be influenced by age, marital status, time living in Portugal and birth country (Goulão et al. 2015). Being married is associated with higher BMI for those immigrants living in Portugal for 10-14 year olds and those more than 15 years. Sex and education were not related to immigrant's BMI.

The 2001 census in Portugal showed that all-cause mortality, and Acquired Immune Deficiency Syndrome prevalence (AIDS) (Williamson et al. 2009) were related with the social inequalities in African migrants (Harding et al. 2008) and more Cape Verdeans died from circulatory diseases than other African migrants. Amongst the social disadvantages the Cape Verdeans experience illegality, low associative participation and few leisure spaces that push the young to negative behaviours (Ilhéu & Silva 1991). More, poverty and aggression have been identified in immigrant children in the hospital serving this neighbourhood (Anacleto et al. 2009). The authors of the study associated the particular cases studied to fragile family connections, school failure and household's over occupation (França 1992).

In summary a deprived community may suffer from inequality, discrimination and low socioeconomic status that can be associated with worst health outcomes. Several environmental variables may also be reflected on these immigrant communities translated into premature mortality.

2.4.3 Diet and physical activity assessment

Changes in dietary habits might be important for predisposition to future diseases (Gilbert & Khokhar 2008). Gilbert and collaborators reported in 2008 that changes in dietary habits from traditional diets to processed foods high in fat, sugar and salt had been observed in several migrant groups. Age and generation were related to that change associated with acculturation processes. Migrants usually moving to big cities or urban settings were exposed to westernized influences but also had access to more traditional ingredients (migrants working on services like trading this also migrate). Consequently dietary changes may be influenced by food availability, income, religion, food beliefs, generation and age and an increase in meat consumption might be observed in certain migrant groups (Gilbert & Khokhar 2008; Montoya et al. 2003). The older generations are less likely to change but to keep their traditional diet. Even when using different methods to assess dietary changes similar results were found. One study using a 24-hour recall and two day food diary reported little dietary change for Afro-Caribbean's in the UK (Sharma & Cruickshank 2001; Sharma et al. 1996). Similarly a study which used a food frequency questionnaire also found a healthy diet for Bubis (Afro Caribbean) in Spain (Montoya et al. 2003; Gil et al. 2005).

On the other hand Greek children showed that their higher overweight and obesity rates compared to a small sample of migrant children were related to higher consumption of energy and carbohydrates (24-hour recall and week food frequency questionnaire) despite higher self-reported exercise (Hassapidou et al. 2009). Sedentary behaviours are common among Greek and Portuguese adolescents and adults as they are the highest compared to other European countries (Vaz de Almeida et al. 1999). Conversely the accurate measurement of physical activity in children is especially challenging. Because of the intermittent activity the choice of the correct tool has to be suitable for the age range and study design (Tudor-Locke CE ; Myers AM 2001). In 2010 a study conducted with pedometers (MLS2505, walk-for-life) in the USA with different minority child groups found similar step count (mean age 11 years) between USA White and minority boys (African American, Hispanic)(Johnson & Brusseau 2010). On the other hand minority girls had lower step counts than USA White girls. The schools were selected for location and similar socioeconomic status. Children (boys) living in minorities and inter urban settings who walked to school had higher total step count. In contrast in the UK Eyre and collaborators showed that South Asian children aged 8 years had lower levels of physical activity than white European children after wearing heart rate monitors for 7 days and the difference was in after school activities (Eyre et al. 2013). A study conducted in 2012 showed that Portuguese adolescents from rural settings were less active over weekends than the ones from urban settings (ActiGraph GT1M mode for 5 days) (Machado-Rodrigues et al. 2012). Another study conducted between 2006 and 2008 also used accelerometer (ActiGraph GT1M mode, 4 days) to objectively measure physical activity in Portuguese children (older than 10 years) and adults. Only 36% of the children (10-11 years) achieved the 60 minutes of physical activity recommendations (Baptista et al. 2012).

The Chinese community in France shows westernized influences on their diet with higher energy intake and low breastfeeding and high consumption of soft drinks while maintaining a traditional diet (Rovillé-Sausse 2005).

Comparing different studies from different ethnic minorities might be confusing as the classification of migrants might be problematic. The length of time the migrant group has been living in the host country might be important to physical activity levels (Dawson et al. 2005). For Williams time is an important factor because the morbidity levels in migrants groups are usually lower than the host population (Williams 1993). The expected trend is that the best integration in the host society is associated with worst health because they adopt host country's disease patterns (Gushulak & MacPherson 2006). Moreover migrant groups may experience vulnerability and be more exposed to risk factors when migrating because of differences in the environment, climate, language, culture and services (Bäckström 2010). Nevertheless with an increase in time living in the new country there is also a better understanding of how health and social services work.

It is essential to gather the absence of data in the literature from other countries from southern Europe, like Portugal, that quite recently became immigrant societies (Castles et al. 2005). It is also important to understand the underrepresentation of these groups and the absence of longitudinal studies with ethnic minorities (Dawson et al. 2005). So far to our knowledge no study focused on objective measurement of physical activity levels or estimation of energy expenditure among the Cape Verdean community in Portugal. Similarly recent dietary quality or quantity was not found on the Cape Verdean ancestry population living in Portugal. The first Portuguese representative dietary information (BAP, Portuguese food scales) dates from 1980 (Ferreira & Cruz 1985; Ferreira & Cruz 1986; Ferreira & Cruz 1988) and the last from 2003 showing that the Portuguese consumed triple of proteins (food availability pattern based on crude diary mean consumption in protein, fat, alcohol and carbohydrates) and that the diet's caloric intake increased 6% (Instituto Nacional de Estatística (INE) (Portugal) 2006a). Also Moreira and collaborators found that the calcium intake was inferior for Portuguese children whose BMI was higher (Moreira et al. 2005). Possible health conditions can be associated with elevated ingestion of sugar sweetened beverages in detriment of milk derivatives lowering the calcium intake (Committee on School Health 2004; Moreira et al. 2005). Portuguese children´s diet was especially elevated in saturated fat, sugars and protein and low in carbohydrates and fibre (Moreira et al. 2007). Recent data mentions deficiencies in Portuguese children from 2 to 5 years in carbohydrates and food fibre consumption and high ingestion of protein and saturated fat (Santos 2006). Micronutrients´ deficiencies (Santos 2006; Valente et al. 2010) are part of Portuguese children´s inadequate diet. More, Portuguese adolescents consume mostly starchy foods, dairy and meat as well as carbohydrates and the higher the parental educational level the healthier the food intake observed (Araújo et al. 2011).

In summary little change in diet has been observed in other migrant communities. However children from the different host countries like Portugal are showing high overweight and obesity rates paired with sedentary behaviours. For Portuguese children national data on food patterns shows some deficiencies in diet associated with nutritional health (BMI) and parental education.

2.5 Research Questions

The literature review helped to conceive the following research questions and hypotheses:

Research Question 1 - How does the nutritional status of the Cape Verdean children associate with time, sex, socioeconomic status (SES), general living conditions, family composition, diet and physical activity levels?

Hypothesis 1.1- Cape Verdean ancestry children born in Portugal will show a positive secular change in height, sitting height and weight.

Hypothesis 1.2 - Low sociodemographic status is expected and will be associated with nutritional status. Diet and physical activity will also be associated with these children´s nutritional status.

Research Question 2 - What maternal, early and intergenerational factors will have significant effect on Cape Verdean ancestry children's nutritional status?

Hypothesis 2.1 - Maternal malnutrition among Cape Verdean mothers will be expected.

Hypothesis 2.2 - Children's birth weight will have significant effect on children's current nutritional status.

Hypothesis 2.3 - Intergenerational factors will be present from mothers to children and will be observed into children's nutritional status.

Research Question 3 – How does the nutritional status of the Cape Verdean ancestry children in Lisbon (Portugal) compare with the general Portuguese population?

Hypothesis 3.1 -The better living conditions in Portugal compared with Cape Verde should be observed while evaluating stunting or leg stunting variables and lower OW/OB rates for the Cape Verdean ancestry children.

Chapter 3. Methodology

This chapter includes all methods used in this research project. The first sub section includes the description of the study design and setting, Cova da Moura neighbourhood, while the following sections refer to the participants, inclusion criteria and recruitment process. Section 3.3 concerns data collection and includes all procedures applied. A brief mention is made to some amendments to initial procedures. The last remaining sections refer to the ethical process, data handling and analysis, respectively.

3.1 Study design and setting

This study was conducted in an urban setting, the metropolitan area of Lisbon city (Portugal's capital, Figure 2.8). There are 11 million Portuguese living in the mainland and island territory according to the latest census in 2011 and most of the population (3.2 million) in concentrated among the biggest cities like Lisbon (INE 2011). In Portugal like in many countries children attend the schools closest to their residency. Lisbon district is divided into 18 councils (AML) and ethnic minorities are concentrated among a few including Amadora municipality which grew mostly from migratory fluxes during the 1980s and 1990s.

3.1.1 Cova da Moura (CM) neighbourhood

The target population of this study was the Cape Verdean community living in the neighbourhood of Cova da Moura in Amadora municipality (Lisbon Metropolitan Area), which spreads across the Buraca and Damaia parishes (Figure 3.1). The space was an old farm where the first Cape Verdean migrants settled when they migrated to Portugal to work in the early 1950s. It's streets are organized according to the geographical position of the Cape Verdean islands and in 2008 it was estimated that it housed approximately 4800 inhabitants (Instituto da Habitação e da Reabilitação Urbana 2013). Recent data from the local cultural association *Moinho da Juventude* estimates that about 7000 habitants live in the neighbourhood with many Cape Verdean families using *creole* and where single parent families are frequent (Barco

Barroseiro 2005). Seventy per cent are of African origin, mainly Cape Verdean with half of the inhabitants below 20 years of age. This neighbourhood tends to suffer from social and ethnic discrimination that is reinforced by a poor public image portrayed by the media (Ferreira 2005).

The public primary school, EB1 Cova da Moura, is located in the Damaia parish in Cova da Moura neighbourhood. The children are mainly of African origin (90%), with more than half from Cape Verdean origin (64%). Just over a tenth (14%) are from São Tomé e Príncipe, 10% from other ethnicities and only 3% are from European-Portuguese ancestry. This is the only school in the total enclosed physical space and thus unique in its setting for the study of this population (Figure 3. 1).

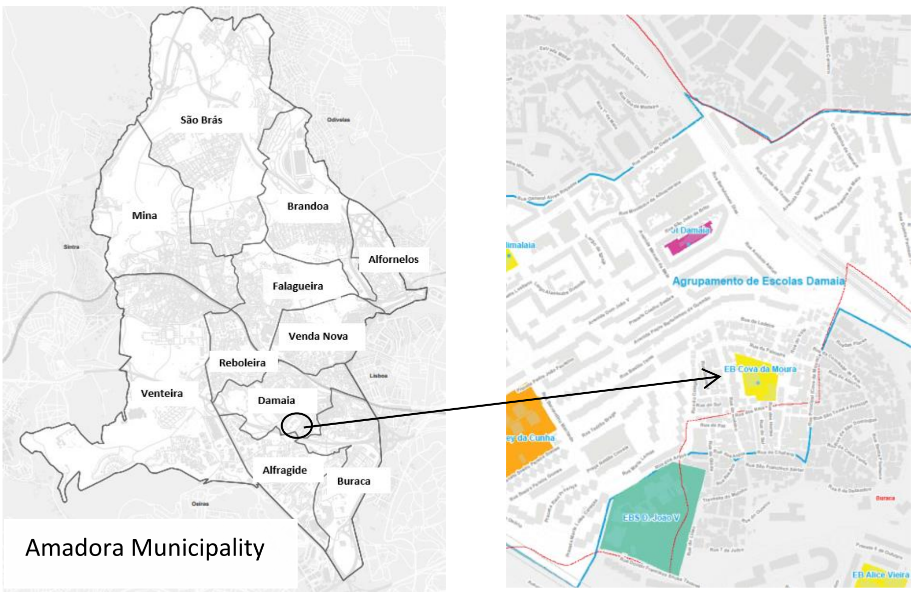


Figure 3. 1 Geographical position of the school in Amadora municipality (http://geoportal.cm-amadora.pt/).


Figure 3. 2 and Figure 3. 3. Narrow streets in Cova da Moura neighbourhood.

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Figure 3. 4 and Figure 3. 5. Other views of Cova da Moura neighbourhood.

The primary school is a public school built in the 1990s. It hosts mostly children that live in the neighbourhood but also some that live outside. Local associations like *Moinho da Juventude* and *Clube* have played an important role in the social care for this population. *Clube* provides an after school clubs hosting several activities such as dance and sports. Snacks are donated by the local food bank and a retailer. *Moinho da Juventude* is the oldest association in the neighbourhood and also provides meals, after school clubs as well as administrative assistance and personal empowerment courses. They act as a voice for the inhabitants and hosts local groups for adolescents and other marginalised groups.

Figure 3. 6 and Figure 3. 7. Cova da Moura primary school and main playground.

3.1.2 Participants

Our aim was to study all of the Cape Verdean children attending Cova da Moura primary school within 6-12 years old. Furthermore, because we want to compare with previous samples the same setting a consensual age range was selected. Also in terms of height and weight gain this should correspond to a period before early maturation (Bogin & Smith 1996). Puberty assessment was made by asking girl's mothers if they had their menses. For the cases of children older than 12 years or a girl who had had her first menses cases were discarded. On the onset of the maturation process other environmental and biological factors may intervene on the children's growth. Because that was not within the study aims it was decided to exclude these cases.

Figure 3. 8 and Figure 3. 9. Cape Verdean ancestry children that participated in the 2013's study.

In this thesis we will be using several databases:

1) The first dataset was collected between 1992/1993 by the late Dr. Carmen Ruiz Garcia 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). Part of this dataset was previously published (Garcia-Ruiz & Marrodán 2000).

2) The second dataset was collected between December 2008 and March 2009 by Dr. Joelma Almeida and its sample size was 170 children (70 boys and 100 girls with mean age of 8.59 ± 1.65).

3) The more recent database was collected by the author (AA) and is the main focus of this thesis collected in 2013/14.

This sample is comprised of 89 children whose decimal age ranged from 5.94 to 11.99 years old (41 boys and 48 girls with mean age of 8.61 ± 1.43) (Tables 3.1 and 3.2). All of the Cape Verdean databases were collected in the same neighbourhood (Cova da Moura) and the same school/spare time association in Lisbon metropolitan area (LMA)

(Figure 3. 1) in an urban setting. There is a small possibility that some of the children measured in 2009 were also measured by AA in 2013. These Cape Verdean samples will be compared to a national database that includes 1642 Portuguese children from Portuguese parents (815 boys and 827 girls with mean age of 8.29 ± 1.24 years) measured between 2009 and 2010 in the Portuguese territory (Lisbon district). Descriptive information can be found in Jago and collaborators paper (Jago et al. 2012). Other papers have been published with the Portuguese national data collected in the project "Trends and predictors in childhood obesity in Portugal. Changes from 2002 to 2008 " (Bingham et al. 2013; Coelho et al. 2013; Ferrão et al. 2013; Li et al. 2015; Machado-Rodrigues, Santana, Gama, Mourão, Nogueira, Rosado & Padez 2014; Machado-Rodrigues, Santana, Gama, Mourão, Nogueira, Rosado, Mota, et al. 2014; Nogueira, Ferrão, et al. 2013; Nogueira, Gama, et al. 2013; Nogueira et al. 2014; Stamatakis et al. 2013b; Stamatakis et al. 2013a; Lourenço et al. 2012; Nogueira et al. 2012) and funded by the Foundation for Science and Technology, Portugal.

Table 3. 1. Descriptive information and sex distribution for Cape Verdean ancestry children in 2013.

	n	Mean age	STD deviation	Min	Max
Boys	41	8.58	1.53	5.94	11.44
Girls	48	8.56	1.46	6.01	11.86
Total	89	8.58	1.45	5.94	11.86
Mothers	47	35.02	8.15	22.03	55.89

Table 3. 2. Distribution of children according to the school grade they are attending in 2013.

	n	%
1st grade	9	10.1
2nd grade	28	31.5
3rd grade	26	29.2
4th grade	26	29.2
Total	89	100

3.1.2.1 Recruitment of children and mothers

For the data collection of 2013-14, the first step was to contact the school headmaster, Ms Sonia Ferreira, prior to the start of the school year 2013-14 (August 2013) to get the project's approval. The Tropical institute of scientific medicine, represented by Dr. Victor Rosado Marques, was the partner that provided fieldwork support and approval from its ethics committee. The scheduled arrangements for data collection were done directly with the teachers and school's headmaster. The study's description and consent forms were delivered and collected before the classes started. The project's information (consents and project details) were given to children after a short presentation of the project at their classrooms. Data collection started after granted authorization with a formal consent form from the children's parents/guardians in October 2013. Parental contacts were checked on consent forms and on the school's database.

The specific inclusion criteria for participants recruited was that they were attending the primary school of Cova da Moura neighbourhood and enrolled on one of the 4 first levels of education (primary education level in Portugal goes from 7 years to 11 years). Also having Portuguese and/or Cape Verdean nationality from a Cape Verdean background, without any known physical impediment like sight problems or mental capacity, aged 6 to 12 years. Subsequently AA arranged interviews after calling the parents (mainly mothers) to arrange a date and time for a home interview. The study aims and purpose were explained to all interviewed and any relevant doubts or questions were also answered. AA asked if they were comfortable answering some private questions that would take place in most of the cases in the child's house.

At the end of each anthropometric measurement the children received a "certificate" based on WHO growth charts (De Onis et al. 2007) they could take home and show their parents.

3.1.3 Inclusion criteria

A preliminary condition was that they had at least one grandparent on the father/ maternal side or parents born in Cape Verde (Cape Verdean ancestry) and were attending Cova da Moura primary school (Table 3.3). The last condition was important due to the special enclosed setting of the school in the neighbourhood but also because of the way this community relies on mutual help and family relations that are promoted in such a small niche. Even though some children did not meet these conditions AA measured all of them regardless of their ancestry (São Tomé and

Príncipe or Guinea Bissau), physical or mental impediment. In total 12 children were excluded because they lived out of Cova da Moura Neighbourhood (cases included when had family living in the area).

Table 3. 3. Different cases of Cape Verdean ancestry included in the 2013's study.

Grandmother	Grandfather	Mother	Father	Child
CV	CV	CV	CV	CVPT
PT	CV	CV	CV	CVPT
CV	PT	PT	CV	CVPT

CV- Cape Verdean ancestry, PT- Portuguese, CVPT : Cape Verdean ancestry Portuguese born

3.2 Power analysis calculation

To calculate the sample size required to test the thesis hypothesis we used software G*Power 3 provided by the Heinrich Heine University of Dusseldorf (http://www.psycho.uni-duesseldorf.de/abteilungen/aap/gpower3/). A linear regression analysis with 4 predictor variables and the outcome variables defined as BMI, %BF or WC would detect significant differences at p=0.05 in child's BMI between two groups of children (Portuguese and Cape Verdean ancestry) with a power goal of 0.80 for 98 participants (Cohen 1992).

It was not possible to meet that requirement due to time and logistic constraints. Despite the fact that the sample total number was 101 children ranging from 6 to 14 years when applying the exclusion criteria that number fell to 89 children.

To this number three more samples were joined from an SPSS database for the subsequent comparison (1993, 2009 for Cape Verdeans) as well as the cross-sectional sample collected in 2009 in Portugal.

To determine children's nutritional status we conducted anthropometric and body composition measurements. After that child's overweight/obesity (OW/OB) status, anthropometric status and risk factors were determined (eg fat deposition) using the different cut off points available in the literature (section 3.6).

The complete list of variables for Cape Verdean children and their mothers used in the 2013/2014 study is shown on Table 3.4. It includes the child and the mother's anthropometric profile, household questionnaire and maternal health history as well as children's objective measurement of step counts (used as a proxy for physical activity). These variables were used before in other studies conducted in this population and were refined by AA before starting fieldwork.

They include physical measurements used to assess growth and nutritional health and also environmental variables to assess the socioeconomic status of the Cape Verdean community.

Table 3. 4. General overview of variables used in the 2013's study.

Dimension	Indicator	Measurement
Child	Biological	Sex, age (years), decimal age, age (months), height (cm), weight (kg), sitting height (cm), sitting height ratio, Body mass index (BMI)
		Circumferences (cm): Arm, waist, abdominal
		Skinfolds (mm): triceps, biceps, subscapular, abdominal, sum of 2 skinfolds (TRI+SUB)
		Bodystat1500 analyser ® (bioelectric impedance technique): Body fat (%), body fat (kg), lean body mass (%), lean mass (kg), water (%), water (kg), Basic Metabolic Rate (BMR, Kcal), Estimate average requirements (EAR, Kcal), Impedance (z)
	Physical activity (PA)	Objective measurement: Step count during school time (nr steps/day) for 3 weekdays, stride length (meters) Self-reported: PE week (hours) and duration (per week) and types of activities in/out school and at club (all), parental perception of child activity (3 categories), transport to school, play area;
	Diet	24 hour recall: last family meal, picky child (yes/no), daily sleep hours, nr meals/day, place where meals were eaten, breakfast yes/no, main meal (yes/no), salty or sweet consumption (yes/no), lunch intake (kcal)
Household	Biological	Mother: Sex, age decimal, age (months, decimal), height (cm), weight (kg), waist and arm circumferences (cm) Bodystat 1500 analyser ® (bioelectric impedance technique): Body fat (%), body fat (kg), lean body mass (%), lean mass (kg), water (%), water (kg), Basic Metabolic Rate (Kcal), Estimate average requirements (Kcal), impedance (z)
	SES	Housing conditions: nr rooms, nr divisions, exclusive kitchen/bathroom; Household income, expenditure/month or year, assets (TV, car, house, pc), remittance CV, income mother/father, nr people living in the house, nr people living under 10 y, people helping house expenditure, parental educational level (years), Parental occupational class, Parental work place, Parental weekly hours, duration unemployment (months), child benefit, other parental benefits, parental second job, parental time out/in house parents
	Cultural	Mother/Father birthplace, nationality, country, time living in Portugal, time living at same address; child birth city, county birth; maternal marital status, single parent family, language spoken at home; city, nationality, age and country grandparents on either father and mother´s side;
Prenatal information	Birth	Offspring: birth data: birth weight (gr), measurements at birth: head circumference (cm), recumbent length (cm), APGAR score, diseases child, birth order gestational age (weeks), breastfeeding (months); nr siblings, siblings in the study Child: birth data, birth weight (gr), gestational age (weeks), breastfeeding (months),
Maternal health history	Biological	Age menarche, nr pregnancies, planned or not planned pregnancies, birth interval, want child, weight gain during pregnancy (kg), supplementation, attendance health care, health conditions, birth control measures, Maternal self-reported physical activity

3.3 Data collection 2013/2014 study

The anthropometric data were collected from November 2013 to January 2014 while the household interviews were conducted in January/February 2014 and the objective measurement of children's physical activity (PA) throughout February 2014.

To answer the proposed research questions both qualitative and quantitative methods were applied (Table 3.5). First an anthropometric profile for both the biological mother and child was done. Subsequently a semi-structured interview was conducted by AA in the children's home to complete the household questionnaire. Anthropometric methods and body composition with Bodystat 1500 analyser ® (Bodystat Limited) were used to collect a biological profile of participants. All the measurements were taken according to the International Society for the Advancement of Kinanthropometry (ISAK) protocol on the right side of the participant (Marfell-Jones et al. 2006). These measures and subsequent indirect variables were used to calculate important nutritional indicators.

Table 3. 5 Different dimensions of data collection

Unit	Indicator	Variable	Method
Child	Biological	Sex, age	Anthropometry
	Growth	Height, sitting height and sitting height ratio	Anthropometry
	Body mass	Weight, circumferences, skinfolds	Anthropometry
	Physical activity (PA)– subjective assessment	PE class week (hours) and duration (per week) , sleep hours	Semi- structured interview
	Physical Activity (PA) – Objective assessment	Step count during school time (nr steps/day) for 3 weekdays, stride length(metres)	Objective measurement with Omron walking style III pedometers
	Dietary information	Composition of last family meal, nr meals/day, main meal	Semi- structured interview
Mother	Biological	Sex, age, height, Weight, circumferences	Anthropometry
	Health history	Age menarche, nr pregnancies	Semi- structured interview
Family/household	Socioeconomic	Income, education, assets	Semi- structured interview
Community	Cultural	Ancestry, healthcare use, housing conditions	Semi- structured interview, observations from field work

3.3.1 Physical measures

3.3.1.1 Anthropometry and body composition

The environmental effects are inferred from the patterns of human growth in size, shape and maturation of human populations (Bogin 1999) from anthropometric methods (Kuczmarski et al. 2002; Frisancho 2008; WHO 1995). Body composition and shape were obtained through anthropometric measures related to growth in length (height, sitting height) and fatness distribution (weight, abdominal, triceps and subscapular), which reflect the environmental impact on the children's growth.

3.3.1.2 Participant's measurement

In order to keep the privacy of the children measured the measurements were done at the school library. This space was free most of the time, was located far away from the classrooms and it was possible to close doors and windows during measurements. No other person would be allowed to remain. Only the participant, child's direct family and interviewer (AA) were present during the application of the questionnaire.

Height and weight are essential to determine physical growth that was later used to compare with international growth standards. While weight is a general indicator of the deposition of adipose tissue in the body, height reflects the long-term effect of environmental variables. Weight is highly modifiable in the short term but the height indicates the length of the growth in a cumulative term effect (Chumlea & Guo 2002; WHO 1995). Leg length is equally vital to assess the quality of the environmental conditions relating sitting height to total height. Moreover sitting height ratio (SHR) allows for the comparison of individuals of different heights ($([\text{sitting height} * 100\ ] \div \text{height})$). Individuals with shorter legs, will have higher SHR and will be affected by adverse environments showing worst health status (Bogin 1999; Varela-Silva et al. 2010; Frisancho et al. 2001; Kinra et al. 2011). On the other hand weight can be an important indicator of health but it is important to use it together with circumferences, skinfolds and BMI so as to give a more accurate measure of growth in children (Collins et al. 2000) .

Based on a previous study conducted in the same setting (Almeida 2012) we were expecting more than 200 children attending the school. However despite the fact that AA measured all the students willing to participate but that value fell short of the initial expectations.

Every day when measuring the children AA, a well-trained physical anthropologist, would arrive to the school and prepare the room (school library), check equipment and determine if heating was needed (fieldwork was done during winter time). Subsequently AA would go to the classrooms and call the students one at a time to be measured. Children were measured if their parents/ guardians had signed and return the written consent. AA would explain the procedures to the children, ask them to take their clothes and shoes off and only leave on their light clothing. Some did not want to take off tights because of the cold. AA noted down those cases and inserted the approximate values. Also because of the hairstyle of some children (braids and other high volume hair styles) height measurement had sometimes to be accounted for the 1/ 2 centimetres error. The duration of each procedure would take approximately 20 minutes in the room.

The children's anthropometric profile included height (cm), weight (kg), sitting height (cm) and skinfolds: triceps, subscapular, biceps and abdominal (mm); circumferences: arm and waist (cm) the accuracy of the measurement being 0.1 cm for these indicators.

The participants would be asked to stand on the scale, both feet touching the base, weight evenly distributed on both feet and looking ahead. Height (cm) and sitting height (cm) were measured with a portable stadiometer SECA ref 213- Stand-alone stadiometer graduated to the nearest 0.1 cm in the Frankfurt horizontal plane. The participant would have heels together and the heels, buttocks and upper part of the back touching the scale. The weight (kg) measurement was done with a flat scale digital SECA, ref.875 to the nearest 0.1kg. The sitting height (cm) was assessed with the subject seated on a small coffee table with hands resting on their thighs, feet off the floor and asking them to stretch back on a short stadiometer platform while AA kept their head in the Frankfurt plane. A Holtain Tanner/Whitehouse skinfold Calliper was used for the measurement of subcutaneous fat tissue like triceps, subscapular, biceps and abdominal skinfolds. For the triceps skinfold the participant would be in a relaxed position with the right arm hanging by the side and the hand in the mid-prone position. The subscapular skinfold was measured in the same relaxed position but with the fold running obliquely downwards at the subscapular site. The biceps skinfold was taken parallel to the long axis of the arm at the biceps skinfold site and the hand in mid-prone position. The abdominal skinfold was taken vertically at 5 centimetres from the navel (Marfell-Jones et al. 2006).

The circumferences including arm relaxed and waist were done with a tape SECA ref 201 with the first measure with the mid-acromiale-radiale landmark situated centrally between the two parts of the tape. Waist circumference, taken approximately half-way between the iliac crest and the lowest rib, was measured to the nearest 1 cm and abdominal circumference next to the navel (Marfell-Jones et al. 2006).

A similar procedure to the one applied to the children was applied to their biological mothers when possible (Table 3.6). Although it was not possible to meet with all the mothers due to several constraints (not available, not willing to participle or lost contacts) the vast majority were receptive and fully collaborated with the procedures. However AA realised after some measurements that some participants were not very comfortable with skinfold or sitting height data collection and later it was decided to drop them. Apart from that the anthropometric measurements included height, weight and circumferences (waist and arm) and body composition data with the body stat 1500. Only one of the mothers was excluded because she was pregnant.

The complete anthropometric profile in adults can provide important health indicators like waist circumference, fat patterning and fat content that can comprise future health and that of their offspring (Scafoglieri & Tresignie 2013; Lichtash et al. 2013). Maternal health history included birth factors like gestational age, parity, number of pregnancies, total weight gain related to last pregnancy, birth weight and parity (assessed with a household questionnaire). Some of the information regarding children's birth includes a photograph of their red book authorised by the mothers. Furthermore information for each of the siblings like gestational age, delivery, birth weight and recumbent length, breastfeeding time, birth order, total number of siblings and siblings in the study were also collected.

Table 3. 6. Anthropometric measures for both children and mothers collected in 2013.

Variables	Children	Mothers
Weight	✓	✓
Height	✓	✓
Sitting height	✓	-
Waist circumference	✓	✓
Arm circumference	✓	✓
Triceps skinfold	✓	-
Biceps skinfold	✓	-
Subscapular skinfold	✓	-
Abdominal skinfold	✓	-

3.3.1.3 Assessment of body composition using bioelectric impedance (BIA)

The assessment of body composition was used in both child and biological mothers via bioelectric impedance based on a tetrapolar system: the Bodystat 1500 analyser ® (Bodystat Limited, Isle of Man, UK). This method allows the estimation of fat mass and fat free mass from electrical resistance(Kyle et al. 2004) and can provide valid body fat measurements in children from different ethnic backgrounds (Nightingale et al. 2011). The participant was asked to lie on a mattress with no socks or gloves on. After that the electrodes were placed on the right hand and foot, 2 centimetres apart, to which alligator strings were fixed. Subsequently the body stat device was switched on and weight, age and height that had been previously measured were inserted. The system works by passing a safe battery generated signal through the body and subsequently measuring the bioelectrical impedance at a fixed frequency of 50 kHz. The results would show on the devices' monitor after some seconds to which AA would note down on the digital form. It collected body fat (%), lean mass (%), water (%), basal metabolic rate (kg/kcal), BMR/ Body weight (kg/kcal), estimate average requirements (kcal) and body impedance (z) (in some cases dry lean mass (kg)).

The maternal anthropometric measurements included height, weight and circumferences (waist and arm) and body composition with Bodystat 1500 analyser ®.

3.3.2 Physical activity objective assessment

Physical activity (PA) information was collected both via self-report (subjective assessment) and via a pedometer (objective assessment). The self-reported data were collected via household questionnaire (Appendix C) and recalled information on type, frequency and duration over a usual week (hours) in and out of school and parental perception of their children's physical activity and type of transportation to/ from school. All children of the study had PE classes at school once a week (1 hour class) and the questionnaire also accounted for type and duration of PA out of school. Also maternal physical activity frequency was assessed through the household questionnaire (self-reported) and it was based on 3 categories: never, sometimes (walk) or frequently (high intensity).

Several methods have been used to measure physical activity in youth (Butte et al. 2012). Self-reported physical activity has been used in some studies (Bauman et al. 2009; Barbosa et al. 2007) due to its practicability, low cost and flexibility with different ages and settings. However it poses a problem on reliability (Prince et al. 2008) and even risk of overestimation (LeBlanc & Janssen 2010). In contrast objectively measured PA can provide accurate and consecutive values that can later be compared and analysed with self-reported data (Welk et al. 2000).

The initial idea for this study was to use Actihearts (CamTech) to objectively measure physical activity through energy expenditure. These combined heart-rate monitors and accelerometers (the Actiheart, https://www.camntech.com/products/actiheart/) had been used before in studies with children from different age ranges and ethnicities (Wilson et al. 2011; Eyre & Fisher 2013) to estimate energy expenditure over a continuous period. However, they proved inadequate in this population due to insecurity issues and minor skin problems. Furthermore, three devices were lost and thus it was decided to use another more feasible/acceptable option.

Pedometers have been proven suitable sensors to measure ambulatory activity in school children over 5 years (Clemes & Biddle 2013) and they are universally comparable (Duncan et al. 2007). They are a good measure if used within the study objectives and population selected (Tudor-Locke CE ; Myers AM 2001).The Omron ™

step counter walking style III (Omron™ healthcare, Kyoto, Japan) was adopted as a cost-effective and practical solution (Peters et al. 2013) even if they have a minimum requirement of 30kg weight per participant. A similar device was validated with similar age range (De Craemer et al. 2015) and proved feasible and reliable (De Cocker et al. 2012). Because they have dual axis acceleration sensors it is possible to provide step counts when placed horizontal or vertically (De Craemer et al. 2015). Even if it underestimated step counts when used around the neck in one study (Silcott et al. 2011).

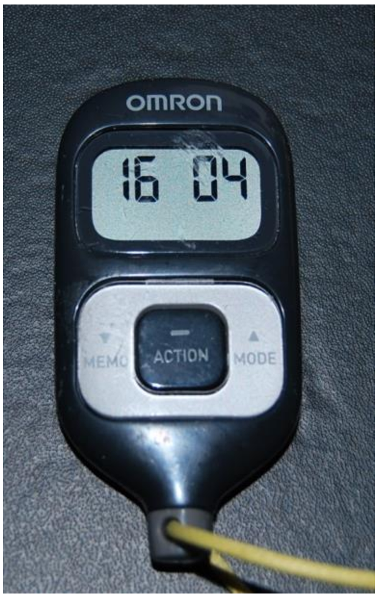

Figure 3. 10 Omron pedometers used in the 2013's study. Figure 3. 11. Participant using a pedometer in the 2013's study.

First in order to individually calibrate the devices, the stride length was measured by total length of ten steps walked by the number of steps (e.g. 6 meters divided by 10 steps: 0.60 m). Children would be asked to walk at their usual pace for 10 meters. After that AA insert stride length, time in hours and minutes, child’s height (cm) and weight (kg). The devices were worn for a minimum of 3 complete school days (e.g. Mon-Wed) between 9 am and 3pm including only wear time and 2 break times (morning and after lunch). Pedometers were used around children's necks (Figure 3.11) and all school personnel (teachers and workers) ensured the devices were worn correctly during the school day. A string was provided by AA to use the pedometers to avoid any disturbance with children's clothing. At the end of a school day (3pm) AA would collect the pedometers and register each child's mean step count on individual log sheets. This provided us with a volume of physical activity for a school day including free recreation time (morning and after lunch period). The measurements of each day (steps, distance walked eg) were automatically stored in memory and reset to 0 at midnight each day.. Each child was assigned a numbered pedometer and used the same pedometer for each day of data collection. These pedometers objectively assessed steps taken during the school hours for one school week in a sub-set of 30 children. Initial problems with calibrating, school and time availability took AA to determine 3 complete weekdays as the minimum wear criteria. A typical school day would go from 9 am to 5.30 pm. Children would have breaks at 10.30-11am, 1-2.15 for lunch and 3.15-3.30. Physical education classes would run once a week from 3.30-5.30pm.

A previous study conducted with Portuguese children had identified short sleep duration with having an inverse association with OW/OB prevalence (Padez et al. 2009). Padez and collaborators found that children that slept less than 9 hours had increased odds ratio of becoming OW/OB. AA followed the same rationale and recoded child's sleep hours for each school/week day (based on the difference between sleeping and waking up time). The sleep duration was later recoded for statistical purposes based on 1: <9 hours, 2:9-10 hours, 3:10-11 hours, 4: >= 11 hours.

3.3.3 Diet evaluation

Dietary data were collected as frequency of daily meals/drinks/snacks and salt and sugar consumption (Table 3.7). It did not include portion size that might cause a limitation for the usefulness of the data. On the other hand a 24-hour recall of food consumption used for dietary assessment is easier, rapid and low-cost to apply (Burrows et al. 2010). It permits assessing nutrient adequacy of the individual diet as part of a household questionnaire. In-person semi-structured interviews were conducted with parents/guardians. For this period (24 hours) each parent was asked to recall times, food and drinks of previous dinner and snacks (Table 3.8). Daily routines like waking up time, times before and after school and sleep time were used as prompts to enhance this recollection. Moreover information was also collected on location of this consumption to determine if it was home cooked and if salt or sugar was added to food and drinks. The information on dinner and snacks was put together with the school menus (example in table 3.8). In Portugal it is not common for students to have a packed lunch. A question on presence of traditional diet was inserted early during fieldwork, and if it was occasionally cooked and if the children liked it. The final questionnaire provided information regarding individual diet diversity, presence of traditional diet, location of meal consumption, number of meals and if the child skipped breakfast. Data on individual diet diversity was based on a protocol developed by EU and FAO on "Guidelines for measuring Household and Individual Dietary Diversity"(Kennedy et al. 2010) adapted from the FANTA Household Dietary Diversity Score Indicator Guide (Swindale & Bilinsky 2006). This system is based on a qualitative score on the consumption of 9 food groups.

Table 3. 7. Individual diet diversity score (IDDS) food groups used in 2013's study.

Food group	Coding	Final score
Starchy staples	1 yes, 0 no	1
Meat and fish	1 yes, 0 no	2
Other fruit and vegetables	1 yes, 0 no	3
Milk	1 yes, 0 no	4
Legumes, nuts, seeds	1 yes, 0 no	5
Eggs	1 yes, 0 no	6
Dark green leafy vegetables	1 yes, 0 no	7
Vitamin A fruit and vegetables	1 yes, 0 no	8
Total		9

The minimum score would be 1 out of 9 possible food groups consumed by a child in a 24-hour period.

AA recoded variables for breakfast, number of meals, main meal. The same coding was followed for salty food (yes 1, 0 no) and sugar consumption. It refers to the question on adding sugar to milk or other beverages and is not what is included in processed food.

Table 3. 8. Example of a diet assessment collection sheet used in 2013.

Meals	Main family meal of the day before	Drink	Soup	Pudding	Total score
Dinner	Fried fish with bean rice, salad	Water, natural juice	------	Fruit	7
Lunch (school)	Minced meat with beans and rice	Water	Kale and carrot	Fruit	
Snacks	Bread with cheese	Milk/yogurt	------	Fruit	

3.3.4 Conducting interviews I household questionnaire

The household questionnaire was conducted by AA through semi-structured interviews to the mothers/guardians and focused on ancestry, household's income and expenditure as well as parental educational level and occupational class. Moreover information was also collected on maternal health history. A household is defined in this project as a physical space in which its members live together and share economic expenditure and resources. This concept also includes single parent families.

A similar questionnaire had been previously applied on this community in other studies and had proven reliable (Marques 1999; Garcia-Ruiz & Marrodán 2000). The household questionnaire was redesigned and refined in June 2013. The content was discussed with the supervisor, Maria Inês Varela Silva (MIVS), and with another researcher, Vitor Rosado Marques, with some experience of working with this community. AA made some adjustments so as to reflect the current situation of most households (income and expenditure, living conditions, shorten the questionnaire). The questionnaire was originally written in English and was later translated into Portuguese that is AA's native language.

The questionnaire was designed to be answered by the children's mother. It consisted of 4 sections (Appendix C) and a list of the variables can be consulted in Table 4.4.

The first section incorporated the child's ancestry and included nationality, age, language spoken at home, birthplace of child, parents and grandparents on each side.

The second section was about current household socioeconomic conditions. It included information on living conditions of the participants like household and family size, number of rooms, type of water/ gas supply, child care and household assets. It is important to measure assets in poor communities as they are key to reducing poverty status (Mckay 2009). Moreover they influence the capacity for households to achieve more. The number of assets means that people can improve their SES and hence that of future generations. To lose assets might get communities into a "poverty trap" or delay into benefitting from positive environment changes (Barrett & Carter 2013). Additionally data on household income, expenditure, benefits, social transfers, parental educational level and occupation were also collected. AA collected monthly income estimation as parents had difficulty assessing a yearly amount probably proof of the insecurity of work contracts and unsettling situations (migration, health problems). The type of housing is more a less similar in this area as the neighbourhood grew from an illegal setting but always maintained the same house structure vital for social relations within the community. Public sewers had been installed and all houses had electricity, water supply and some even cable television.

The third section included maternal health history and referred to antenatal events like age at pregnancy, gestational age and diseases during pregnancy. Also it included postnatal events of her offspring like birth weight, number of progeny, birth order and birth spacing. The children's red book was consulted and the information was recorded. This document is given to mothers at the hospital when their child is born. It included birth measures like, gestational age, birth weight, APGAR index, birth length and head circumference. Additionally information on breastfeeding duration, health care access and health conditions of the child were also obtained.

The fourth and last section includes information on the child's diet and physical activity. The mother/guardian was asked to recall the main meals, snacks and drinks consumed by the child in a 24-hour period. Because most of them have lunch at school this recollection would be referent to dinner and afternoon snacks, as sometimes parents did not know what the child had had for lunch. Also information on the presence of a traditional diet, sugar and salt consumption were included. For the physical activity assessment questions were asked about participation, frequency and duration of PE (physical education) classes in and out of school. Also participants were asked if their children participated in collective sports, their usual sleep hours, if they walked to the school and location of play areas.

3.3.4.1 Interview procedure

After sending and receiving formal consent from the parents/guardians the contact details would be used to arrange a time to visit them at their home. In some cases AA had to try several times or ask the school for updated contacts. In other cases contact had to be made directly at their home or through relatives and friends. The neighbourhood is not only unsafe but also extremely difficult to walk around. The big slope, houses have several floors and are sometimes located in a narrow close. Street names and numbers were sometimes written in ink on the concrete and were difficult to pinpoint. Much time was spent trying to work out the location or waiting for the mothers to arrive. All the interviews and measurements of the mothers were conducted at their homes by AA. First AA would explain the aims of the project and would give to the mothers/guardians a description of all the procedures including the child measurement. After that the household questionnaire would be briefly explained in detail and it would be stressed that their participation would be rigorously voluntary and that they could stop their participation at any moment. The questionnaire was applied in an informal conversation and would take 30 minutes. AA would extend some of the questions and would avoid others if the mothers showed some discomfort. Even with the difficulties the majority of the mothers were compliant and happy to answer all the questions. Most of them spoke fluent Portuguese but in a few cases help was needed from a relative to make the questions and register their answers. The majority of the interviews were conducted with children's biological mothers but in the absence of them some interviews were conducted with the fathers or guardians of the child (n=8).

3.3.4.1 Lessons Learned - Amendments to field work procedure

Recruitment of participants: AA's initial approach was to set meetings with the teachers and then with the parents at the school library. If the former went really well, the latter were unfruitful. The majority of the parents/guardians did not show up for the meetings and either demonstrated lack of interest or more commonly had time constraints that made attendance difficult. After the unsuccessful initial plan to work with parents at the school, AA decided to give the project's information (consents and project details) to the children to take home to parents after a short presentation to them in their classrooms. Most parents collaborated and signed the consents as well as the contact details that AA later used to arrange the meetings for the second part of the data collection.

The Actihearts were to be used to objectively record children's physical activity. Nevertheless Actihearts proved unsuitable for this population due to the insecurity of the neighbourhood and consequential loss of some of the equipment. AA later decided to add a question on the parental physical activity perception of their children's and use the low cost pedometers as an alternative.

The initial idea was that the anthropometric profile of the mothers should include sitting height, skinfolds and Actihearts. When first measuring the mothers AA noticed that some were uncomfortable with the measurements and even more so if they had to take their clothes off. Apart from that some of my participant's mothers were overweight/ obese and also there were space restrictions on some of the houses (in some AA could barely carry the equipment in). After discussing with her supervisors, AA decided to suppress the skinfold measurement and use the body composition measurements from the bioelectric impedance only (Bodystat 1500 analyser ®).

3.4 Observational methods conducted during fieldwork

It was decided to combine qualitative and quantitative methods so that some key observational elements would provide a better understanding of how children live in this ecological context, given the unique context of this neighbourhood and the importance of this to understanding the quantitative research results. The qualitative methods were also important to make some changes while collecting data. Fieldwork notes were taken (Bernard 2006) from interviews at the household with mothers/ guardians of children and were combined with AA's observational notes on the neighbourhood and school daily life (non-participant direct observation, observations and experiences). Observation was conducted by walking along the streets, visiting local leisure institutions, and chatting with parents and locals while waiting at the bus stop. Subsequently thematic analysis was also used in order to examine specific themes that emerged from household interviews and personal observations during fieldwork (Table 3.9).

Case studies were also selected from the interviews with parents/guardians. Because of the feeling of suspicion from the locals of a foreigner in the community no notes were taken during the observation in public spaces to protect AA's safety. Only during household questionnaires and after explaining and presenting a sample questionnaire did AA write some notes while working on her laptop. During the interviews with family/carers AA would extend some of the questions when feeling the respondent would be comfortable with them. There would be some divergence from the main topic but all observations would be written down during or after the questionnaire was over. The walks in the neighbourhood were restricted to daytime, between 9 and 5 pm because after that there would be security issues. It was possible to collect information on social (child care and health) and cultural (traditions, diet, ancestry) aspects of the community in which the child is growing up.

A sum of qualitative information of the Cape Verdean community was previously presented in chapter 2. The description of these qualitative methods will assist in the understanding of the chapter 5 results and in the discussion section (Table 3.9).

Table 3. 9. List of different themes identified during fieldwork in 2013.

Ecological level and key informants	Theme	Subtheme
Interpersonal level	Single parent family	Social relations, parental absence
	Remittances	Contact with Cape Verdean culture
	Household dynamic	Marital status, economy, diet, composition
	Social support	Food ,school, health
	Health care	Prenatal, check up
	Difficult to reach	Enclosed social relations
Organisational level	Project	Meaning to parents/guardians
	Physical space	Use, meaning, child confinement
	Movement in/out	Remigration to another country
	Distance inhabitants	Criminality, drugs, discrimination

3.5 Ethical procedure

Ethical forms and questionnaires were submitted to Loughborough University Ethical Advisory Committee (LUEAC) and approved under the reference R13-P56 in February 2013. Subsequently some minor amendments were needed and final approval was received in March 2013. After that, the proposal was sent to the Portuguese Ethics Committee of the Tropical Institute of Scientific Medicine, in Lisbon, and an approval was granted in July 2013 with the reference 15-2013-TD. All questionnaires and formal consents were translated to Portuguese, AA's native language, and complied with the amendments from the Tropical Institute of Scientific Medicine's Ethics Committee. Approval was also granted in June 2013 from Antonio Jose dos Santos Gamboa, head of set of schools Pedro d'Orey da Cunha, in which Cova da Moura primary school is incorporated. Assistance on the preparation of questionnaires was provided by Dr. Victor Rosado Marques from the Tropical Institute of Scientific Medicine.

3.6 Data handling

3.6.1 Data input and cleaning

The informed consent forms and participant's information sheet were printed and sent to parents. Data was manually inserted by AA on her laptop during the measurements and interviews and automatically saved and uploaded to a private adobe forms account managed by AA and her supervisor (MIVS). Several data backups were saved and shared with the main researchers (AA, MIVS). Information on coding and personal identification of the participants was stored on an excel sheet only available to AA and MIVS. The student's list and parental contact information were shared by the school headmaster only under full commitment of AA's safeguarding information and was never shared with other people outside of the project.

Subsequently data were extracted on a form of excel sheet from the Adobe form account and then introduced into a Statistical Package for Social Sciences version 22.0 database. Subsequently it was cleaned and double checked by AA when introduced and reordered in the SPSS file. Each match on the dataset was checked for a match with questionnaires of all participants. If any mistake was found it would be corrected and checked again on the initial Adobe form or on photos taken (red book). Children's variables were separated from maternal and household data. Variables related with the objectively measured physical activity and diet had to be analysed and coded first in the original Excel spread sheet and then included in the final SPSS file. Because no check on paper could be done when inserting data on a digital format, subsequent analysis of the box plot distributions were done for the main variables. Frequencies with histograms for child's continuous data measurements were analysed as well as anomalies. Descriptive data for direct and indirect variables were calculated according to sex and age. For each age the mean and standard deviation was calculated.

Variables were then analysed segmented by age in order to identify outliers. Values deviating more than 1.5 interquartile range below the first and above the third quartile were excluded and then deleted.

3.6.2 Derived variables

3. 6.2.1 Anthropometry

The first step was to calculate chronological age for every participant and their mothers so as to better assess their biological age. It is based on date of observation and date of birth.

To calculate "decimal birth date":

$$\lceil \text{(Birth month- 1*30) + day of birth} \rceil / \text{ 365 + year birth}$$

While for "decimal date of observation" the following formula was used:

$$\lceil \text{(obs month- 1*30) + day of obs} \rceil / \text{ 365 + year obs}$$

The final formula to transform into decimal age = decimal age observation - decimal age birth. Decimal age was also calculated for father when he was present in the household. Other derived variables like indices and indicators were subsequently created to better understand and to compare the data (Table 3.10, 3.11)

Table 3. 10. Derived variables from anthropometric measurements used in 2013's study.

Derived variable	Formula
Body Mass Index (BMI)	BMI= weight (kg) / height $(m)^2$
Total leg length	Leg length/ height *100
Sitting height ratio	(sit height *100)/ height
Leg length	Height – sit height
RLLI or relative leg length index (Azcorra et al. 2013)	(leg length*100)/ height
Length index (%)	(leg length/height)*100
WHtRatio (waist- to -height ratio)	Waist circumference / height

BMI was defined as a continuous variable or dichotomous (overweight/obese) calculated with World Health Organization cut off points for BMI-for-age (De Onis et al. 2007). Subsequently data were used to classify leg length into an index (Frisancho 2007) :

Low leg length index (%) = Z-score <- 1.036 the age and sex-specific reference of leg length index (%);

High leg length index (%) = Z-score >1.036 the age and sex-specific reference of leg length index (%);

Leg length index was derived by computation and the subsequent classification was based on Frisancho's anthropometric reference (Frisancho 2008).The cut-off point of -1.036 Z-score for leg length index was defined by Frisancho's and a low leg length index reflects negative growth conditions (Frisancho 2007).

The formulas used for skinfold and circumference derived variables are shown in Table 3.11:

Table 3. 11. Formulas used with skinfold and circumference measures used in the 2013's study.

Derived variable	Formula
Sum 2 skinfolds	TRCsk + SUBC sk
Sum 3 skinfolds	TRCsk +BIC sk+ SUBC sk
Sum of 4 skinfolds	TRCsk +BIC sk +SUBC sk+ ABD sk
Upper arm muscle area (UPA)	⌈ arm circun final – (TRC sk mean* π ⌉^{2} / 4* π
Total upper arm area (TUA)	⌈ (arm circun final)/4* π ⌉^{2}
Arm fat area (AFA)(Frisancho 1990; Martorell et al. 1976)	TUA -UMA
UMA(Frisancho 1990)	⌈ arm circun final – (TRC sk * π ⌉^{2} / 4* π

SUBsk: subscapular skinfold (mm); TRCsk: triceps skinfold (mm); BCsk (mm): biceps skinfold; Arm circun final: Arm circumference in centimetres I all skinfold measurements were in millimetres I **π** =3.14159265358979

All anthropometric data were inserted in the evaluation software of nutritional anthropometry designed by Robert Frisancho (Frisancho 2008) based on the anthropometric data source derived from the NHANES III growth references. Z-score transformation allows for the comparison of the child with the reference population that is based on normally distributed categorical variables. This subsequent computation takes each score and subtracts the mean of all participants, divides the resulting value by the standard deviation. It measures the distance (in standard deviation units) a child's value is above or below the mean (WHO 1995; Frisancho 2008). The National Health and Nutrition Examination survey, NHANES, may be a more legitimate source of comparison because the sample includes Cape Verdean ancestry American residents (Carling 1997). The following tables show the standards that were chosen for this study to compare the two populations. Furthermore nutritional status categories were calculated based on percentiles and z-scores (Table 3.12 and 3.13) for Height-forage, Sitting height-for-age, Leg length-for-age, weight-for-age, BMI-for-age and waist circumference-for-age.

Table 3. 12. Anthropometric indicators and cut offs points used on the assessment of nutritional status for Cape Verdean and Portuguese children adapted from (Varela-Silva et al. 2012) .

Children	WHO	CDC	IOTF
Stunting	Height-age < -2SD	Height-age <5^{th} percent	
Underweight	Weight-age < -2SD	BMI-age <5^{th} percent	Centile curves
Overweight	BMI-age >+ 2SD	BMI-age <85^{th} >95^{th}	Cut off points
Obesity	BMI-age >+3SD	BMI-age >95^{th}	

Table 3. 13. Nutritional status categories according to percentiles and Z-score values (Frisancho 2008).

Categories	Percentiles	Z-score
Low	< 5^{th}	< -1.650
Below range	5.1-15^{th}	-1.650 to -1.040
Healthy range	15.1-85^{th}	-1.036 to 1.030
Above average	85.1-95^{th}	1.036 to 1.640
Excessive	>95^{th}	>1.645

Children's waist circumference was classified in age, sex and ethnic group specific percentiles (Fernández et al. 2004). Values higher than the 75^{th} and 90^{th} percentiles for waist circumference represent a risk for cardiovascular diseases (CVDs). Further waist-height ratio was classified (McCarthy & Ashwell 2006) as a risk of cardiovascular diseases for values higher than 0.5 centimetres.

3.6.2.1.1 Maternal variables

Other maternal variables were collected during the household questionnaire (Table 3.15). Subsequently maternal nutritional status was evaluated with anthropometric indicators defined as underweight, and overweight, obesity, waist circumference and skinfolds according to the World Health organization (WHO) and the Centre for disease control (CDC) classifications (Table 3.14). Moreover mean values for WHtRatio, waist circumference / height, were above 0.50 which according to the literature on African ancestry populations might be considered a risk factor for cardiovascular diseases (CVDs)(Okosun et al. 2000). Maternal waist circumference was used as a continuous variable and as a categorical variable (Women’s cut-off points (Gonçalves et al. 2015) with the values ≥ 88 centimetres defined as increased risk of cardiovascular diseases and above 80 centimetres as a risk of metabolic complications. The maternal arm circumference TUA (total upper arm area) was calculated with the same formula used for a child.

Table 3. 14. Maternal BMI cut-off points for under and over nutritional international standards (WHO, CDC) used in 2013.

Mother	WHO / CDC
Underweight	< 18.50
Normal weight	18.50-24.99
Overweight	≥25
Obesity	≥30

Birth spacing was defined as the difference of months between the first and second birth as an important indicator of maternal reproductive patterns that may affect childcare and maternal health. Maternal weight gain (kg) was self-reported and is referent to the last pregnancy. Subsequently this variable was categorised into 3 categories (2-5 kg, 5-10 kg, > 10kg) based on the distribution of the sample. Gestational age (weeks), birth weight, birth length and head circumference were taken from the children's red book (Table 3.15).

Table 3. 15. Maternal variables recoded in the 2013's study.

Variable	Original	Recoded	Categories
Birth weight (World Health Organization (WHO) 2011)	Scale (kg)	Categorical	NBW 2500-3.999 LBW < 2500 grams, HBW > 4000 grams,
Gestational age	Scale (weeks)	Categorical	Preterm (<37 weeks) Term (37-42 weeks) Post term (> 42 weeks) ,
Birth order	Scale	Categorical	>3 <3
Weight gain pregnancy(kg)	Scale	Categorical	2-5 kg, 5-10 kg >10kg
Breastfeeding length	Scale (months)	Categorical	0-2.99 months, 3-5.99 months, 6-11.9 months, >12 months

Common anthropometric derived variables for children and mothers can be seen in Table 3.16. Percentiles and Z-scores for height, weight, WC, and AC were calculated in children and adult women using growth references used by Frisancho (2008). This is a specific sex and age comprehensive metric reference with age ranging from 2.5 months to 18 years. Percentiles and Z-scores for SH, SHR, LL were only calculated for children.

Table 3. 16. Derived variables using anthropometric techniques used on children and their mothers.

Variables	Children	Mothers
HAZ percentiles/z-scores	✓	✓
Sitting height -for-age percentiles/z-scores	✓	-
Sitting height ratio (%)	✓	-
Sitting height ratio percentiles/z-scores	✓	-
Leg length(cm)	✓	-
Total leg length	✓	-
Total leg length percentiles/z-scores	✓	-
RLLI or relative leg length index	✓	-
Length index (%)	✓	-
Sum of 2 skinfolds (triceps+ subscapular)	✓	-
Sum of 4 skinfolds (tric, bic, sc, abd)	✓	-
Mean triceps skinfold (mm)	✓	-
Ts-for-age percentiles/z-scores	✓	-
Mean subscapular skinfold	✓	-
Subscapular-for-age percentiles/z-scores	✓	-
Upper arm muscle area (UPA)	✓	✓
Total upper arm area (TUA)	✓	✓
Arm fat area (AFA)	✓	✓
UMA(Frisancho 1990)	✓	✓
WFAZ percentiles/z-scores	✓	✓
BMI (kg/m^2)	✓	✓
BMI-for-age percentiles/z-scores	✓	✓
Waist-for-age percentiles/z-scores	✓	✓
WHtRatio	✓	✓

HAZ: Height-for-age : z-score height, SH: sitting height, SHR: sitting-height ratio (sit height*100/height), LL: leg length (height-sit height), LLZ : z-score leg length; RLLI: relative leg length index (leg length*100/height); WFAZ: Weight-for-age z-score weight for age, BMI: body mass index (weight (kg) /height (meters)^2), AFA : arm fat are (cm), WFA: waist circumference for age (cm); SUBsk: subscapular skinfold (mm); TRCsk: triceps skinfold (mm); BCPsk (mm): biceps skinfold ; SUM2sk : sum of triceps and subscapular skinfold (mm); SUM4sk: triceps, biceps, abdominal, subscapular (mm) ; WHtR: waist-to-height ratio

3.6.2.2 Bioelectric impedance

Since there is not a specific formula for the Cape Verdean population we used Slaughter's sex specific formula for children's body fat (Table 3.17)(Slaughter et al.

1988). For mothers fat free mass was estimated from body stat values for body fat (%) and later Segal and collaborator's formula was applied (Segal et al. 1988).

Table 3. 17. Transformed variables from body composition measures used on children and their mothers.

Derived variable	Formula
Sum_2sk_calc	TRCsk + SUBC sk
Slaughter_ boys	BF(%)=0.783*(⌈ TRCsk + SUBC sk)+ 1.6⌉
Slaughter_ girls	For sum 2k > 35 mm BF (%)=0.546*(⌈ TRCsk + SUBC sk)+9.7⌉

Fat Free Mass for mothers
Based on body fat (%) from Bodystat
Segal et al 1988
	If (BF_percent_moth < 25 %
	Maternal_FFM=((0.00064602 * (Height_Mother * Height_Mother)) - (0.01397 * Maternal_impedance) + (0.42087 * Weight_Mother) + 10.43485).
	
	IF (BF_percent_moth >= 25 & BF_percent_moth 35 %)
	Maternal_FFM=((0.00064602 * (Height_Mother * Height_Mother)) - (0.01397 *Maternal_impedance) + (0.42087 * Weight_Mother) + 10.43485) + ((0.00091186*(Height_Mother * Height_Mother)- (0.01466*Maternal_impedance)+(0.2999*Weight_Mother)- (0.07012*AgeMother)+9.37938)) / 2.
	
	IF (BF_percent_moth >= 35%)
	Maternal_FFM=((0.00091186*(Height_Mother * Height_Mother)- (0.01466*Maternal_impedance)+(0.2999*Weight_Mother)- (0.07012*AgeMother)+9.37938)).

3.6.2.3 Objectively measured physical activity

All activities out of school were coded according to the compendium of physical activities (Ainsworth & Haskell 2011). Data on child's recorded step count was daily collected and noted down. First, mean steps per day were calculated by dividing step counts for the days children used the device (3 complete school days). Subsequently data were then organized into quartiles in SPSS (analyse>frequencies>quartiles) and later compared with the literature.

3.6.2.4 Socioeconomic data

On the initial forms there were several variables (year of construction, legality, sewer service) related to the house that were later discarded. Most parents were renting and could not report on these variables accurately. However household size had been used before in other studies (Marques 1999) and includes all people living in the physical space of the house. Overcrowding index was calculated dividing number of people living in the house by number of sleeping rooms in the same space. This is especially relevant because some families refurbish some parts of the house when they need more space for relatives coming to live with them. Another variable was created based on type of parental absence and was categorised into mother, father or both. This variable is important because it shows that many working mothers rely on after school clubs to care for the child when her husband/partner cannot do it.

Parental education was initially coded into 3 categories (primary or none, 6 years, 9-12 years and university) but later it was decided to use fewer categories due to the small numbers. Parental education was subsequently divided into 2 categories (none or primary and high).

Parental occupational class is presented in two different ways. The first was used before by Harding and collaborators (Harding et al. 2008). It includes non-manual, manual and unclassified jobs. The second is the ISCO standard (International Standard Classification of Occupations (Hoffmann 2003; Instituto Nacional de Estatística (INE) (Portugal) 2010a). It defines each category based on the skill level and specific functions required to perform those tasks. The two references are used as a term of comparison (Table 3.18).

Table 3. 18. Different categories used in the classification of parental occupation in 2013.

Paternal occupation ISCO	Harding et al 2008	Maternal occupation ISCO
Executives, directors (managers)	Non-manual	Executives, directors
Professional and scientists		Professional and scientists
Middle management and technicians		Middle management and technicians
Administrative and related workers		Administrative and related workers
Service and sales workers	Manual	Service and sales workers
Farmers and skilled agricultural and fisheries workers		Farmers and skilled agricultural and fisheries workers
Skilled workers, craftsman and similar		Skilled workers, craftsman and similar
Machine operators and assembly workers		Machine operators and assembly workers
Elementary occupations		Unskilled workers
Retired	Retired	Housewife
Unemployed	Unemployed	Retired
		Unemployed

Single parent families were created as a dichotomous variable (yes/no). For the fathers that were absent from the households their information was only added if the mother referred to them as contributors to the household budget and could report on their contributions. Furthermore household income, expenditure and child benefit were collected in Euros and were later converted into Sterling pounds (exchange rate is shown in the results section) and will be compared with the Portuguese minimum wage. The variable number of people in the household with monetary income refers to the mother or the father or both including cases where both are unemployed but still getting benefits (before or when they complete 24 months of unemployment). The head of the household refers to the biggest earner in the household who might be the father or the mother. The neighbourhood perimeter includes children that live within or over 1 mile from the school. All variables used to assess socioeconomic status are listed in tables 3.19 and 3.20.

Table 3. 19. Variables used to assess the socioeconomic status of Cape Verdean ancestry households in 2013.

Assets	Income	Education (each parent)	Occupation (each parent)
Rented/own house	Household Monthly income	Years studied	Current occupation
Cable TV	Household Monthly Expenditure	Educational level attained	Distance from home
Car	Remittances (yes/no)	Occupational class	Weekly working hours
Internet	Wages/month/ £ each parent		Duration unemployment
Computer	Children under 10 years		
	Social benefit yes/no		
	Head household (main breadwinner)		
	Free school meal		

Table 3. 20. Derived variables from household questionnaire applied to Cape Verdean families in 2013.

Derived variables	Type variable
Maternal educational level	Categorical
Maternal occupational class	Categorical
Maternal single	Dichotomous
Mother unemployed (yes or no)	Dichotomous
Mother time out of house day	Continuous
Cape Verdean ancestry	Categorical
Single parent family	Dichotomous
Head household (main breadwinner) (mother/father)	Dichotomous
Father educational level	Categorical
Father occupational class	Categorical
Household size	Categorical
Overcrowding index	Continuous
Assets all (TV, internet, PC, house, car)	Continuous
Number of Cape Verdean grandparents	Continuous
Neighbourhood perimeter	Dichotomous
Child number meals	Continuous
Child sleep hours	Continuous

3.7 Data analysis

For chapters 4 and 5 only the Cape Verdean dataset (CVPT2013) was used while all of the datasets were included in some sections of chapter 6 (CVPT1992, CVPT2009 and CVPT2013, PT2009). All children from all of the databases used come from an urban setting and Lisbon district and are aged 6 to 12 years old.

Data were analysed with Excel and the Statistical Package for Social Sciences version 22.0 (SPSS). Descriptive statistics were used to provide a general description of the samples and a chi-square test was used to compare prevalence of under and over nutrition. Analysis of variance (ANOVAs) allowed the comparison between the samples and to determine possible trends between groups in continuous data outcomes. The Kruskall Wallis test using a chi-square statistic of independence was performed to determine the association between key explanatory variables and outcomes of interest with a non-parametric distribution. Subsequently Mann-Whitney U tests were done for associations labelled as significant from the Kruskall Wallis test to determine which groups were significantly different. A subsequent Bonferroni adjustment for the final p-value was done because multiple comparisons were being undertaken.

For chapter 4 on living conditions and nutritional health the Cape Verdean database 2013 was used. Descriptive statistics in this chapter were used to do a general description of the living conditions of Cape Verdean households residing in Cova da Moura neighbourhood. Frequencies and percentages were calculated for marital status, parental educational level and occupational status, parental age, nationality and birth place, week work hours, head of the household, child benefit, child care, free school meal, income and expenditure. Also dispersion statistics (median and interquartile range, minimum and maximum values) were calculated for household size, and the number of children under 10 years variables given the non-parametric nature of these data. Similarly percentages and descriptive statistics (means and standard deviations) were calculated for ancestry, early life factors like birth weight, gestational age, birth spacing, and breastfeeding duration and birth order.

Descriptive statistics (means and standard deviations) for most anthropometric variables (raw and derived) are presented according to age and sex of the child.

Furthermore tables on percentage of children under each category of HFA, SHFA, LLFA, WFA, BMIFA, WCFA are presented. Nutritional status was classified according to the participants' anthropometric values with the Frisancho 2008 reference values (Z-scores and percentiles). International obesity task force references (IOTF) were used along with Centre for diseases control and World Health Organization to classify children according to their BMI. Children's waist circumference (Fernandez et al 2004) and waist-height ratio were classified (McCarthy & Ashwell 2006) as risk of cardiovascular diseases. Body fat percentage is presented only for descriptive use. Unpaired T-tests and Wilcoxon rank sums test compared continuous variables between boys and girls. Chi-square analysis was used to compare nutritional categories (eg. overweight, obese, normal weight, underweight) for boys and girls.

Consequently for chapters 5 and 6 multiple regression analyses were performed. These were done using generalized linear models for analysing multiple variables in an integrated way adjusting for potential confounders. These models will be subsequently detailed under the relevant chapter headings. Only variables that meet the multiple linear regression assumptions were included in the models. The presence of linear relationships between each independent and dependent variable and the non-colinearity assumption between independent variables was verified. Residual scatter plots were performed and permitted identifying possible outliers in the sample and checking of the homoscedasticity assumption. The beta coefficient, p-value, and standard error are presented for each variable included in the models. A scatter plot analysis showed that there was no curvilinear association of the different child outcome variables with maternal age. The variance inflation factor (VIF) was checked to see if each predictor had a strong correlation with other predictors. Values around 1 (1-1.3) were used as a distinction measure that multicolinearity may be biasing the regression model (Field 2013).

Chapter 5. Multiple linear regression model building on maternal and intergenerational (mother to child) effects on health and growth outcomes of Cape Verdean ancestry children

The aim for this chapter was to assess how early life factors and intergenerational effects have an impact on children's nutritional health. A subset (47) of the original dataset (CVPT2013) of 89 children from Cova da Moura Neighbourhood in Lisbon, Portugal was analysed. It included only biological mothers and one of their children from Cape Verdean ancestry.

Descriptive (means and standard deviations) and dispersion statistics (median and quartiles) for maternal age, parity, number pregnancies, total weight gain, time living in Portugal, maternal age at birth were calculated. Also for this subset descriptive statistics were presented (mean and standard deviations, median and interquartile range) for child and maternal age, height, weight, BMI, waist circumference, waist-height-ratio, arm circumference, fat free mass, body fat (%) as well as Z-score values. Malnutrition rates were calculated for mothers according to World Health organization and Centre for diseases control growth references. Over fatness (% BF), waist-to-weight ratio and waist circumference risk for cardiovascular diseases was also determined (Frisancho 2008). In order to determine the impact of early life and intergenerational factors on the nutritional status of children multiple linear regression models using the enter method were run with BMI and height, WC, WHtR of the child as outcome variables, controlling for child sex and age. Pearson and Spearman's correlation were used to compare the outcome variables and environmental variables.

Table 3. 21. Intergenerational and environmental variables included in chapter 5 multiple regression analyses (models 1, 2 and 3).

Effect	Variable	Model 1	Model 2	Model 3
Control	Child sex and age	✓	✓	✓
Intergenerational	Maternal height/ BMI/WC/ WHtRatio	✓	✓	✓
Environmental	Maternal age		✓	✓
	Birth order (scale)			✓
	Single parent families (dichotomous)			✓
	Maternal educational level (dichotomous)			✓

Variables used in the models are presented in Table 3.21. Models were built using the enter method using different steps defined by AA based on the literature review. First each maternal anthropometric variable was regressed against the separate child outcomes. We run additional models for Z-score for leg length and sum of 2 skinfolds (triceps and subscapular) to complement the previous models. After that several environmental variables were individually regressed against different outcomes for child anthropometric variables (child BMI and child height for age Z-scores). The variables that showed a significant association ($p<0.05$) with the outcome were retained in the analysis. All models were adjusted for age and sex of the child. Model 1 was adjusted for sex and age only while model 2 accounted for intergenerational effects (Maternal height, BMI, WC, WHtRatio) and model 3 for environmental variables (maternal age, birth order, single parent families and maternal educational level).

Environmental variables included maternal age and birth order that were used as continuous variables, single parent family was used as dichotomous variable (yes as reference) and maternal education as a categorical variable (low/high). Child's sex was used as dummy variable with girl as reference. The same effect was verified for boys and it was decided to define girl as a one way to present results.

Different levels of analysis were needed to validate the models. The first one was to run bivariate and partial correlations for all the variables used in this chapter to identify potential problems with multicolinearity. This method allowed the identification of the strength of the association. After analysing correlation coefficients it was determined that there were no problematic correlations between the variables used in the models. Furthermore diagnostics tests were applied to each model to check its validity. Linear relationships between predictor and outcome variables were verified by scatter plots. Residual values were examined for assumptions of normality through statistical tests and dispersion diagrams. Correlation between the predictor variables was checked by producing the variance inflation factor (VIF) and no cases of violated assumptions were found (if predictor has a strong linear relationship with other predictor). Cook’s distance test was applied to residuals when performing regression models and they provided information on outlier cases. Cook's measure had values between zero and one. For each association between each predictor and outcome variable, 95% confidence intervals were calculated.

Chapter 6. Multiple linear regression model building on socioeconomic and biological determinants of growth for Cape Verdean and Portuguese databases (CVPT2013 and PT2009)

Descriptive statistics (means and standard deviations) and dispersion statistics (median and quartiles) on all datasets are presented and malnutrition rates were calculated based on IOTF, CDC and WHO references. Chi-square was used to compare prevalence of under and over nutrition between the samples. Analysis of variance (ANOVAs) allowed the comparison between the samples and to determine significant trends for parametric data. Kruskall Wallis permitted identification of differences for the non-parametric data. Multiple linear regression models were built to measure the influence of environmental variables on height, BMI, weight, and waist circumference of children. First models for child growth outcomes (Z-score height) were performed followed by body mass (Z-score BMI) and body composition variables (Z-score sum 2 skinfolds), and other anthropometric measures (Z-score weight, leg length, waist circumference, arm circumference).

Models were built using the enter method using different steps defined by AA based on literature review. Each environmental variable was regressed against the separate child outcomes. Statistical significance was assessed using $p<0.05$. All models were adjusted for age and sex of the child. Table 3.22 shows the biological, prenatal and environmental determinants used in the regression models. Model 1 was adjusted for child's sex and age only and included only maternal anthropometric parameters (maternal height, BMI, waist circumference, waist-to-height ratio) while model 2 accounted for biological effects (parental age), model 3 for prenatal effects (birth weight) and model 4 for environmental variables (birth order, maternal marital status, parental occupation class).

Table 3. 22. Biological and environmental predictors significant for Cape Verdean ancestry children's growth and body composition included in chapter 6 multiple regression analyses (models 1, 2, 3 and 4).

Effect	Variable	Model 1	Model 2	Model 3	Model 4
Control	Child sex and age	✓	✓	✓	✓
	Maternal height/ BMI/WC/ WHtRatio	✓	✓	✓	✓
Biological	Parental age (years)		✓	✓	✓
Prenatal	Birth weight (kg)			✓	✓
Environmental	Birth order (scale)				✓
	Parental occupation (categories)				✓
	Maternal marital status (categories)				✓

Parental age (years) and child birth weight (Kg) were analysed as continuous variables and accounted for biological and prenatal influences. Environmental variables included birth order that was used as a continuous variable, parental occupation class used as dichotomous variable (categorical, non-manual as reference) and maternal marital status (categorical, single as reference). Child's sex was used as dummy variable with girl as reference.

To validate the models different tests were performed. First bivariate and partial correlations were run for all the variables used in this chapter to identify potential problems with multicolinearity. After analysing strength of the association with correlation coefficients it was determined that there were no problematic correlations between the variables used in the models. Also diagnostics tests were applied to each model to check its validity. Linear relationships between predictor and outcome variables were verified by scatter plots. Residual values were examined for assumptions of normality through statistical tests and dispersion diagrams. Cook's distance test was applied to residuals when performing regression models and they provided information on outlier cases. Cook's measure had values between zero and one. Correlation between the predictor variables was done by producing the variance inflation factor (VIF) and no cases of violated assumptions were found (if predictor has a strong linear relationship with other predictor). For each association between each predictor and outcome variable, 95% confidence intervals were calculated.

A logistic regression permitted differences between the Portuguese and Cape Verdean ancestry children in terms of overweight/obesity (BMI) to be assessed. This process was performed including the PT2009 and CVPT2013 samples for comparison and permitted determining the biological (birth weight and breastfeeding time) and socio-demographic (maternal education and occupation) factors associated with OW/OB to assess differences in nutritional status between the two ethnic groups. Models for overweight and obesity are presented because of the low prevalence of under nutrition across the two datasets. Odds ratios and 95% confidence intervals are presented along with Hosmer Lemeshow statistics that demonstrated the model fit parameters. Models were built by inserting age, sex, and ancestry (PT as reference) at step 1. Subsequently in step 2 significant socio-demographic variables (Table 3.22) from an unadjusted analysis were included. This strategy allows identifying differences in overweight and obesity between the samples explained by the biological and socio demographic factors entered into this step of the model building process.

Chapter 4. Living conditions, SES and nutritional status assessed by anthropometry of Cape Verdean children in Lisbon (Portugal)

The aim for this chapter is to present general living conditions of the Cape Verdean families who participated in this research project collected in 2013/2014. All participants included in the analysis presented in this chapter are of Cape Verdean ancestry and they will be referred to as CVPT throughout. Data include:

- Socio-demographic variables
- Household income and expenditure
- Ethnic background (ancestry)
- Descriptive information on nutritional status of Cape Verdean ancestry children
- Physical activity (PA) and dietary assessment

4.1 Living conditions of the families

4.1.1 General demographic data of the families

In total data were collected in 62 households where 41 boys and 48 girls lived. Living conditions were moderately good. The majority of the houses had exclusive use of the kitchen and bathroom (only in two cases the kitchen was shared). Most were rented and were on the first or second level. Most of the houses were built in concrete and cement and dated from at least 20 years ago. Several repairs and refurbishments were done during that period of time either by the tenants or landlords. The majority had a kitchen, living room, bathroom and bedrooms. The entrance was sometimes extremely narrow and steep. In some cases one of the floors of the house was rented. Moreover the house could function as a shop or trading place. For example some mothers would cook and sell their food or use the space as a hairdresser saloon.

In 45.2% of the cases children lived in traditional nuclear families with both parents (fathers and mothers) and offspring while in 54.8% they lived with mother, father or a relative (see Appendix D).

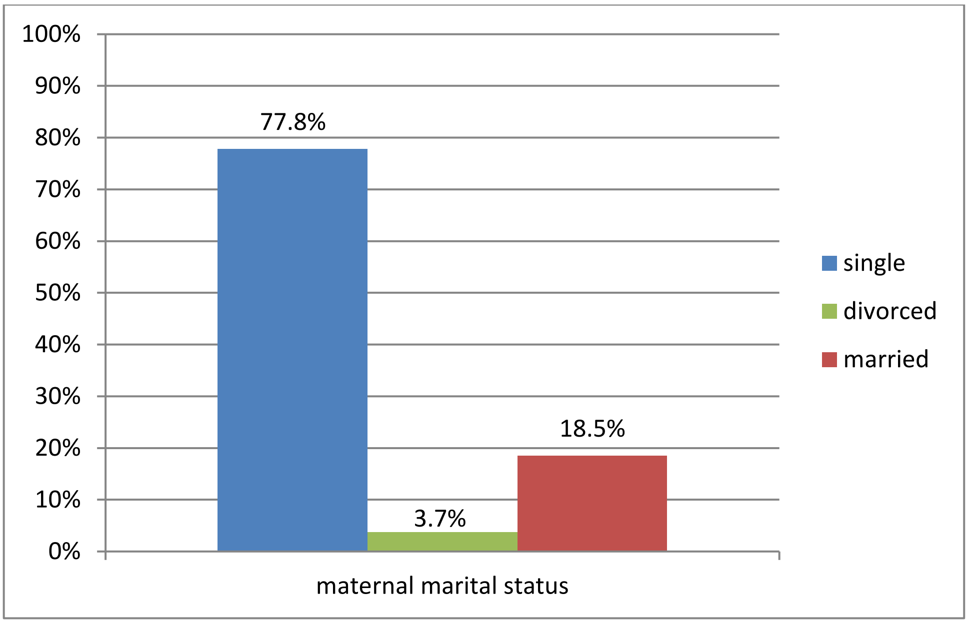

Figure 4. 1. Percentages of maternal marital status categories in Cape Verdean mothers in 2013 (n=54).

For single parent families father absence is more common than mother absence (n= 27 versus n=6) and only one household had both parents absent (Figure 4.1). Even though some of the mothers live with their partners/ father of the child they would consider themselves single (77.8%). A small proportion was married (18.5%) and 2 (3.7 %) were divorced (Figure 4.1).

Household size (people that are living at the house) and number of children living at the house were also measured (Figures 4.2 and 4.3). In relation to household size half of the families have 4 members per family living in same household[2] (Figure 4.2). There are cases of family members or relatives staying at the household for a specific period of time and that might account for a higher household size.

[2]Household is defined on methods chapter as group of people that live together and share expenditure or resources.

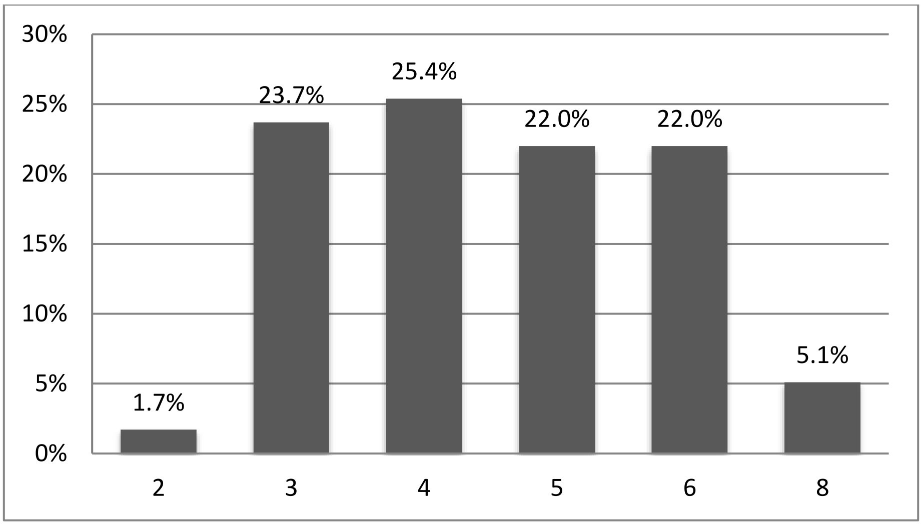

Figure 4. 2. Percentages of Cape Verdean's household size in 2013 (n=59). DISPERSION: P25= 3, P50= 4, P75 =6

Overcrowding was defined as the number of people living at the household divided by the number of rooms. Values higher than 2.5 indicate an overcrowding household. Table 4.1 shows that in our case 26.7% (16 out of 60 households) were overcrowded.

Table 4. 1. Overcrowding observed in Cape Verdean households in 2013 .

Categories	n	%
1	16	26.7
2	26	43.3
3	16	26.7
4	2	3.3
Total	60	100

In Figure 4.3 the total number of dependents under 10 years living at households is presented and on average and there are 2 children (43.3%) living at the household and 41.7% of the households had one child.

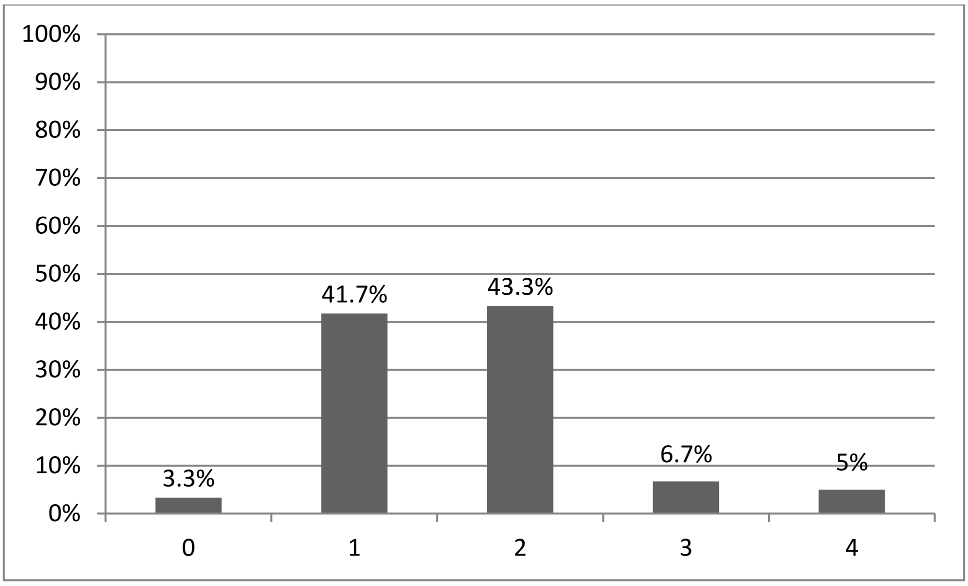

Figure 4. 3. Percentages of total number of children under 10 years living at Cape Verdean households in 2013 (n=60). DISPERSION: P25= 1, P50= 2, P75 =2.

4.1.2 Socio demographic information of children and parents

Information on the CVPT2013 dataset also included 60 fathers even though some did not live with the child and were not part of the household. We found that mothers have lower mean age compared to fathers (Table 4.2). The middle of the distribution (25th to 75th percentile) of father's age falls between 31 and 46 years. For mothers the middle of the distribution falls between 27.79 and 40.34.

Table 4. 2. Descriptive information on Cape Verdean fathers and mothers in 2013.

		Age father	Age mother
N		60	60
Mean		38.10	34.51
Median		35.50	33.87
Std. Deviation		9.28	8.02
Minimum		20.00	22.03
Maximum		61.00	55.89
Percentiles	25	31.00	27.79
	50	35.50	33.87
	75	46.00	40.34

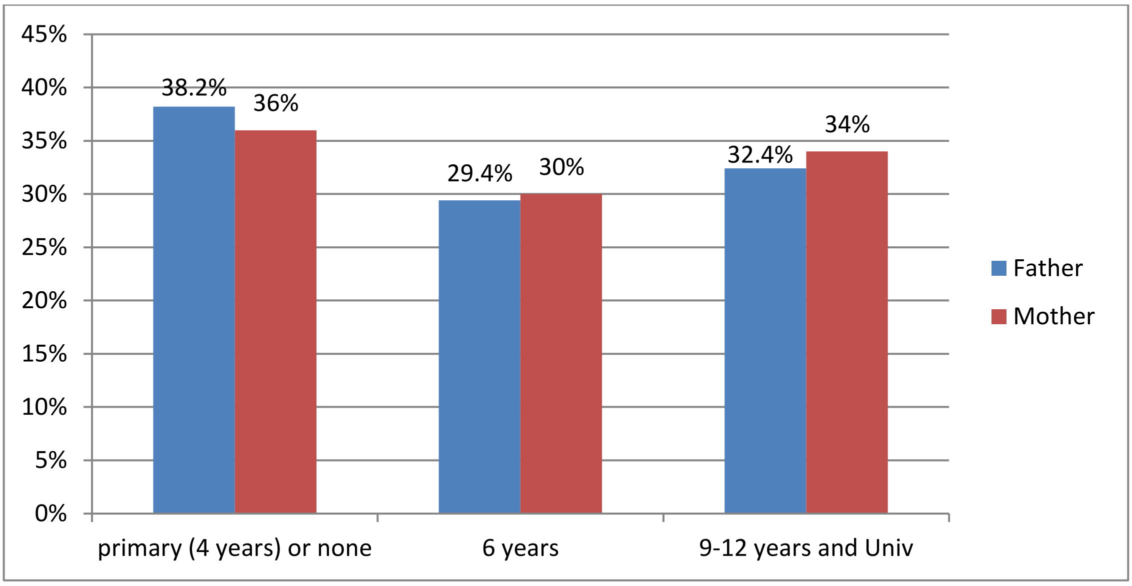

Figure 4. 4. Percentages of parental educational levels in Cape Verdean fathers (n =34) and mothers in 2013(n=50).

Parental education was divided into 3 categories by level attained by each parent: primary, 6 years and 9-12 years due to the sample's distribution. In almost all cases analysed (n=34) maternal education is higher than paternal education, although the overall differences in paternal and maternal education in the sample are small (Figure 4.4). The median values for educational level attained were 6 years for both mothers (30%) and fathers (29.4%) .

Consequently the majority of mothers and fathers who have low educational level (4 years), were employed in manual jobs like the service sector and were low paid unskilled workers (Table 4.3, Figure 4.5). However, when comparing non-manual categories fathers score higher (9.5%) compared to mothers (5.7%). Higher unemployment rates were found for fathers (45.2%) as opposed to mothers (32.1%) (Figure 4.5). No significant differences between mothers and fathers were found by level of education or occupational class.

Higher educational level for fathers had been obtained for Portuguese fathers (9-12 years,n=6, 18.2%) (Appendix D). For Cape Verdean and Portuguese mothers the same percentage of conclusion of 9-12 years (n=8, 16%) was found but more Portuguese mothers had higher education (Portuguese n=8, 16%, Cape Verdean n=5, 10%) compared to Cape Verdean ancestry.

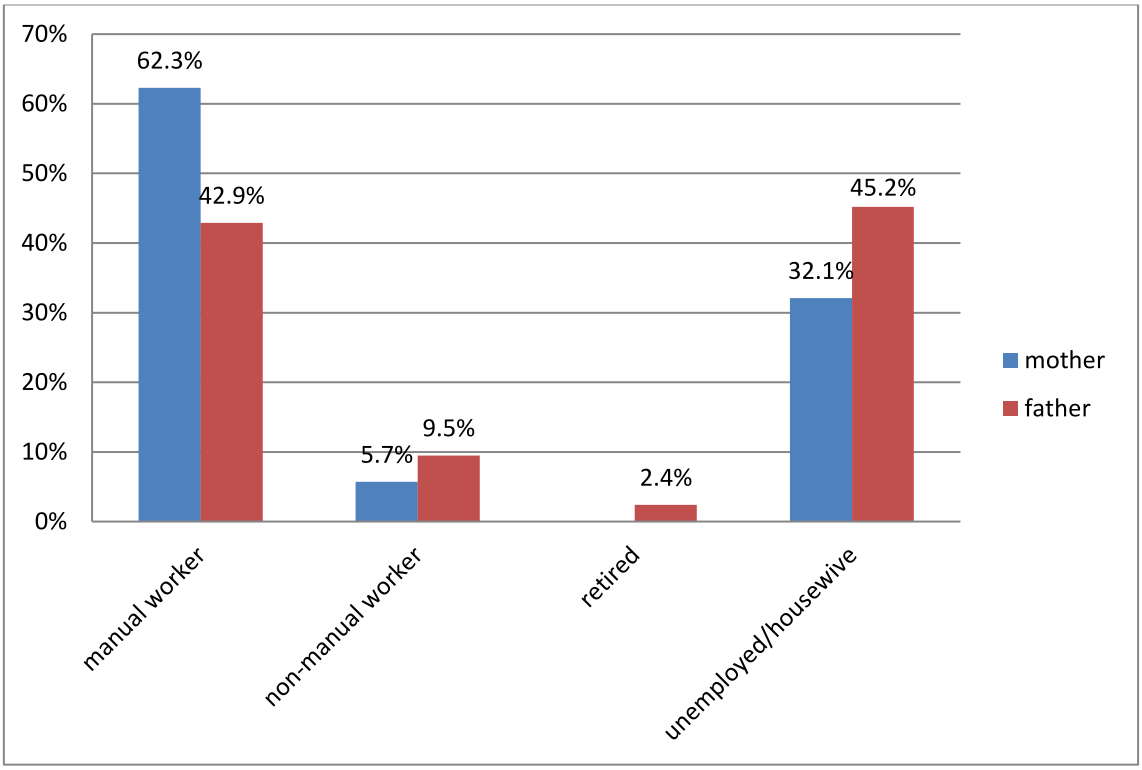

Figure 4. 5. Percentages of parental occupational classes on Cape Verdean mothers (n=53) and fathers (n=42) in 2013.

When breaking down occupation into more detailed categories, fathers occupy the higher categories with a few of them working as technicians (2.5%) and others clerical support workers (2.5%) and the majority as building workers (15%) and assemblers (5%) (Table 4.3). However mothers were mainly working in non skilled occupations like cleaners and helpers (43.1%), service and sales employees (19.6%) and van drivers (3.9%) (Table 4.3).

Table 4. 3. Detailed parental occupation based on job groups by ISCO for Cape Verdean mothers (n=42) and fathers (n=40) in 2013.

	Group	Mothers (%)	Fathers (%)
1	Managers	_	_
2	Professional	_	_
3	Technicians and associate professionals Aircraft controller and technicians	_	2.5
4	Clerical support workers	_	2.5
5	Service and sales workers Cooks, waiters, child care and other personal service worker	19.6	7.5
6	Skilled agricultural, forestry and fishery workers	_	_
7	Craft and related trade workers Handicraft and building workers	_	15
8	Plant and machine operators and assemblers Assemblers, car, van drivers	3.9	5
9	Elementary occupations Cleaners and helpers, construction labourers, food preparation assistants	43.1	17.5
10	Unemployed	33.3	50

Updated in 2011. INE Portugal. New Classifications Of Occupations – Portuguese Classification Of Occupations of 2010.ISCO : International Standard Classification of Occupations. Total sample size is composed of 82 parents.

A more detailed description of parental occupational class is shown in Table 4.4. Maternal occupational class was divided mainly betwen cleaners (48.72%) and personal care worker (10.26%) and waitress (15.38%). Moreover for fathers there was a wider range of occupations (Table 4.4). The highest being aircraft controller (2.5%) while the majority work in the construction sector (17.5%). Fathers worked on average more hours (M=38.92, SD=5.20, n=25) per week compared to mothers (M=35.14, SD=10.60, n=44) (data not shown, Appendix D).

Table 4. 4. Parental occupational class for Cape Verdean mothers and fathers in 2013.

Mother	n	%	Father	n	%
Casual work	2	5.13	Aircraft controller	1	2.5
Child care worker	1	2.56	Assembler	1	2.5
Cleaner	19	48.72	Building worker	2	5
Driver	2	5.13	Construction labourer	7	17.5
Food preparation assistant	3	7.69	Cook	1	2.5
Housewife	2	5.13	Handicraft worker	3	7.5
Personal care worker	4	10.26	Protective service work	1	2.5
Waitress	6	15.38	Public servant	1	2.5
			Waiter	2	5
			Retired	2	5
			Truck driver	1	2.5
Total	39	100		40	100

It is important to note that this information was self-reported and most mothers work in cleaning services, where weekly hours may be under evaluated. Moreover many mothers spend time commuting as they may leave the house several times during the day. This would affect time available for childcare, but would not be reported in working hours.

In this sample a high percentage of families have only one person supporting the household financially (57.9%, Table 4.5), although a third of them report that both parents were contributing to the household's economy (36.8%) and only 3 (5.3%) households reported both parents not bringing in income.

Table 4. 5. People with monetary income * living in Cape Verdean's households in 2013.

	n	%
None	3	5.3
One	33	57.9
Two	21	36.8
Total	57	100

* Calculated based on mother or father occupation, includes parents that are currently unemployed but are still getting benefits (unemployment <= 24 months);

4.1.3 Income and expenditure

Information on household income and expenditure by month and year was collected for the CVPT2013 database. Because of the low incomes of these households and also the uncertainty of the values each month categories are given comparing with the Portuguese minimum wage. The minimum wage in Portugal at the time of the sample collection (2013) was 485 € = approximately 370 £ (Source: PORDATA, conversion rate consulted on Banco de Portugal, 30-05-2016, https://www.bportugal.pt/).

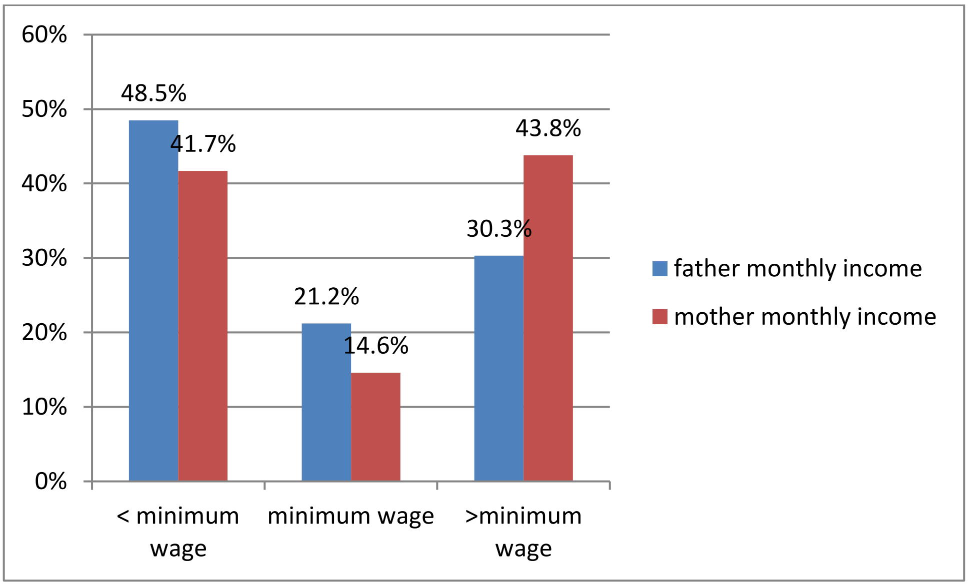

Figure 4. 6. Household monthly income distribution for Cape Verdean mothers (n=48) and fathers (n=33) in 2013.

A great proportion of the mothers and fathers have monthly income lower than minimum wage and also mothers are relatively the highest earners but still with only low incomes (Figure 4.6). Half of the mothers (n=20, 41.7%) reported earning less than minimum wage while another 21 reported making more than that. For fathers more reported earning less than minimum wage 48.5% (n=16) while 10 of them (30.3%) assumed earning more than that. In 55 of the households, total income ranged from 113.80£ (98.11€) to 517.28£ (445.97€) per month. Even though this is a wide variation half of the households had less than 431.07£ (500€) of income (Table 4.6).

Table 4.6 shows the difference between reported household income and expenditure. The income is higher than expenditure. The average household reported spending around 344.85£ (399.99€) per month while income (431.07£)(500€) was higher than Portuguese minimum wage (370£, 485 €).

The majority of the households reported yearly incomes below 7759.17£ (9000 €). Only 8 households reported earning between (7759.17-12931.95 £)(9000-15000 €). Comparing this figures with the Portuguese average income in 2013 which was 29.249€, this data shows the relative poverty affecting the Cape Verdean households in 2013 (PORDATA, 14-03-17).

Table 4. 6. Descriptive statistics on monthly income and expenditure (£) on Cape Verdean households.

	N	min	P25	median	P75	max	diff
Household expenditure	55	94.83	288.81	344.85	387.96	620.73	86.22
Household income	55	113.80	344.85	431.07	517.28	1034.56	

Rate of conversion on 2016-09-20 £1= 1,1599€ conversion rate consulted on Banco Portugal, 21-09-2016, https://www.bportugal.pt/)1 euro =0.8621

Table 4. 7. Household income and expenditure per year on Cape Verdean households in 2013.

	Year income	Percentage	Year Expenditure
< 9000 **€** (7759.17£)	47	85.7	
< 10 000 **€** (8621.3£)			55
9-15 000 **€** (7759.17-12931.95£)	8	14.3	
	55	100	

Categories in Table 4.7 were updated in 2013 before starting the fieldwork. The values were taken from the Portuguese Statistics Institute (INE, PORDATA) and correspond to the lowest categories determined by the IRS Table (the Portuguese equivalent to the British H & M revenue grades) on household income reflecting the low socioeconomic status of this community.

Apart from the household monthly income parents also reported receiving child benefit and social support to pay for meals and books at school. Most of the mothers were entitled to child benefit (91.5%, n=43 out of 60) while only 4 fathers reported receiving it (8.5%, n=4 out of 60).

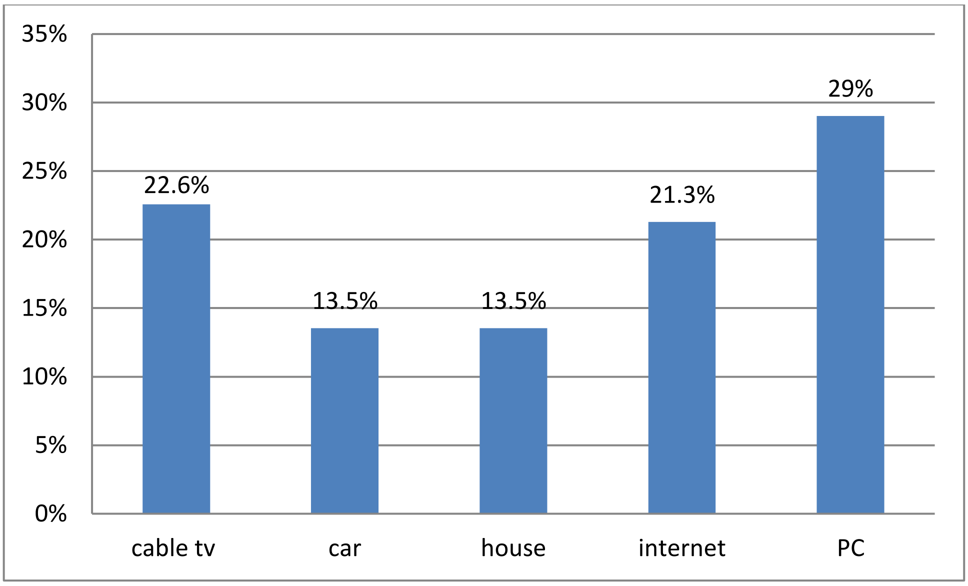

Figure 4. 7. Percentage of possession of household assets on Cape Verdean families in 2013 (n= 61).

Because this is a deprived neighbourhood data was collected on 5 main assets: car, house, Internet, personal computer and cable TV to supplement income and expenditure data. As it can be observed in Figure 4.7 the most common asset is the computer in 29% of the cases. To own a car or a house is only accomplished by just over a tenth of cases (13.5%). Comparing with Portuguese national scenario once again it can be observed the material deprivation in this sample of Cape Verdean households. For the Portuguese in 2010 52.3% had cable TV and in 2013 66.7% had a personal computer while 62.3% had Internet connection at home (INE, PORDATA, 14-03-2017).
The school seems to play an important role in this community. Most of the children have lunch at school (63, Appendix D) and 82.5% (n=52) of those meals are entirely paid for by the Portuguese government and 17.5%, (n=11) of those meals are subsidised by the Portuguese government.

4.1.4 Ethnic background (ancestry)

The majority of the families said they usually speak Portuguese at home (46.7%) as opposed to the 38.3% that confirmed they used both Portuguese and *Creole* (Figure 4.8). On the other hand only 15% of the households would only use *creole*. Furthermore Cape Verdean culture is still present in many households. Although most of the children were born in Portugal the majority keep in contact with relatives in Cape Verde and their culture through activities at local associations like *Moinho da Juventude* as observed while conducting fieldwork.

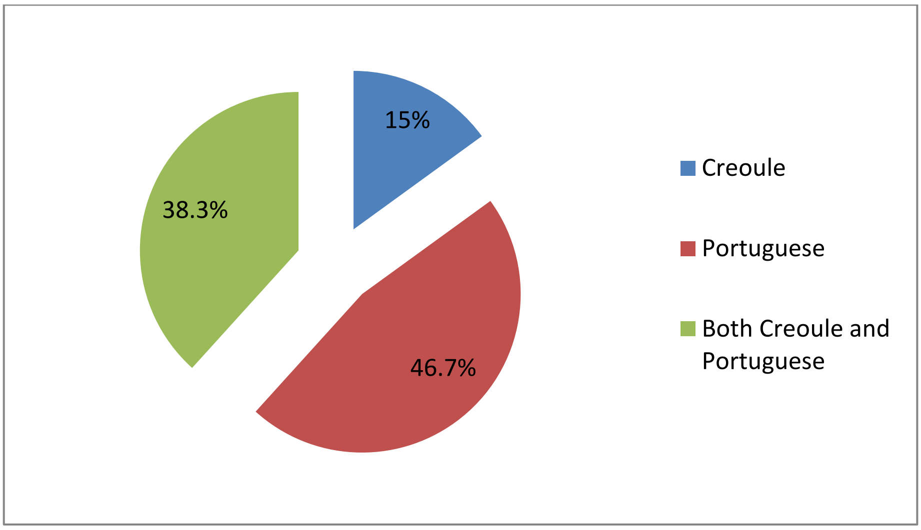

Figure 4. 8. Main language spoken at Cape Verdean households in 2013 (n=60).

More than 60% of the children have 4 grandparents born in Cape Verde (67.7%, n=42) (Appendix D). This means that both maternal and paternal lines have Cape Verdean ancestry. At least 17.7 %(n=11) of the children have 2 grandparents born in Cape Verde. A little over 4% reported having only one grandparent with Cape Verdean ancestry (4.8%, n=3). Many were living in Cape Verde or were already deceased. Half of the families (49.1%, 27) reported sending remittances (money or food items) to relatives in Cape Verde (Figure 4.9).

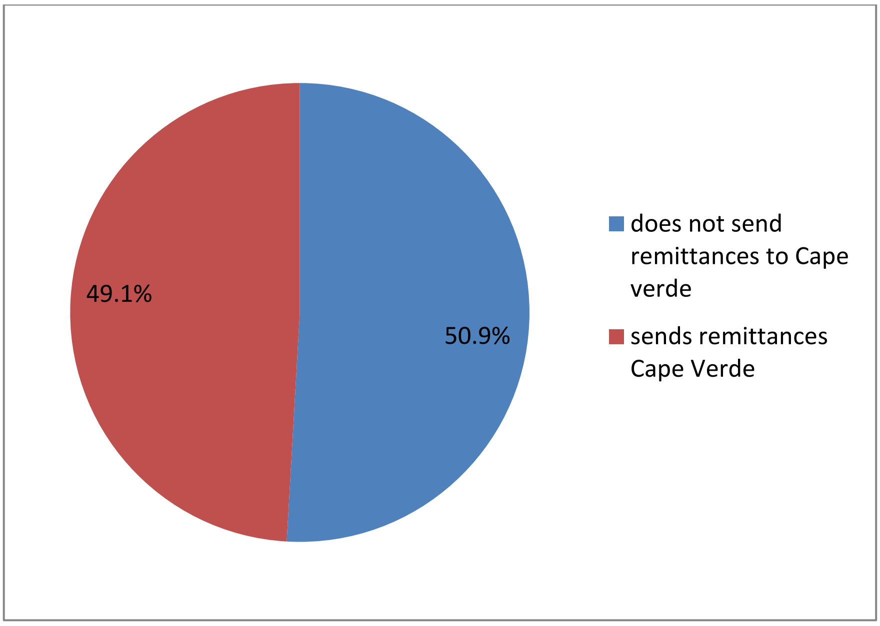

Figure 4. 9. Percentages of Cape Verdean families sending remittances in 2013 (n =55).

Most of the parents who were not born in Portugal arrived in Portugal 12-13 years ago that means between 2004-2006, just before the economic crisis (2008) (Appendix D). Mothers have been living in Portugal from mean age of 13.37 years (SD=7.63, n=46) and for fathers 13.22 years (SD=8.85, n=23).

For parents born in Cape Verde they are mainly from urban centres of Santiago, the main island in Cape Verde archipelago, and also where the capital city is located. A small percentage is from Angola or São Tomé and Príncipe, also ex-colonies from Portugal and Portuguese speaking countries. The majority of the mothers were born in Cape Verde's main island (57.4%), Santiago, while 9 (16.7%) were born in another island (Table 4.9). For fathers, 29 of them were born in Santiago island (60.4 %,) while 9 (18.8%) were born in another island. Within the group of parents that was born in Portugal the majority are natives of the Lisbon area (Figure 4.10, fathers 18.8% and mothers 22.2%). Nearly half of mothers have Portuguese nationality (45.9%) while 27 of them (44.3%) have Cape Verdean nationality (Table 4.8). A small percentage was born in another Portuguese speaking country (9.8%). With regards to fathers 30.4% have Portuguese nationality and 57.1% Cape Verdean. Again a small percentage of them were born in another Portuguese speaking country (12.5%).

Table 4. 8. Parental birth country and nationality distribution for Cape Verdean parents in 2013.

Parental birth country			Parental nationality		
Mother	n	%	Mother	n	%
Portugal	12	22.2	Portugal	28	45.9
Cape Verde (other)	9	16.7	Cape Verde	27	44.3
Capital Cape Verde	31	57.4			
Other country	2	3.7	Other country	7	9.8
Total	54	100		61	100
Father	n	%		n	%
Portugal	9		Portugal	17	30.4
Cape Verde (other)	9	45.9	Cape Verde	32	57.1
Capital Cape Verde	29	44.3			
Other country	1	9.8	Other country	7	12.5
Total	48	100		56	100

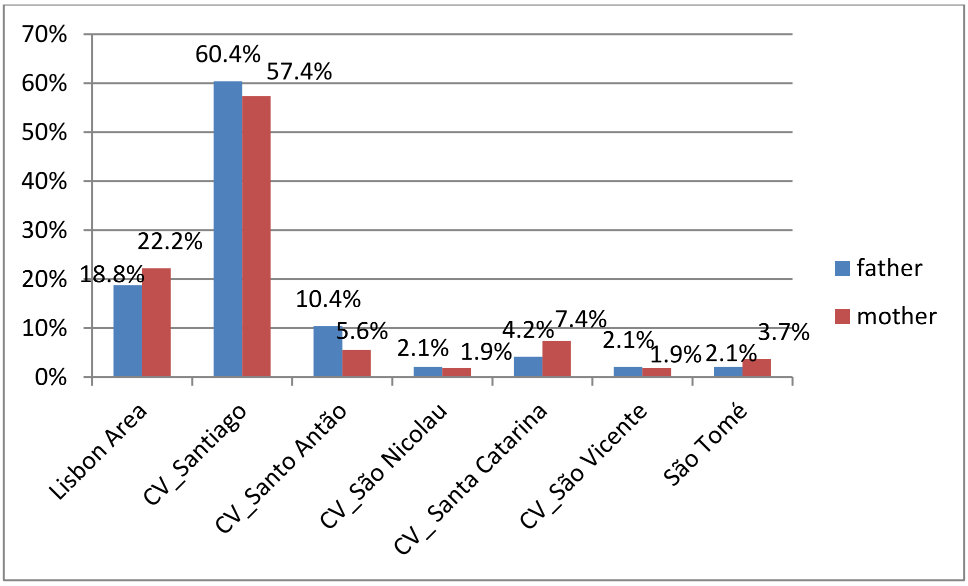

Figure 4. 10. Paternal birth place for Cape Verdean fathers (n=49) and mother (n=55) reported in 2013.

The important role of the local institutions and family connections is seen on the main carers for after school hours. More than a quarter of the mothers (32.5%) reported leaving their children in the care of relatives while 45% used local institutions. Only a small proportion of the children were looked after by their father/ mother (12.5%) and 2 of them by a friend or neighbour (Table 4.9).

Table 4. 9. After school child care at Cova da Moura neighbourhood in 2013.

		n	%
	No one	2	5.0
	Relatives	13	32.5
	Institutions	18	45
	Mother/father	5	12.5
	Neighbour/friend	2	5.0
	Total	40	100

4.2 Early life factors

In this section some early life factors are displayed for the CVPT2013 database (Table 4.10). These were considered the most influential for this population based on previous findings identified in the literature review and will be used in subsequent analyses in the following chapters. The n values are lower than on the previous sections because they account for only first born in Portugal and their biological mothers excluding siblings used in chapter 5. Gestational age (weeks) and birth weight (grams) were collected based on the child's red book which is an informative document given to mothers when their child is born. It also contains information filled in by health care workers, on child's height, weight and head circumference from birth onwards. Breastfeeding and birth order were self-reported by the mothers.

The majority of the children were born with normal birth weight (2.500-4.000 kilograms). More than 10% were low birth weight babies (n=6, 13%) and 1 was high birth weight (2.2%). Mean birth weight was 3.0574kg (n=46) and 25% of the babies were born with a birth weight of at least 3.440 kg. Most of the children were term babies (77.8%) with 22.2% (n=10) pre-term. Mean gestational age was 39.71 weeks (Appendix D) and there was no post-term baby. No statistical differences were found for sexual dimorphism. However mean values for birth weight for boys was 3.127 (SD=0.41, n=21) and for girls 2.999 grams (SD=0.52, n=25). Birth spacing was higher for boys (M=68.14 SD=47.68, n=21) compared to girls (M=42.16, SD=30.60, n=19). Higher incidence of pre-term babies was found for boys (n=6, 28.6%) as opposed to girls (n=4, 16.7%).

Approximately a third of children had more than 2 siblings (31.9%, n=15). Most of the mothers reported having breastfed their baby for more than 6 months (64.4%,n= 29) and only 7 of them did not breastfed their babies at all (15.6%, n=7). Cape Verdean mothers breast-feed from 3 to 17 months and 25% of the mothers reported breastfeeding for more than a year (17 months) (Appendix D).

Children's health conditions reported by the mothers ranged from asthma to anaemia. In fact 4 children had been diagnosed with asthma, 3 with anaemia and 2 with other respiratory diseases.

Table 4. 10. Early life factors observed in the 2013 sub- sample.

Variable				Girls		Boys	
		n	%	n	%	n	%
Gestational age							
	Pre-term	10	22.2	4	16.7	6	28.6
	Term	35	77.8	20	83.3	15	71.4
	Total	45	100	24	100	21	100
Birth weight							
	Low BW	6	13	4	16	2	9.5
	Normal BW	39	84.8	20	80	19	90.5
	High BW	1	2.2	1	4	0	0
	Total	46	100	25	100	21	100
Birth order							
	≤ 3 child	9	20.0	4	16.7	5	23.8
	> 3 child	36	80.0	20	83.3	16	76.9
	Total	45	100	24	100	21	100
Breastfeeding							
	Not breastfed	7	15.6	4	16	3	15
	< 6 months	9	20.0	5	20	4	20
	> 6 months	29	64.4	16	64	13	65
	Total	45	100	25	100	20	100

4.3 Nutritional status of Cape Verdean children (CVPT2013) ancestry assessed by anthropometry

This section will focus on nutritional status of Cape Verdean ancestry children measured in 2013/2014 (CVPT2013) compared to international growth standards. First descriptive information on children’s physical growth and body fat composition is presented. Subsequently malnutrition rates are compared with international growth references.

4.3.1 Descriptive information on Nutritional status of Cape Verdean ancestry children (2013)

Descriptive statistics of the measured and derived anthropometric variables of children by age and sex are provided (Tables 4.11 and 4.12). Significant differences between boys and girls in the measures are denoted and the explanation for the acronyms can be found on the lower part of the tables.

Table 4. 11. Decimal age distribution for Cape Verdean ancestry children in 2013 by sex (Mean± SD).

	Boys			Girls			All		
Age (years)	n	Mean ±SD		n	Mean ±SD		n	Mean ± SD	
6.00-7.99	16	7.22	0.46	21	7.26	0.65	37	7.24	0.57
8.00-9.99	16	8.86	0.48	18	9.06	0.54	34	8.97	0.52
10.00-11.99	9	10.77	0.42	9	10.70	0.62	18	10.73	0.51
Total	41	8.64	1.43	48	8.58	1.44	89	8.61	1.43

SD: Standard Deviation

Table 4. 12.Decimal age distribution for Cape Verdean ancestry children in 2013 by sex (Median± IQR).

	Boys			Girls			All		
Age (years)	n	Median	IQR	n	Median	IQR	n	Median	IQR
6.00-7.99	16	7.00	6.25-7.00	21	7.00	6.00-7.00	37	7.00	6.00-7.00
8.00-9.99	16	8.00	8.00-9.00	18	9.00	8.00-9.00	34	8.00	8.00-9.00
10.00-11.99	9	10.00	10.00-11.00	9	10.00	10.00-10.50	18	10.00	10.00-11.00
Total	41	8.00	7.00-9.00	48	8.00	7.00-9.00	89	8.00	7.00-9.00

Data not normally distributed; Median and Interquartile Range are shown (IQR)

The age range is from 6 to 12 years old and that means that the older children were born in 2003 and the youngest in 2010. The age distributions were similar for boys and girls with no significant difference between the genders. In total there are 41 boys and 48 girls accounting for 89 participants between 6 to 12 years old of Cape Verdean ancestry (Tables 4.11, 4.12). Most of the participants are aged 6.00-9.99 years (54.9% girls, 45.1% boys).

4.3.1.1 Linear Growth

Mean height increases with age for both sexes (Table 4.13). Boys are taller than girls except for the last category (10-12 years). Despite the differences not being significant between the two sexes it can be seen that for girls the increase is bigger during the first years analysed (6-8 and 8-10 years). Similarly boys show a small increase from 8-10 to 10-11 years old and greater increase from 10 to 12 years old. Sexual dimorphism was only found for sitting height ratio (SHR) and relative leg length (RLLI) on all age ranges and the 8-10 year old interval (Table 4.13).

Boys showed higher leg length measurements and lower sitting height compared to girls (non-significant). 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 and gender. Sitting height ratio (SHR) X^2 (1, 89) = 3.968, p≤0.05) was significantly higher for girls (Median=52.40 interquartile (25-75%) =51.76-53.89), compared with boys (Median=51.99 interquartile (25-75%) =51.13-52.90). Relative leg length index (RLLI) X^2 ((1, 89) =3.968, p≤0.05) median was higher for boys (Median=48.01 interquartile (25-75%) =47.10-48.87) compared with girls (Median=47.60 interquartile (25-75%) =46.11-48.24). In the 8 to 10 year age range SH ratio X^2 (1, 34) = 4.005, p≤0.05) was higher for girls (Median=52.98 interquartile (25-75%) =51.61-53.82) compared to boys (Median=51.70 interquartile (25-75%) =50.36-52.75). In the same age range but for RLLI the inverse relation was found X^2 (1, 34) = 4.005, p≤0.05) with boys showing higher values (Median=48.30 interquartile (25-75%) =47.25-49.65) than girls (Median=47.02 interquartile (25-75%) =46.18-48.39).

Table 4. 13. Descriptive values (Mean/median [a] ±SD/IQR [b]) for linear growth measures according to sex and age for Cape Verdean ancestry children in 2013.

Age (years)		Height (cm)		SH[1] (cm)		SHR[2] (%)		LL[3] (cm)		RLLI[4] (%)	
	n	Mean	SD	Mean	SD	Median	IQ	Mean	SD	Median	IQ
Boys all	41	134.25	9.76	69.55	4.85	***51.99***	***51.13-52.90***	64.70	6.12	***48.01***	***47.10-48.87***
6.00-7.99	16	126.91	5.12	66.55	2.39	52.33	51.66-53.10	60.36	3.11	47.66	46.90-48.31
8.00-9.99	16	136.94	8.00	70.02	5.01	***51.70***	***50.36-52.75***	66.93	5.90	***48.30***	***47.25-49.65***
10.00-11.99	9	142.50	10.40	74.03	4.35	51.65	51.04-52.93	68.47	6.34	48.35	47.07-48.96
Girls all	48	131.28	9.96	69.00	5.10	***52.40***	***51.76-53.89***	62.27	5.55	***47.60***	***46.11-48.24***
6.00-7.99	21	123.94	6.99	65.17	3.08	52.84	51.35-54.13	58.76	4.89	47.15	45.87-48.65
8.00-9.99	18	134.12	7.54	70.62	4.31	***52.98***	***51.61-53.82***	63.51	4.28	***47.02***	***46.18-48.39***
10.00-11.99	9	142.70	5.75	74.71	2.90	52.26	51.77-52.67	67.99	3.16	47.74	47.33-48.23
Total	89	132.64	9.92	69.25	4.97	52.26	51.43-53.21	63.39	5.91	47.74	46.79-48.57

[1]SH: sitting height, [2]SHR: sitting height ratio (sit height*100/height), [3]LL: leg length (height-sit height); [4]RLLI: relative leg length index (leg length*100/height); ***Bold and italic:*** significant differences for p<0.05 on independent Student's t-test; a Mean/ SD are presented where the data were normally distributed and T-student test applied and [b] median/ IQR are presented where the data were non-normally distributed and the Kruskal-Wallis rank sum test was applied.

Table 4.14 shows mean values for Z-scores for HFA, SHA, and LLA. No significant differences were found for any of these measures between boys and girls. Negative values can be observed for SH for age for boys. Height for age mean is negative for boys and girls at ages 10-12 years. Moreover for boys it can be observed that SH for age is also negative at all ages. For boys and girls LL for age is negative at 10-12 years old. For girls mean values for LLA are also negative for all ages.

Table 4. 14. Descriptive values (Mean/median[a] ±SD/IQR[b]) for linear growth Z-score measures according to sex and age for Cape Verdean ancestry children in 2013.

Age (years)		Height-for-age		SH-for-age[5]		LL-for-age[6]	
	n	Mean	SD	Mean	SD	Mean	SD
Boys all	41	0.58	1.05	-0.03	1.05	0.02	1.14
6.00-7.99	16	0.77	0.78	0.25	0.67	0.14	0.73
8.00-9.99	16	0.76	1.01	-0.14	1.29	0.27	1.26
10.00-11.99	9	-0.08	1.37	-0.32	1.13	-0.63	1.38
Girls all	48	0.12	0.90	0.38	0.94	-0.12	0.90
6.00-7.99	21	0.29	0.93	0.43	0.97	0.11	0.97
8.00-9.99	18	0.09	0.82	0.48	0.95	-0.23	0.83
10.00-11.99	9	-0.21	0.96	0.14	0.89	-0.43	0.83
Total	89	0.33	1.00	0.19	1.00	-0.06	1.02

[5]SHFA: sitting height-for-age, [6]LLZ: Z-score leg length for age; ***Bold and italic***: significant differences for $p<0.05$ on independent Student's t-test; [a] Mean/ SD are presented where the data were normally distributed and T-student test applied and [b] median/ IQR are presented where the data were non-normally distributed and the Kruskal-Wallis rank sum test was applied. Frisancho Comprehensive reference (2008) by sex and age z-score.

4.3.2.2 Body composition

Child body composition measurements are presented in Tables 4.15 and 4.16. These include weight, BMI, arm and waist circumference and respective Z-score values. Subsequently mean values for fat deposition measurements presented include skinfold measurements of the triceps, biceps, abdominal and subscapular areas as well as the sum of 2 (triceps and subscapular skinfold) and sum 4 (triceps, biceps, subscapular, abdominal) skinfolds in Tables 4.17 and 4.18.

No significant differences between boys and girls were found for weight, BMI, arm and waist circumference. For boys and girls, mean arm and waist circumference, weight and BMI increases with age (Table 4.15). Weight is always higher for boys except for the 10 to 12 year age range. However, girls show higher arm and waist circumferences except for the 8 to 9 year interval for waist circumference.

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Table 4. 15. Descriptive values (Mean/median [a] ±SD/IQR [b]) for body composition measures according to sex and age for Cape Verdean ancestry children in 2013.

Age (Years)		Weight (kg)		BMI[7]		AC[8] (cm)		WC[9] (cm)	
	n	Median	IQ	Median	IQ	Median	IQ	Median	IQ
Boys all	41	28.60	24.95-31.80	15.73	15.07-17.28	19.00	17.85-21.10	57.40	53.83-59.63
6.00-7.99	16	25.60	22.90-27.35	15.62	14.89-16.19	18.33	17.55-19.56	54.40	52.25-58.13
8.00-9.99	16	30.10	25.83-34.38	15.76	15.18-17.30	20.25	18.05-21.48	57.40	52.80-60.60
10.00-11.99	9	32.80	29.25-39.55	15.93	14.98-18.20	20.50	17.95-22.60	58.30	56.60-63.75
Girls all	48	26.95	23.83-35.30	16.22	15.37-17.81	19.50	18.00-21.88	56.00	53.00-61.15
6.00-7.99	21	23.90	22.05-27.15	15.53	14.81-17.32	18.50	17.35-20.40	53.70	52.90-60.93
8.00-9.99	18	29.80	25.56-36.03	16.54	15.48-17.68	20.75	18.80-21.62	56.10	53.13-58.45
10.00-11.99	9	34.70	30.70-43.95	16.56	15.66-20.70	20.20	18.75-24.85	62.20	54.00-66.15
Total	89	27.40	24.25-34.05	15.93	15.32-17.34	19.50	17.95-21.50	57.00	53.00-60.00

[7]BMI: body mass index (weight (kg) /height (metres) ^{2}), [8]AC: arm circumference (centimetres), [9]WC: waist circumference (centimetres); ***Bold and italic***: significant differences for p<0.05 on independent Student's t-test; [a] Mean/ SD are presented where the data were normally distributed and T-student test applied and [b] median/ IQR are presented where the data were non-normally distributed and the Kruskal-Wallis rank sum test was applied.

Table 4. 16. Descriptive values (Mean/median [a] ±SD/IQR [b]) for body composition Z-score measures according to sex and age for Cape Verdean ancestry children in 2013.

Age (Years)		Weight-for-age		BMI-for-age[10]		AC-for-age		WC-for-age	
	n	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Boys all	41	-0.25	0.63	-0.05	0.66	-0.54	0.71	-0.15	0.50
6.00-7.99	16	-0.06	0.47	***0.15***	***0.04***	-0.45	0.59	0.01	0.43
8.00-9.99	16	-0.25	0.66	-0.10	0.75	-0.52	0.77	-0.16	0.52
10.00-11.99	9	-0.59	0.73	-0.31	0.76	-0.74	0.83	-0.32	0.52
Girls all	48	0.05	0.77	0.16	0.80	0.50	0.90	0.17	0.68
6.00-7.99	21	0.22	0.83	***0.29***	***0.83***	0.62	1.00	0.51	0.70
8.00-9.99	18	-0.07	0.70	0.08	0.74	0.51	0.75	0.04	0.61
10.00-11.99	9	-0.14	0.80	0.01	0.88	0.18	0.92	-0.07	0.64
Total	89	-0.09	0.72	0.06	0.74	0.02	0.96	0.03	0.62

[10]BMI-for-age: body mass index (weight (kg) /height (metres)^2 for-age), AC: arm circumference (centimetres), WC: waist circumference (centimetres); ***Bold and italic***: significant differences for $p<0.05$ on independent Student's t-test; [a] Mean/ SD are presented where the data were normally distributed and T-student test applied and [b] median/ IQR are presented where the data were non-normally distributed and the Kruskal-Wallis rank sum test was applied. Frisancho Comprehensive reference (2008) by sex and age z-score.

In Table 4.16 mean values for Z-scores are presented for WFA, BMI, AC and WC for age. It can be observed that boys have negative WFA scores as well as AC for age for all age intervals. The same is observed for BMI and WC with the exception of the 6 to 8 year age range. Significant differences were found for Z-score BMI in this age interval. A significant t-test for independence of samples showed that in the 6 to 8 year olds BMI Z-score for girls was significantly higher (M= 0.2947, SD=0.83) than boys (M=0.1499, SD=0.47),t(37)= 4.190, p<0.05 . A decrease in WFA values is observed for girls in the 8 to 12 year age range. For all sexes Z-score values are lower at the higher age ranges.

Table 4.17 shows mean values for fat deposition measures. Significant differences were found for all measurements with a Kruskal-Wallis rank sum test using a Chi-square statistic of independence. For all age ranges triceps skinfold X^2 (1, 89) = 18.788, p≤0.01) was significantly higher for girls (Median=10.30 interquartile (25-75%) =8.20-13.84), compared with boys (Median=7.10 interquartile (25-75%) =6.15-10.50). Subscapular skinfold X^2 (1, 89) = 14.883, p≤0.01) was significantly higher for girls (Median=6.30 interquartile (25-75%) =5.10-8.95), compared with boys (Median=4.60 interquartile (25-75%) =4.05-6.25). Biceps skinfold X^2 (1, 89) = 17.332, p≤0.01) was significantly higher for girls (Median=5.90 interquartile (25-75%) =4.44-7.53), compared with boys (Median=4.00 interquartile (25-75%) =3.30-5.10). Abdominal skinfold X^2 (1, 89) = 20.942, p≤0.01) was significantly higher for girls (Median=10.00 interquartile (25-75%) =7.10-15.00), compared with boys (Median=5.4 interquartile (25-75%) =4.30-8.60). The sum of 2 skinfolds X^2 (1, 89) = 19.251, p≤0.01) was significantly higher for girls (Median=16.25 interquartile (25-75%) =13.03-22.55), compared with boys (Median=11.40 interquartile (25-75%) =10.10-16.80). The sum of 4 skinfolds X^2 (1, 89) = 19.141, p≤0.01) was significantly higher for girls (Median=32.20 interquartile (25-75%) =24.81-44.08), compared with boys (Median=19.80 interquartile (25-75%) =17.80-32.03). For 6 to 8 year olds and 8 to 10 years old all skinfolds measures were significantly higher for girls compared with boys. However the same is not verified for the latter age group (10-12 years old).

Table 4. 17. Descriptive values (Mean/median [a] ±SD/IQR [b]) for fat deposition measures according to sex and age for Cape Verdean ancestry children in 2013.

Age (years)		TRCsk (mm)		SUBsk(mm)		ABDsk (mm)		BCsk (mm)		SUM2sk (mm)		SUM4sk (mm)	
	n	Median	IQ	Median	IQ	Median	IQ	Median	IQ	Median	IQ	Median	IQ
Boys all	41	***7.1***	***6.15-10.50***	***4.60***	***4.05-6.25***	***5.4***	***4.30-8.60***	***4.00***	***3.30-5.10***	***11.40***	***10.10-16.80***	***19.80***	***17.80-32.03***
6.00-7.99	*16*	***6.55***	***5.88-8.45***	***4.30***	***4.00-5.38***	***4.45***	***4.05-5.74***	***3.98***	***3.13-4.78***	***10.70***	***9.80-14.13***	***18.83***	***17.33-25.48***
8.00-9.99	16	***7.43***	***6.43-11.33***	***4.75***	***4.2-6.25***	***6.30***	***4.56-10.50***	***4.05***	***3.74-6.13***	***12.50***	***10.55-18.09***	***22.80***	***18.65-33.11***
10.00-11.99	9	7.40	5.75-12.20	4.70	4.18-7.65	7.30	5.10-11.75	3.70	3.30-6.20	12.10	9.93-19.85	23.10	17.75-36.10
Girls all	48	***10.30***	***8.20-13.84***	***6.30***	***5.10-8.95***	***10.00***	***7.10-15.00***	***5.90***	***4.44-7.53***	***16.25***	***13.03-22.55***	***32.2***	***24.81-44.08***
6.00-7.99	*21*	***9.00***	***7.95-12.90***	***6.00***	***4.50-8.80***	***8.63***	***7.10-12.28***	***5.30***	***4.30-7.65***	***14.70***	***12.68-21.28***	***29.00***	***23.63-40.15***
8.00-9.99	18	***10.63***	***8.75-13.28***	***6.40***	***5.40-8.41***	***10.03***	***7.08-12.30***	***6.00***	***4.51-7.19***	***17.55***	***14.15-21.76***	***33.95***	***27.35-41.83***
10.00-11.99	9	14.00	8.90-19.50	6.60	5.25-9.35	14.00	7.25-23.50	6.10	4.75-11.45	19.20	14.50-28.58	36.56	27.50-63.53
Total	89	9.00	6.75-12.15	5.50	4.40-7.50	7.55	5.20-11.35	4.90	3.90-6.55	14.60	11.25-19.65	27.15	19.70-36.73

SUBsk: subscapular skinfold (mm); TRCsk: triceps skinfold (mm); BCsk (mm): biceps skinfold; SUM2sk : sum of triceps and subscapular skinfold (mm); SUM4sk: triceps, biceps, abdominal, subscapular (mm), ***Bold and italic*** : significant differences for $p<0.05$ on independent Student's t-test; [a] Mean/ SD are presented where the data were normally distributed and T-student test applied and [b] median/ IQR are presented where the data were non-normally distributed and the Kruskal-Wallis rank sum test was applied.

Table 4. 18. Descriptive values (Mean/median [a] ±SD/IQR [b]) for Z-score fat deposition measures according to sex and age for Cape Verdean ancestry children in 2013.

Age (years)		TRCZ		SUBZ		ABDZ		Sum2skZ	
	n	Median	IQ	Median	IQ	Mean	SD	Mean	SD
Boys all	41	***-0.42***	***-0.82 to 0.34***	***-0.50***	***-0.72 to 0.16***	0.01	0.45	-0.58	0.61
6.00-7.99	*16*	-0.39	-0.67 to 0.17	-0.53	-0.71 to 0.03	0.12	0.34	***-0.61***	***0.42***
8.00-9.99	16	-0.38	-0.81 to 0.46	-0.38	-0.66 to 0.22	0.00	0.49	-0.46	0.59
10.00-11.99	9	-0.67	-1.25 to 0.37	-0.68	-0.94 to 0.30	-0.18	0.55	-0.73	0.91
Girls all	48	***-0.01***	***-0.43 to 0.56***	***-0.19***	***-0.49 to 0.28***	0.44	0.71	0.09	0.71
6.00-7.99	*21*	0.14	-0.44 to 0.73	0.11	-0.51 to 0.57	0.56	0.76	***0.16***	***0.83***
8.00-9.99	18	0.03	-0.41to 0.46	-0.19	-0.45 to 0.33	0.40	0.67	0.05	0.60
10.00-11.99	9	0.38	-0.48 to 1.06	-0.48	-0.72 to 0.14	0.22	0.70	-0.01	0.68
Total	89	-0.22	-0.56 to 0.42	-0.31	-0.64 to 0.17	0.24	0.64	-0.22	0.74

TRCZ: Z-score triceps skinfold; SUBZ: Z-score subscapular skinfold; *ABDZ*: Z-score abdominal skinfold; Sum2skZ: Z-score sum 2 (triceps+ subscapular) skinfolds; ***Bold and italic***: significant differences for p<0.05 on independent Student's t-test; [a] Mean/ SD are presented where the data were normally distributed and T-student test applied and b median/ IQR are presented where the data were non-normally distributed and the Kruskal-Wallis rank sum test was applied. Frisancho Comprehensive reference (2008) by sex and age z-score.

Table 4.18 shows mean/median values for Z-score skinfold measures. Significant differences were found between boys and girls for 6-8 years for Z-scores for the sum of 2 skinfolds. Significant T-tests for independence of samples showed that the Z-score sum of 2 skinfolds for girls was significantly higher (M= 0.16243, SD=0.833) for boys (M=-0.60625, SD=0.417), t (37) = 5.537, p<0.05). Significant differences were also found for Z-scores for triceps and subscapular skinfolds with a Kruskal-Wallis rank sum test using a Chi-square statistic of independence. For all age ranges the Z-score for triceps skinfold X^2 (1, 89) = 6.744, p≤0.01) was significantly higher for girls (Median=-0.01 interquartile (25-75%) =-0.43 to 0.56), compared with boys (Median=-0.42 interquartile (25-75%) =-0.82 to 0.34). For all age ranges the Z-score for subscapular skinfold X^2 (1, 89) = 6.744, p≤0.01) was also significantly higher for girls (Median=-0.19 interquartile (25-75%) =-0.49 to 0.28), compared with boys (Median=-0.50 interquartile (25-75%) =-0.72 to 0.16).

The same trend observed for direct measures (Table 4.17) is observed for boys and negative values for Z-scores for triceps, subscapular and the sum of 2 skinfolds are observed. For girls this trend was only observed in total for subscapular and triceps skinfolds.

4.3.2.3 Nutritional status indicators

Significant differences were found when classifying children's weight and height based on different cut-off points from the World Health Organization (WHO), the Centre for Diseases Control (CDC) and the International Obesity Task force (IOTF) (Table 4.19). The under nutrition rates are low when compared with all the cut off points while the OW/OB rates vary according to the standards used. This sample displays a relatively healthy nutritional status. Where cases of malnutrition do exist (Table 4.19), boys are more commonly affected by under nutrition (only 2 stunted and 2 underweight) than girls while girls show higher rates for overweight and obesity (6 and 2 respectively). None of the boys is obese.

Table 4. 19. Nutritional status indicators for Cape Verdean ancestry children in 2013.

Classification	References			
	WHO	CDC	IOTF	*p-value*
Stunting	0	3.4(3)	N/AV	-------
Underweight	1.1(1)	2.2(2)	1.1	p<0.001
Normal weight	96.6 (86)	84.3(75)	85.4(76)	p<0.001
Overweight	2.2(2)	11.2(10)	11.2(10)	p<0.001
Obese	0	2.2(2)	2.2(2)	p<0.001
Boys				
Stunting	0	4.9(2)	N/AV	
Underweight	2.4(1)	4.9(2)	2.4(1)	
Normal weight	97.6(40)	87.8(36)	87.8(36)	
Overweight	0	7.3(3)	9.8(4)	
Obese	0	0	0	
Girls				
Stunting	0	2.1(1)	N/AV	
Underweight	0	0	0	
Normal weight	95.8(46)	81.3(39)	83.3(40)	
Overweight	4.2(2)	14.6(7)	12.5(6)	
Obese	0	4.2(2)	4.2(2)	

N/AV: Non- available reference for this category.

When analysing classification of children with height-for-age (HFA), leg length-for-age (LLFA) and sitting-height-for-age (SHFA) categories the same trend can be observed. A small percentage of children are on the low ranges (2) for sitting height and 2 for leg length and the majority are in the healthy percentile ranges (73.2% for boys HFA) (Table 4.20). However a considerable percentage of Cape Verdean boys is positioned in the high extreme either by height-for-age (12.2%), sitting height for age (9.8%) or leg length for age (7.3%).

When using weight, BMI for age most of the children are in the normal range and a small percentage are defined as over nourished (e.g. 4.9%, boys, WFA) (Table 4.20). Even when a different cut-off point for waist circumference (Fernandez and collaborators 2004) was applied the same result is obtained (only 4 children with WC higher than 75th percentile (see methods, Table 4.20). Moreover only 4 of the 75 children would be at risk of developing future CVD based on their waist-to-height ratio according to McCarthy and collaborators cut-off points (5.3%) (Table 4.21).

Table 4. 20. Distribution of percentages (%) according to HFA, LL and SH categories for Cape Verdean ancestry children in 2013.

CVPT2013	Boys					Girls				
Indicator	HFA	SHFA	LLFA	WFA	BMIFA	HFA	SHFA	LLFA	WFA	BMIFA
Low (< 5th)	2.4(1)	4.9(2)	4.9(2)	4.9(2)	2.4(1)	0	2.1(1)	0	0	0
Below average (5-15th)	2.4(1)	4.9(2)	7.3(3)	--	--	8.3(4)	6.3(3)	16.7(8)	--	--
Healthy (15.1- 85th)	65.9(27)	80.5(33)	73.2(30)	92.7(38)	95.1(39)	75(36)	68.8(33)	68.8(33)	89.6(43)	85.4(41)
Above average (85.1-95th)	17.1(7)	0	7.3(3)	2.4(1)	2.4(1)	12.5(6)	16.7(8)	12.5(6)	6.3(3)	10.4(5)
Excessive (>95th)	12.2(5)	9.8(4)	7.3(3)	0	0	4.2(2)	6.3(3)	2.1(1)	4.2(2)	4.2(2)

HFA: Height-for-age; SHFA: sitting height-for-age; LLFA: leg length-for-age; WFA: Weight-for-age; BMIFA: BMI-for-age. Indicator on percentiles (5th, 15th, 85th, 95th percentile) classification proposed by Frisancho Comprehensive reference (2008); percentages and (frequencies) presented.

Table 4. 21. Waist circumference classification (Fernandez et al 2004) and Waist-height ratio risk of cardiovascular diseases for child (McCarthy & Ashwell 2006).

Waist circumference (cm)		
	n	%
< 10th percentile	13	17.3
10-75th percentile	56	74.7
75-90th percentile	4	5.3
> 90th percentile	2	2.7
Total	75	100
Waist-to-Height ratio		
	n	%
No risk	71	94.7
At risk	4	5.3
Total	75	100

Based on leg length values proposed by Frisancho 2008 the majority of the children in this sample have normal leg length (70.8%, Table 4.22). The rest of the sample is divided between low (14.6%) and high leg length (14.6%).

Table 4. 22. Leg length classification (Frisancho 2008).

	n	%
Low leg length	13	14.6
Normal leg length	63	70.8
High leg length	13	14.6
Total	89	100

4.4 Physical activity and dietary assessments

4.4.1 Physical activity assessment

4.4.1.1 Household questionnaire

All children had physical education (PE) classes at school for 1 hour, once a week doing a wide range of activities. On top of that 26 children reported doing another activity out of school (Appendix D, Table 4.23). Playing out of school would mean any extracurricular sport or leisure activity out of school hours. In total 4 children played out of school three times per week while 6 played twice a week and 9 played once a week (Appendix D). Only one child reported playing in a team twice a week (data not shown).

Table 4. 23. Information on Cape Verdean ancestry children participating in PA out of school in 2013.

	% Yes (n)	% No (n)
	54.2 (26)	45.8 (22)
1 hour	4.5 (4)	
2-3 hours	20.2 (18)	
Total	48	

Table 4. 24. Type of spare time activity and respective classification age for Cape Verdean ancestry children in 2013.

Activity out school		n	%
	Religion	2	11.1
	Acting	2	11.1
	Football	4	22.2
	Basketball	4	22.2
	Roller skating	1	5.6
	Dancing	3	16.7
	Capoeira	1	5.6
	Running	1	5.6
	Total	18	100

Within the out of school activities there are a range of MET values associated with activities reported (Ainsworth et al. 2000). More children practised football and basketball, two of the most demanding activities in the list (n = 8 and 8.0/6.5 METs for football and basketball respectively).

Despite attending the local school, 11 (20.4%) of the families, lived outside the neighbourhood (Table 4.25). This would include a radius of 1-hour distance on public transport. The majority of the children walk to the school (89.8%) which is situated in the centre of the neighbourhood, while a small percentage use other means of transportation like train or car (Table 4.25).

Table 4. 25. Distribution of families living in/out of neighbourhood perimeter and type of transport used for Cape Verdean ancestry children in 2013.

	n	%
Out of the neighbourhood	11	20.4
Inside neighbourhood	43	79.6
Total	54	100
Type of transport to school		
Walk	53	89.8
Train	3	5.1
Car	2	3.4
bus and train	1	1.7
Total	59	100

Table 4. 26. Play area and how active parents consider their children and themselves age for Cape Verdean ancestry children in 2013.

Place where child plays	n	%
Public place	11	19.6
School	11	19.6
Friend's house	10	17.9
Leisure time institution	24	42.9
Total	56	100
Parental view of how active their children are		
Not active	2	4.3
Active	14	30.4
Very active	29	65.2
Total	58	100
Maternal view of how active they consider themselves		
Not active	34	70.8
Active	8	16.7
Very active	6	12.5
Total	48	100

Only 25% (14) of the parents reported letting their children play on the street. Table 4.26 shows that most of the children spend their time at after school clubs provided by leisure time institutions like *Moinho da Juventude* and *Clube* located inside the neighbourhood (42.9%, Table 4.26, see chapter 3). The second and third options would be the school or a friend's house (19.6% and 17.9%, respectively). Most of the parents consider their child to be very active (65.2%) while a small percentage does not think they are active (4.3%). Conversely, it seems that most of the mothers do not consider themselves to be active (70.8%) (Table 4.26). This assessment was based on a question about how physically active they were and does not account for commuting or housework activities. The mean sleeping time is 10 hours per day as reported by parents. Values range from 9 hours to 13 hours with 75% of the Cape Verdean ancestry children sleeping around 10 hours (Appendix D). The reported sleep duration for Cape Verdean children in 2013 is within the values expected from previous studies on this age range (6-12 years old) and that show average sleep duration of 9-11 hours(Biggs & Dollman 2007; Thorleifsdottir et al. 2002) .

4.4.1.2 Objective measurement of physical activity

After initially attempting to use Actihearts devices in this sample, which proved unsuccessful (see chapter 3 for further details), it was decided to employ Omron walking style III pedometers to get an estimate of steps taken by this sample. In total 27 children (13 boys and 15 girls) used the pedometer for 1 week during school time (9 am to 3 pm). That included morning and afternoon breaks where they would play freely inside the school area.

Table 4. 27. Basic information taken from pedometers on a school day for Cape Verdean ancestry children in 2013.

		Mean step count	Step stride length
	n	28	28
	Mean	6431.26	0.51
	Median	5512.17	0.50
	Std. Deviation	2348.54	0.14
	Minimum	3391.67	0.31
	Maximum	11652.33	0.86
Percentiles	25	4844.94	0.40
	75	7214.81	0.59

Stride length was measured by total length of ten steps walked by the number of steps (e.g. 6 metres divided by 10 steps: 0.60 m)

Based on Table 4.27, three categories were determined for this population based on the closest values to the lower quartile, median and upper quartile for all children:

1: relatively inactive for 4844 steps or less per school day (21.4%ile)

2: moderately active for (5512-7214) steps per school day (53.6%ile)

3: highly active for at least 7214 steps per school day (75%ile)

Table 4.28 shows mean values for step count between boys and girls although no significant differences were found (U (28)=61, Z=-1.681, p>0.05). In fact 25% of the boys had values as high as 10.270 steps per day compared to 6.034 in girls. Values range from 3967 to 11652 for boys and 3391 to 10696 for girls.

Table 4. 28. Information collected during a school day from pedometers for age for Cape Verdean ancestry boys and girls in 2013 respectively.

Boys		Mean step count	Step stride length	Girls	Mean step count	Step stride length
n		13	13		15	15
Mean		7376.04	0.55		5612.45	0.48
Median		6713	0.58		5302.50	0.46
Std. Deviation		2703.57	0.10		1680.77	0.17
Minimum		3967.75	0.36		3391.67	0.31
Maximum		11652.33	0.70		10696.50	0.86
Percentiles						
	25	5057.88	0.47		4634.67	0.37
	75	10270.13	0.61		6034.67	0.51

Step stride length measured by total length of ten steps walked by the number of steps (e.g. 6 metres divided by 10 steps: 0.60 m).

Significant differences were found for height and Z-score height for girls using the pedometer. Table 4.30 shows that the girls who used the pedometers (n=15) were taller (M=136.47, SD=8.12) compared to the ones that were not measured, t (46) =-2.581, p<0.05. The same trend was verified for Z-score height with the girls measured having higher means (M=0.69, SD=1.011), t (46) =-3.224, p<0.05. Similarly Z-score sitting height was higher (M=1.00, SD=0.73 compared to M=0.10, SD=0.89) for the girls whose PA was measured (t (46) =-3.418, p<0.05). For girls Mann-Whitney tests also showed that weight, Z-score weight, BMI, subscapular and Z-score subscapular skinfold means were significantly higher for the girls that had their PA measured (Table 4.30). For weight girls with PA assessed were heavier (median= 35.40 IQ=31.30-37.10) than the ones that were not (median= 35.40 IQ=31.30-37.10), (U(48)=88, z=-3.548, p<0.05). For girls, BMI was also higher (median= 17.88 IQ=16.99-19.59) than the ones that were not measured (median=15.53 IQ=14.80-16.77) (U (48)=79, Z=-3.748, p<0.05). For body composition measures the same was verified and girls had higher triceps (median= 13.10 IQ=9.8-17.0) and subscapular skinfold (median= 8 IQ=6.28-11.0) as opposed to the ones that were not measured (Median= 35.40 IQ=31.30-

37.10), respectively (U (48) =166, Z=-1.824, $p<0.05$), (U (48) =141, Z=-2.370, $p<0.05$). The same trend was verified for Z-score triceps and Z-score subscapular skinfolds.

Moreover significant differences were found using Man-Whitney and T-tests for weight, BMI, triceps, and subscapular skinfolds were found for boys with PA measured (Table 4.29). For weight boys that were measured were heavier (Median= 30 IQ=28.45-31.80), had higher BMI (Median= 17.31 IQ=15.94-17.75), higher fat deposition reflected on triceps (Median= 10.90 IQ=8-11.75) and subscapular (Median= 6.20 IQ=5-7.55) skinfolds than those not measured. It is important to note that differences found in Tables 4.29 and 4.30 are only for anthropometric variables and not for child's age.

Table 4. 29. Descriptive values (Mean/median [a] ±SD/IQR [b]) for Mann-Whitney and T-test for Cape Verdean ancestry boys in 2013.

Variables			Difference [x,y]		
	PA assessed N=13	Not PA assessed N=28	*U*	*t/z*	*p-value*
Age decimal (years) [x]	8.29±0.75	8.80±1.64		1.383	ns
Height (cm) [x]	*137.90±8.16*	*133.94±10.55*		-0.289	*ns*
Z-score height	*1.00±0.933*	*0.39±1.05*		-1.780	*ns*
Sitting height (cm) [x]	68.68±4.69	69.95±4.96		0.771	ns
Z-score SH[x]	*-0.05±1.33*	*-0.02±0.91*		0.091	ns
Weight (kg) [y]	30.00 28.45-31.80	26.15 23.80-32.33	106	-2.129	*p<0.05*
Z-score weight [y]	0.19±0.44	-0.46±0.60	64	-3.306	*p<0.05*
BMI[y]	17.31 15.94-17.75	15.46 14.82-16.01	62	-3.362	*p<0.05*
Z-score BMI[y]	0.44 0.003-0.809	-0.23 -0.667 to0.039	66	-3.250	*p<0.05*
Triceps SK (mm) [y]	*10.90* *8-11.75*	*6.40* *5.84-7.35*	50	-3.700	*p<0.05*
Z-score Ts SK[y]	*0.33* *-0.10 to 0.65*	*-0.64* *-0.98 to -0.29*	45	-3.838	*p<0.05*
Subscapular SK (mm) [y]	*6.20* *5-7.55*	*4.30* *4-4.70*	66	-3.255	*p<0.05*
Z-score subscapular SK[y]	*0.24* *-0.25 to 0.55*	*-0.67* *-0.80 to -0.35*	51	-3.670	*p<0.05*

[a] Mean/ SD are presented where the data were normally distributed and T-student test applied ([x]) and [b] Median/ IQR are presented where the data were non-normally distributed and Mann-Whitney test was applied ([y]).

Table 4. 30. Descriptive values (Mean/median ^{a} ±SD/IQR ^{b}) for Mann-Whitney and T-test for Cape Verdean ancestry girls in 2013.

Variables			Difference $^{x, y}$		
	PA assessed N=15	Not PA assessed N= 33	*U*	*t/z*	*p-value*
Age decimal (years) ^{x}	8.75±1.02	8.50±1.61		-0.648	ns
Height (cm) ^{x}	*136.47±8.12*	*128.91±9.92*		2.581	*p<0.05*
Z-score height ^{x}	*0.69±1.011*	*-0.14±0.73*		-3.224	*p<0.05*
Sitting height(cm) ^{x}	71.81±3.76	67.73±5.16		-2.749	*p<0.05*
Z-score SH ^{x}	*1.00±0.73*	*0.10±0.89*		-3.418	*p<0.05*
Weight(kg) ^{y}	35.40 31.3-37.10	25.40 23.05-29.30	88	-3.548	*p<0.05*
Z-score weight ^{y}	0.63±0.84	-0.22±0.58	93	-3.448	*p<0.05*
BMI ^{y}	17.88 16.99-19.59	15.53 14.80-16.77	79	-3.748	*p<0.05*
Z-score BMI ^{y}	*0.568* *0.18-1.31*	*-0.17* *-0.523to 0.19*	94	-3.414	
Triceps SK (mm) ^{y}	*13.10* *9.8-17.0*	*9.15* *8.15-12.90*	165	-1.824	*p<0.05*
Z-score Ts SK ^{y}	*0.33* *-0.21 to 1.28*	*-0.22* *-0.44 to 0.42*	167	-1.791	*p<0.05*
Subscapular SK (mm) ^{y}	*8* *6.28-11.0*	*6* *4.7-8.2*	141	-2.370	*p<0.05*
Z-score subscapular SK ^{y}	*0.12* *-0.30 to 0.75*	*-0.43* *-0.57 to 0.12*	146	-2.269	*p<0.05*

^{a} Mean/ SD are presented where the data were normally distributed and T-student test applied (^{x}) and ^{b} Median/ IQR are presented where the data were non-normally distributed and Mann-Whitney test was applied (^{y}).

Table 4.31 shows the relationship between the group of children that was not measured and their socioeconomic background. A Chi-square test was performed with SES measures like number of assets, father and mother education and occupation in order to determine a possible trend between the children with and without PA assessment. Fisher's exact test was used because of unequal distribution of frequencies for the different categories.

Table 4. 31. Distribution of socio-economic variables according for Cape Verdean ancestry children in 2013 according to PA assessment.

Variables	PA assessed N=23	Not PA assessed N= 38	X^2	*df*	*p-value*
Number assets	4 (2-5)	4(3-5)	4.541	5	ns
Father education			1.036	2	*ns*
Primary	5(45.5)	8(34.8)			
6 years	2(18.2)	8(34.8)			
9-12 years	4(36.4)	7(30.4)			
Father occupation			3.606	3	*ns*
Manual	4(28.6)	14(50)			
Non-manual	2(14.3)	2(7.1)			
Retired	1(3.6)	0			
Unemployed	7(25)	12(42.9)			
Mother education			0.556	2	*ns*
Primary	7(38.9)	11(34.4)			
6 years	6(33.3)	9(28.1)			
9-12 years	5(27.8)	12(37.5)			
Mother occupation			4.884	2	0.010
Manual	15(75)	18(54.5)			
Non-manual	2(10)	1(3.0)			
Unemployed	3(15)	14(42.4)			

Frequencies and (percentages) shown; Median and interquartile range presented for variable number of assets; df: degrees of freedom.

Unemployed mothers and mothers working in manual jobs were amongst the ones with children on the lower end of the healthy spectrum and whose PA was not measured ($p<0.05$, Fisher's exact test). No further significant relations were found between environmental variables and physical activity groups.

4.4.2 Diet evaluation

Descriptive data shown here is the result of a 24-hour recall of foods eaten at lunch, dinner and snacks for Cape Verdean ancestry children in 2013. A more detailed description of the method applied for a qualitative evaluation of the diet can be found in the chapter 3. The n values are slightly lower than the previous analysed because AA could not collect information on diet in all children measured. Because this is an assessment of the quality of the diet no quantities were taken and a descriptive approach was chosen. It permitted information reported by parents on individual diet diversity, presence of traditional diet, location of meal consumption, number of meals and skipping breakfast to be assessed. It also shows information on consumption of salty food or added sugar to the diet. In total there is information on 52 children. No cases of dining out or consumption of high-energy dense foods were identified in this previous 24-hour period but there were 3 cases of children where the mother reported dining sometimes at a fast food restaurant. The majority of children have 5 meals/snacks per day (26) while 17 of them have 6 meals/ snacks and 12 have 4 meals/ snacks. Only 5.2% (3) of them reported only having 3 meals/ snacks per day (Appendix D).

Table 4. 32. Information on meal consumption and individual diet diversity score (IDDS) for Cape Verdean ancestry children in 2013.

	Nr daily meals	IDDS
Mean	5	6.21
SD	0.848	0.749
Minimum	3	5
Maximum	6	8
Perc25	4	6
Per75	6	7
Total	52	52

The IDDS is based on snacks and meals in the previous 24 hours. The majority of children consumed 6 out of the 9 possible food groups showing some dietary diversity (Table 4.32).

Table 4. 33. Main composition of Cape Verdean ancestry children's diet in 2013 based on its consumption on a 24- hour period.

	n	%
Starchy staples	52	100
Meat and fish	52	100
Milk	52	100
Other fruit and vegetables	51	98
Legumes, nuts, seeds	39	75
Dark green leafy vegetables	37	71.1
Vitamin A fruit and vegetables	35	67.3
Eggs	5	9.6

Taking into account the previous table three categories can be defined for this evaluation (Table 4.33). A large group of children consume daily 6 food groups that included starchy staples, meat and fish, milk, other fruit and vegetables, legumes, nuts and seeds and dark green vegetables. This would be considered a medium level of diet diversity as opposed to the ones that consume only 5 food groups (starchy staples, meat and fish, milk, other fruit and vegetables, legumes, nuts and seeds). Following that group a smaller number of children consume 8 food groups in a diet higher in diversity composed of staples, meat and fish and milk, other fruit and vegetables as well as legumes, nuts and seeds, Vitamin A fruit and vegetables. Non-significant differences between boys and girls were found for IDDS even if girls had higher scores than boys (higher mean for girls =6.24 compared to boys n=6.17).

Furthermore 8.6% of the children did not have breakfast and 91.4% had at home or at a local institution. The main meal reported for 58.8% of the children was dinner and for 17.6% this was lunch served at school. Also for 7.8% the main meal was the break snack and for 15.7% it was breakfast. The majority of the mothers/guardians (62.7%, n=37) reported that their child liked traditional dishes (Table 4.34). The presence of a traditional diet would mean that one of the family members would prepare occasionally typical food from Cape Verde.

Table 4. 34. Traditional diet response rates and school meal attendance for Cape Verdean ancestry children in 2013.

	%Yes (n)	%No (n)
Traditional diet	62.1 (36)	37.9(22)
School meal	96.6(56)	3.4(2)
Total	58	58

Only two children (3.4%) reported not having lunch at school and that was because one of them ate at the local institution and another had lunch at home. Furthermore if we account for the fact that the majority of the children have free meals it shows the dependency on schools for lunchtime food. On the household questionnaire there was also a question about whether the child normally consumed salty food or added sugar to milk or another drink. More than half of the children (52.5%, n=31) added at least one teaspoon of sugar to a daily drink and a slightly lower rate reported eating salty food (23.7%, n=14) (Appendix D).

In summary Cape Verdean children from the CVPT2013 database live in households headed mainly by single mothers, with low SES, predominantly with low educational level and manual occupations. Their parents have migrated from Cape Verde before the economic crisis in Portugal (2008). Most of the Cape Verdean ancestry children were born in Portugal but maintain a strong cultural link to Cape Verde with good nutritional status assessed by anthropometry and good levels of dietary diversity provided by the households and the local school. They also show high step counts assessed by pedometers on a school day (9-3pm). Anthropometric measures might mask intergenerational effects that need to be analysed in detail. The following section presents pre-natal and early factors that might explain these children's current nutritional health. The results presented in this chapter are discussed in further detail in Chapter 7.

Chapter 5. Maternal and intergenerational (mother to child) effects on the health and growth outcomes of Cape Verdean ancestry children

This chapter first presents a general description of the background setting of this project. This first section is based on observations and thematic analysis from the household interviews. It provides a unique insight to the way this community is structured and will help understand the quantitative results. Subsequently results for the second research question, regarding maternal and intergenerational (mother to child) effects on the health and growth outcomes of the children are presented. All participants included in the analysis presented in this chapter are of Cape Verdean ancestry and they will be referred to as CVPT throughout. For the first objective, which was to determine maternal malnutrition among Cape Verdean mothers maternal health history is analysed using parity, maternal diseases in adulthood, weight gain during the participant's pregnancy, time living in Portugal, current nutritional status and risk factors related to cardiovascular diseases (CVDs). Descriptive information presented in this chapter refers to the maternal health history while descriptive data pertaining to the children has been detailed in the previous chapter (chapter 4). After the descriptive data the second objective on intergenerational effects associated with anthropometric outcomes is presented.

5.1 Background qualitative and contextual information on the community and families included in the study

Thematic analysis was performed after the application of the household questionnaire to parents and guardians of the children. To the list of themes parents/guardians referred to in the interviews notes were also incorporated from observations and small interviews AA conducted with key informants (see chapter 3). Family structure, household deprivation and remittances, and support of local institutions are some of the themes identified and whose examples are shown below.

This is a difficult to reach and very deprived community suffering from discrimination and insecurity (Ferreira 2005). This is the rationale for placing results within the context of this community's experiences. By combining information from household interviews and fieldwork observations it was possible to give an account on the background of this community.

Observations in the field identified that its inhabitants tried to maintain a certain distance from the study team probably because of insecurity issues. However and despite the initial difficulty in contacting some of the parents, the majority of the mothers were very compliant and happy to participate in the study. They believed that it was important for their children’s good health and they also respected the school as an institution that could provide a better future for their children. School personnel, teachers and social workers have reported serious discipline problems incremented by difficult family situations and continuous police raids in the community. Furthermore cases of parental negligence and enormous affective deprivation were also reported by school staff.

This community is characterized by a certain mobility that means that people may come from different countries and social situations. Cape Verdean migrants sometimes decide to stay in Portugal until they sort out their documentation and later move to work and live in another European country. They usually stay with relatives or friends to save up some money and that could increase the household numbers within a short period of time. Consequently this community's different family dynamic is observed into how marriage is viewed by its inhabitants, as most of the mothers interviewed would not even consider marriage. In chapter 4 it was observed that for this group there was a high percentage of single mothers (marital status) as opposed to a lower percentage of single parent families. This means that even though children's mothers are not married they mostly live with a male companion that may or may not help with the household income and contribute to expenditure within a period of time. In some cases but not all, this person would be the child's biological father. Nevertheless many mothers referred the important help from the community like family and friends for the care of their children. To give some insight into the experiences of family structure in this group the following examples have been identified:

Example 1 : The child was the first born of a mother who used to work for the local association (*Moinho da Juventude*) but later decided to migrate to France. However at the time of the interview the mother was unemployed and it was the maternal grandmother who was providing for the child and acting as her guardian.

Example 2: This case was the eldest of 3 siblings, all-living with the mother at their maternal grandparents' house. The biological father was working in France and would usually send money to the mother, visit them but he had also started another family in France. The mother had also migrated sometime before while pregnant with the child but had later decided to return to Portugal. She had enrolled on a professional course as a health care assistant given by the local association (*Moinho da Juventude*). She was living with her parents while waiting for the local municipality to provide a new home for her because the previous one was not suitable for her due to respiratory diseases that both her and eldest son suffer from. She was helped by her parents and was trying to get child benefit from one of the fathers of her children.

Example 3: The house where the mother and two children were living was the property of the oldest daughter's father. This mother reported feeling economic and physical insecurity.

Example 4 : The child's mother migrated to the USA and left the child to be taken care of by her biological father. Despite dropping out from a private law school the father, currently with another women and baby child, hoped he would try to enrol again in future.

Example 5: This child was being raised by his maternal grandmother because his mother passed away. The grandmother assumed economic difficulties and her main income was from selling homemade food to the neighbourhood.

Example 6: The father and the child had been living in Portugal since 2007. He is the only guardian and had been unemployed since 2009 with some occasional work. He understood the importance of education for a better future. He told AA he was sharing the rent with a lady that was also taking care of the child. The mother of the child was living in Cape Verde. The father had another family in Cape Verde and one of his children was studying at the university but had to drop out because he had lost his job and could not pay for university fees. He wanted to move to a different house because of current problems with humidity in this one. He admits deprivation because he cannot pay for the school meals for the child.

Example 6: The mother migrated to Portugal to study but after the first year had to give up. The child was living with the father that had another family in Cape Verde. The maternal grandparents went to France to work. The child's relatives (uncles) who also migrated to Portugal to study were living with the mother and would take care of the child. The mother was the only one working long hours and because she couldn't afford the bus ticket she would walk to work.

Example 7: Another mother confided that she had 4 older children living in Santiago island in Cape Verde and that they had several economic difficulties but also that they understood the importance of studying and that one of her older daughters was studying to be a nurse while working part-time. The mother would use both Creole and Portuguese and AA had to have help from relatives to conduct the interview. The biological father of the child had been in jail for 9 months and was currently trying to get a job while doing some temporary work. She had been unemployed for 6 months and was late with her rent. A local church was providing support to the family with occasional food and money.

Consequently observations in the field also identified the theme of deprivation and remittances in this neighbourhood. Participants of this study reported being less able to afford sending packages even when they had direct family in need (second family in Cape Verde). This is a deprived community showing low household income, expenditure and only a few assets. As a result the majority of the children have access to free school meals and books.

To give some insight into the experiences of deprivation the following examples have been identified:

Example 1: One mother reported having several family members in Cape Verde and sending packages with food once a year (services on transport agencies were available in the neighbourhood). She was working at a restaurant but had to quit taking care of her mother. Maternal grandparents were living with the child in the same building and would help taking care of the child like preparing traditional dishes. The mother assumed household deprivation and that the child's biological father was absent.

Example 2: Both parents had been unemployed for 3 years and were living on children's benefit (2 children) and the help of the local associatio*n Moinho da Juventude* that would provide meals for them. Sometimes they would manage to supply breakfast for the children while others they would ask the school to do it. At the time of the interview the father was awaiting an authorization from the Portuguese foreign office to emigrate.

Example 3: The biological father was living in Cape Verde but was receiving the child's benefit. The child was the youngest of 5 children who all lived with the mother (the only one working in the household). The child had her first menstruation at 9 years and the mother took her to see a doctor because she was concerned. The family had always lived in the neighbourhood and the mother was interviewed on a Sunday because she would work from Monday to Saturday.

Example 4: The mother was concerned about the child playing on the streets for security reasons. She would cook for her child and leave the food to her neighbour who worked as a child minder. The mother and child were living outside the neighbourhood but had returned a year ago. At the time of the interview they were living in a room/studio with a shared bathroom. The mother worked late hours and sometimes would pick her child up late. Even though she was proud of her country's culture (Cape Verde) she understood the importance of using Portuguese. She would only speak Portuguese with the child. She recognised that the neighbourhood was a closed environment and that sometimes that could be detrimental for the children's education.

Example 5: In another family the mother was living outside the neighbourhood perimeter but had family in the neighbourhood. The child’s maternal grandfather was a fisherman and the mother got used to eating a lot of fish but she says that fish is very expensive in Portugal. The maternal grandmother had emigrated to Luxemburg and would send money when she could. The mother was the only one working in the household and would get the minimum wage (345£/ month). The child's father had immigrated to France and was unemployed at the time of the interview.

Among these situations of deprivation, local associations (*Associação Clube Desportivo Alto Cova da Moura* and *Associação Cultural Moinho da Juventude*) and the primary school (*EB1 Cova da Moura*) play an important role providing all types of support in the neighbourhood.

Two NGO institutions are located in the neighbourhood: Ass*ociação Clube Desportivo Alto Cova da Moura* and *Associação Cultural Moinho da Juventude* supply meals and function as after school clubs. The first one, *Clube*, provides light snacks that are donated by the local food bank or a local retailer. They support several after school activities like dance and hockey for 43 children from 3 to 9 years (the majority are from the local primary school). It's based right in front of the school but according to some parents charges a high fee for its services. They also organize charity campaigns to collect clothes for the most deprived families of the neighbourhood.

Moinho da Juventude, one of the oldest associations in the neighbourhood were struggling with economic and human resource difficulties at the time of data collection (Associação Cultural Moinho da Juventude 2012). They provide educational, professional, socio-cultural and legal, services as well as leisure activities for children (basketball, indoor soccer and running clubs). Educational/childcare includes 2 nurseries, 20 child minders, 1 pre-school and 1 after school club (the last one is open until 21:30). On the professional variant they give advice on social support issues, citizenship training, documentation issues and active job searches. Moreover they also support Cape Verdean cultural practices like the celebration of a traditional festivity like *Kola San Jon*, *Finka Pé* drumming group with older women, a music studio and occasional festivities and celebrations.

According to one of the informants ***Moinho da Juventude*** association provides on a daily basis 100 meals for families living in and out of the neighbourhood and 300 meals for local child minders, nurseries and day care and in the evening dinner for some children. The after school club is open from 8 to 18h and supports 180 children from 6 to 12 years who might or might not be eligible to pay a fee (41.50€/ month, 35.78£) according to the household's earnings. They also provide snacks (8-13, 13-18h), organize school trips, beach camps and spare time activities like acting classes, gymnastics, homework assistance. A worker from the Moinho's after school club would usually collect the children from school at 15h each day and walk with them to the school club. Child minders, *amas de bairro*, are inhabitants trained by the social services that work from home taking care of children aged 2 to 6 years. *Associação Cultural Moinho da Juventude* is supported by donations, Amadora municipality, Portuguese government (social security) and job centre but they also work with volunteers from different backgrounds and age ranges.

Cova da Moura primary school is open from 8:30 am to 5:15pm each day and has gates surrounding it. It is located in the middle of the neighbourhood and is easily accessed by the local bus stop and a train station even though most of the children walk from their homes. The school has a pre-school unit for children aged 3 to 5 years and provides 4 grades of teaching to children from 6 to 10/12 years old. Among several activities organized during the school year one was particularly important. The celebration of Portuguese language day (10^{th} June) a story telling activity in *creole* was one of the most praised by the children who loved singing and listening to traditional stories. The head of the school board defended more activities target to this population's background (language, history, content) in terms of books and educational contents. Teachers referred some learning disabilities observed in some students marked by comprehension issues related to language. Some children need two or three additional years to finish their basic primary schooling.

Living conditions have improved in the neighbourhood as AA was told by several informants. The houses were refurbished, roads paved and public sewage was installed in the early 2000s. The type of construction into several levels and the narrow spaces between some buildings are vital to their inhabitant's social interaction but lately problems with housing conditions and high rents have been driving people away from the neighbourhood. In this dynamic web of relations and social interactions contact information or addresses changed rapidly and its inhabitants move due to work or family relocations. Even though refurbishments were made, some people have been trying to find other places to live outside the neighbourhood perimeter. Fieldwork observations suggest that most landlords are people that left the neighbourhood to live in other parts of the city while still profiting from renting their old houses. If parents move in and out of the neighbourhood to commute to work on a daily basis some children only leave on specific occasions.

The physical space is also used to do business and to socialize. AA saw weekly a fish truck, people selling clothes, fruit/vegetables stalls and also coffee shops. Local stores in and out of the neighbourhood sell ingredients for Cape Verdean traditional dishes. When the weather was nice BBQ sets would be laid outside and the smell of food and music would be felt across the neighbourhood. However there was also insecurity at certain times of the day when the neighbourhood had more movement (cars, people) and that would be starting from the afternoon (around 3 pm and until night) and on Saturdays. Informants told AA that this movement would be propelled from outsiders mainly drug dealers located in specific parts of the neighbourhood. Fewer people other than its inhabitants are seen inside the neighbourhood even during the day. The built environment determines the way people move in it and because the neighbourhood is located on a high slope and the houses have several floors it is difficult to move around with a pushchair. During fieldwork AA did not see any pushchair or pram but observed mothers carrying their children in their arms or with a fabric around their back.

In summary this qualitative and contextual approach provides background information on this community. It shows how family structure is viewed, the deprivation situations in which some households are living, the mobility of its residents, the importance of social support institutions and local businesses. A mixture of plasticity from its residents supported by local institutions seems to be protecting this group of Cape Verdean ancestry children from unhealthy behaviours.

5.2 Descriptive information on maternal early life and environmental factors

Table 5.1 shows some descriptive data on maternal health history. Further description on maternal variables can be consulted in Appendix E. In total data was collected on 47 mother-child pairs in a young population with a mean age of 35.02 years (SD= 8.15). The mean parity, for this group is 3.40 children, which is consistent with the number of pregnancies reported. Moreover mean values for weight gain (kg) in last pregnancy are around 6- 7 kg. Table 5.2 reveals that only 2 mothers reported weight gain over 10 kg. Most of the mothers were not born in Portugal (chapter 4) and mean values for time of living in Portugal (12.45 years, SD = 6.76) at birth show that most mothers migrated before the economic crisis (2008). Only 6 of the 47 mothers reported their birthplace as Portugal (Appendix E). Also mean age for mothers at time of child birth was around 27 years (Table 5.2).

Table 5. 1 Maternal health and environmental factors observed in Cape Verdean mothers in 2013.

	Age	Parity	Number of pregnancies	Total weight gain from last pregnancy (Kg)	Time (years) living in Portugal at birth	Maternal age at child birth
N	47	47	47	30	39	47
Mean	35.02	3.40	3.45	6.83	12.45	27.23
Median	34.62	3.00	3.00	7.00	12.00	26.98
SD	8.15	1.81	1.84	3.67	6.76	7.89
P25	27.62	2.00	2.00	5.00	8.00	20.04
P75	40.70	4.00	4.00	10.00	15.00	32.65

Table 5. 2. Maternal total weight gain (kg) in the last pregnancy self-reported by Cape Verdean mothers in 2013 (retrospective).

	n	%
Lost weight	3	10
2-5 kg	8	26.7
5-10 kg	17	56.7
> 10kg	2	6.7
Total	30	100

Information from the household questionnaire included questions about health care attendance and maternal health history. Consequently Cape Verdean mothers reported using and attending the health centre for a variety of reasons, with the most common reasons being for routine check-up (83.7%) and for family planning meetings (74.1%). The local health centre (*Centro de Saúde da Buraca*) was the one that was mostly used by the mothers (67.6%). Participants reported that the main reason for not having more children was economic constraints (27.7%), while health considerations (birth control, old age, difficult delivery) were also important (6.3%). In general, mothers reported being healthy in pregnancy although a few cases of maternal morbidity were reported. Gestational diabetes (n=4) was the most commonly reported maternal morbidity, 2 mothers reported suffering from asthma and one had asthma and gestational diabetes. Only one mother reported being currently obese, 2 had anaemia and 2 hypertension cases were reported.

5.3 Maternal nutritional status

Tests of normality of distribution for the measures of maternal nutritional status were performed. Table 5.3 shows medians and inter-quartile ranges as well as the means and standard deviations (SD). Cape Verdean mothers were slightly below the median references for height with median values around 160 centimetres (Mean= 160.08 cm, SD= 5.85) and negative Z-scores (Mean= -0.20, SD=0.85). On the other hand, measures of body composition and fatness showed that their mean values were quite elevated. For weight the median value was 71.05 kg IQ=62.50 to 79.90 and the mean body fat percentage was M=38.70% SD=9.97, while waist circumference was Median=85.00 cm IQ=78.75 to 90.00, and arm circumference Median=31.00 cm IQ=28.10 to 32.75. Mean Z-score values were always positive for body fatness measures like weight, M=0.52

SD=0.89, ranging from -0.09 to 0.93. For BMI M= 0.54 ranging from 0.03 to 1.03 and waist circumference M=0.09, ranging from -0.33 to 0.41. Arm circumference M=0.49, interval -0.04 to 0.85. Lastly fat free mass (FFM) ranged from 41.64 and 61.69 and body fat percentage (BF %) 32.90 to 43.70%.

Table 5. 3. Descriptive anthropometric and age information for Cape Verdean mothers (CVPT2013).

Variable	Mean	SD	Median	Intervals	N
Age (years)	35.02	8.15	34.62	27.62-40.70	47
Height (cm)	160.08	5.85	161.0	156 to 164.50	47
Z-score Height	-0.20	0.85	-0.05	-0.79 to 0.50	47
Weight (kg)	75.29	18.56	71.05	62.50 to 79.90	47
Z-score Weight	0.52	0.89	0.37	-0.09 to 0.93	47
BMI (kg/m^2)	29.39	7.24	28.21	25.36-31.39	47
Z-score BMI	0.54	0.80	0.43	0.03 to 1.03	47
Waist circumference (cm)	86.24	13.31	85.00	78.75 -90.00	45
Z-score WC	0.09	0.76	0.07	-0.33 to 0.41	45
Waist-to-height ratio (WHtR)	0.54	0.08	0.53	0.48-0.57	45
Arm circumference (cm)	30.99	4.03	31.00	28.10-32.75	45
Z-score arm circumference	0.49	0.83	0.47	-0.04 to 0.85	45
FFM (kg)	52.29	13.61	47.53	41.64- 61.69	47
BF (%)[a]	38.70	9.97	38.30	32.90-43.70	47

a: Body fat percentage from BODYSTAT 1500 analyser ; WHtRatio : waist-to-height ratio ;BMI : body mass index ; FFM : fat free mass

Table 5. 4. Prevalence (%) of current maternal underweight, overweight, and obesity based on the cut-off points by WHO and CDC international references.

WHO/CDC	%	n
Normal weight	23.4	11
Overweight	40.4	19
Obesity	36.2	17
Total	100	47

Table 5. 5. Number and percentages of mothers at risk for cardiovascular diseases.

	Waist to height ratio risk %(n)	Waist Circu risk %(n)	Over fatness %(n)
No risk	29.8 (14)	33.3(15)	29.8(14)
At risk	66(31)	22.2(10)	70.2(33)
Increase risk		44.4(20)	
Total	100(45)	100(45)	47(100)

WHtRatio: waist-to-height ratio; WC: waist circumference; Over fatness according to body fat % higher than 34% (Frisancho, 2008). Increase risk for CDVs for waist circumference higher than 88 cm, risk of CVDs for waist circumference higher than 80 cm

According to WHO and CDC international references 40.4% of mothers were overweight and 36.2% were obese (Table 5.4). No cases of underweight were identified among mothers. High overweight and obesity rates (Table 5.4) were found for Cape Verdean mothers who also showed high values for fatness indicators like Waist-to-Height Ratio (WHtR) and percentage body fat (Table 5.5). Based on percentage of body fat cut off points 33 out of the 47 mothers would be at risk of developing CVDs. Similarly based on WHtR and WC, 31 and 30, respectively, out of 45 mothers would also be at risk.

5.4 Intergenerational effects

In order to observe intergenerational effects on anthropometric outcomes of the children, the sample had to be reduced in order not to include younger brothers and sisters (n=47 children and n=47 mothers). The analyses presented in this chapter therefore consider only mother and first-born pairs.

Table 5.3 shows that maternal age ranged from 27.62 to 40.70 years with a median value of 34.62 years (Mean=35.02, SD=8.15). Descriptive statistics of observed and derived values of maternal height variables and body composition are given in table 5.6. Maternal mean height is 160.08 (SD=5.85). Their height Z-score is negative (M= -0.20, SD=0.85) and all their weight and WC Z-score are positive, respectively (M=0.52, SD=0.89; M=0.09, SD=0.76). Normality tests and variance tests were used to test for gender differences (independent T-test and Mann-Whitney test). Significant sexual dimorphism was found for child's Z-score waist circumference and sum 2 skinfolds (subscapular+ triceps) in this sample (Table 5.6). Cape Verdean ancestry girls have significantly higher values (M=0.343, SD= 0.79) than boys (M=-0.080, SD=0.564), t (45) =-2.086, p= 0.043). Also girls have higher Z-scores skinfold medians (Median=-0.042, IQ= -0.42 to 0.64) compared to boys (Median=-0.28, IQ= -0.95 to 0.084, U(47)=160, z=-2452, p=0.014).

Table 5. 6. Distribution of anthropometric variables for Cape Verdean ancestry children and their mothers (Mean/median [a] ±SD/IQR [b]).

	Children								Mothers	
	Boys		Girls		All		Difference			
	M/Med	SD/IQR	M/Med	SD/IQR	M/Med	SD/IQ	t/U	*p-value*	Mean/ Med	SD/IQ
n(%)	22	46.8	25	53.2	47	100			47	100
Age (years) $^{x, y}$	8.00	7.00-8.25	7.00	7.00-9.00	8.00	7.00-8.75			35.02	8.15
Height (cm) ^{x}	132.62	7.67	130.1	9.16	131.28	8.50	1.012	ns	160.08	5.85
Height Z-score^{x}	0.57	1.00	0.26	0.89	0.40	0.95	1.116	ns	-0.20	0.85
Weight (kg) $^{x, y}$	27.65	29.83-30.95	26.60	23.70-35.05	27.20	24.10-31.70	262	ns	71.20	62.50-79.90
Weight Z-score^{x}	-0.19	-0.60 -0.020	-0.14	-0.44-0.47	-0.15	-0.4610 to 0.31	229.5	ns	0.52	0.89
BMI$^{x, y}$	16.02	15.08-17.43	15.75	15.00-17.99	15.98	15.09-17.65	262.50	ns	29.39	7.24
BMI Z-score^{x}	0.89	-0.33- 0.70	-0.05	-0.044-0.48	0.04	-0.39 to 0.66	261.00	ns	0.54	0.80
WC (cm) $^{x, y}$	57.45	52.60-59.40	56.00	53-61.90	56.75	53-60.60	-0.790	ns	85.00	78.75-90.00
WC Z-score^{x}	-0.08	0.56	0.34	0.79	0.14	0.72	-2.086	0.043	0.09	0.76
Sum 2 skinfolds$^{x, y}$	13.75	10.26-17.88	16.30	13.05-23.95	15.20	11.85-20.70	151.50	0.008	----	-----
Sum 2 sk Z-score^{y}	-0.28	-0.95 to 0.084	-0.04	-0.42 to 0.64	-0.070	-0.62 to 0.41	160	0.014		

WC: waist circumference; Sum 2 skinfolds: subscapular and triceps skinfold sum. ns: non-significant; [a] Mean/ SD are presented where the data were normally distributed and T-student test applied (^{x}) and [b] median/ IQR are presented where the data were non-normally distributed and the Kruskal-Wallis rank sum test was applied(^{y});

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A detailed description of the data analysis strategy is presented in the methods chapter (chapter 3), however for ease of interpretation key factors relating to the analysis are summarised again here for the reader. The models focus on anthropometric outcomes in the Cape Verdean ancestry children (Height, BMI, WC, WHtR), while considering intergenerational factors (Height, BMI, WC, WHtR)) and controlling for child's sex and age. Environmental factors like maternal age, birth order, single parent families and maternal education (high, low) were considered. The following tables (5.7 to 5.15) present the models for the different intergenerational effects tested.

Table 5. 7. Influence of maternal Z-score waist circumference on children's height Z-scores using multiple regression.

	Model 1			Model 2			Model 3			
	B	SE	*p*	B	SE	*p*	B	SE	*p*	*95% CI*
Constant	2.158	1.100	0.057	1.441	1.010	0.161	1.986	1.010	0.056	-0.056 to 4.028
Sex child										
Girl (ref)	1.00									
Boy	-0.371	0.288	0.204	-0.337	0.258	0.199	-0.432	0.253	0.096	-0.944 to 0.080
Age child	-0.205	0.137	0.143	-0.373	0.133	0.008	-0.392	0.129	0.004	-0.652 to -0.132
Z-score WC mother	0.159	0.191	0.409	0.070	0.173	0.690	-0.025	0.173	0.887	-0.375 to 0.326
Age mother				0.057	0.017	0.002	0.034	0.020	0.090	-0.006 to 0.074
Birth order							0.172	0.085	0.049	0-0.343
R^2 adjusted		0.031			0.221			0.277		

Model 1 is adjusted for child sex and age and tests for intergenerational influences of maternal chronic early life environment, model 2 and model 3 control for child's own environmental exposures; SE: standard error, N=45, F(4.368), $p<0.05$, $R^2= 0.359$ adjusted $R^2 =0.277$.

Maternal WC was not significantly associated with the height-for-age- Z-score of these children (Table 5.7) and this association did not change even after adjusting for the variables used in model 2 and 3. However birth order did show a marginally significant relationship (0.085, 95%CI 0 to 0.343,) with children's height for age Z-score. The final model explains 27.7% of the variation on children’s height for age Z-scores.

Table 5. 8. Influence of maternal waist-to-height ratio on children's height Z-scores Cape Verdean ancestry living in Portugal using multiple regression.

	Model 1			Model 2			Model 3			
	B	SE	*p*	B	SE	*p*	B	SE	*p*	95% CI
Constant	1.081	1.472	0.467	1.580	1.342	0.246	2.646	1.371	0.0061	-0.128 to 5.420
Sex child										
Girl (ref)	1.00			1.00			1.00			
Boy	-0.354	0.286	0.224	-0.348	0.259	0.187	-0.454	0.252	0.080	-0.964 to 0.057
Age child	-0.213	0.136	0.125	-0.381	0.134	0.007	-0.406	0.129	0.003	-0.666 to -0.145
Mother WHtR	2.120	1.826	0.252	-0.247	1.815	0.892	-1.291	1.798	0.477	-4.928 to 2.347
Age mother				0.059	0.019	0.003	0.038	0.020	0.069	-0.003 to 0.079
Birth order							0.185	0.084	0.034	0.014 to 0.355
R^2 adjusted	0.043			0.218			0.286			

Model 1 is adjusted for child sex and age and tests for intergenerational influences of maternal chronic early life environment, model 2 and model 3 control for child's own environmental exposures; SE: standard error, N=45, F(4.523), p<0.05, R^2= 0.367, adjusted R^2 =0.286

Maternal WHtRatio was not significantly associated with the height-for-age- Z-score of these children (Table 5.8) and this association did not change after adjusting for the variables used in model 2 and 3. However, birth order showed a significant relationship (0.084, 95%CI 0.014 to 0.355,) with children’s height for age Z-score. The final model explains 28.6% of the variation on children’s height for age Z-scores.

Table 5. 9. Influence of maternal Z-score height on children's height Z-scores Cape Verdean ancestry living in Portugal using multiple regression.

	Model 1			Model 2			Model 3			
	B	SE	*p*	B	SE	*p*	B	SE	*p*	95% CI
Constant	1.923	0.955	0.050	1.082	0.945	0.259	1.686	0.937	0.079	-0.206 to 3.578
Sex child										
Girl (ref)	1.00			1.00			1.00			
Boy	-0.336	0.260	0.203	-0.258	0.244	0.296	-0.359	0.237	0.137	-0.837 to 0.119
Age child	-0.162	0.119	0.180	-0.256	0.116	0.034	-0.280	0.111	0.016	-0.505 to -0.056
Z-score Mother height	0.380	0.154	0.017	0.316	0.146	0.036	0.309	0.139	0.032	0.029 to 0.588
Age mother				0.043	0.016	0.010	0.020	0.018	0.291	-0.017 to 0.057
Birth order							0.180	0.078	0.026	0.023 to 0.337
R^2 adjusted	0.123			0.234			0.306			

Model 1 is adjusted for child sex and age and tests for intergenerational influences of maternal chronic early life environment, model 2 and model 3 control for child's own environmental exposures; SE: standard error, N=47, F(5.057), p<0.05, R^2= 0.381, adjusted R^2 =0.306

Maternal Z-score height was significantly positively associated with the height-for-age-Z-score of these children (Table 5.9) and this association decreased but remained significant after adjusting for the variables used in model 2 and 3. Moreover birth order showed a significant relationship (0.078, 95%CI 0.023 to 0.337) with the height for age Z-score of the children. The final model explains 30.6% of the variation on children's height for age Z-scores.

Table 5. 10. Influence of maternal Z-score BMI on children's height Z-scores Cape Verdean ancestry living in Portugal using multiple regression.

	Model 1			Model 2			Model 3			
	B	SE	*p*	B	SE	*p*	B	SE	*p*	95% CI
Constant	1.760	1.039	0.098	0.744	1.011	0.466	1.464	1.1031	0.163	-0.619 to 3.546
Sex child										
Girl (ref)	1.00			1.00			1.00			
Boy	-0.332	0.277	0.238	-0.243	0.256	0.348	-0.344	0.251	0.177	-0.851 to 0.162
Age child	-0.157	0.128	0.226	-0.261	0.122	0.039	-0.291	0.118	0.018	-0.530 to -0.052
Z-score Mother BMI	0.078	0.176	0.660	0.124	0.162	0.450	0.040	0.161	0.803	-0.285 to 0.366
Age mother				0.050	0.017	0.004	0.026	0.020	0.199	-0.014 to 0.066
Birth order							0.179	0.085	0.042	0.007 to 0.350
R^2 adjusted		0.002			0.160			0.223		

Model 1 is adjusted for child sex and age and tests for intergenerational influences of maternal chronic early life environment, model 2 and model 3 control for child's own environmental exposures; SE : standard error, N=47, F(3.646), p<0.05, R^2= 0.308, adjusted R^2 =0.223,

Maternal BMI was not significantly associated with the height-for-age- Z-score of these children (Table 5.10) and this association did not change even after adjusting for the variables used in model 2 and 3. However birth order showed a significant relationship (0.085, 95%CI 0.007 to 0.350) with the height for age Z-score of the children. The final model explains 22.3% of the variation on children's height for age Z-scores.

Table 5. 11. Influence of maternal waist-to-height ratio on children's BMI Z-scores Cape Verdean ancestry living in Portugal using multiple regression.

	Model 1			Model 2			
	B	SE	*p*	B	SE	*p*	95% CI
Constant	0.458	1.179	0.700	-0.330	1.133	0.773	-2.620 to 1.960
Sex child							
Girl (ref)	1.00			1.00			
Boy	0.071	0.229	0.757	0.031	0.214	0.886	-0.401 to 0.463
Age child	-0.231	0.109	0.040	-0.238	0.101	0.024	-0.443 to -0.034
Mother WHtR	2.546	1.463	0.089	2.558	1.360	0.067	-0.190 to 5.306
Single parent families				0.574	0.210	0.009	0.149 to 0.999
R^2 adjusted		0.096			0.219		

Model 1 is adjusted for child sex and age and tests for intergenerational influences of maternal chronic early life environment, model 2 controls for child's own environmental exposures, SE : standard error, N=45, F(4.083), $p<0.05$, $R^2= 0.290$, adjusted $R^2 =0.219$

Maternal WHtRatio was not significantly associated with the BMI-for-age- Z-score of these children (Table 5.11) even after adjusting for environmental factors. Single parent families showed a significant positive relationship (0.210, 95%CI 0.149 to 0.999) with the BMI for age Z-score of the children, such that single parent families had on average children with BMI for age Z-scores 0.57 units higher than those living in other types of families. Child’s age was also significant showing a negative relationship with BMI Z-score. The final model explains 21.9% of the variation on children’s BMI for age Z-scores.

Table 5. 12. Influence of maternal Z-score waist circumference on children's BMI Z-scores Cape Verdean ancestry living in Portugal using multiple regression.

	Model 1			Model 2			
	B	SE	*p*	B	SE	*p*	95% CI
Constant	1.717	0.874	0.056	0.977	0.867	0.267	-0.775 to 2.729
Sex child							
Girl (ref)	1.00			1.00			
Boy	0.059	0.229	0.798	0.017	0.215	0.937	-0.417 to 0.451
Age child	-0.219	0.109	0.051	-0.227	0.102	0.032	-0.433 to -0.020
Z-score WC mother	0.264	0.152	0.090	0.242	0.142	0.097	-0.046 to 0.530
Single parent families				0.552	0.212	0.013	0.123 to 0.980
R^2 adjusted		0.096			0.207		

Model 1 is adjusted for child sex and age and tests for intergenerational influences of maternal chronic early life environment, model 2 controls for child's own environmental exposures, SE : standard error, N=45, F(3.872), $p<0.05$, R^2= 0.279, adjusted R^2 =0.207,

Maternal waist circumference was not significantly associated with the BMI-for-age- Z-score of these children (Table 5.12). On the other hand single parent families showed a significant positive relationship (0.212, 95%CI 0.123 to 0.980) with the BMI for age Z-score of the children. Children’s age was also significantly negatively associated with their BMI-for-age- Z-score. The final model explains 20.7% of the variation on children’s BMI for age Z-scores.

Table 5. 13. Influence of maternal Z-score height on children's leg length Z-scores Cape Verdean ancestry living in Portugal using multiple regression.

	Model 1			Model 2			
	B	SE	*p*	B	SE	*p*	95% CI
Constant	1.100	0.973	0.264	0.349	0.982	0.724	-1.632 to 2.330
Sex child							
Girl (ref)	1.00			1.00			
Boy	0.163	0.265	0.541	0.233	0.254	0.365	-0.280 to 0.745
Age child	-0.143	0.121	0.246	-0.226	0.121	0.069	-0.470 to 0.018
Z-score height mother	0.350	0.157	0.031	0.292	0.151	0.060	-0.013 to 0.597
Age mother				0.039	0.017	0.025	0.005 to 0.072
R^2 adjusted		0.078			0.164		

Model 1 is adjusted for child sex and age and tests for intergenerational influences of maternal chronic early life environment, model 2 controls for child's own environmental exposures, SE: standard error, N=47, F(3.248), $p<0.05$, R^2= 0.236, adjusted R^2 =0.164.

Maternal height was not significantly associated with the leg length-for-age- Z-score of these children after adjusting for other factors, although it was significantly associated with leg length for age Z-score before controlling for other factors (model 1)(Table 5.13). However maternal age showed a significant relationship (0.017, 95%CI 0.005 to 0.072) with the leg length for age Z-score of the children. The final model explains 16.4% of the variation on children’s leg length for age Z-scores.

Table 5. 14. Influence of maternal Z-score waist circumference on children's sum 2sk Z-scores Cape Verdean ancestry living in Portugal using multiple regression.

	Model 1			Model 2			
	B	SE	p	B	SE	p	95% CI
Constant	-0.129	0.798	0.872	-0.507	0.836	0.547	-2.197 to 1.182
Sex child							
Girl (ref)	1.00			1.00			
Boy	0.618	0.209	0.005	0.593	0.207	0.006	0.178 to 1.105
Age child	-0.039	0.100	0.697	-0.043	0.099	0.665	-0.242 to 0.156
Z-score WC mother	0.272	0.138	0.056	0.261	0.137	0.064	-0.016 to 0.538
Single parent families				0.282	0.205	0.176	-0.132 to 0.695
R^2 adjusted		0.179			0.197		

Model 1 is adjusted for child sex and age and tests for intergenerational influences of maternal chronic early life environment, model 2 controls for child's own environmental exposures , SE: standard error, N=45, F(3.688), $p<0.05$, R^2= 0.269, adjusted R^2 =0.196.

Maternal WC Z-score was not significantly associated with sum 2 skinfolds Z-score of these children (Table 5.14) even after adjusting for the variable (single parent families) used in model 2. However the sex of the child (boy) was significantly positively associated with sum 2 skinfolds Z-score of these children (0.207, 95%CI 0.178 to 1.105. The final model explains 19.7% of the variation on children's sum 2 skinfolds for age Z-scores.

Table 5. 15. Influence of maternal WHtRatio on children's sum 2 skinfolds Z-scores Cape Verdean ancestry living in Portugal using multiple regression.

	Model 1			Model 2			
	B	SE	p	B	SE	p	95% CI
Constant	-1.592	1.064	0.142	-2.012	1.082	0.070	-4.199 to 0.176
Sex child							
Girl (ref)	1.00			1.00			
Boy	0.636	0.207	0.004	0.614	0.204	0.005	0.202 to 1.027
Age child	-0.052	0.098	0.602	-0.055	0.097	0.570	-0.251 to 0.140
WHtR mother	2.927	1.319	0.032	2.934	1.299	0.029	0.309 to 5.558
Single parent families				0.306	0.201	0.135	-0.100 to 0.712
R^2 adjusted		0.198			0.223		

Model 1 is adjusted for child sex and age and tests for intergenerational influences of maternal chronic early life environment, model 2 controls for child's own environmental exposures; SE: standard error, N=45, F(4.155), $p<0.05$, R^2= 0.294, adjusted R^2 =0.223, Maternal WHtRatio was significantly associated with sum 2 skinfolds Z-score of these children (1.299, 95%CI 0.309 to 5.558) (Table 5.15) and this association was stronger after adjusting for the variable (single parent families) used in model 2. The final model explains 22.3% of the variation on children's sum 2 skinfold for age Z-scores.

In summary the combined model findings show maternal height and child birth order have a significant association with child's height. Single parent families significantly (54.8%, Appendix E) explain some of the decreases in child's (Z-score BMI in 0.552) BMI in 1.480 units when accounting for maternal WHtRatio. Subsequent models showed maternal age as a significant contributor to child total leg length and maternal WHtRatio to child body fat (sum 2 skinfolds). A positive association was found for children's leg length Z-score with a decrease when accounting for maternal age. For WHtRatio a negative significant relation was found on children's sum 2 skinfolds Z-score. Models presented are the ones that best and significantly matched the outcome with the predictors selected. This was determined after different levels of analysis to validate the models. Linear relationships between predictor and outcome variables were verified by scatter plots. Residual values were examined for assumptions of normality through statistical tests and dispersion diagrams. Correlation between the predictor variables was checked by producing the variance inflation factor (VIF) and no cases of violated assumptions were found (if predictor has a strong linear relationship with another predictor). Cook's distance test was applied to residuals when performing regression models and they provided information on outlier cases. The variables that showed a significant association ($p<0.05$) with the outcome were retained in the analysis and all models were adjusted for age and sex of the child.

Table 5.16 summarizes de main conclusions from the regression models. An intergenerational effect was found for maternal Z-score height when accounting for child's height. Important environmental variables identified in this sample of Cape Verdean ancestry children were child's birth order, single parent families and maternal age.

Table 5. 16. List of intergenerational and environmental effects significant on Cape Verdean ancestry children's growth in 2013.

Intergenerational factors	Environmental factors
Maternal age	Birth order
Maternal height	Single parent families
Maternal WHtRatio	Maternal age

The next section will focus on research question regarding the nutritional health of the Cape Verdean children compared to the Portuguese child population. Malnutrition rates translated into overweight and obesity, stunting and leg stunting rates will be analysed and compared for the Cape Verdean ancestry and Portuguese children. Biosocial determinants (anthropometry + SES) will be considered as predictors of children's nutritional health.

Chapter 6. Socioeconomic status and biological factors related to physical growth of Cape Verdean ancestry children living in Lisbon (Portugal) compared to the general Portuguese population.

This chapter will focus on differences between children born in Portugal from Cape Verdean ancestry at different time frames (1992, 2009, and 2013). Some of the participants included in the analysis presented in this chapter are of Cape Verdean ancestry and they will be referred to as CVPT throughout. Moreover these samples will be compared with a national study on the Portuguese population (PT2009). The Portuguese national study by Padez and collaborators (Bingham et al. 2013) was a national survey that included several data regarding the anthropometric profile for the children, as well as active and sedentary behaviours and characteristics of the built in environment collected by a questionnaire sent to parents. Firstly, descriptive data are presented on children's height, weight, BMI, sitting height, triceps and subscapular skinfolds. The respective Z-score values will also be analysed according to child's age and sex. Secondly, malnutrition rates are presented according to International references (WHO, CDC, IOTF) on the Portuguese (PT2009) and Cape Verdean databases (CVPT1992, CVPT 09, CVPT2013). Subsequently section 6.3 will show multiple linear regression models on socioeconomic determinants of CVPT2013 nutritional health. The last section will present a logistic regression model that allowed differentiating of socio-demographic and biological predictors of overweight and obesity of Portuguese and Cape Verdean ancestry children (PT2009 and CVPT2013 respectively).

6.1 Descriptive information on databases (CVPT1992, CVPT2009, CVPT13 and PT2009) used to compare children's nutritional status

Table 6. 1. Common anthropometric measures for Portuguese and Cape Verdean ancestry children.

	Database			
	CVPT1992	CVPT2009	CVPT2013	PT2009
Variables				
Height (cm)	✓	✓	✓	✓
Sitting height (cm)	✓	✓	✓	✓
Weight (Kg)	✓	✓	✓	✓
BMI	✓	✓	✓	✓
Arm circumference (cm)	✓	✓	✓	
Waist circumference (cm)			✓	
Sitting height ratio (Frisancho 2008)	✓	✓	✓	✓
Total leg length (Frisancho 2008)	✓	✓	✓	✓
Relative leg length index	✓	✓	✓	✓
Triceps skinfold (mm)	✓	✓	✓	✓
Subscapular skinfold (mm)	✓	✓	✓	✓
Abdominal skinfold	✓	✓	✓	
Biceps skinfold	✓	✓	✓	
Sum of skinfolds (triceps+subscapular)	✓	✓	✓	✓
Sum 4sk(trc+bc+abdom+subsc)	✓	✓	✓	

Tables 6.1 (anthropometric variables) and 6.2 (environmental variables) show the common measures on 4 databases. For all the direct measures in Table 6.1 Z-score equivalents were calculated. Some variables like arm and waist circumference were not collected on the Portuguese (PT2009) sample and waist circumference wasn't collected on any of the earlier Cape Verdean ancestry databases (CVPT1992, CVPT2009). No significant information was available on the biosocial variables for the Cape Verdean databases from 1992 and 2009.

Table 6. 2. Common environmental variables used in Cape Verdean and Portuguese ancestry children.

	Database	
	CVPT2013	PT2009
Variables		
Single parent families	✓	✓
Household size	✓	✓
Children under 10 years living household	✓	✓
Age mother	✓	✓
Age father	✓	✓
Father education	✓	✓
Maternal education	✓	✓
Maternal occupational class	✓	✓
Father occupational class	✓	✓
Asset Personal computer (desktop or laptop)	✓	✓
Asset internet	✓	✓
Asset TV	✓	✓
Ethnic group both parents (ancestry)	✓	✓
Maternal birth place	✓	✓
Father birth place	✓	✓
Birth weight	✓	✓
Birth order	✓	✓
Gestational age	✓	✓
Breast feeding duration	✓	✓
Breastfeeding yes /no	✓	✓
Maternal weight gain pregnancy	✓	✓
Sleep hours per week	✓	✓
Meals per day	✓	✓
Way to school	✓	✓

Descriptive information on the different age ranges is given in Table 6.3. For all databases median/ Interquartile range are presented where the data were non-normally distributed and mean/ SD are presented where the data were normally distributed. Age ranges are from 6 to 12 years old and these are divided into three equal categories: 6-7.99, 8-9.99 and 10-11.99 years old.

Table 6. 3. Descriptive information on Portuguese and Cape Verdean samples according to sex and age.

	Boys			Girls			All		
Age (years)	n	Median	IQR	n	Median	IQR	n	Median	IQR
Cape Verdean PT database 1992									
6.00-7.99	43	7.13	6.55-7.63	41	7.02	6.52-7.65	84	7.07	6.55-7.65
8.00-9.99	35	9.01	8.58-9.35	18	9.43	9.15-9.60	53	9.15	8.78-9.48
10.00-11.99	18	10.24	10.05-10.37	9	10.23	10.19-10.57	27	10.23	10.14-10.38
Total	96	8.17	7.32-9.47	68	7.83	6.34-9.48	164	7.97	7.05-9.47
Cape Verdean PT database 2009									
6.00-7.99	21	6.70	6.42-6.91	45	6.94	6.51-7.31	66	6.85	6.47-7.11
8.00-9.99	33	9.00	8.44-9.52	31	8.90	8.65-9.40	64	9.00	8.54-9.42
10.00-11.99	16	11.08	10.36-11.53	24	10.59	10.38-11.10	40	10.97	10.38-11.42
Total	70	8.84	6.92-9.95	100	8.46	6.99-9.98	170	8.65	6.94-9.97
PT database 2009									
6.00-7.99	351	7.12	6.67-7.55	356	7.11	6.72-7.54	707	7.12	6.71-7.55
8.00-9.99	382	8.97	8.52-9.44	414	9.12	8.59-9.59	796	9.03	8.57-9.51
10.00-11.99	82	10.24	10.15-10.44	57	10.29	10.18-10.67	139	10.26	10.15-10.52
Total	815	8.34	7.24-9.29	827	8.35	7.24-9.33	1642	8.34	7.24-9.30
Cape Verdean PT database 2013									
6.00-7.99	16	7.22	0.46	21	7.26	0.65	37	7.24	0.57
8.00-9.99	16	8.86	0.48	18	9.06	0.54	34	8.97	0.52
10.00-11.99	9	10.7	0.42	9	10.7	0.62	18	10.3	0.51
Total	41	8.64	1.43	48	8.58	1.44	89	8.61	1.43

In the last age category a median value of 10 is observed for all databases except for CVPT2009 boys. Median values of 9 years old are found among CVPT1992, CVPT2009 and PT2009 for the second age category. The lowest median value is found for the first age category in CVPT2009 (6.85 years old). Most of the children from the other databases (CVPT2013, PT2009 and CVPT1992) have mean/median values close to 7 years old. Table 6.4 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 (CVPT92, CVPT09, CVPT13 and PT09). The general pattern of differences was that Cape Verdean boys in 2013 were generally taller (M=134.25, SD=9.76) compared to other Cape Verdean counterparts (CVPT2009 (M=132.75, SD=10.67)) and compared with the Portuguese in 2009 (M=129.63, SD=8.54). Also Cape Verdean boys in 2013 had higher Z-score sitting height (-0.04±1.05), lower triceps (Median=7.10 interquartile range (25-75%) =6.15 to 10.50) and subscapular skinfold (Median=4.60 interquartile range (25-75%) =4.05 to 6.25) compared to Portuguese in 2009 and Cape Verdean in 1992. For girls the general trend was that Cape Verdean girls in 2009 were taller than other Cape Verdean ancestry children from the earlier cohorts and the Portuguese in 2009. The same trend was observed for triceps skinfold for the Cape Verdean girls measured in 2009. In Table 6.5 height and triceps skinfolds/triceps Z-score show significant differences compared to the Portuguese sample ($p<0.05$).

Table 6. 4. Descriptive values (Mean/median [a] ±SD/IQR [b]) and ANOVA test for Portuguese and Cape Verdean boys.

Variables					Diff [x,y]		
	1992 CVPT N=96	2009 CVPT N= 70	2013 CVPT N= 41	2009 PT N= 815	X^2	*F*	*p-value*
Age decimal (years) [y]	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*
Height (cm) [x]	*129.35±8.71*	*132.75±10.67*	*134.25± 9.76*	*129.63 ± 8.54*		6.160	*p<0.001*
Z-score height [x]	*0.05±0.82*	*0.22±0.89*	*0.58±1.05*	*0.16 ± 0.88*		3.652	*0.012*
Sitting height (cm) [x]	69.41±4.43	68.22±4.22	69.55± 4.85	68.48± 4.11		2.302	*ns*
Z-score SH [x]	*0.14±1.09*	*-0.47±0.95*	*-0.04±1.05*	*-0.07±0.92*		5.751	*0.001*
Weight (kg) [y]	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*
Z-score weight [5]	-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*
BMI [y]	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*
Triceps SK (mm) [y]	*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*
Z-score TRC SK [y]	*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*
Subscapular SK (mm) [y]	*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*
Z-score SUBC SK [y]	*-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 6. 5. Descriptive values (Mean/median [a] ±SD/IQR [b]) and ANOVA test for Portuguese and Cape Verdean girls.

Variables					Diff [x,y*]		
	1992 CVPT N=68	2009 CVPT N= 100	2013 CVPT N= 48	2009 PT N= 827	X^2	*F*	*p-value*
Age decimal (years) [y]	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*
Height (cm) [y]	*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*
Z-score height [x]	-0.03±0.78	0.31±0.91	0.12±0.90	0.08±0.92		2.337	*ns*
Sitting height (cm) [x]	68.39±4.48	68.09±4.74	69.00± 5.09	68.33± 4.38		0.462	*ns*
Z-score SH [x]	0.62±0.96	0.25±1.73	0.38±0.94	0.44±0.94		1.721	*ns*
Weight (kg) [y]	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*
Z-score weight [y]	-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*
BMI [y]	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*
Triceps SK (mm) [y]	*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*
Z-score TRC SK[y]	*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*
Subscapular SK (mm)[y]	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*
Z-score SUBC SK [y]	-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*

[*] **[a]** Mean/ SD are presented where the data were normally distributed and ANOVA test was applied([x]) . Median/ IQR (interquartile range) are presented where the data were non-normally distributed and the Kruskal-Wallis rank sum test was applied (y); ns: non-significant values; df: degrees if freedom from ANOVA test.

An analysis of variance showed that there were significant 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 in height between Portuguese (PT2009) (M=129.63, SD=8.54) and two of the Cape Verdean datasets (CVPT2009 (M=132.75, SD=10.67; CVPT2013 (M=134.25, SD=9.76), with the Cape Verdean children being taller on average. Z-score height (*F* (3) =3.652, *p*=0.012) was significantly higher for Cape Verdean measured in 2013 (CVPT2013 (M=0.58, SD=1.05)) than the Portuguese (M=0.16, SD=0.88) and the Cape Verdean measured in 1992 (CVPT1992 M=0.05, SD=0.82). On the other hand Cape Verdeans 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 (CVPT1992 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 labelled 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 CVPT2013 (Median=-0.42 interquartile range (25-75%) =-0.82 to 0.34), compared with the Portuguese (Mean=-0.13, interquartile range=-0.55 to 0.40) and the Cape Verdean 1992 database (CVPT1992 Median=0.06, interquartile=-0.29 to 0.85). For Z-score subscapular X^2 (3, 1020) = 19.133, p≤0.01, CVPT1992 (Median=-0.08 interquartile range=-0.33 to 0.73) have significantly higher means than CVPT2013 (Median=-0.50 interquartile range=-0.72 to 0.16) and PT (Median=-0.04 interquartile=-0.40 to 0.50).

The girls height from the CVPT2009 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 (Mean=128.9,interquartile=122.4 to 135.1) and their counterparts measured in 1992 CVPT1992 (Mean=128.1 interquartile=120.1 to 133.5). However, there were no 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. Z-score triceps X^2 (3, 1041) = 22.089, p≤0.01) is higher for CVPT2009 (Median=0.13, interquartile=-0.52 to 0.67,) compared to Portuguese (Median=-0.23, interquartile range= -0.68 to 0.37) and lower than CVPT1992 (Median=- 0.01, interquartile= -0.43 to 0.56).

6.2 Nutritional status indicators for all databases (CVPT1992, CVPT2009, CVPT13 and PT2009)

Nutritional status indicators were assessed using under and overweight/obesity prevalence. Figure 6.1 shows under and over nutrition rates for the CVPT databases compared to the Portuguese database using centile curves of the IOTF (International Obesity Task Force) references (Cole et al. 2000; Cole et al. 2007). No significant differences were found in nutritional status between Cape Verdean ancestry children in the four different databases (CVPT92, CVPT09, CVPT13 and PT09).

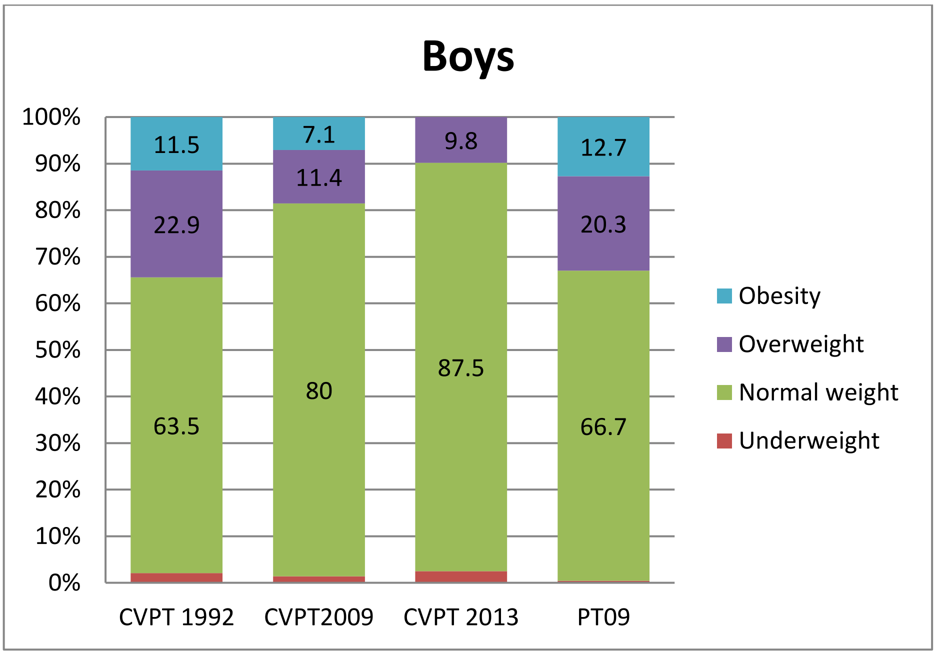

Figure 6. 1 Over and under nutrition for boys using IOTF cut-off points for Cape Verdean and Portuguese databases.

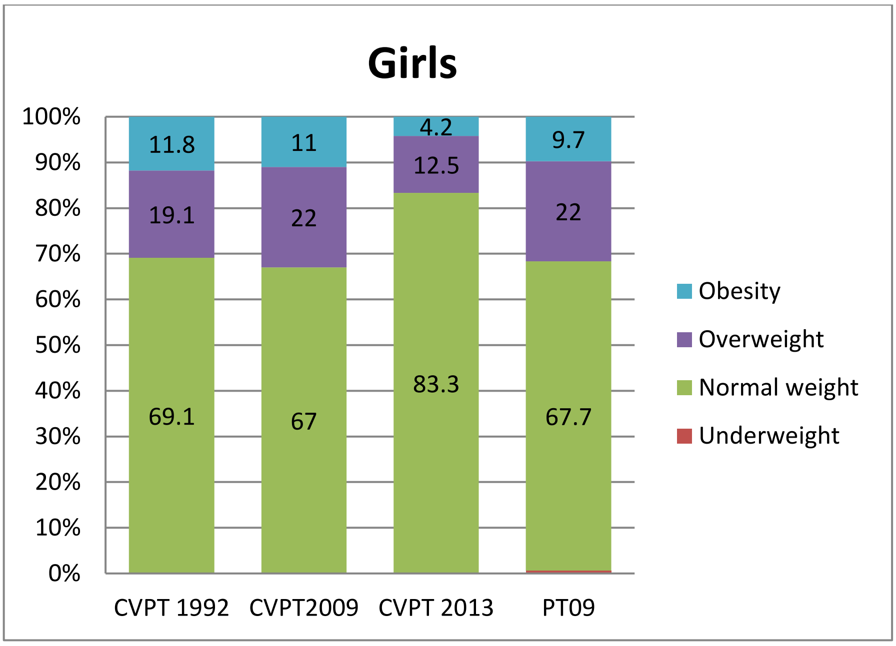

Figure 6. 2 Over and under nutrition for girls using IOTF cut-off points for Cape Verdean and Portuguese databases.

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% of obese boys and 11.8% of obese girls. Table 6.6 refers to the test statistics for the differences between the boys and girls in the CVPT2013 database. Boys in CVPT2013 have lower over nutrition rates (OW/OB= 9.8%) compared to girls (OW/OB=16.7%) when using IOTF cut off points.

Table 6. 6. Test statistics for differences found for under and over nutrition references.

Dependent variable	X^2	df	p-value	n
Boys				
IOTF	16.827	3	*0.001*	1022
Stunted WHO	1.944	3	0.584	1024
Underweight CDC	1.761	3	0.623	1024
Girls				
IOTF	4.775	3	0.189	1041
Stunted WHO	1.567	3	0.667	1047
Underweight CDC	3.903	3	0.270	1043

df: degrees of freedom

Tables 6.7 and 6.8 present different malnutrition rates according to different growth references for the Cape Verdean and Portuguese ancestry children. Over and under nutrition rates for the CVPT 13 database have been already reported in chapter 4 (section 4.3.2.3) and are presented again here to help in comparing with other databases. Values found for either boys or girls were quite similar. The same trend was observed for boys regardless of the growth reference used i.e. higher OW/OB prevalence for Portuguese children compared to Cape Verdean ancestry children.

Table 6. 7. Nutritional status indicators (%) for Cape Verdean and Portuguese ancestry boys.

Percentages	CVPT1992			CVPT 2009			CVPT2013			PT2009		
	WHO	CDC	IOTF	WHO	CDC	IOTF	WHO	CDC	IOTF	WHO	CDC	IOTF
Stunting	0	2.1(2)	---	1.4(1)	1.4(1)	---	0	4.9(2)	---	0.5(4)	2.1(17)	---
Underweight	1(1)	3.1(3)	2.1(2)	1.4(1)	1.4(1)	1.4(1)	2.4(1)	4.9(2)	2.4(1)	0.2(2)	2.3(19)	0.4(3)
Normal weight	86.5(83)	66.7(64)	63.5(61)	90(63)	81.4(57)	80(56)	97.6(40)	87.8(36)	87.8(36)	85.3(695)	68.7(560)	66.7(543)
Overweight	11.5(11)	18.8(18)	22.9(22)	5.7(4)	10(7)	11.4(8)	0	7.3(3)	9.8(4)	10.2(83)	15.7(128)	20.3(165)
Obese	1(1)	11.5(11)	11.5(11)	2.9(2)	7.1(5)	7.1(5)	0	0	0	4.3(35)	13.3(108)	12.7(103)

WHO- World Health Organization, CDC- Centre for disease control, references available in Frisancho (Frisancho 2008) and IOTF- International Obesity Task Force (Cole et al. 2000; Cole et al. 2007). Stunting was analysed using Frisancho -2 standard deviation using Z-score values (Frisancho 2008). Values presented are percentages and frequencies are shown in brackets.

Table 6. 8. Nutritional status indicators (%) for Cape Verdean and Portuguese ancestry girls.

Percentages	CVPT 1992			CVPT2009			CVPT2013			PT2009		
	WHO	CDC	IOTF	WHO	CDC	IOTF	WHO	CDC	IOTF	WHO	CDC	IOTF
Stunting	0	0	---	0	1(1)	---	0	2.1(1)	---	0.7(6)	3.4(28)	---
Underweight	0	1.5(1)	0	0	2(2)	0	0	0	0	0.5(4)	1.7(14)	0.6(5)
Normal weight	88.2(60)	72.1(49)	69.1(47)	87(87)	70(70)	67(67)	95.8(46)	81.3(39)	83.3(40)	88.5(732)	69.4(574)	67.7(558)
Overweight	11.8(8)	14.7(10)	19.1(13)	12(12)	16(16)	22(22)	4.2(2)	14.6(7)	12.5(6)	9.6(79)	18.3(151)	22(181)
Obese	0	11.8(8)	11.8(8)	1(1)	12(12)	11(11)	0	4.2(2)	4.2(2)	1.5(12)	10.6(88)	9.7(80)

WHO- World Health Organization, CDC- Centre for disease control, references available in Frisancho (Frisancho 2008) and IOTF- International Obesity Task Force (Cole et al. 2000; Cole et al. 2007). Stunting was analysed using Frisancho -2 standard deviation using Z-score values (Frisancho 2008). Values presented are percentages and frequencies are shown in brackets.

Higher OW/OB prevalence for Portuguese children compared to Cape Verdean ancestry children was found when comparing data collected in the same year (2009). Portuguese girls have lower OW/OB rates when using WHO references. Over nutrition rates were higher for CVPT2009 and lower for CVPT1992 (ns) when using IOTF references. Contrary to this, combined rates when using CDC reference standards are higher among the Portuguese (28.9%) than the Cape Verdean sample (28%) in the same year (2009), although these differences are small. Between Cape Verdean ancestry children from the 1992 database and 2009, the earlier sample always scores higher rates regardless of the growth reference used. Moreover stunting rates for both sexes were still very low.

When comparing Cape Verdean children with the Portuguese national study, significant differences were found only for over nutrition among boys ($X^2(3) = 16.827$, n=1022, $p \leq 0.001$) (Figure 6.1). There is more overweight and obesity among Portuguese boys (20.3% and 12.7%, respectively) when compared to Cape Verdeans in 2013 (9.8% and 0%, respectively for 2013 database) ($p \leq 0.001$). This significant difference is also apparent when comparing the Portuguese sample with the Cape Verdean sample in the same year 2009 (11.4% OW, 7.1 % OB) $p<0.05$. However, more stunting is also observed in Portuguese boys although the percentage is small (4 cases) and differences are 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 6.2). 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 in 2013 (12.5% and 4.2%, respectively, non-significant).

Tables 6.9 and 6.10 show percentiles rates for height, sitting height, leg length, weight and BMI for age for the Cape Verdean ancestry children (CVPT1992, CVPT2009, CVPT2013) and for the Portuguese children (PT2009). For the Portuguese database (PT2009) some of the children were in the unhealthy categories for HFA, SH and LL. For WFA and BMI for age and only a small percentage of children were on the lower rates (lower 5th percentile). The highest percentages of low HFA, SH and LL were found in the CVPT2009 database even though all children were on the healthy range for BMIFA. The CVPT2009 database showed the highest rates for excessive HFA and leg length. Moreover more boys had low leg length (lower 5th percentile) in older samples (CVPT1992 and PT2009, 18.8% and 12.8% respectively).

Table 6. 9. Percentile categories for Cape Verdean ancestry children (CVPT1992, CVPT2009).

CVPT1992	Boys					Girls				
Indicator	HFA	SHFA	LLFA	WFA	BMIFA	HFA	SHFA	LLFA	WFA	BMIFA
Low (< 5th)	1(1)	3.1(3)	18.8(18)	0	0	0	1.5(1)	8.8(6)	0	0
Below average (5-15th)	6.3(6)	8.3(8)	27.1(26)			10.3(7)	4.4(3)	22.1(15)		
Healthy (15.1- 85th)	79.2(76)	70.8(68)	54.2(52)	90.6(87)	76(73)	77.9(53)	55.9(38)	66.2(45)	88.2(60)	79.4(54)
Above average (85.1-95th)	11.5(11)	13.5(13)	0	8.3(8)	12.5(12)	8.8(6)	20.6(14)	2.9(2)	8.8(6)	8.8(6)
Excessive (>95th)	2.1(2)	4.2(4)	0	1.1(1)	11.5(11)	2.9(2)	17.6(12)	0	2.9(2)	11.8(8)

CVPT2009	Boys					Girls				
Indicator	HFA	SHFA	LLFA	WFA	BMIFA	HFA	SHFA	LLFA	WFA	BMIFA
Low (< 5th)	1.4(1)	12.9(9)	17.1(12)	2.9(2)	0	1(1)	7(7)	14(14)	0	0
Below average (5-15th)	8.6(6)	10(7)	11.4(8)			7(7)	20(20)	11(11)		
Healthy (15.1- 85th)	70(49)	71.4(50)	52.9(37)	91.4(64)	100(70)	71(71)	45(45)	42(42)	80(80)	100(100)
Above average (85.1-95th)	17.1(12)	4.3(3)	10(7)	2.9(2)	0	12(12)	7(7)	12(12)	15(15)	0
Excessive (>95th)	2.9(2)	1.4(1)	8.6(6)	2.9(2)	0	9(9)	21(21)	21(21)	5(5)	0

HFA: Height-for-age; SHFA: sitting height-for-age; LLFA: leg length-for-age; WFA: Weight-for-age; BMIFA : BMI-for-age. Indicator on percentiles (5th, 15th, 85th, 95th percentile) classification proposed by Frisancho Comprehensive reference (2008); percentages and (frequencies) presented.

Table 6. 10. Percentile categories for Cape Verdean ancestry and Portuguese children (CVPT13, PT2009).

CVPT2013	Boys					Girls				
Indicator	HFA	SHFA	LLFA	WFA	BMIFA	HFA	SHFA	LLFA	WFA	BMIFA
Low (< 5th)	2.4(1)	4.9(2)	4.9(2)	4.9(2)	2.4(1)	0	2.1(1)	0	0	0
Below average (5-15th)	2.4(1)	4.9(2)	7.3(3)	---	---	8.3(4)	6.3(3)	16.7(8)	---	---
Healthy (15.1- 85th)	65.9(27)	80.5(33)	73.2(30)	92.7(38)	95.1(39)	75(36)	68.8(33)	68.8(33)	89.6(43)	85.4(41)
Above average (85.1-95th)	17.1(7)	0	7.3(3)	2.4(1)	2.4(1)	12.5(6)	16.7(8)	12.5(6)	6.3(3)	10.4(5)
Excessive (>95th)	12.2(5)	9.8(4)	7.3(3)	0	0	4.2(2)	6.3(3)	2.1(1)	4.2(2)	4.2(2)

PT2009	Boys					Girls				
Indicator	HFA	SHFA	LLFA	WFA	BMIFA	HFA	SHFA	LLFA	WFA	BMIFA
Low (< 5th)	1.7(14)	4.7(38)	12.8(104)	0.4(3)	0	3(25)	1.3(11)	7(58)	0.4(3)	0.2(2)
Below average (5-15th)	7(57)	9.7(79)	19.1(156)	---	---	8.6(71)	5.3(44)	11.5(95)	---	---
Healthy (15.1- 85th)	75.8(618)	75.3(614)	64(522)	89.7(731)	75.7(616)	74.1(613)	68.2(563)	71.8(593)	83(686)	75.5(624)
Above average (85.1-95th)	9.3(76)	7.2(59)	3.1(25)	6.5(53)	12.4(101)	9.2(76)	15.4(127)	7.5(62)	11.6(96)	14.5(120)
Excessive (>95th)	6.1(50)	3.1(25)	1(8)	3.3(27)	11.9(97)	5.1(42)	9.8(81)	2.2(18)	5.1(42)	9.8(81)

HFA: Height-for-age; SHFA: sitting height-for-age; LLFA: leg length-for-age; WFA: Weight-for-age; BMIFA: BMI-for-age. Indicator on percentiles (5th, 15th, 85th, 95th percentile) classification proposed by Frisancho Comprehensive reference (2008); percentages and (frequencies) presented.

Sexual dimorphism was found for leg length and sitting height for age percentiles in the PT2009 database U (1641)=280074, z=-7.133 and U(1641)=269273, z=8.845, p <0.001 respectively. Boys had lower leg length (Median=27.60, IQ=10.59-50.95) compared to girls (Median=38.00, IQ=20.60-64.00). Also sitting height was higher for boys (Median=68.60, IQ=65.50-71.20) compared to girls (Median=68.20, IQ=65.30-71.20). Also leg length and sitting height were significantly different for boys and girls in the CVPT1992 U (164)=2667, z=-2.264, U(164)=2470, z=-3.112, p<0.05,respectively. Boys showed lower medians for leg length (Median=15.54, IQ=6.11-38.76) than girls (Median=23.67, IQ=11.49-48.64). On the other hand sitting height values were higher for boys (Median=69.60, IQ=66.30 to 72.40) than girls (Median=68.00, IQ=65.03-71.95).

6.3 Sociodemographic and biological determinants of growth for Cape Verdean ancestry children (CVPT2013)

Multiple regression models were used to determine biological and environmental determinants on Cape Verdean ancestry children's growth in 2013 (CVPT2013). A detailed description of the data analysis strategy is presented in the methods chapter (chapter 3), however for ease of interpretation key factors relating to the analysis are summarised again here for the reader. The models focus on outcomes of anthropometric outcomes in the Cape Verdean ancestry children, while considering biological factors (paternal age) and controlling for child's sex and age and maternal anthropometric outcomes (Height, BMI, WC, WHtR). More prenatal factors (birth weight, kg) and environmental factors like birth order, parental occupation (non-manual, manual, unemployed) and maternal marital status (single, married, divorced) were considered. The following tables (6.11 to 6.18) present the models for the different biological and environmental effects tested.

Table 6. 11. Multiple regression parameter estimates (se) of biological and environmental predictors of Cape Verdean ancestry children's height for age Z-scores.

	Model 1			Model 2			Model 3			
	B	SE	p	B	SE	p	B	SE	p	95% CI
Constant	0.678	0.919	0.464	0.569	0.856	0.509	1.136	0.848	0.188	-0.574 to 2.846
Sex child										
Girl (Reference)	1.00			1.00			1.00			
Boy	-0.330	0.246	0.186	-0.416	0.231	0.078	-0.555	0.227	0.019	-1.013 to -0.097
Age child (years)	-0.209	0.110	0.064	-0.232	0.103	0.029	-0.237	0.098	0.019	-0.434 to -0.041
Age mother (years)	0.044	0.016	0.007	-0.014	0.025	0.587	-0.048	0.028	0.090	-0.105 to 0.008
Z-score height mother	0.253	0.143	0.084	0.234	0.134	0.086	0.243	0.127	0.062	-0.013 to 0.500
Age father (years)				0.061	0.021	0.007	0.067	0.020	0.002	0.026 to 0.109
Birth order (ordinal)							0.186	0.078	0.021	0.029
R^2 adjusted		0.221			0.325				0.388	

Model 1 is adjusted for child sex and age, model 2 tests for parental biological influences, model 3 for environmental factors; SE : standard error, N=51, F(6.291), p<0.05, R^2= 0.462 adjusted R^2 =0.388.

Maternal Z-score for height was not significantly associated with the height-for-age- Z-scores of these children (Table 6.12) even after adjusting for father's age and birth order used in models 2 and 3. Father's age and birth order were positively significantly associated with a child's Z-score for height. Boys have significantly lower heights than girls. Maternal age has a negative and significant relation with child's Z-score height (0.028, 95%CI -0.105 to 0.008). The final model explains 38.8% of the variation on children's height.

Table 6. 12. Multiple regression model of biological and environmental predictors for Cape Verdean ancestry children's weight for age Z-scores.

	Model 1			Model 2			Model 3			
	B	SE	p	B	SE	p	B	SE	p	95% CI
Constant	0.347	0.770	0.655	0.278	0.745	0.710	0.957	0.694	0.175	-0.443 to 2.357
Sex child										
Girl (reference)	1.00			1.00			1.00			
Boy	0.447	0.206	0.035	0.394	0.201	0.056	0.227	0.186	0.230	-0.148 to 0.601
Age child	-0.179	0.092	0.058	-0.194	0.089	0.035	-0.200	0.080	0.016	-0.361 to -0.039
Age mother	0.023	0.013	0.082	-0.013	0.022	0.547	-0.055	0.023	0.021	-0.101 to -0.009
Z-score height mother	0.209	0.120	0.088	0.197	0.116	0.096	0.208	0.104	0.052	-0.001 to 0.418
Age father				0.038	0.019	0.045	0.046	0.017	0.008	0.012 to 0.080
Birth order							0.223	0.064	0.001	0.094 to 0.351
R^2 adjusted	0.171			0.226					0.380	

Model 1 is adjusted for child sex and age, model 2 tests for parental biological influences, model 3 for environmental factors; SE : standard error, N=51, F(6.107), $p<0.05$, R^2= 0.454 adjusted R^2 =0.380.

Maternal height was significantly associated with the weight-for-age- Z-score of these children (Table 6.12), even after adjusting for father's age and birth order used in models 2 and 3. Also the child’s birth order was positively significantly associated with child's weight for age Z-score. Other significant factors were child's age with older children presenting higher weight Z-scores. Moreover father's age was also positively and significantly associated to the child's weight Z-score (0.017, 95%CI 0.012 to 0.080). Child's sex was not significantly associated with children’s weight Z-score. The final model explains 38% of the variation in children's weight.

Table 6. 13. Multiple regression model of biological and environmental predictors for Cape Verdean ancestry children's BMI for age Z-scores.

	Model 1			Model 2			Model 3			
	B	SE	p	B	SE	p	B	SE	p	95% CI
Constant	0.858	0.849	0.444	1.136	0.888	0.198	0.574	0.818	0.487	-1.078 to 2.227
Sex child										
Girl (reference)	1.00			1.00			1.00			
Boy	0.147	0.213	0.493	0.076	0.212	0.722	0.078	0.194	0.692	-0.314 to 0.700
Age child	-0.204	0.103	0.055	-0.20	0.101	0.049	-0.229	0.093	0.018	-0.416 to -0.041
Age mother	0.022	0.013	0.100	0.001	0.018	0.979	0.010	0.017	0.564	-0.024 to 0.043
Z-score AC mother	0.242	0.131	0.072	0.189	0.131	0.157	0.191	0.120	0.119	-0.052 to 0.434
Birth order				0.135	0.074	0.076	0.113	0.068	0.107	-0.025 to 0.251
Marital status single							1.00			
other							0.647	0.217	0.005	0.210 to 1.085
R^2 adjusted		0.131			0.175			0.306		

Model 1 is adjusted for child sex and age, model 2 tests for parental biological influences, model 3 for environmental factors; SE: standard error, N=48, F(4.458), $p<0.05$, R^2= 0.395 adjusted R^2 =0.306.

Maternal arm circumference was not associated with the BMI-for-age- Z-score of these children (Table 6.13) even after adjusting for birth order and maternal marital status used in models 2 and 3. Similarly child birth order was not significant in its association with child's BMI for age Z-score. In contrast maternal marital status other than single mothers had a significant association with a child's BMI. Mothers who were not single parents had children with significantly higher BMI for age Z-scores (on average 0.647 units higher). Child's age had a negative but significant association with BMI (0.194, 95%CI -0.314 to 0.700). Child's sex was not significantly associated with BMI for age Z-score. The final model explained 30.6% of the variation on children's BMI.

Table 6. 14. Multiple regression model of biological and environmental predictors for Cape Verdean ancestry children's waist circumference Z-scores.

	Model 1			Model 2			Model 3			
	B	SE	p	B	SE	p	B	SE	p	95% CI
Constant	0.915	0.699	0.199	1.328	0.681	0.059	1.520	0.659	0.027	0.181 to 2.858
Sex child										
Girl (reference)	1.00			1.00			1.00			
Boy	0.553	0.187	0.005	0.471	0.179	0.013	0.460	0.172	0.011	0.111 to 0.809
Age child	-0.108	0.082	0.195	-0.121	0.077	0.125	-0.160	0.076	0.044	-0.315 to -0.005
Age of mother	-0.006	0.012	0.642	-0.023	0.014	0.093	-0.022	0.013	0.104	-0.048 to 0.005
Z-score height mother	0.348	0.119	0.006	0.327	0.112	0.006	0.291	0.109	0.011	0.070 to 0.512
Birth order				0.138	0.058	0.022	0.143	0.055	0.014	0.030 to 0.255
Father non-manual (reference)							1.00			
Father other categories							0.824	0.403	0.049	0.005 to 1.643
R^2 adjusted		0.301			0.380				0.430	

Model 1 is adjusted for child sex and age, model 2 tests for parental biological influences, model 3 for environmental factors; SE: standard error, N=42, F (6.153), $p<0.05$, R^2= 0.513 adjusted R^2 =0.430.

Maternal height was significantly associated with the WC-for-age- Z-score of these children (Table 6.15) and that association became slightly weaker but remained significant after adjusting for the variables used in models 2 and 3 (birth order and father's non-manual occupation). Child's age and sex were significantly associated with child waist circumference Z-score. Younger boys were associated with significantly higher values for WC Z-scores. Also child birth order and father’s occupation (non-manual) were significant in their association with the child’s WC Z-score. Higher waist circumference is expected for a higher birth order (0.055, 95%CI 0.030 to 0.255). Paternal occupation other than non-manual is also associated with children's higher waist circumference Z-score (0.403, 95%CI 0.005 to 0.255). The final model explains 43% of the variation in children's WC.

Table 6. 15. Multiple regression model of biological and environmental predictors for Cape Verdean ancestry children's sum of 2 skinfolds Z-scores (triceps and subscapular).

	Model 1			Model 2			Model 3			
	B	SE	p	B	SE	p	B	SE	p	95% CI
Constant	-0.918	0.779	0.245	-0.950	0.754	0.214	-2.098	0.934	0.030	-3.983 to -0.213
Sex child										
Girl (Reference)	1.00			1.00			1.00			
Boy	0.598	0.196	0.004	0.556	0.191	0.006	0.569	0.185	0.004	0.196 to 0.941
Age child	-0.040	0.095	0.676	-0.051	0.092	0.584	-0.035	0.089	0.693	-0.216 to 0.145
Age mother	0.020	0.012	0.118	-0.015	0.021	0.484	-0.015	0.020	0.455	-0.056 to 0.025
Z-score AC mother	0.264	0.120	0.033	0.247	0.116	0.039	0.207	0.114	0.078	-0.024 to 0.438
Age father				0.035	0.017	0.051	0.031	0.017	0.073	-0.003 to 0.065
Birth weight							0.387	0.197	0.056	-0.010 to 0.785
R^2 adjusted		0.227			0.277				0.322	

Model 1 is adjusted for child sex and age, model 2 tests for parental biological influences, model 3 for prenatal factors; SE : standard error, N=49, F(4.800), p<0.05, R^2= 0.407 adjusted R^2 =0.322.

Maternal arm circumference was initially associated with the sum of 2 skinfolds (triceps and subscapular) for-age- Z-score of these children (Table 6.16) but that association changed to be insignificant after adjusting for father's age and child's birth weight used in models 2 and 3. Child's age was not significantly associated with Z-score sum 2 skinfolds. However, the model shows that boys have significantly lower sum 2 skinfolds Z-score (0.185, 95%CI 0.196 to 0.914). Moreover child birth weight and father's age were not significantly associated with higher child's sum 2sk-for-age- Z-score. The final model explains 32.2% of the variation on children's sum 2sk-for-age- Z-score.

Table 6. 16. Multiple regression model of biological and environmental predictors for Cape Verdean ancestry children's sum 2 skinfold Z-scores with maternal WHtRatio.

	Model 1			Model 2			
	B	SE	p	B	SE	p	95% CI
Constant	-1.915	0.983	0.058	-1.573	1.019	0.130	-3.628 to 0.482
Sex child							
Girl (Reference)	1.00			1.00			
Boy	0.724	0.193	0.001	0.686	0.194	0.001	0.295 to 1.078
Age child	-0.011	0.095	0.906	-0.012	0.095	0.903	-0.203 to 0.180
Age mother	0.003	0.013	0.836	-0.007	0.016	0.637	-0.039 to 0.024
WHtR mother	2.650	1.280	0.044	2.332	1.302	0.080	-0.293 to 4.957
Birth order				0.079	0.066	0.238	-0.054 to 0.213
R^2 adjusted	0.246					0.253	

Model 1 is adjusted for child sex and age , model 2 tests for environmental factors; SE : standard error, N=49, F(4.259), $p<0.05$, R^2= 0.331 adjusted R^2 =0.253.

Maternal WHtRatio was initially significantly associated with the sum 2sk-for-age- Z-score of these children (Table 6.17) but that association changed to become insignificant after adjusting for birth order used in model 2. Child’s sex was significantly associated and boys were associated with lower sum of 2 skinfolds Z-scores (0.194, 95%CI 0.295 to 1.078). However child birth order was not significant in its association with child’s sum of 2sk-for-age- Z-score. The final model explains 25.3% of the variation of children's sum 2sk-for-age- Z-score.

Table 6. 17. Multiple regression model of biological and environmental predictors for Cape Verdean ancestry children's arm circumference Z-scores.

	Model 1			Model 2			
	B	SE	p	B	SE	p	95% CI
Constant	-0.542	1.033	0.602	-0.604	1.00	0.552	-2.630 to 1.423
Sex child							
Girl (Reference)	1.00			1.00			
Boy	0.989	0.262	0.000	0.926	0.257	0.001	0.409 to 1.444
Age child	-0.157	0.116	0.180	-0.173	0.113	0.133	-0.401 to 0.055
Age mother	0.013	0.016	0.409	-0.029	0.028	0.297	-0.085 to 0.027
BF% mother	0.021	0.013	0.097	0.021	0.012	0.091	-0.004 to 0.046
Age father				0.044	0.024	0.068	-0.03 to 0.091
R^2 adjusted		0.278				0.314	

Model 1 is adjusted for child sex and age, model 2 tests for parental biological influences; SE : standard error, N=53, F(5.754), $p<0.05$, R^2= 0.380 adjusted R^2 =0.314.

Maternal body fat (%) was not significantly associated with the AC-for-age- Z-score of these children (Table 6.18) and that association did not change after adjusting for father's age. Also father's age was not significantly associated with the child's AC -for-age- Z-score. However child's sex was significantly different for boys and girls with the girls showing lower AC Z-score values (0.257, 95%CI 0.409 to 1.444). The final model explains 31.4% of the variation on children's AC-for-age-Z-score.

Table 6. 18. Multiple regression model of biological and environmental predictors for Cape Verdean ancestry children's leg length Z-scores.

	Model 1			Model 2			
	B	SE	p	B	SE	p	95% CI
Constant	-0.867	0.963	0.372	-2.415	1.194	0.048	-4.810 to -0.020
Sex child							
Girl (Reference)	1.00			1.00			
Boy	0.221	0.250	0.380	0.217	0.242	0.376	-0.270 to 0.703
Age child	-0.076	0.114	0.507	-0.068	0.110	0.538	-0.290 to 0.153
Age mother	0.038	0.016	0.019	0.036	0.015	0.021	0.006 to 0.067
Birth weight				0.500	0.240	0.042	0.018 to 0.982
R^2 adjusted		0.056			0.112		

Model 1 is adjusted for child sex and age, model 2 tests prenatal factors; SE: standard error, N=57, F(2.765), $p<0.05$, R^2= 0.175 adjusted R^2 =0.112.

Child birth weight was significantly associated with their leg length-for-age- Z-score (Table 6.18). Maternal age was also significant for child's length-for-age- Z-score (0.240, 95%CI 0.018 to 0.982). Children born from younger mothers showed higher leg length. No other significant predictors were found for this dependent variable. Only 11.2 % of the variation in leg length is explained by this model.

Information in table 6.19 biological and environmental variables found to be significantly related to Cape Verdean ancestry children's growth and body composition. Both biological factors and sociodemographic predictors were identified. Parental education was not significant in any of the models.

Table 6. 19. Biological and environmental predictors significant for Cape Verdean ancestry children's growth and body composition.

Biological	Significant
Age child	✓
Sex child	✓
Maternal height Z-score	✓
Child birth weight	✓
Age mother	✓
Age father	✓
Environmental factors	
Maternal marital status	✓
Birth order	✓
Father occupation	✓

For variables associated with linear growth (height, leg length) the strongest predictors based on *p-value* and CI95% were parental age, birth order and child's birth weight. Older parents had children with higher mean values for height Z-score and lower leg length Z-score. It was observed that the higher the birth order the higher the children’s height. On the other hand the higher the birth weight the lower the leg length Z-scores. Also birth weight and child's sex were significant for child's body composition (Z-score sum 2 skinfolds). For a higher birth weight a lower sum skinfold (Z-score) would be observed specially among boys. For the socioeconomic variables it can be observed that maternal marital status (single, reference) was significantly associated with child's BMI Z-score and that father's non-manual occupation was significantly associated with the child’s waist circumference Z-score. Mothers married or divorced compared to single mothers had children with higher BMI while fathers working manual jobs, retired or unemployed have children with on average higher waist circumference Z-score (girls) compared to those working in non-manual occupations.

6.4 Sociodemographic and biological determinants of overweight and obesity of Cape Verdean and Portuguese ancestry children (CVPT2013 and PT2009 databases)

Because there was missing data on socio-demographic factors the CVPT2009 and CVPT1992 databases these databases were excluded from this section. The Portuguese (PT2009) and Cape Verdean databases (CVPT2013) were used because they shared common variables like maternal education, occupation and breastfeeding duration (months). Mann-Whitney (scale variables) and Chi-square tests (categorical variables) were performed in order to determine differences in socio-demographic factors for child OW/OB between the two databases. Consequently differences between PT2009 and CVPT2013 were identified for maternal age, birth weight and breastfeeding duration (Appendix F). Portuguese mothers were significantly older (Median=38.00, IQ=34.00-42.00) than the Cape Verdean ones (Median=33.87, IQ=27.79-40.34), U (1647) =32653, z=-4.141, p<0.01. Also Cape Verdean mothers breastfed for longer (Median=10.50, IQ=3.00-16.00) than Portuguese mothers (Median=3.00, SD=1.00-4.00), U (1640) =22828, z=-5.906, p<0.05. Birth weight was borderline significantly different for the two groups with the Portuguese having higher birth weight on average (kg) (Median=3.25, IQ=2.95-3.55) than the Cape Verdean ancestry children (Median=3.13, IQ=2.74-3.50), U (1593) =38350, z=-1.818, p=0.069. Maternal education and maternal occupation were also significantly different between the two databases $X^2(2, 1783) = 264.285$, $p<0.001$, $X^2(2, 1495) = 156.511$, $p<0.001$ respectively (Figures 6.3 and 6.4).

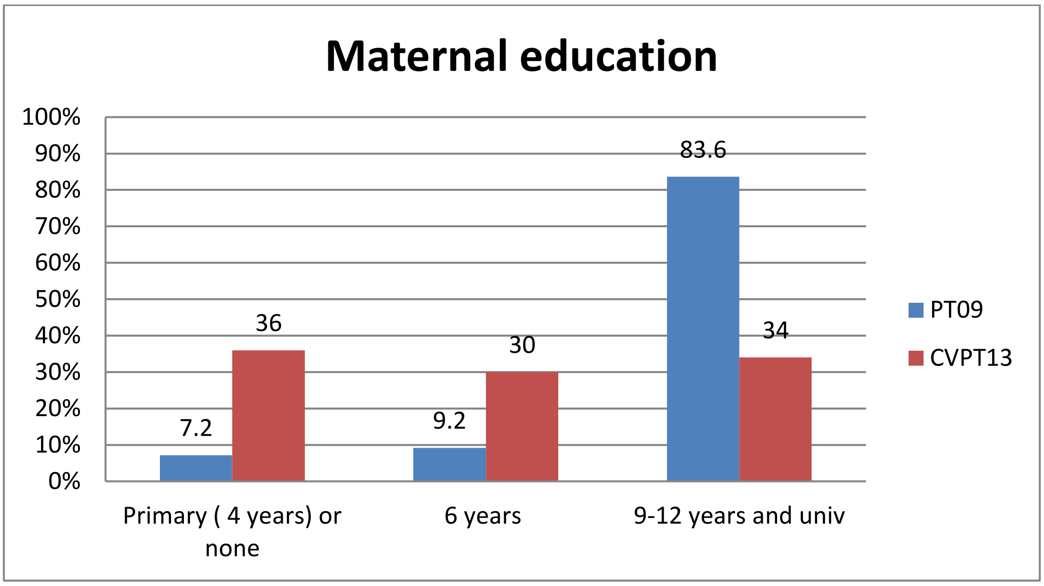

Figure 6. 3.Maternal education levels (%) in Cape Verdean (2013) and Portuguese mothers (2009).

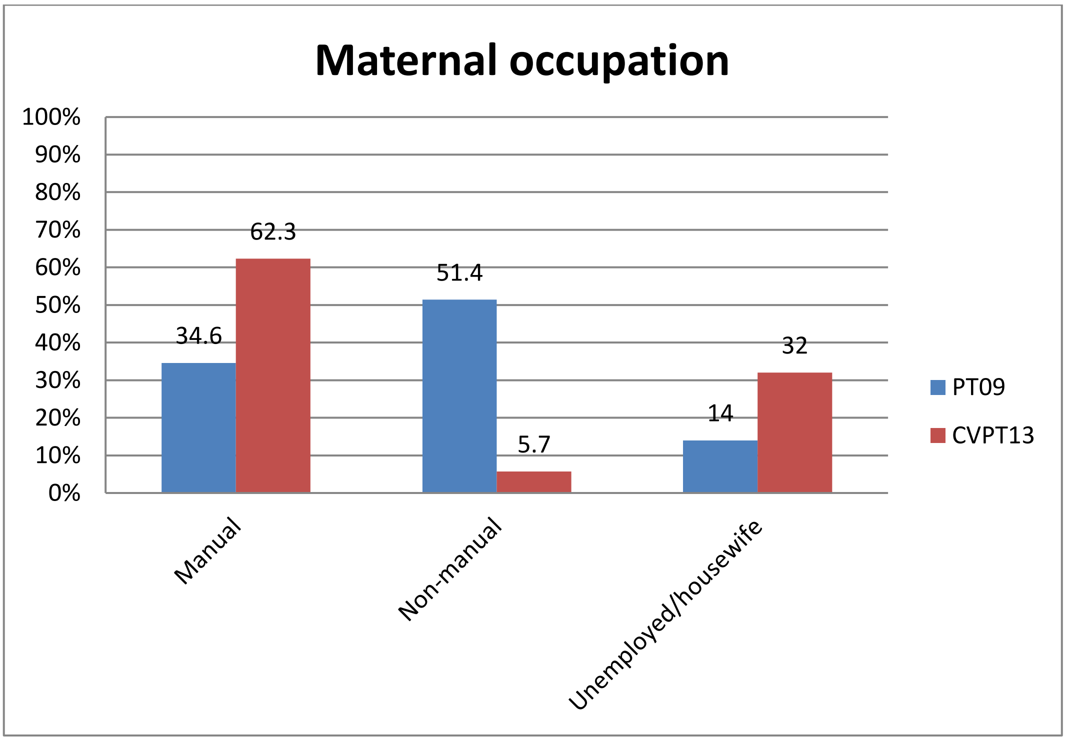

Figure 6. 4. Maternal occupation classes (%) in Cape Verdean (2013) and Portuguese mothers (2009).

Subsequently a logistic regression was performed (Table 6.22) and showed that the model fitted the data well (Hosmer-Lemeshow test 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 6.20). 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.

Table 6. 20. 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 (PT2009, CVPT2013).

	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**;** Explain model 1 tests for control factors like child's sex, age and ancestry, model 2 tests for maternal age , model 3 for and 4 for early file factors , models 5 and model 6 for sociodemographic factors.

Summary

In summary Cape Verdean ancestry children's linear growth (height) increased over time, especially for boys. This change in height was only statistically significant for boys, although the direction of the trend was similar but not statistically significant for girls, with an increase in height between the 1992 and 2009/2013 samples. In contrast there were no significant increases in weight over the same period for the Cape Verdean samples. Consequently decreases in BMI and adiposity indicators (subscapular and triceps skinfolds) were observed for this population during this difficult period (economic crisis, 2008) were observed. Differences between the Portuguese and Cape Verdean databases (PT2009 and CVPT2013, respectively) lie in maternal age, birth weight, maternal education and occupation. Cape Verdean children have a lower risk of overweight and obesity even after adjusting for confounding effects like age, sex, maternal age, maternal education, maternal occupation, birth weight and whether the child was breastfed (model 6).

Chapter 7. Discussion

This chapter puts together all of the findings from previous chapters and contextualizes these within the existing literature. It discusses the research questions and aims of the thesis as well as gaps and limitations of this research area. It ends with strengths and policy implications for future research.

This work has shown that Cape Verdean children living in Lisbon, Portugal in 2013 show good nutritional health with low levels of overweight and obesity (OW/OB) and stunting rates. Despite living in a socio-economically deprived neighbourhood Cape Verdean ancestry children in 2013 seem to have been protected from nutritional transition in Portuguese society. The predominant family structure is composed of single mothers with low educational levels, and long working hours. The diet is diverse and physical activity levels are appropriate for the age range, although there were limitations in the assessment methods used to ascertain physical activity levels in this sample. Cultural practises like breastfeeding seem to be working along with sociodemographic factors to buffer nutritional status of these Cape Verdean ancestry children living in Portugal.

Research Question 1 - How does the nutritional status of the Cape Verdean children associate with time, sex, socioeconomic status (SES), general living conditions, family composition, diet and physical activity levels?

Summary of findings

Cape Verdean ancestry children living in Portugal in 2013 present good nutritional status translated into low OW/OB rates and stunting compared to previous samples collected from the same community (1992, 2009). Linear growth measured by height increased over time especially for boys. Good nutritional health is verified on the analysis of waist circumference (Fernandez and collaborators 2004) and waist-to-height ratio (WHtRatio (McCarthy & Ashwell 2006) showed that only a small percentage of Cape Verdean children in 2013 would be at risk of developing future cardiovascular diseases. Moreover the same trend was observed when analysing classification of children with percentiles for height, leg length and sitting height for age. The majority of the children were classified on the healthy percentile ranges (70.8%

for height-for-age) and a small percentage of children were classified on the low ranges (3) for sitting height and for leg length (2).

Socioeconomic status measured as parental education was associated with their children's nutritional status. Sociodemographic factors observed to be associated with anthropometric outcomes in children were maternal marital status (BMI) and father's non-manual occupation (manual jobs, retired or unemployed) (waist circumference Z-score). Mothers married or divorced had children with higher BMI compared to single mothers while fathers working manual jobs, retired or unemployed were associated with children with higher waist circumference Z-score compared to fathers working non-manual jobs. Furthermore parental age, birth order and child's birth weight were associated with child's linear growth (height, leg length). Older parents had children with higher mean values for height Z-score when accounting for maternal height. It was also observed that birth order had a significant effect on children's height (boys negative effect when accounting for maternal height). Lower leg length Z-score was observed when accounting for lower maternal age and higher child birth weight. Birth weight was also associated with Z-score sum 2 skinfolds. Higher birth weight was associated with a lower sum skinfold (z-score) especially among boys. Moreover most children from this sample were born within normal birth weight (84.8 %).

While maintaining strong cultural links to Cape Verde this first generation of Cape Verdeans born in Portugal show adequate dietary diversity with the support of the local school that provides lunch for the majority of them. Also both their self-reported and measured physical activity levels are in accordance with the school day and age range reported to be approximately 5000 steps in the literature (Burns et al. 2016).

Discussion research question 1

The results of this study are in line with part of the first hypothesis which stated that Cape Verdean ancestry children born in Portugal would show a positive secular change in height (1992, 2003, 2013), although that relationship was only statistically significant for boys. This kind of positive trend with improving socio-economic circumstances was expected (Barreto 2000; Padez & Rocha 2003; Padez 2003b; Padez & Johnson 1999; Padez 2002). This finding is similar to what was observed in other studies of migrants and their height trajectories: 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 et al. 2002; Bogin 2012b).

However and contrary to the latter part of hypothesis 1.1 the same trend was not verified for children's sitting height and weight. The fact that Z-score sitting height shows a different direction of association compared to overall height may be related with the analysis being performed for whole age group (6-12 years old) which covers differences in a specific age range and sex. Previous findings in a similar study showed lower height means for boys and girls in later ages (9-10 years) (ns) (Gama 2002). Gama proposed that these children were worse off because they had failed in school and that it would be reflected in their lower height-for-age (Gama 2002).

Some evidence for hypothesis 1.2 was shown with some socio-demographic factors showing a relationship with anthropometric outcomes including maternal marital status and father's occupation. Our findings are in contrast with a paper published in 2009 with Portuguese adults that showed that neither maternal marital status nor paternal occupation were associated with child's BMI. Maternal marital status (married) was associated only with a healthy diet but not child BMI (OW/OB). A similar association was found for manual workers without significant effect (Santana et al. 2009). The study by Santana and collaborators was conducted in Lisbon Metropolitan Area (LMA) with 7669 adults living in 143 neighbourhoods and reported the relationship between physical and social environments with physical activity and consequently body mass index (BMI) using a multilevel logistic regression model. However Padez and collaborators' study found that in a Portuguese setting paternal education had a protective effect on childhood obesity (Padez et al. 2005). Later on the same effect was reinterred by Bingham and collaborators (Bingham et al. 2013) with Portuguese children. In previous work maternal marital status was associated with small-for-gestational age (SGA) babies independent of childhood conditions (Correia & Barros 2015). In fact single and cohabiting mothers showed higher odds of SGA babies than married ones because unmarried women were more exposed to unhealthy behaviours and social support (Raatikainen et al. 2005). The different associations verified across these studies may be due to different groups studied, sampling techniques, geographies (Oporto, Correia and Barros) and the periods in which the variables were measured (1998/99 for the Santana et al study, 2002/2003 for the Padez et al study also excluding older children than 9 years, Correia and Barros study was conducted in 2005/2006).

A systematic review of previous studies have shown parental occupation to have mixed effects on child adiposity (Shrewsbury & Wardle 2008). Parental occupation including both maternal and paternal occupation was inversely associated with children's adiposity on some studies while no association was found on other studies. The study by Shrewdbury and Wardle showed that the association of SES and adiposity indicators (height, weight, BMI age and sex specific) in children in western developed countries was for the majority of cases inverse and only some cases had positive associations. SES measures included in the analyses were parental education and occupation, family income and home address. In our findings paternal occupation (non-manual) were significant with birth order in their association with the child’s WC Z-score. Paternal occupation other than non-manual was associated with children's higher waist circumference Z-score (0.403, 95%CI 0.005 to 0.255).

Contrary to the second part of hypothesis 1.2 neither diet nor physical activity measurements were associated with Cape Verdean ancestry children's nutritional status in 2013, although there were some methodological limitations with these measures that are discussed in the following sections and that might explain the lack of association observed. We would expect a relationship between dietary measurements, physical activity and BMI if using a different procedure (Moreira et al. 2005). Moreira and collaborators applied a 24-hour recall questionnaire on a random sample of 7-9 years old Portuguese children and extracted that the calcium intake below dietary reference intake, which was higher in Portuguese girls compared with Portuguese boys (Moreira et al. 2005). Calcium intake collected, as calcium-to-protein ratio was later used in a regression analysis that determined the association of calcium intake and BMI. Calcium-to-protein ratio was inversely significantly associated with BMI only in girls after adjusting for age, energy intake, parental education and physical activity.

The general trend of increasing height over time among Cape Verdean ancestry boys is consistent with the secular trend observed in Portugal. This has been associated with significant socioeconomic changes and improved quality of life which is reflected in increasing average height (Barreto 2000; Padez & Rocha 2003; Padez 2003b; Padez 2003a). Past studies showed a positive pattern in the Portuguese Lisbon male population (Lacerda 1904; Padez & Johnson 1999) with increments of 1.8 cm and 1.5 cm respectively (De Castro et al. 1998; Sobral 1988). Moreover, the entry to the European Union (1986) and the democratic period increased the average height in adults by 2.9 cm/decade (Padez & Johnson 1999; Padez 2002). While rising height was associated with better living conditions regional differences became less expressive in 1996 (Padez & Johnson 1999). For Portuguese children at 9 years another study found a mean increase of 4 centimetres comparing mean values from 1988 to 1964 (Carmona da Mota 1990). Subsequently Padez and collaborators when analysing data from 2002/2003 for Portuguese 7-9 years in a national study found that mean values for height among Portuguese boys were 131.3±6.6 and for Portuguese girls 130.9±7.0, both values are higher than our means reported for the Portuguese population in 2009. The explanation might be the selectivity applied to our sample to include only children living in Lisbon district and not using a nationally representative sample like the one Padez and collaborators reported. Also the national study in 2002 reported that BMI increased between 1970 and 2002 (Padez et al. 2004). In the latter period (1992-2002) BMI increased as changes in weight were higher than in height verified for boys and girls (except 9 years old). In our findings lower height means verified for Cape Verdean samples in the earlier sample (1992) compared to latter samples (2009, 2013) for boys are consistent with a positive trend in height like the one experienced by the Portuguese population between 1992 and 2002.

Favourable changes might be observed in linear growth following the fast development of some countries' economies (Martorell & Zongrone 2012), and this seems to have happened to the Cape Verdean children living in Portugal. A similar positive effect of living in Portugal translated into height and weight increases in Cape Verdean ancestry children had been observed before as they were taller and heavier than their counterparts living in Cape Verde (Rocha 1987). Previously Varela Silva had found in 2004 that Cape Verdean ancestry boys had negative trends in height and weight between 1993, 1999, 2001. The author attributed these to worse biocultural changes and that boys were more sensitive to environmental changes (Stinson 1985). The positive trend in linear growth observed for the Cape Verdean children in 2013 is not accompanied with increases in weight or higher fat deposition over the same period for the Cape Verdean samples. This has resulted in good outcomes for adiposity indicators (subscapular and triceps skinfolds) for this population during this difficult economic period in Portugal. Cape Verdean boys in 2013 had lower Z-score triceps (Median=-0.42 interquartile range (25-75%) =-0.82 to 0.34) compared the Cape Verdean 1992 children (CVPT1992 Median=0.06, interquartile=-0.29 to 0.85). Also Cape Verdeans boys in 1992 had (Median=-0.08 interquartile range=-0.33 to 0.73) significantly higher subscapular skinfold means than Cape Verdean boys in 2013 (Median=-0.50 interquartile range=-0.72 to 0.16).

In the Cape Verdean ancestry children in 2013 significant differences were found when classifying children's weight and height based on different cut-off points from the different references including World Health Organization (WHO), the Centre for Disease Control (CDC) and the International Obesity Task force (IOTF). The under nutrition rates are low when compared with all the cut off points while the OW/OB rates vary according to the standards used. This sample displays a relatively healthy nutritional status. Where cases of malnutrition do exist, boys are more affected by under nutrition (only 2 stunted and 2 underweight) while girls show higher rates for overweight and obesity (6 and 2 respectively). None of the boys are obese. CDC growth charts identified more cases in the extreme ranges either stunting (3) or overweight (2). Even though differences between growth references were not significant the other growth references (WHO and IOTF) have produced a different prevalence (WHO boys stunting: n= 0, underweight: n= 1, OW: n=0, OB: n=0 in 2013, for girls stunting: n=0, underweight: n=0, OW: n=2, OB: n=0 in 2013; IOTF boys underweight: n=1, OW: n=4, OB: n=0, girls underweight: n=0, OW: n=6, OB: n= 2). Nevertheless caution should be taken when using for example WHO cut off points in populations not exclusively breast fed like the ones the standards were based in (Norris et al. 2009). Moreover CDC growth charts were based on a nationally representative sample from the United States of America which would include children with African- American ancestry similar to the ones we have analysed in our study. Our findings show in 2013 when using CDC Cape Verdean boys had stunting: n=2, underweight: n=2, OW: n=3, OB: n=0, for Cape Verdean girls stunting: n=1, underweight: n=0, OW: n=7, OB: n=2. The higher stunting rates found for CDC show higher risk for later life because of different gestational programming.

General characterization of the Cape Verdean community in 2013

The assessment of socioeconomic status, living conditions and family composition showed that the 62 Cape Verdean households and 89 children selected for this study (41 boys and 48 girls) are part of a socioeconomically deprived group compared to the Portuguese. Socioeconomic status measured by parental education and occupational status showed that Cape Verdean ancestry children in 2013 lived in households headed mainly by single mothers, with low socioeconomic status, predominantly with low educational levels and manual occupations. No significant differences in education and occupation class between mothers and fathers were found and that might have been due to the lower educational levels observed related with essentially manual jobs and also the homogeneity of the group. Even though some of the mothers lived with their partners/ father of the child they would consider themselves single (47.2%). This is reflected in families composed by mainly mothers heading the household as main economic providers, working long hours and relying on relatives and local leisure time institutions to take care of the child. This finding is consistent with a previous study on the role of the Cape Verdean women in the migration process as the sole earner identified by Åkeson and collaborators (Åkesson et al. 2012). However and despite the fact that many mothers reported being single some had partners helping out the household economy thus maximising the resources available for the child. Moreover household wealth measured in terms of assets' possession (Mckay 2009) showed that for these Cape Verdean families the most common asset was the personal computer. Only in a few cases (13.5%) did parents report having a car or a house. Again this level of poverty is consistent with qualitative data showing that most families were renting and that household composition would vary with time. Half of the families had 4 members per family living in the same household but in some cases relatives could be staying at the household for a specific period of time either to study, job hunt or waiting for visas to migrate to other countries. These situations place the household under tremendous economic strain as qualitative data showed cases of deprivation resulting from unemployment, leaving of one of the members of the household and precarious job conditions.

Consequently our regression models explored the importance of socio-demographic variables on the nutritional status of Cape Verdean ancestry children in 2013. Despite the homogenous socio-demographic characteristics in the sample there were some differences in nutritional status by these factors, even after controlling for sex and age of the child. Maternal marital status and father's occupation were observed to be important predictors of a children's nutritional status.

Only a few studies conducted in Portugal have explored the socio-demographic influences on nutritional status. Our findings are similar to a paper published in 2009 that showed that environmental factors were influencing weight gain in Portuguese adults as well as deprivation, urban mass, social capital and safety (Santana et al. 2009). The study conducted in Lisbon Metropolitan Area (LMA) with 7669 adults living in 143 neighbourhoods reported the relationship between physical and social environments with physical activity and consequently body mass index (BMI) when using a multilevel logistic regression model. Effectively BMI and both socio-demographic and behavioural characteristics were connected with the environment showing a significant and positive association with overweight and obesity. Furthermore Padez and collaborators' study found that in a Portuguese setting higher parental education and family size had a protective effect on childhood obesity (both maternal and paternal) (Padez et al. 2005). This is consistent with our findings showing that higher socio-economic status (paternal non-manual occupation) is associated with lower fat deposition. Moreover in cases where the mothers were married or divorced a higher childhood BMI would also be associated. Paternal education and marital status seem to be contributing to more secure household and better nutritional outcomes (linear growth and body composition) in this group. Gama's study back in 1988 did find significant associations between a Cape Verdean child's (boys) nutritional health and socioeconomic status (SES). The author showed that Cape Verdean children from lower SES (illiterate or < 4 years education) compared to medium SES (>= 4 years education) were shorter and lighter. It is important to explain that those significant differences were only found for boys and that SES was defined based on paternal schooling and occupation. In the 1988 sample Cape Verdean mothers were mostly illiterate and fathers had a mean of 4 years of schooling (Gama 2002). Similar to Gama's findings, our sample is composed of parents working mainly in manual jobs (42.9%) and low educational levels (38.2%). However Gama did not account for marital status or cases of a mother living alone with children. We hypothesize that in our sample maternal marital status is important as a long-term benefit in children's nutritional status because it results in a more socioeconomically wealthy household.

This hypothesis is reinforced by the results from other models on linear growth that showed that parental age, birth order and child's birth weight were the strongest predictors for these children's linear growth (height, leg length). Father's age was significantly associated with Z-scores for height and Z-scores for weight (positive association). Z-score leg length was associated with maternal age (negative association) and child's birth weight. Birth order had a significant association with children's height (positive association). Also birth weight and child's sex were significantly associated with the child's body composition (Z-score sum 2 skinfolds) (negative association). The importance of father's age may be associated with current socio-economic position. The majority of fathers were born in Cape Verde (57%) compared to Portugal. However mean age range for fathers was wider than mothers with values going from 20 to 60 years which can include several work situations. Despite the high educational level obtained for some Cape Verdean ancestry fathers (9-12 years, n=6, 18.2%, appendix) manual jobs in the construction sector were common in this sample. Cases of unemployment were also more prevalent among fathers (45.2%) as opposed to mothers (32.1%). Older fathers were associated with taller children. We hypothesize that it might mean a better integration in society and the improvement of the work situation. It might also mean that Cape Verdean fathers managed to reap the benefits of the past wealthy economic situation of Portugal and that was reflected in a child's height and weight. On the hand the literature review showed that increased paternal age was related with risk of low birth weight among North American children (USA) from urban setting (Reichman & Teitler 2006). The authors hypothesized on the indirect effect of parental age through social effects on the mother's health. Cases of lack of financial or emotional support could affect a mothers' reproductive health through induced stress. There is no evidence of such a relationship existing in the Cape Verdean sample studied.

Health inequalities have been increasing in almost all developed countries including Portugal. The Portuguese economic recession has been documented in official reports (Instituto Nacional de Estatística (INE) (Portugal) 2010b). The absence of information on socioeconomic status among other ethnic minorities living in Portugal and its relation with health outcomes were referred to before in this thesis. Even with improvements in social and health conditions since launching its National Health Service in 1974, Portugal stills presents deep social problems (Correia & Barros 2015). In addition the country occupies one of the first places in European poverty statistics (Santana 2002) and as several studies have shown, health and poverty/deprivation are related (Ellaway et al. 1997; Van Lenthe & Mackenbach 2002). For example in 1997 Ellaway and collaborators found in the United Kingdom that residents of more deprived neighbourhoods were shorter, had higher waist circumference, waist -to hip ratio and BMIs. Similarly Van Lenthe and Mackenback in 2002 reported in the Netherlands that there were increased OW rates in more deprived neighbourhoods that could explain the relationship with coronary heart disease. In a recent report Portugal's poverty levels had gone back 10 years (Sanches et al. 2015). Among the more deprived are elderly people and children, single parents (mainly single mothers), unemployed and immigrants who represent about 98% of disadvantaged Portuguese people. Moreover low incomes have direct consequences on poverty and indirect effects on social exclusion of some groups. Also unemployment has both direct and indirect detrimental effects on health (Santana 2002). Despite the fact that the Portuguese general population now has a longer life expectancy than ever before, this trend is less significant among disadvantaged people.

Inequalities in earnings or in educational level are responsible for inequalities in health among the Portuguese population (Simões et al. 2006). More socioeconomic inequalities contribute to health inequalities in ethnic minorities (Krieger et al. 2005).

Effectively Nogueira and Santana found in 2005 a strong association between socioeconomic variables and health outcomes (Nogueira & Santana 2005). For Nogueira and Santana's study occupation (men's unemployment and people with non-qualified jobs) and living conditions (percentage of people living in shanties) were collected during the 2001 Census, (males and females under 64 years old, between 1998 and 2002 (Deaths registration). The results pointed to a strong relationship between multiple deprivation and premature mortality. Furthermore, deprivation scores were higher in metropolitan areas like Lisbon showing associations with recent urbanization and ethnic diversity. The authors reflected on the specificity of areas like African communities that combine both high deprivation and premature mortality and where urban tensions and social conflicts are common.

Our study's findings have added further weight to this association between deprivation and health even in a community that is overall described as deprived. The effect of a lower paternal occupation was associated with higher child waist circumference and mothers married or divorced compared to single mothers had children with higher BMIs in this sample.

Dietary Diversity, Physical Activity and Nutritional Status

Some studies have linked nutritional health or disease to children's food patterns (Dawson et al. 2005; Gilbert & Khokhar 2008; Rovillé-Sausse 2005; Moreira et al. 2010). In our study no significant differences in nutritional status were observed for diet or physical activity in these 2013 Cape Verdean ancestry children. This could be due to populations sampled, type of dietary and physical activity assessment and differences in analytical methods or statistical models. On the other hand important cultural and environmental factors might be protecting these children from unhealthy behaviours. AA walked around the neighbourhood and could not find energy dense food selling either at school, household, or in the observable physical space of the community. This absence of energy dense food may indicate low market integration of the community but also a protective effect on the availability of energy dense and nutrient poor foods in this environment (Wilson 2012).

For this first generation of Cape Verdean ancestry children born in Portugal the connection to Cape Verde's culture is still vivid and is maintained due to local associations like *Moinho da Juventude* and family relations. This strong cultural link to Cape Verde is observed by remittances, celebration of traditional festivities like Kola San Jon, preparation of traditional dishes and language usage as observed during the time spent in the field to conduct this PhD research. Even though most families use Portuguese at home (46.7%), 38.3% confirmed they used both Portuguese and Creole. Family connections are still strong and more than half of the children share Cape Verdean ancestry on both the maternal and paternal lines (67.7%). This influence is observed in a qualitative assessment and a 24-hour recall method both used to evaluate diet among Cape Verdean ancestry children. The majority of Cape Verdean children ancestry in 2013 consumed on a daily basis 6 out of the 9 possible food groups showing adequate dietary diversity. Information reported by parents on individual diet diversity included presence of traditional diet, location of meal consumption, number of meals and skipping breakfast to be assessed as well as consumption of salty food or added sugar to the diet of 52 children. No cases of dining out or consumption of high-energy dense foods were identified and only in 3 cases of children did the mother report dining out at a fast food restaurant. A large group of children consumed daily 6 food groups, which included starchy staples, meat and fish, milk, other fruit and vegetables, legumes, nuts and seeds and dark green vegetables. Their diet based on school menus is healthy and because this is a deprived community children do not have a disposable income to buy other food outside or inside the school and so it is a limitation to their contact with high-energy dense food.

Moreover the importance of local institutions for social support is shown by lunch provided at school where the majority of the children had their meals and snacks. Benefits from the Portuguese government guaranteed books and meals and for some free after school clubs within the neighbourhood. A previous study conducted by Gomes in 1988 and cited in Gama 2002 in a Lisbon parish (*Caparica*) with Cape Verdean ancestry children 7 to 12 years old showed that Cape Verdean children living in Portugal had a more varied diet than the traditional one followed in Cape Verde at the time (1988) with less maize and more potatoes, bread, rice, milk and meat (Gama

2002). In Cape Verde due to the harsh climate conditions the traditional diet is composed of vegetable sources (80%) and maize is the base of the diet associated with beans, rice and wheat (Almeida et al. 1987).Only maize is grown in Cape Verde and the wheat and rice are imported (Food Fortification Initiative & Global Alliance for Improved Nutrition 2015). A report from FAO has shown that diet is mainly based on cereals (maize, rice, and wheat), vegetable, starchy roots, and fish (Fao Africa 2009). The same report shows that over the course of the last decades, the diet has become more diversified and currently includes more protein- and micronutrient-rich foods (meat, dairy products, fruit and vegetables). As a feature of the nutrition transition, fat- and sugar-rich foods have also become more common in the diet (Fao Africa 2009). Comparing with our results the diet followed by Cape Verdeans living in Portugal is well varied and includes staples, meat and fish, milk, other fruit and vegetables, legumes, nuts and seeds and dark green vegetables. Moreover school menus do not seem to have changed drastically since 1993. The economic crisis in Portugal might have affected the preparation of food at the school but not its contents.

Departure from the traditional diets might be observed with the acculturation processes. Based on literature available the risk is that the change towards more westernized diets that has been observed in younger generations in the UK (Jamal 1998) may also be associated with future diseases (Gilbert & Khokhar 2008). Changes to traditional diets can have a different impact on migrants' health depending on host country. For instance the change from African to Spanish diets observed in a group of migrants (Cameroon) living in Spain back in 2001 using a food frequency questionnaire showed that migrant women had higher obesity rates than men and Spanish women. Later in 2003 Montoya and collaborators found that the first and second generations of immigrants had higher consumption of vegetables, fruits, legumes and eggs showing a healthier diet than the Spanish children aged 6-12 years (Montoya et al. 2003). Moreira and collaborators reported in a Portuguese context that a higher maternal educational level and sleeping duration were significantly and positively associated with diets including fruit and vegetables (Moreira et al. 2010). A more accurate method to evaluate diet would depend on the study aims, the population and the resources available. When analysing dietary quality and intake it is important to understand each particular cultural background as Sharma and collaborators referred to while devising a food frequency questionnaire with different migrant populations of African origin (Cameroon, Jamaica, Caribbean) in the United Kingdom (Sharma et al. 1996). Sharma and collaborators also explained how the accurate measurement of food intake, the assessment of recipes and food composition, cultural context and literacy of populations were essential to establish associations between diet and health conditions like diabetes and hypertension.

Change towards a westernized diet may also be connected with diet and physical activity associated with sedentary behaviours. Our findings show that no significant differences were found between Cape Verdean ancestry children's nutritional status and their physical activity levels. This might be related with methodological problems. Self-reported physical activity frequency (household questionnaire) and objectively measured data (pedometers) assessed in Cape Verdean ancestry children showed that most children walked to the school and that 26 of the total of 89 practised basketball or football as an out of school activity. The group of 27 Cape Verdean ancestry children measured for this project with pedometers showed high step counts on a school day (9-3pm) when using Omron™ step counter walking style III (Omron™ healthcare, Kyoto, Japan) pedometer. Values ranged from 3967 to 11652 for boys and 3391 to 10696 for girls. In fact 25% of the boys had values as high as 10,270 steps per day compared to 6,034 in girls. Physical activity data were only collected for a sub-sample due to difficulties experienced in the field with this aspect of the study. Post hoc tests of the randomness of the missing nature of the data showed bias in the samples that were collected. For girls Mann-Whitney U tests showed that weight, Z-score weight, BMI, subscapular and Z-score subscapular skinfold means were significantly higher for the girls that had their physical activity measured. Girls who used the pedometers (n=15) were significantly taller and had higher Z-scores for sitting height presenting better nutritional health than the ones that were not measured. It is important to note that significant differences were found only for anthropometric variables and not for child's age. Unemployed mothers and mothers working in manual jobs were amongst the ones with children on the lower end of the healthy spectrum and whose physical activity was not measured ($p<0.05$, Fisher's exact test). This could be one of the reasons for the lack of association between physical activity and the nutritional status outcomes measured along with small sample size, which reduces statistical power. It is also important to note that the minimum weight for pedometer usage was 30 kg with no age adjustment that could have worked as a confounding factor to our models because younger and lower weight individuals (< 30 Kg) were not able to wear the pedometers.

Despite methodological differences our findings are consistent with the literature available that shows that it would be expected for boys to be physically more active (Chung et al. 2012) and also the mean step count values do fall around 5000 steps for school children in the USA (Burns et al. 2016). Our study was the first to objectively measure physical activity in school children from an ethnic minority in Portugal. We could not find comparison with other Portuguese studies prior to 2013 in ethnic minority groups in the literature. However a study conducted by Johnson and Brusseau with pedometers in the USA showed that minority (Hispanic and African American) girls had lower physical activity levels (Johnson & Brusseau 2010) and that similar step counts were observed for boys from minority and white groups within the same socioeconomic status and inner city perimeter. It would be expected to see a similar trend in our study but it was not possible to differentiate with another majority group. The fact that comparisons by the Johnson and Brusseau study were made within the same socioeconomic group is important for future interventions on ethnic minorities in high-income countries.

Research Question 2 - What maternal, early and intergenerational factors will have a significant effect on Cape Verdean ancestry children's nutritional status?

Summary of findings

Cape Verdean women from this study show high OW/OB rates as well as waist circumference, body fat and waist-to-height ratio representing higher risk of cardiovascular diseases (CVDs). A significant positive association was found between maternal waist-to-height and child body fat (sum 2 skinfolds). Single parent families (54.8%) significantly explained some of the variance in a lower child's Z-score for BMI, with a difference of 0.55 units or 1.48 units when accounting for maternal waist circumference.

In accordance with hypothesis 2.1 high maternal malnutrition rates were found among Cape Verdean mothers with high prevalence of overweight (40.4%), obesity (36.2%), high percentage of body fat (70.2%), high waist-to-height ratio (66%) and high waist circumference (63.8%). However contrary to hypothesis 2.2 child's birth weight was not significantly associated with Cape Verdean children's nutritional status in this subsample. Most of the factors tested under this research question in hypothesis 2.3 were not significant. Despite a lack of significance of most of the intergenerational factors, maternal age was associated with child's total leg length (positive association) and maternal height with child's height (positive association).

Maternal malnutrition status and risk factors

A smaller sub- sample was created to observe early life and intergenerational effects on Cape Verdean ancestry children measured in 2013 in Portugal. This only included the older children (first born in Portugal) of each Cape Verdean mother to observe the effect of past environmental conditions on children's current nutritional status. The information available was mainly for first born in Portugal and because we wanted to test the effect of current living conditions in Portugal we did not include first born of the mother. Maternal pre-natal variables were collected in total on 47 mother- child pairs who showed a mean age of 35.02 years (SD= 8.15). Our findings show high rates of malnutrition for Cape Verdean mothers with 40.4% overweight and 36.2% obese. These are higher values compared to the Portuguese adult female population. One study using national data from 2003 and 2005 reported that among Portuguese women 34.4% were overweight and 13.4% were obese (do Carmo et al. 2008). Moreover the same study showed that 24.6% of the women had a waist circumference higher than 88 centimetres (WHO) and thus increased risk of CVDs (WHO 2008c). The paper also found that the combined prevalence of over nutrition (OW/OB) had increased in the general Portuguese population 4% up from 1995-1998 to 2003-2005. Sardinha and collaborators observed a similar tendency in a study conducted in 2008-2009 reporting 38.1% overweight and 19.8% obesity in a representative sample of Portuguese females after adjusting for educational level. Moreover the authors showed that abdominal obesity measured as a waist circumference higher than 88 centimetres in females reached 37.9% in this sample (Sardinha et al. 2010). In our study and despite the smaller sample size a higher percentage (44.4%) for waist circumference above 88 cm was found for Cape Verdean women. Also 70.2% of the Cape Verdean mothers had body fat percentages above 34% (Frisancho 2008) and waist-to-height ratio (WHtR) higher than 0.5 was found for 66% contributing to a high risk of developing cardiovascular diseases (CVDs). Obesity is associated with an increased risk of cardio vascular disease and mortality (WHO 2000). Even if BMI measured as the ratio of body weight to height squared (WHO) has been used in several studies because of its simplicity and different cut offs available it does not account for sex differences, short people or distribution of visceral fat (Bogin 2012a; Zemel 2012). Also there has been consensus on association of health risks (cardiovascular disease (CVD) and diabetes) and the distribution and amount of fat (Ashwell & Gibson 2009). Consequently waist-to-height ratio (WHtR) was used in Japan (Hsieh & Yoshinaga 1995) and the UK (Ashwell, Lejeune, et al. 1996) as an indicator for disease risk factors. A study with European children and adolescents (including Portuguese) aged 8 to 17 years showed the association for BMI, waist circumference and waist-to-height ratio with cardio metabolic risk factors (Sardinha et al. 2016). The cross-sectional study published in 2016 by Sardinha and collaborators used anthropometric data (BMI, WC and WHtR) and cardio metabolic indicators (HDL-cholesterol, triglycerides, blood pressure) from 5 studies with mixed effect regression models. The conclusions from the study show that all anthropometric variables were associated with a combined risk for cardio metabolic indicators in a similar way and that the association worked better with higher BMI values.

The relationship between family demographic and linear growth includes multiple measures and there is a complex interaction between environment and life style during the life course. In Portugal the 4th national survey of health status for migrants revealed some immigrants showed even better health indicators than the Portuguese (Instituto Nacional de Estatística (INE) (Portugal) 2014) but a previous review article (Almeida et al. 2013) concluded that immigrants had an increased level of comorbidity, reduced access to health services, poor communication skills, more stillbirth and early neonatal death. Effectively in the past more foetal deaths were identified during pregnancy and post-natal mortalities in immigrants (European and African mainly) living in a more socio-materially deprived area of greater Lisbon area (Machado et al. 2007). Recently Goulão showed that overweight rates (self-reported) were higher for African females compared to Brazilian female migrants of first generation living in Portugal in 2007 (Goulão et al. 2015). Age, marital status, time of residence in Portugal and nativity were associated with higher BMI. Migrant women living in Portugal for more than 15 years had higher OW/OB. This result is similar to our findings. Our sample is composed of Cape Verdean mothers assessed in 2013 who were not born in Portugal and whose mean values for time of living in Portugal at birth was around 15 years (12.45 years, SD = 6.76). Most mothers migrated to Portugal before the economic crisis (2008) and they seem to be already showing high values for over nutrition consistent with later stages of nutrition transition in Portugal. The previous literature is consistent with our findings that place Cape Verdean migrant adults living in Portugal at high risk of displaying increased propensity for respiratory and cardiovascular impairments (Harding et al. 2008). The marital structure among Cape Verdean families where women are the main provider may place imbalance that may affect this women's health and subsequent cascade down to the children.

Our findings for Cape Verdean mothers in terms of OW/OB are very different from the OW/OB in children. Differences may lie in environmental factors. We hypothesize that children attending the local school and within that age range (6-12 years) seem to stay mainly in the neighbourhood and are somewhat protected from "obesogenic" environments. Despite the fact that other studies related maternal health condition being associated with the next generations' health status, it does seem that for these Cape Verdean ancestry children contact with high energy dense food is probably experienced later in life when they leave the neighbourhood perimeter to study or work meaning that there is not a strong relationship between maternal nutritional status and child nutritional outcomes. After completing primary education at the local school Cape Verdean ancestry children have to attend another school located outside the neighbourhood perimeter, at this point they will become less protected by the lack of unhealthy food choices available within the neighbourhood itself.

Maternal over nutrition may also be associated with past factors. The fact that this population’s genetic background is very heterogeneous has an impact on the growth trajectories due to high inbreeding(Beleza et al. 2012; Beleza et al. 2013). However our findings did not find any association between maternal weight gain and child nutritional health. This in contrast to Moreira and Padrão (Moreira & Padrão 2006) that showed that a maternal weight gain during pregnancy higher or equal to 16Kg in the Portuguese population represented an increase of OW/OB risk in the offspring. In a cross-sectional study, Portuguese researchers demonstrated that the probability of a child having increased risk of OW/OB was greater in mothers with considerable weight gain in pregnancy (Padez et al. 2009). Our findings show that more than half of the mothers (56.7%) had weight gains around 5-10 kg. The absence of association between maternal weight gain during pregnancy with child's nutritional health might be because of our low OW/OB rates found for the children. It is also necessary to take into account that this is a retrospective and self-reported method of weight gain during pregnancy which might have some bias associated.

Early life factors (birth weight)

The majority (39 out of 46) of the children had normal birth weight (2.500-4.000 kilograms) and were term babies (77.8%). No association was found with birth weight or gestational age and child's nutritional status. This could be due to the current discussion on the effect of birth weight (BW) (Brisbois et al. 2012) and infant size on a child's risk of OW/OB. Some researchers found a significant relationship between birth weight and obesity in the early life course stages (infancy and childhood) (Martins & Carvalho 2006) and for different countries (Reilly et al. 2005; Mamun et al. 2005; Jones-Smith et al. 2007). Nevertheless, there might be some inconsistencies. When growth is restrained during gestation it is reflected in a child’s birth weight and may condition higher fat deposition and insulin resistance (Ibáñez et al. 2006). A review paper showed the relationship between infant size/ growth and subsequent OW/OB (Baird et al. 2005). It seems that values falling on each end of the birth weight distribution, both low and high, could be predisposing factors for later development of obesity. Some researchers found increased risk of obesity (Guo et al. 2000) or abdominal obesity (WHR) (Laitinen et al. 2004) with low birth weight and a higher birth weight was positively associated with increased adult BMI or OW/OB rates. The lack of association in our study might be related to the normal birth weight range in our sample but also to the fact that the association previously reported in the literature focused on child OW/OB outcomes that do not apply to our case because most of our children show low rates for OW/OB.

Also ancestry measured as maternal country of origin might influence the low birth weight of new-borns (Carballo & Nerukar 2001; Mosher et al. 2004; Urquia et al. 2007). In a study conducted in Spain in 2004, Moroccan mothers had children with higher birth weight while Sub-Saharan Africa mothers had lower birth weight babies. (Domingo et al. 2008). Our results are in line with previous data in Portugal where a similar birth weight was found for Portuguese and African immigrant families (Angola, Cape Verde, Guinea Bissau, Guinea Equatorial)(Harding, Boroujerdi, et al. 2006). However data collected between 1995 and 2002 showed that there had been a decline in birth weight in both groups for term babies. Other research in the Portuguese context showed that a higher birth weight (> 4000 grams) was associated with increased probability of obesity in adult life (Padez et al. 2005). The absence of a significant effect in our findings may also be due to by the absence of a control group or because most birth weights were within the normal range. The fact that the children in this sample show healthy BMI and that Cape Verdean mothers from this group seem to be having better and regular access to health care is consistent with length of stay in Portugal and the regular utilization of health services (Dias et al. 2008). This is also in line with Harding and collaborators paper where a higher pre-term delivery of African babies was found between 1995 and 2002 compared to Portuguese (Harding, Boroujerdi, et al. 2006). The same trend was observed in Sosta and collaborator's study in Italy that found higher preterm deliveries observed in immigrants from African ancestry (Sosta et al. 2008). The fact is that health problems affecting migrant women might be aggravated when moving to a host country (Carballo & Nerukar 2001; Lewis 2007; Gissler et al. 2003; Temmerman et al. 2004; Waterstone et al. 2001). It has been observed that miscarriage and prematurity indicators may in the long term represent worst health outcomes in migrant populations (Machado et al. 2009). However and because this is a small group it is difficult to make extrapolations. The information on birth that includes gestational age and birth weight was collected by health professionals so it is quite accurate and shows that the mother was using local services at the time the child was born.

Our results support the association between Cape Verdean maternal waist-to-height ratio and child body fat (sum 2 skinfolds). In line with the literature waist-to-height ratio of mothers can be used as a valuable indicator (Ashwell et al. 2012) of cardio metabolic risk factors in their offspring.

In this sub-sample, Cape Verdean ancestry girls had a significantly higher Z-score waist circumference and sum of 2 skinfolds (subscapular+ triceps) compared to Cape Verdean ancestry boys. Taking into account the high OW/OB and risk factors (body fat, waist-to-height ratio and waist circumference) observed in Cape Verdean mothers measured in 2013 this result in children and especially girls might be a warning for future interventions. Despite the fact that Cape Verdean ancestry children present healthy BMI, parental obesity is known to be strongly associated with childhood obesity status due to both genetic and environmental variables (Albert et al. 1990; Parsons et al. 1999). Among the environmental variables measured in our sample single parent families (54.8%) were associated with a decrease in child's (Z-score BMI of 0.552) or 1.48 BMI units when accounting for maternal waist circumference. A proxy for social security single parent families' show how living in this situation might be associated with lower BMI and worst socioeconomic status. However this work has shown that Cape Verdean children living in Lisbon, Portugal in 2013 show good nutritional health with low levels of overweight and obesity (OW/OB) and stunting rates. This could be an indication for future policy makers to invest in social protection policies to avoid the escalation of risk for overweight and obesity rates especially among Cape Verdean girls. Different approaches might invest in nutritional programs oriented for girls to stop them from transitioning towards the levels of obesity seen in their mothers from their currently healthy state.

Intergenerational effects

Despite the use of several measures that have the potential to capture intergenerational effects our results from this section found that the only intergenerational factor was that maternal height Z-scores were significantly associated with Z-scores for height in children. An environmental effect also found that higher maternal age was associated with lower child's total leg length. The findings are consistent with the literature on how current maternal biological health and that of the previous generations is likely to influence a child's growth (Emanuel 1986; Kuzawa 2005). Maternal nutritional status at the time of the pregnancy as well as her health history have proven to be determinants for their children's health in many studies (Moreira et al. 2007; Varela-Silva et al. 2009; Marques 1999; Baker et al. 2004; Poston 2012; Harding, Boroujerdi, et al. 2006; Reilly et al. 2005). Moreover the recent history of Cape Verde shows the high prevalence of health care deficiencies like anaemia and hypertension among pregnant women (Wessel et al. 1996; Wessel et al. 1999; Trincão et al. 1956; Wessel et al. 1998) (WHO 2014b) which would constitute an increased burden of disease for future generations. This could have been reflected in gestational age and birth weight of the mothers whilst they were residing in Cape Verde before migrating to Portugal. The Cape Verdean mothers that migrated to Portugal might have done it because they came from low socioeconomic status backgrounds in Cape Verde and would have been worst off during infancy. Our findings did not reflect any intergenerational relationships seen in a previous study (Varela-Silva et al. 2009). That might be attributed to the small sample size but also to the fact that Cape Verdean mothers living in this neighbourhood share similar life histories and come from a similar urban setting from Santiago Island (Praia, Cape Verde's capital).

More findings from this study relating to intergenerational and environmental effects show that maternal height and child birth order were significantly associated with child's height. This again is consistent with the literature that shows that maternal height influences child's linear growth during the growing process (Addo et al. 2013).

In contrast with Gama's findings in 2002 we did find significant differences for birth order in Cape Verdean children's height. In Gama's paper with data from 1989 only a higher number of siblings living in the household was associated with lower weight for girls among the Cape Verdean community. Gama explained that birth order was only significant for Portuguese girls and that the first-born were taller. When the study was conducted (end of the 1980s) family composition among the Portuguese did not commonly include children from other relationships living in the same household even if that was frequent among Cape Verdeans. Differences between our results and Gama's paper may also lie in the methodology used as the author applied ANOVA tests and a Sheffé test for multiple comparisons between Cape Verdean ancestry and Portuguese children. In our study associations between maternal height and child birth order with child's height were found using regression models only for the Cape Verdean ancestry sub-sample because the data was not available for the Portuguese sample. However the association in our findings might also be explained because birth order could be a proxy for environmental resources available for children's growth. In this study the birth order effect when accounting for maternal height, child sex and age is associated with a lower Z-score for height for children and this could be a long-term effect of living conditions experienced in Portugal. More children living in a household would also mean resources need to be shared by more household members and a negative effect on a child's growth. In the Portuguese context Padez and collaborators found in 2005 that parental education and family size had a protective effect on child obesity. Being a single child in Portuguese families was related with higher risk of overweight and obesity among girls and obesity in boys. The same effect was observed for number of siblings and birth order with children from larger families and those with higher birth order presenting lower risk of being OW/OB. This study has not shown such relationships with OW/OB but only linear growth.

Our findings suggest that despite the positive early life effects observed for Cape Verdean ancestry children in 2013 this sample of Cape Verdean mothers shows increased malnutrition rates expressed as a higher risk for OW/OB in a high income country like Portugal. The high malnutrition rates observed for Cape Verdean women in OW/OB, waist circumference, body fat and waist-to-height ratio might represent a burden of disease for higher risk of cardiovascular diseases. The fact that maternal waist-to-height ratio is associated with child body fat (sum 2 skinfolds) is especially concerning among girls as they should be targeted in future interventions before their risk level rises to be closer to that of their mothers. Also environmental conditions may be having a significant impact on children's BMI like the cases of household insecurity observed in single parent families. In these cases the child with a lower BMI may be negatively affected by a more vulnerable socioeconomic position. Important measures of social protection especially for mothers should be reinforced through local partners.

Research Question 3 – How does the nutritional status of the Cape Verdean ancestry children in Lisbon (Portugal) compare with the general Portuguese population?

Summary of findings

Cape Verdean ancestry populations show over time, an increase in linear growth (height) compared with the nationally representative Portuguese, especially for boys. There were significant differences in height between Portuguese (PT2009) (M=129.63, SD=8.54) and two of the Cape Verdean datasets (CVPT2009 (M=132.75, SD=10.67; CVPT2013 (M=134.25, SD=9.76), with the Cape Verdean children being taller on average. The Z-score for height was significantly higher for Cape Verdeans measured in 2013 (CVPT2013 (M=0.58, SD=1.05)) than the Portuguese (M=0.16, SD=0.88) and the Cape Verdean children measured in 1992 (CVPT1992 M=0.05, SD=0.82). Also, a decrease in adiposity indicators (subscapular and triceps skinfolds) was observed for boys. Significant differences were found only for over-nutrition among boys. There was a greater percentage of overweight and obesity among Portuguese boys (20.3% and 12.7%, respectively) when compared with Cape Verdean boys in 2013 (9.8% and 0%, respectively, for the 2013 database; $p \leq 0.001$). However, more stunting was also observed among the Portuguese boys even if the percentage was small (four cases) and non-significant. Among the girls, no statistically significant differences in the rates of overweight and obesity as well as under-nutrition were found, but some trends could be observed. For example, more Portuguese girls were classified as overweight (22%) or obese (9.7%) in comparison with Cape Verdean girls in 2013 (12.5% and 4.2%, respectively, $p = 0.189$). Further Cape Verdean ancestry children in 2013 seem to be protected from overweight and obesity in comparison to Portuguese children living in similar environments, even after controlling for a range of socio-demographic and biological factors (age, sex, maternal age, birth weight, whether the child was breastfed, maternal education, and maternal occupation). Protective effects included being breast-fed, being of lower birth weight, having a mother with more years of education and having a mother who spends more time at home, such as being unemployed or a housewife.

Effectively, in line with hypothesis 3.1 Cape Verdean children, living in Portugal in 2013, presented lower rates of stunting or leg stunting (3.4 % and 4.9% respectively) and their height increased over time compared to the Portuguese. Lower OW/OB rates were found even when using different growth standards (CDC, WHO, IOTF) for the Cape Verdean ancestry children measured in 2013.

Linear growth

An analysis of the Cape Verdean ancestry population's linear growth, measured by height means, showed an increase between 1992, 2009, and 2013, especially for boys when comparing with the nationally representative Portuguese dataset (PT2009). Significant differences for height and height Z-scores, sitting height Z-scores, triceps and subscapular skinfolds and Z-scores between Cape Verdean and Portuguese boys aged 6–12 years were found in all databases. An analysis of variance showed Cape Verdean boys in 2013 were taller on average compared to the Portuguese in 2009. Z-score height was significantly higher for Cape Verdeans measured in 2013 (CVPT2013 (M=0.58, SD=1.05)) than the Portuguese (M=0.16, SD=0.88) and the Cape Verdeans measured in 1992 (CVPT1992 M=0.05, SD=0.82). The direction of the change in height trend was similar for Cape Verdean girls, with an increase in height between the 1992 and 2009/2013 samples. For Cape Verdean girls only height and triceps skinfolds/triceps Z-scores revealed significant differences compared with the Portuguese sample ($p<0.05$) with the Cape Verdean children having higher means. In 2009 Cape Verdean ancestry girls were significantly taller compared to the Portuguese and their counterparts measured in 1992. The absence of significant differences in Z-scores for height for girls suggests that age differences and/or maturational status may have accounted for the significant differences in the raw height data observed for girls.

In contrast differences were found for Cape Verdeans boys measured in 2009 who had a lower Z-score sitting height mean (M =-0.47, SD= 0.95) compared to the Portuguese 2009 (M =-0.07, SD= 0.92) and the 1992 Cape Verdean children (CVPT1992 M = 0.14, SD=1.09). The positive trend observed for Z-score height on Cape Verdean boys in 2013 would be expected to be followed with an increase in sitting height. During the different growth phases like infancy, childhood and pre-pubertal years lower limbs grow faster than the trunk, head and upper limbs (Bogin et al. 2002; Bogin et al. 2007;

Malina et al. 2004). Leg length and sitting height have been shown to contribute to the secular trend in height in adolescents boys (Malina 2004). Our results are in line with better living conditions having a short-term effect and especially on girl's body composition and a positive effect on boys' linear growth. The lower values found for sitting height in 2013 may be related to the analysis being performed on entire age range as this might influence the different trend observed in some age intervals.

Body composition

Linear growth measurements were also accompanied with body composition changes. Significant differences for triceps and subscapular skinfolds and Z-scores for these measures between Cape Verdean and Portuguese boys aged 6–12 years were found in all four databases. Cape Verdean ancestry boys had lower Z-score triceps in 2013 (Median=-0.42 interquartile range (25-75%) =-0.82 to 0.34), compared with the Portuguese (Mean=-0.13, interquartile range=-0.55 to 0.40). For Z-score subscapular Cape Verdean boys in 2013 had lower values (Median=-0.50 interquartile range=-0.72 to 0.16) compared to Portuguese (Median=-0.04 interquartile=-0.40 to 0.50). Among the Cape Verdean ancestry girls in 2013, fat deposition (z-score triceps) were significantly higher (Median=-0.01 interquartile=-0.42 to 0.56) compared to Portuguese girls in 2009 (Median=-0.23 interquartile=-0.68 to 0.37).

Our findings show that there was a positive and significant increase in height over time among Cape Verdean boys without a correspondent increase in fat deposition (triceps, subscapular skinfold). The same was not verified in girls and differences in height found were not verified in Z-score probably due to age differences in the sample. On the other hand there was a small decrease in Z-score triceps from 2009 to 2013 for Cape Verdean girls. In 2013 mean values for Z-score triceps in Cape Verdean girls were higher than the Portuguese girls in 2009. This could be related to the different periods but also due to the selectivity applied to our analysis that included children from Cape Verdean ancestry compared with a wider sample of Portuguese living in Lisbon's district. Differences found for boys are consistent with the literature showing that boys are more sensitive to environmental changes (Stinson 1985). The fact that boys also show significant differences in body composition measures like triceps and subscapular skinfolds, both lower means than the previous Cape Verdean samples (1992, 2009) might mean that an important environmental factor such as economic stability of the household is affecting the entire sample.

However our findings of differences in height between the Cape Verdean and the Portuguese children are in contrast with earlier studies conducted by Gama in 1989 and Garcia-Ruiz and Marrodán in 1992. Both authors did not find significant differences in height between the two groups of children (Portuguese and Cape Verdean ancestry children measured at the time)(Garcia-Ruiz & Marrodán 2000; Gama 2002). Nevertheless methodological issues need to be considered. Because both Gama’s and Garcia-Ruiz and Marrodán's sample were collected in the same area (Amadora) for both Portuguese and Cape Verdean ancestry children a similar SES and urban environments this might explain the absence of difference. On the other hand, in 1992 Garcia-Ruiz and Marrodán did find differences for body mass variables (weight, triceps skinfold) between Cape Verdean and Portuguese ancestry children living in the same setting (Buraca parish, including Cova da Moura neighbourhood). Weight means were higher for Portuguese children. Consistent with our findings triceps skinfold was significantly higher for Portuguese compared to the Cape Verdean ancestry boys. Garcia-Ruiz and Marrodán attributed their results to genetic and environmental factors. The effect of the higher family number in the Cape Verdeans and cultural factors were most strongly identified. We do think that similar factors are affecting our sample. Additionally to Garcia-Ruiz and Marrodán and Gama's study we have identified that these children stay in the neighbourhood during their infancy and primary school years and that there were not high energy nutrient foods readily available in a fast and cheap format. Moreover we have identified a higher breastfeeding length among this Cape Verdean ancestry mothers compared with the Portuguese, which might provide a protective effect.

When comparing Cape Verdean children with the Portuguese national study, significant differences were found only for over-nutrition among boys. There was more overweight and obesity among Portuguese boys (20.3% and 12.7%, respectively) when compared with Cape Verdean boys in 2013 (9.8% and 0%, respectively, for the 2013 database; $p \leq 0.001$). For girls no statistically significant differences in overweight and obesity or under nutrition were found for any of the references used between the samples but some trends could be observed. For example, more Portuguese girls were classified as overweight (22%) or obese (9.7%) in comparison with Cape Verdean girls (12.5% and 4.2%, respectively, non-significant). These values are lower than previous reports that compare OW/OB in Portuguese children and adolescents. This result could be explained by the fact that the group of Portuguese children compared here is a small one and is from a specific area of Portugal (Lisbon district). Despite similar environmental conditions within this sample there might be different SES factors responsible for the effect observed.

Portugal has shown one of the highest European obesity rates (Lobstein & Frelut 2003; Cattaneo et al. 2010) exceeding 30% and 31.8% in OW/OB along with deep social disparities (Padez et al. 2004; Padez et al. 2005; Padez 2003a; Branca et al. 2007; Ferrão et al. 2013). Moreover the last National Study of Childhood Obesity conducted in 2009, showed a prevalence of 37.9% for overweight (OW) and 15.3% for obesity (OB) in 6-8 year old school children (Rito et al. 2012). In the older children (6-10 years) the percentages for OW/OB ranged from 5.3 to 13.2% in boys and 6.4 to 12.6% for girls. The adolescents born in the 90s presented with 11.3% boys and 9.2% girls being obese, according to CDC references (Centre for Disease Control,(Kuczmarski et al. 2002)). Recently, in 2008, 1 in 3 Portuguese children aged 6 to 8 years was overweight showing a similar trend to southern European countries (Rito et al. 2012). The findings quantified for 6 to 8 years old children underweight, overweight and obese according to the IOTF standards, as 4.8%, 28.1% and 8.9% respectively. Interestingly the islands, Azores and Madeira, showed a higher concentration of OW/OB children while the south of Portugal exhibits lower rates. Furthermore in 2012 rising excessive weight among pre-schoolers marked a north-south pattern (Wijnhoven et al. 2013) and showed the highest European values (26.8% and 28.5% for Portuguese boys and girls, respectively) for overweight and obesity (7.9% and 9.3%). Back in 2007, Moreira presented a review on OW/OB prevalence rates in Portuguese children. Starting from 2 to 6 years (Mira 2006). IOTF criteria were used in the lower age range (International Obesity Task Force). The single study with a pubertal population (Ramos & Barros 2005) born in the 1990s showed incidences of obesity of 11.3% in boys and 9.2% in girls, even though using a different growth standard (CDC, Centre for Disease Control, (Kuczmarski et al. 2002)). Despite the difficulties to compare data from different age ranges, locations and assessed using different criteria, the main conclusion was the fact that high OW/OB rates are observed among the Portuguese child population (30%). The same tendency was observed by Padez and collaborators in a national study of 7 to 9 years old attending public teaching Institutions based on data collected in 2002/2003 (4511 in total)(Padez et al. 2009). Similar to other southwest European countries these are only exceeded by Italian children (Binkin et al. 2010). The actual values reported are that 31.5% of the children are OW/OB and 11.3% obese (using IOTF standards). As expected girls presented higher values (33.7%) while boys accounted for almost a third (29.4%). One of the recent review studies on over nutrition in Portugal has shown that CDC growth charts have been used in more studies to determine the prevalence in children while IOTF was used in adolescents (Antunes & Moreira 2011). The authors though highlight that all standards used (CDC, IOTF, WHO) indicate high values of overweight and obesity. The same was verified by Rito and collaborators when analysing Portuguese children aged 6–8 years of age data from the COSI study, Childhood Obesity Surveillance Initiative (Rito et al. 2012). They reported underweight, overweight and obesity rates for the three growth references and concluded that when using the WHO cut off points more obesity was identified (15.3%) compared with the CDC (14.6%) and the IOTF (8.9%). The opposite was found for underweight prevalence with IOTF (4.8%) identifying more cases than the other references, CDC (2.1%) and WHO (1.0%). The authors concluded that it was important to monitor high levels of overweight and obesity in Portugal using all references available to allow comparison with other countries and studies. Our findings point to a different trend than the one observed by Rito and collaborators. In our case a higher percentage of underweight was found using CDC and a similar value when using CDC and IOTF for obesity with the same trend observed for boys and girls. Differences between our findings and Rito's and collaborators might lie with the adequate use of CDC references with African ancestry populations like the one in our study. Rito’s and collaborators study used Portuguese national data but they do not specify participants’ ancestry used for the study.

It is important to consider that these are different populations compared in different time frames so different environmental effects would be expected. Entrance to the European Union in 1986 brought rising wages, better infrastructure and higher household incomes for the Portuguese. Moreover, there were important improvements in the Portuguese society in, for example, health care services, educational levels and socioeconomic status (Veiga et al. 2004; OECD 2011). Qualitative data showed that Cape Verdeans living in Portugal currently have better access to health services and school nutritional programmes than is reported in Cape Verde (UNICEF 2015). The same process was observed in the American-Maya children after migrating from Mexico to Florida when they experienced an improvement in their growth and living conditions (Smith et al. 2002; Bogin 2012b).

Several environmental variables were considered to explain the difference between Cape Verdean (CVPT2013) and Portuguese children’s (PT2009) overweight and obesity rates. 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 that, even after controlling for a range of socio-demographic and biological factors (age, sex, maternal age, birth weight, whether the child was breast-fed, maternal education and maternal occupation), this Cape Verdean community have experienced the positive aspects of nutritional transition in relation to linear growth without the negative aspects associated with becoming overweight or obese.

Protective effects also identified included being breastfed, being of lower birth weight, having a mother with more years of education and having a mother who spends more time at home, such as being unemployed or a housewife. Breast-feeding behaviour explains some of the difference in risk for overweight and obesity between Cape Verdean ancestry and other Portuguese children. After including the breast-feeding variable in the model there was a change in the ancestry parameter effect of close to 18%. This is in line with our model and the frequencies presented for Cape Verdean mothers showing that they breastfed for longer (Median=10.5 months) than Portuguese mothers (Median=3.00 months). This fact is reinforced by qualitative data collected during fieldwork. Reports from the OECD (Organization for economic cooperation and development) show that only 40% of Portuguese babies are breast-fed (OECD 2014) while in Cape Verde 60% are exclusively breast-fed until 6 months (UNICEF 2015). Consequently most Cape Verdean mothers' breast-feed from 3 to 17 months and 25% of the mothers reported breastfeeding for more than a year (17 months). This is in accordance with the World Health Organization (WHO) guidelines, which recommend exclusive breastfeeding continued for the first 6 months of age (Saadeh 2003) to have a protective effect against obesity in all world populations (Kries et al. 1999; Bosnjak & Grgurić 2013). Consequently positive breastfeeding practices have been discussed in a migrant context (Neault et al. 2007). Our findings are also similar to others that showed higher adherence to breastfeeding initiation and longer duration in immigrant mothers (Merten et al. 2007; Singh et al. 2007) reinforced by cultural beliefs (Ergenekon-Ozelci et al. 2006). Nevertheless, breastfeeding length and its effect on OW/OB outcomes do not show consensus among researchers. Some indicate that breastfeeding (Arenz et al. 2004) has an inverse relation with childhood obesity. If some studies validate this relationship (Moschonis et al. 2008) others could not find significant relationships (Davis et al. 2007). Another study identified the importance of breastfeeding in reducing the probability of becoming OW/OB (Horta et al. 2007). In addition other researchers also found that breastfeeding protected against overweight, high blood cholesterol, high blood pressure and type II diabetes (Plagemann & Harder 2005). In the Portuguese context this fact was also verified by the significant association of breast-feeding a child for 3–6 months or more than 6 months with a decreased risk of overweight (Padez et al. 2005).

Sociodemographic variables (education and occupation)

In our findings maternal education (primary, six, 9-12 years) and maternal occupation (manual, non-manual, retired, unemployed) were significantly different in the Cape Verdean and the Portuguese ancestry children. For the Cape Verdeans in 2013 almost all cases analysed (n=34) maternal education was higher than paternal education even though the majority of mothers and fathers had low educational level (4 years) and were employed in manual jobs like the service sector and were low paid unskilled workers. Regarding the Portuguese educational level, low educational level defined as having less than primary, primary or lower secondary (ISCED 2011) is 48.4% compared to the European average that was 23.8% in EU-19 (Eurostat 2016). Consequently maternal practises seem to be important for child's health (Behrman & Wolfe 1987; Armar-Klemesu et al. 2000). Brisbois and collaborators reported in a review paper that in children under 5 years household income, maternal education, parental employment (head of the household), ethnicity, birthplace (country comparisons), birth order and number of siblings did not have any significant association with excess of weight (OW/OB) in adult life (Brisbois et al. 2012). However in another study maternal education has been associated with child's nutritional status (Frost et al. 2005) and mortality (Basu & Stephenson 2005). In an African context, Accra in Ghana, maternal education was associated with better child feeding health care utilization and prevention of infectious diseases (Armar-Klemesu et al. 2000). Even when the educational level is low there have been significant effects on the reduction of child mortality rates (Basu & Stephenson 2005). Furthermore parental occupation, maternal education, (Huntsman & White 2007),income and housing were also used in the Portuguese context (Freitas et al. 2007) as an approximate measure of socioeconomic status. A study with Portuguese mothers conducted in the north of Portugal in 2005-2006 explored the association of social conditions with pregnancy outcomes (Correia & Barros 2015). Consequently grandparents' highest education, childhood social class and family structure were used as proxies of childhood social environment while maternal education and marital status were used as adult SES. Correia and Barros concluded that for a higher maternal educational level there was protection from SGA (small-for-gestational age) in deprived neighbourhoods. An increase in maternal education seemed to be enough to diminish disadvantages of earlier life (lower education or low social class).

This study results show that being an unemployed mother or a housewife is associated with mothers being able to provide better nutritional care for a child. However it might also be explained by the effect of household socioeconomic insecurity observed in single parent families from Cape Verdean ancestry and its association with lower BMI hence lower risk of OW/OB. Nevertheless the fact is that in this context many Cape Verdean mothers worked mostly as cleaners and childcare workers allowing some flexibility to care for children. This fact along with educational level and breastfeeding length reinforced by cultural practises seems to be protecting Cape Verdean ancestry children compared to the Portuguese from high overweight and obesity rates.

In summary it has been observed that differences between Cape Verdean ancestry and Portuguese children seem to lie mostly in sociodemographic factors like maternal education and cultural practises like breastfeeding, and community availability of fast foods, although these factors do not wholly explain the differences observed.

Strengths and Limitations

This was the first study to objectively measure physical activity in an ethnic minority in Portugal in school children. Pedometers are cheap, easy to apply and can be reliable and accurate when used in combination with self-reported physical activity questions. Moreover this is the first household economic account applied to an ethnic minority during the aftermath of an economic European crisis (2008). It was conducted only inside the neighbourhood at a local public school. One of the main researchers (VR) was present at data collection for all the datasets referred to in this thesis, and he can give assurance that similar strategies were followed for the recruitment of participants and data collection. Qualitative methods contributed greatly to a better understanding of the biosocial framework of the Cape Verdean community living in Cova da Moura neighbourhood.

Many of the limitations of this study are related to my knowledge learning through my PhD studies, e.g. from methods available and their limitations in application in hard to reach communities. The fact that this is a hard to reach population has influenced the timing and application of the work process. Future studies with similar populations should work closely with local institutions like the school that can make the bridge between the population and the study. Insecurity in the area of the study meant that AA could only work during light hours and when the school was open, which restricted the hours available for data collection. On the other hand the portability of the materials used (stadiometer, laptop and scale) made it possible to collect measurements, even in this hard to reach community. The fact that mothers had a flexible work schedule facilitated the visits to the households even with difficult geography of the neighbourhood and the type of construction (high slope, vertical).

These methods seem to work when on a limited budget and maximising the resources available (walkability of neighbourhood). School was the main point of contact and it overcame the suspicion from the residents to have a gatekeeper to aid access to the community. This study did not use a specific food frequency questionnaire because of a lack of time available with participants to collect such measurements due to their busy schedules. A specific food frequency questionnaire would be time consuming even though it would be a more accurate reflection of patterns of dietary intake to better define associations with cardiovascular risk. Future research might focus on gaining a better understanding of dietary intake in this population. Most research has not given in-depth consideration into the rapid urbanisation and epidemiological transition influences on health related chronic diseases.

The small sample size of the Cape Verdean samples, could have limited the representation of these samples at the different time points. Especially for the latter age range, results might be biased by the small number of participants. Due to limited time and lack of extra funding and resources (especially physical, only 2 researchers were available in the field) it was not possible to amplify the sample size further. Moreover, the Portuguese sample (2009) was restricted to the Lisbon district and might mask effects in other urban neighbourhoods with different socioeconomic status that house Cape Verdean communities. Furthermore limited information from the 1992 dataset might have affected the representation of the sample. The data were obtained on paper but the information reported here is a subset of the initial data collected. Because the researcher died who collected the 1992 data it was not possible to recover that information in total. It was not possible to quantity items on the diet due to time constraints. A more constructive approach should be used in the future.

Information on previous maternal health history was collected using the household questionnaire and it included maternal weight gain during pregnancy. This was used in a previous study with Portuguese population (Moreira et al. 2007). It was chosen for this cross-sectional study to show possible predisposition for children's obesity. The self-report of the pregnancy weight gain information may however have some error associated with it (Marques 1999). Also body fat percentage was measured using body stat, a different method from the one used for waist circumference (anthropometry), which could contribute to the difference in the association observed with these outcome variables. This is especially because we don't know the formulas the company uses (Bodystat 1500 analyser ®) and also if that formula was validated for African ancestry populations. There could therefore be some inaccuracy in these assessments. Also using BodyStat 1500 in children has its limitations because, according to the manufacturer (https://www.bodystat.com/support/), this device should only be used in children older than 8 years. This case was verified in part of the sample and it was determined to not use data for normalization purpose. Slaughter's equation to estimate body composition is not adequate for this population and that is why it was dropped in the end of analytical procedures.

In order to objectively measure physical activity the Omron walking style III pedometer was used during school days. However and despite being a cost-effective and practical solution (Peters et al. 2013) limited accuracy was identified for these type of pedometers (HJ-203 Omron) on free-living conditions when using it on a necklace and pants pocket (De Cocker et al. 2012). When used around the neck it might even underestimated step counts (Silcott et al. 2011). More the manufacturer (Omron™ healthcare, Kyoto, Japan) recognises that the pedometer must be perpendicular to the ground in order for the device to accurately report step counts (Holbrook et al. 2009).

There were cases (n=2) where AA spotted children that might have been juggling the pedometer once they discovered the numbers would increment on the pedometer display. Despite attention given by school personnel the step values might therefore be overestimated. Future studies should explore the use of a similar device worn correctly in the upright position and placed on the hip using an elastic belt. The use of stickers on the pedometer's display may be used in order to prevent children from looking at it.

The small sample size is associated with reduced statistical power and this limits the interpretation of significance of statistical tests (Cohen 1992). For example the regression models in chapters 5 and 6 p-values were in some cases marginal and in a larger sample it is possible these would be statistically significant. Further data would need to be collected to test such associations. Nevertheless the depth of data collected is unique in the post economic climate context of Portugal and we have demonstrated that combining the data collected with other Portuguese data sources can make the findings publishable and a useful addition to the academic literature. However, the limitation to working with the Portuguese secondary data source was that it was not possible to compare maternal variables between the Cape Verdean ancestry children in 2013 and Portuguese children in 2009 mothers because the Portuguese data set did not directly measure the mothers.

It is important to also note that time frames may be important in explaining the differences between Cape Verdean ancestry children in 2013 and Portuguese children in 2009. This is because the national study in 2009 did not fully include the economic crisis effects. Differences in SES along with geographical differences between the samples might influence the OW/OB rates observed in the two samples and alter the relationships observed. Because we used information on first born in Portugal children some information relative to maternal health history was lost.

Policy implications and future research:

Cultural practises seem to be working as a buffer for Cape Verdean ancestry children against Portuguese nutritional transition characterized by high OW/OB rates and stunting. One of the challenges for policy makers would be to improve SES of this community while not placing children at risk of exposure to obesogenic environments. The lower overweight and obesity rates in primary school aged pupils during this time might have been propelled by the world economic crisis that contributed to higher deprivation on this community.

Also macro and community level health factors could be further explored, as this study is only able to report on observations from field notes regarding the community environment. A full mapping of food availability in the community and time children spend in and outside of the community could add further policy and intervention relevant material. More specific measurement of physical activity for children out of school time could be devised with security ensured. Also more information could be gained by objectively measuring weekend and out of school physical activities in this group of children. Subsequent studies should aim at larger sample sizes and other ethnic minorities living in Portugal to better understand the combined relationships between biological and environmental variables and risk for poor nutritional outcomes in children of this Cape Verdean community.

After the financial economic crisis in 2008 that affected the global economy the impact on health inequality, healthcare provision and on public health in Europe has been studied (Cooper 2011; Karanikolos et al. 2013; WHO 2013). More than ever it is essential to target better and adequate policies to all society levels. This would be the chance for policies oriented for neighbourhood health (Diez Roux 2007) and to account for each specific community and how social inequality impacts their health. Moreover it could be also used as an opportunity to tackle inequalities in women's health because this effect could be prolonged to impact the next generations and help curb social disparities in children's health (Kahn et al. 2005). Especially in this community where women are so important policies investing into better education and empowering opportunities would greatly benefit the next generation's health and integration in society.

Some weaknesses identified in the current system for the Cape Verdean community are the lack of a consistent approach and financial cut backs that place local social support agents in terrible stress. Communities like these would greatly benefit from an integrated approach from other partners, especially in a consistent manner. Interventions should use traditional diets as a positive lever for good nutrition within this poverty exposed community while ensuring local farmed goods are available eg from community allotments. Migration related with psychological stress is not known among Cape Verdean groups in Portugal. It would be important to know how this relates with body composition and health. It would be beneficial to track these children in future studies.

These Cape Verdean children have better living conditions and still maintain traditional practises like a common food environment but that might change when going to other schools outside the neighbourhood when they transition to secondary school. The mothers who do leave the neighbourhood for work for instance do show much higher risk of overweight and obesity. Living outside the neighbourhood perimeter seems to have a different effect on both children and mothers. The ones living outside the neighbourhood seem to have better living conditions and might be more exposed to obesogenic environments. The fact that these Cape Verdean mothers present high OW/OB demands a need for different policies and interventions focused on the physical environment. Also marital structure of the Cape Verdean families where women seem to be the main provider may propel a specific imbalance affecting women's health. The mechanisms on how this may cascade down to the children would be very important to explore in future studies.

Maternal education and household income should also be considered in future interventions. It is important to use the predominant role of the Cape Verdean mother's independence by targeting policies at them that support their caring role, which often takes place in single parent households. In fact short term and long-term good effects could be reaped on healthy growth and that of the next generations. Local nurseries received Government support and have been valuable in providing childcare in extended hours for these working mothers.

Concluding remarks

This thesis has identified associations between maternal marital status (child BMI) and father's non-manual occupation (manual jobs, retired or unemployed) (child waist circumference Z-score) with nutritional status of Cape Verdean children. Also protective factors were identified among this Cape Verdean group compared with the Portuguese children even after controlling for a range of socio-demographic and biological factors (age, sex, maternal age, birth weight, whether the child was breastfed, maternal education, and maternal occupation). Protective effects included being breast-fed, being of lower birth weight, having a mother with more years of education and having a mother who spends more time at home, such as being unemployed or a housewife. Further work with larger samples is needed to better understand the relationship between those factors. Cape Verdean children seem to be behind Portuguese children in the nutritional transition, which is positive for Cape Verdean children's nutritional health at this stage of transition. The Cape Verdean children's low OW/OB rates and low stunting rates show that even though under an economic crisis (2008) these children seem to be keeping healthy nutrition behaviours. That is observed by meeting physical activity recommendations, measured by step count and consuming a qualitatively diverse diet along with traditional influences. Despite the high socio-material deprivation observed in this neighbourhood its dynamic of being an isolated community for primary school aged children may work as a buffer from obesogenic exposures. Moreover the school menu almost did not change during the periods studied. On the other hand Cape Verdean mothers analysed in this study showed a different pattern than their children and show risk factors for cardiovascular diseases. The fact that mothers leave the neighbourhood to work might expose them to the nutritional transition affecting the Portuguese adult population. Despite the local support (institutions, relatives) and cultural practises that have been helping many families during the economic crisis those resources are at the breaking point and need to be addressed in future studies. Cova da Moura neighbourhood would benefit from integrated interventions aimed at Cape Verdean ancestry girls on health and nutrition to prevent them from transitioning during adolescence to the high OW/OB levels observed in Portuguese society.

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Associação Cultural Moinho da Juventude: http://www.moinhodajuventude.pt/).
Education Cabinet Amadora Municipality I Educação Câmara Municipal Amadora:
http://educa.cm-amadora.pt

Appendix

Appendix A. Approval form from both Ethics committees (Scientific Institute of Tropical Medicine and Loughborough University)

QUAERENS IN·TROPICOS
INSTITUTO DE HIGIENE E MEDICINA TROPICAL
UNIVERSIDADE NOVA DE LISBOA

Parecer sobre Protocolo de Estudo

15-2013-TD

Conselho de Ética do Instituto de Higiene e Medicina Tropical

Nome da Investigadora (requerente): Ana Lúcia Vieira Peixoto André

Título: "Obesidade e fatores ambientais entre os migrantes Cabo-verdianos residents em Portugal"

Objectivo do estudo

Determinar a prevalência de sobrepeso/obesidade na comunidade imigrante Cabo-Verdiana a viver em Portugal.

Conflito de interesses:

Não foi identificada a existência de conflito de interesses.

Consentimento informado, informação para o participante:

Contemplados na descrição do projecto.

Conclusão:

Consideramos que o estudo pode ser genericamente válido e justificado do ponto de vista ético.

Lisboa, 25 de Julho de 2013

As relatoras,

Sónia F. Dias, Professsora Associada IHMT-UNL

Luzia Gonçalves, Professsora Auxiliar IHMT-UNL

GILLES DUSSAULT
Presidente do Conselho de Ética

LOUGHBOROUGH UNIVERSITY

ETHICS APPROVALS (HUMAN PARTICIPANTS) SUB-COMMITTEE

RESEARCH PROPOSAL Ref No: R13-P56

INVOLVING HUMAN PARTICIPANTS

Title: Obesity and Environmental factors among Cape Verdean migrants living in Portugal

Applicant: Dr M Varela-Silva, A L Andre

Department: SSEHS

Date of clearance: 15 March 2013

Appendix B. Consent forms (translated from Portuguese).

"Health, growth and environmental factors among Cape Verdean children living in Portugal"

Informed consent

The project's main objectives are:

- Determine the prevalence of overweight/obesity on the Cape Verdean ancestry community living in Portugal;
- Understand how the bio cultural and living conditions are affecting them in a different environment; It is important to define the appropriate actions and interventions to curb the increase of overweight/obesity.
- Understand the growth patterns and nutritional status of Cape Verdean migrants living in Lisbon. We want to consider the different physical, intergenerational, social and economic variables that may have an impact on future generations' health.

This project is developed on Ana Lúcia Vieira Peixoto André PhD scope and she is supervised by Maria Inês Varela-Silva from Loughborough University, UK and Dr. Vitor Manuel Rosado Marques from Scientific Medicine Tropical Institute, Portugal.

This project is based on children and parents from Cape Verdean ancestry living on deprived neighbourhoods of Great metropolitan Lisbon area (GMLA).

Your participation is voluntary. At any moment of the study you may decide to withdraw from it without any justification or penalization. You should only have to inform the main researcher (Ana Andre) that you intend to do so using one of the following contacts. Even if you have signed the informed consent form you can still give up and withdraw your family from the study.

All procedures should take three hours in total and your scheduling will be arranged with all parts implied.

The household interviews will be arranged by Ana Andre and parents/guardian of the child. Also household questionnaire will be explained and filled in by the Ana Andre on living conditions, ancestry and diet.

All data collected and subsequent analysis will respect anonymity and confidentiality.

I have read and understand the participant information document and the informed consent form.

I have presented any doubts about my participation.

I am in any obligation of participating in the study.

I have understood that I withdraw my participation on the study at any moment and that I would be obliged to justify it.

I do understand that all information will be managed with the utmost confidentiality and that it will be kept confidential and anonymous by the researchers (unless it should be disclosed by any legal obligation associated to their work institutions) unless it should be define to do so to guarantee the participants' security.

I agree in participating in the study and I authorize my child (dren) to participate in this study.

◯ I do authorize taking photos of my child(dren) to be used under school projects and to the broadcast of this project.

Name and school grade attending ______________________________

Signed (parent/guardian)

____

My current address and ______________________________

contact details: ______________________________

MR (AAndre) signature

____

Place and date

____

Appendix C. Questionnaires

The phD project entitled "Health, growth and environmental factors among Cape Verdean children living in Portugal"

aims at:

Determine the growth and nutritional status of the Cape Verdean migrants living in Lisbon

Assess the impact of the exposure to different physical, social, and economic ecologies that shape child's growth

Evaluate the risk for overweight and obesity and metabolic and intergenerational factors

We are contacting you in order to collect information of the Cape Verdean children's living conditions, physical activity levels and nutritional status in this community.

This interview is part of a PhD study in Human Biology and will take approximately 1hour and 15 minutes.

All safeguard anonymity of participants/confidentiality of personal data will be insured during the collection, analysis/treatment and presentation of the data. If you want we can send you a copy of the conclusions of the study. You can stop the interview at any time of, or withdraw your participation in the study without any problem.

Thank you for participating.

Household questionnaire

Health, growth and environmental factors among Cape Verdean ancestry children living in Portugal

Reference | **Date**

Place of Observation | **Interviewer**

Child Birth place

Child Birth country

Cape Verde

Portugal

Other

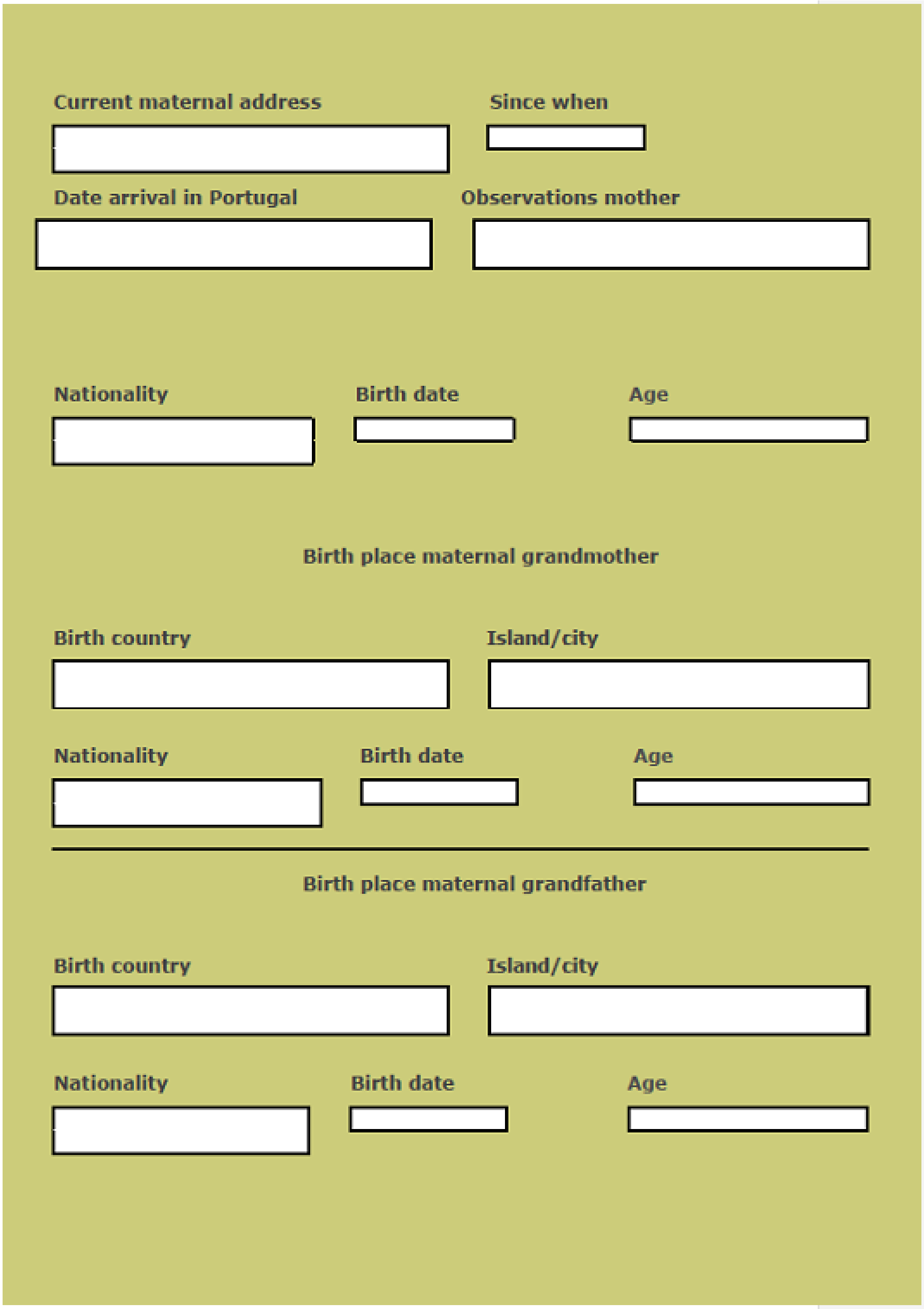
Ancestry

Maternal ancestry

Country of birth mother | **Island/ city birth mother**

Birth date mother

Nationality mother


Current maternal address

Since when

Date arrival in Portugal

Observations mother

Nationality

Birth date

Age

Birth place maternal grandmother

Birth country

Island/city

Nationality

Birth date

Age

Birth place maternal grandfather

Birth country

Island/city

Nationality

Birth date

Age

Birth place maternal grandmother

Birth country

Island/city

Nationality

Birth date

Age

Birth place maternal grandfather

Birth country

Island/city

Nationality

Birth date

Age

Living conditions

House structure

Classic   shanty

Other

Sewing

Public

Other

Year it was built

How long living in this address

Energy

yes

no

Gas

pumped

bottle

Water supply

yes

no

Legal

yes

no

House

renting

own

Number of rooms

Number of divisions

Exclusive kitchen

yes

no

Exclusive WC

yes

no

Assets: car

yes

no

Internet

yes

no

Personal computer

yes

no

Cable TV

yes

no

Family economy

Income per household (thousands euros/year)

< 9.000 9-15.000 15-19.000 19-25.000
25-30.000 30-40.000 >40.000
Other

Monthly income household (euros)

Spending per household (thousands euros/year)

<10.000 10-14.000 14-17.000 17-22.000 22-30.000
>30.000
Other

Approximate montlhy spending (euros)

Do you have family in Cape Verde?

yes
no

Do you send remittances to Cape Verde?

Sim
Não

Montlhy wage* Mother

< Minimum wage
Minimum wage
> Minimum wage
Other

Monthly wage Father

< Minimum wage
Minimum wage
>Minimum wage
Other

*Minimum wage (2013)= 485 euros

Number of people living at household

Number of children < 10 years

maternal job

Workplace

week work hours

Type of work contract

Maternal occupation

- housewife
- unemployed
- retired
- student

Duration unemployment (mnoths)?

Receiving benefit?

- yes
- no

Monthly amount

Duration (mths)

Receiving social support?

- yes
- no

Monthly amount

Duration (mths)

Second job?

- yes
- no

Extra month wage

Work hours

Time mother leaves the house to work

Time mother arrives from work

Childcare after school

Time mother need to leave again

Paternal education

Do you know how to read?

yes
no

Observations

Educational level

none (<4a)
primary (6 a)
secondary(12a)
university(>15a)
master/doctorate
technical

Did you finish that level?

yes
no
duration

work situation

self-employed
manager
employed

Paternal job

workplace

Week work hours

type contract

Ocupation father
- unemployed
- retired
- student

Duration unemployed (months)?

Receiving benefit?
- yes
- no

Monthly amount | **Duration (months)**

Receiving social support?
- yes
- no

Monthly amount | **Duration (months)**

Second job?
- yes
- no

Monthly amount | **Week work hours**

What time father leaves the house to work

When is he back?

Chilcare after school

Do you leave again?

Maternal health history

Maternal age (years)

Maternal civil status

married | single | widower | divorced
separated | living alone

Living with husband/partner?

yes
no
relation to the child

Health history

Number of marriages

Age at first marriage

Age at first period

Related to husband?

Poligamy?

Number of pregnancies

Non planned pregnancy

Planned pregnancy

Unwanted pregnancy

Birth interval

Want to have more children?

yes
no
reason

Total weight gain on last pregnancy (kg)

Did you take any supplement?

yes
no
what?

How frequently do you attend your local surgery?

Regularly
Immunisations
Only when feeling ill

observation

Do you attend family planning meetings regularly?

yes
no
why?

Diabetes?

Type I
Type II
Gestational

Other health conditions?

Are you using any contraceptive method?

yes
no
which?

How long (months)?

Offspring

baby nr	birth date	weight/ length	GA	Sex	breastfeed (months)
			PT	F	yes
			T	M	no
			POT		duration?

baby nr	birth date	weight/ length	GA	Sex	breastfeed
			PT	F	yes
			T	M	no
			POT		duration?

baby nr	birth date	weight/ length	GA	Sex	breastfeed
			PT	F	yes
			T	M	no
			POT		duration?

baby nr	birth date	weight/ length	GA	Sex	breastfeed
			PT	F	yes
			T	M	no
			POT		duration?

baby nr	birth date	weight/ length	GA	Sex	breastfeed
			PT	F	yes
			T	M	no
			POT		duration?

Do you exercise regularly _ Mother

yes

no

type ?

Child health conditions :

Aenemia
Diabetes
Ashma
Diahrrea
Respiratory
Other

Observations

Sibling id in the study

Birth weight(gr)

Head circumference(cm)

Recumbent length(cm)

APGAR

Child health conditions

Aenemia
Diabetes
Ashma
Diahrrea
Respiratory
Other

Observations

Reported physical activity child

Do you consider your child to be active?

litlle
active
very active

How do you get to school?

walking
riding a bicycle
car
bus
train
Other

Do you walk alone?

yes
no
Who do you go with? ____________

Where do you usually play?

public space
friend's house
association
school
football field
street
other ____________

PA at school?

yes
no

Daily duration?

1 hour
2-3 hours
3-5 hours
>5 hours

Weekly frequency?

1 X
2 X
3 X
4 X
>5 X

What activities?

____

Do you practise PA out of school?

yes
no

Daily duration?

1 hour
2-3 hours
3-5 hours
>5 hours

Weekly frequency?

1 X
2 X
3 X
4 X
>5 X

What activities?

Are you playing for a club?

yes
no
which?

What type of activity do you play?

Daily duration?

1 hour
2-3 hours
3-5 hours
>5 hours

---

24 hour recall

What time do you get up?

What time do you go to bed?

Breakfast

yes
no

time

place

home
school
leisure
other

Morning snack

yes
no

time

place

home
school
leisure
other

Lunch time place

yes [ ] home school

no leisure

other [ ]

Afternoon snack time place

yes [ ] home school

no leisure

other [ ]

Dinner time place

yes [ ] home school

no leisure

other [ ]

Supper time place

yes [ ] home school

no leisure

other [ ]

What was your main meal yesterday?

Breakfast lunch snack

dinner

other [ ]

What did you have? (select several options if necessary)

Vegetable Soup

Meat

Fish

Fruit

Other [ ]

What did you drink?

- Water
- Starchy drink
- Natural juice
- Milk
- Milk with cooffee
- Milk with chocolat
- Tea
- Coffee
- Other [ ]

What was your pudding?

- Fruit
- Sweet
- Other [ ]

Food prepared by at home on the day of the visit

[ ]

Do you add suggar daily?

- yes
- no
- how much? [ ]

Observation (soup and tea spoons)

[ ]

On your milk?

- yes
- no
- How many? [ ]

What do you like to eat?

[ ]

What is your favourite dish?

[ ]

What don't you like to eat?

[ ]

What is your least favourite dish?

[ ]

Anthropometric and body composition measurements of the mother

Health, growth and environmental factors among Cape Verdean ancestry children living in Portugal

Mother Anthropometry

Reference

Place Interview

Interviewer

Date measurement

Time

Ancestry

Age

Date of birth

Anthropometry

Height 1(cm)	Height 2 (cm)	Height mean (cm)
Weight 1 (Kg)	Weight 2 (Kg)	Weight mean (Kg)
Arm circumference relaxed 1 (cm)	Arm circumference relaxed 2 (cm)	Arm circumference mean (cm)
Waist circumference1 (cm)	Waist circumference 2 (cm)	Waist circumference Mean (cm)

Body composition Biostat 1500

Bioscan ID

Impedance (Ω)

Reactance

Body fat percentage

Total body fat (kg)

Total body fat (%)

Lean mass (%)

Lean mass (kg)

Basal metabolic rate (Kcal)

Water (%)

Water (Lt)

BMI

Body weight (kg/kcal)

Mean energetic requirements

Health, growth and environmental factors among Cape Verdean ancestry children living in Portugal

Child's Anthropometry and Physical activity assessment

Reference **Place Interview** **Interviewer**

Date measurement **Time** **Notes**

Sex
Female
Male

Date of birth **Age**

Anthropometry child

Height 1(cm) Height 2 (cm) Height mean (cm)

Weight 1 (Kg) Weight 2 (Kg) Weight mean (Kg)

Sitting height 1 (cm) Sitting height 2 (cm) Sitting height mean (cm)

BMI1 BMI 2 BMI mean

Abdominal circumference 1(cm) Abdominal circumference 2(cm) Abdominal circumference mean (cm)

Waist circumference 1(cm)

Waist circumference 2(cm)

Waist circumference mean (cm)

Arm circumference 1 (cm)

Arm circumference relaxed 2 (cm)

Arm circumference relaxed mean (cm)

Abdominal skinfold 1 (mm)

Abdominal skinfold 2 (mm)

Abdominal skinfold mean (mm)

Triceps skinfold1 (mm)

Triceps skinfold 2 (mm)

Triceps skinfold mean (mm)

Biceps skinfold 1 (mm)

Biceps skinfold 2 (mm)

Biceps skinfold mean (mm)

Subscapular skinfold 1 (mm)

Subscapular skinfold 2 (mm)

Subscapular skinfold mean (mm)

Body composition Biostat 1500

Bioscan ID

Impedance (Ω)

Reactance

Body fat percentage

Total body fat (kg)

Total body fat (%)

Lean mass (%)

Lean mass (kg)

Basal metabolic rate (Kcal)

Water (%)

Water (Lt)

BMI

Body weight (kg/kcal)

Mean energetic requirements

Pedometers

Serial number

Stride length

calibration day

number days used

Mean step count (week)

Kilometres walked

Kilocalories

Fat burn

Time in/out

Feedback forms

Participation Certificate

This document certifies that

______________________________ weights ____ kg and is ____cm tall

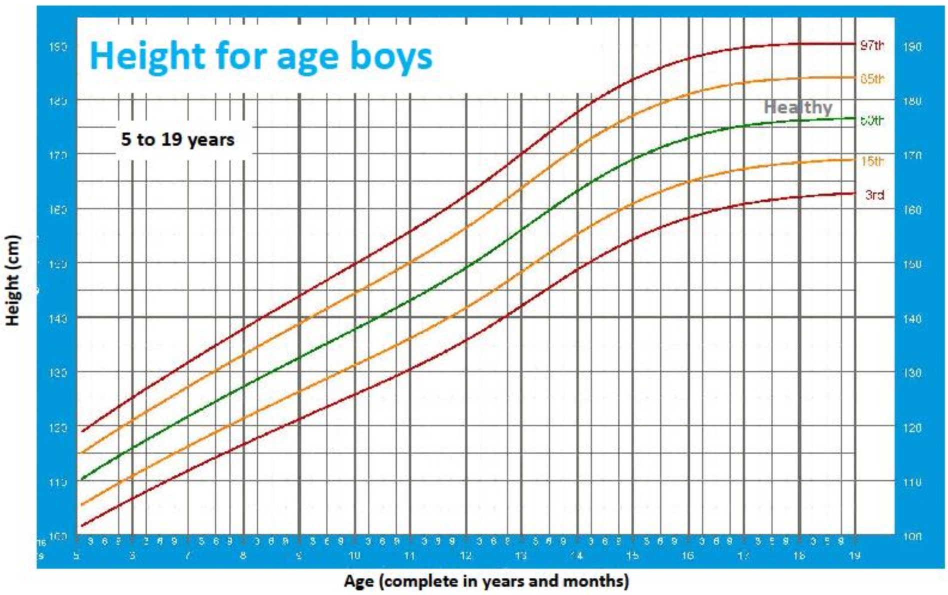
Her/His participation on the project **"health, growth and environmental factors among Cape Verdean ancestry children living in Portugal"** was very important.

____________________ __________

Main Researcher Date

World Health Organization

Health, growth and environmental factors among Cape Verdean ancestry children living in Portugal



Appendix D. Chapter 4

Table 1. Single parent families distribution in 2013.

Single parent families		
	Frequency (n)	Percent (%)
no	28	45,2
yes	34	54,8
Total	62	100

Table 2. Single parent families distribution (n) among neighbourhood perimeter in 2013.

Single parent families within neighbourhood perimeter in or out				
		neighbourhood perimeter		Total
		out	in	
Single parent families	no	6	21	27
	yes	5	22	27
Total		11	43	54

Table 3. Paternal educational level according to nationality in 2013.

Father educational level * father nationality Crosstabulation						
			father nationality			Total
			Portugal	Cape Verde	Other	
Father educational level	primary (4 years) or none	Count	3	8	2	13
		% of Total	9,1%	24,2%	6,1%	39,4%
	6 years	Count	1	7	1	9
		% of Total	3,0%	21,2%	3,0%	27,3%
	9-12 years and Univ	Count	6	4	1	11
		% of Total	18,2%	12,1%	3,0%	33,3%
Total		Count	10	19	4	33
		% of Total	30,3%	57,6%	12,1%	100%

Table 4. Maternal educational level according to nationality in 2013.

mother educational level * mother nationality Crosstabulation						
			mother nationality			Total
			Portugal	Cape Verde	other	
mother educational level	primary (4 years) or none	Count	6	9	3	18
		% of Total	12,0%	18,0%	6,0%	36,0%
	6 years	Count	8	5	2	15
		% of Total	16,0%	10,0%	4,0%	30,0%
	9-12 years and univ	Count	8	8	1	17
		% of Total	16,0%	16,0%	2,0%	34,0%
Total		Count	22	22	6	50
		% of Total	44,0%	44,0%	12,0%	100%

Table 5. Cape Verdean's maternal working week hours in 2013.

		maternal week work hours	weekly work hours father
N		44	25
Mean		35,14	38,92
Median		40,00	40,00
Std. Deviation		10,60	5,20
Minimum		6,00	21,00
Maximum		50,00	46,00
Percentiles	25	36,00	40,00
	50	40,00	40,00
	75	40,00	40,00

Table 6. Frequencies for main member of head of household.

Head of household		Frequency (n)	Percent (%)
	Father	18	29,5
	Mother	43	70,5
	Total	61	100

Table 7.Child benefit distribution among Cape Verdean parents in 2013.

Child benefit		Frequency (n)	Percent (%)
		42	47,2
	father	4	4,5
	mother	43	48,3
	Total	89	100

Table 8. Ancestry measured by number of family members born in Cape Verde reported in 2013.

Ancestry (nr grandparents CV)		Frequency (n)	Percent (%)
	1	3	4,8
	2	11	17,7
	3	6	9,7
	4	42	67,7
	Total	62	100

Table 9. Parental length of time living in Portugal reported in 2013.

		Time years father living PT	Time years mother living PT
N		23	46
Mean		13,22	13,37
Median		13,00	12,50
Std. Deviation		8,852	7,63
Minimum		2	3,00
Maximum		42	35,00
Percentiles	25	7,00	8,00
	50	13,00	12,50
	75	16,00	15,25

Descriptive information on early life factors among subset of Cape Verdean children measured in 2013 :

Table 10. Frequencies found for early life factors in 2013.

		Birthweight kg	Birth order	Breastfeeding duration (months)	gestational age categ	Birth spacing	gestational _age weeks
N		46	47	45	45	40	24
Mean		3,06	2,60	10,69	,78	55,80	39,71
Median		3,03	2,00	12,00	1,00	37,41	40,00
Std. Deviation		,476	1,87	8,36	,42	42,08	1,805
Minimum		2,20	1	,0	,00	15,44	37
Maximum		4,00	10	24,0	1,00	163,55	44
Percentiles	25	2,67	1,00	3,00	1,00	22,44	38,25
	50	3,03	2,00	12,00	1,00	37,41	40,00
	75	3,44	3,00	17,00	1,00	81,17	40,00

Table 11. Early life factors frequencies among Cape Verdean ancestry boys in 2013.

		Birthweight kg	Birth order	Breastfeeding duration (months)	Birth spacing	Gestational_age weeks
N		21	22	20	21	11
Mean		3,13	2,45	11,30	68,14	39,55
Median		3,20	2,00	12,00	53,95	39,00
Std. Deviation		,41	1,47	8,21	47,68	1,92
Minimum		2,30	1	,0	17,68	37
Maximum		3,65	6	24,0	163,55	43
Percentiles	25	2,78	1,00	4,00	25,71	38,00
	50	3,20	2,00	12,00	53,95	39,00
	75	3,45	3,25	17,50	87,54	41,00

Table 12. Early life factors distribution among Cape Verdean ancestry girls in 2013.

		Birthweight kg	Birth order	Breastfeeding duration (months)	Birth spacing	Gestational_age weeks
N		25	25	25	19	13
Mean		3.00	2,72	10,20	42,16	39,85
Median		2,90	2,00	9,000	24,94	40,00
Std. Deviation		,52	2,189	8,61	30,60	1,772
Minimum		2,20	1	,0	15,44	37
Maximum		4,00	10	24,0	106,94	44
Percentiles	25	2,62	1,00	3,00	18,99	38,50
	50	2,90	2,00	9,00	24,94	40,00
	75	3,45	3,00	17,00	65,87	40,00

Table 13. Breastfeeding length based on 6 month cut- off point in 2013.

Breastfeeding cut off 6 mth		Frequency (n)	Percent (%)
	not breastfed	7	15,6
	< 6 mths	9	20,0
	> 6 mths	29	64,4
	Total	45	100

Table 14. Birth order distribution for sub set of Cape Verdean ancestry children in 2013.

Birth order		Frequency (n)	Percent (%)
	1	13	27,7
	2	19	40,4
	3	5	10,6
	4	3	6,4
	5	3	6,4
	6	2	4,3
	7	1	2,1
	10	1	2,1
	Total	47	100

Table 15. Health conditions among Cape Verdean ancestry children in 2013.

Diseases child		Frequency (n)	Percent (%)
		38	80,9
	Asthma	3	6,4
	Anaemia	3	6,4
	Other respiratory	2	4,3
	Surgery	1	2,1
	Total	47	100

Table 16. Health conditions reported by Cape Verdean mothers in 2013.

Health conditions mother		Frequency (n)	Percent (%)
	Gestational diabetes	3	27,3
	Gestational diabetes and asma	1	9,1
	Obesity	1	9,1
	Anaemia	2	18,2
	Hypertension	2	18,2
	Asthma	1	9,1
	Total	11	100

Table 17. Frequency of Cape Verdean ancestry children participating in PE classes at school in 2013.

PA out school		Frequency (n)	Percent (%)
	yes	26	54,2
	no	22	45,8
	Total	48	100

Table 18. Frequency (week) of Cape Verdean ancestry children playing PA activity out of school in 2013.

PA out school		Frequency (n)	Percent (%)
		68	76,4
	>5 X	1	1,1
	1 X	9	10,1
	2 X	6	6,7
	3 X	4	4,5
	4 X	1	1,1
	Total	89	100

Table 19. Frequency of mean sleep hours per week on Cape Verdean ancestry children in 2013.

Sleep hour week		
N		58
Mean		10,38
Median		10,13
Std. Deviation		,76
Minimum		9,00
Maximum		13,00
Percentiles	25	10,00
	50	10,13
	75	11,00

Table 20. Frequency of daily meals reported on Cape Verdean ancestry children in 2013.

How many meals does your child have each day?		Frequency (n)	Percent (%)
	3	3	5,2
	4	12	20,7
	5	26	44,8
	6	17	29,3
	Total	58	100

Table 21. Place where Cape Verdean ancestry children reported consuming dinner.

place where child consumes dinner		Frequency	Percent
	not consumed	1	1,7
	home	54	93,1
	other	3	5,2
	Total	58	100

Table 22. Place where Cape Verdean ancestry children reported consuming breakfast.

place where child consumes breakfast		Frequency (n)	Percent (%)
	not consumed	5	8,6
	home	48	82,8
	other	5	8,6
	Total	58	100

Table 23. Frequencies for children consuming salty food and adds sugar to drink.

Salty food		Frequency (n)	Percent (%)	if added sugar to drinks	Frequency (n)	Percent (%)
	no	45	77,6		27	46,6
	yes	13	22,4		31	53,4
	Total	58	100,0		58	100,0

Table 24. Main daily meal consumed by Cape Verdean ancestry children in 2013.

	Main meal child	Frequency (n)	Percent (%)
	Lunch	9	17,6
	Dinner	30	58,8
	Break snack	4	7,8
	Breakfast	8	15,7
	Total	51	100

Table 25. Number of daily means consumed by Cape Verdean ancestry children in 2013.

Nr meals child		Frequency (n)	Percent (%)
	3	3	5,2
	4	12	20,7
	5	26	44,8
	6	17	29,3
	Total	58	100

Table 26. Frequencies for Cape Verdean ancestry children having lunch at school in 2013.

School meal reported		Frequency (n)	Percent (%)
	No	2	3,4
	Yes	56	96,6
	Total	58	100

Table 27. Number of Cape Verdean ancestry children benefitting from free lunch at school.

child with benefit meal at school		Frequency (n)	Percent (%)
	free school meal	52	82,5
	help school meal	11	17,5
	Total	63	100

Appendix E. Chapter 5

Table1. Descriptive Information on maternal variable's .

Variable	n	Description	Observation
Maternal Age (dd/mm/yyyy)	47	Scale	Self-reported via date of birth (dd/mm/yyyy)
Parity	47	Scale	Number of viable pregnancies (live babies)
Maternal total weight gain	30	Scale, categorical	could not recall
Time living in Portugal	39	Scale	34 were born in Cape Verde and 5 in PALOPs
Birth order	47	Scale	birth order of child included
Child Birth weight	46	Scale	grams, reported and confirmed on child red book
Maternal educational level (high, low)	43	Dichotomous (what is the code for these variables?) 0=low, 1=high	Some did not answer
Single parent families	47	Dichotomous 1=No, 2=Yes	Defined by mother or father interviewed (HQ)
Maternal anthropometric variables	47	Scale	2 mothers were not comfortable with WC and AC

All data in this table was collected with Household questionnaire. WC and AR: waist and arm circumferences

Table 2. Frequencies for Cape Verdean maternal birth place in 2013.

Mother birth place		Frequency (n)	Percent (%)
	Portugal	6	13,3
	Santiago	28	62,2
	Sao nicolau	1	2,2
	Sao tome	3	6,7
	Sao vicente	3	6,7
	Angola	2	4,4
	Santo antao	2	4,4
	Total	45	100

Table 3. Frequency of health centre reported by Cape Verdean mothers.

freq health centre		Frequency (n)	Percent (%)
	Frequently	36	83,7
	Only when necessary	7	16,3
	Total	43	100

Table 4. Attendance of local health centre by Cape Verdean mothers.

Healthcentre		Frequency (n)	Percent (%)
	Local health centre	25	67.6
	Other	11	29.7
	Hospital	1	2.7
	Total	37	100,0

Table 5. Reasons for not wanting to have another child presented by Cape Verdean mothers.

		Frequency (n)	Percent (%)
	Health	2	11,8
	Age	1	5,9
	Economic	13	76,5
	Optional	1	5,9
	Total	17	100

Table 6. Health conditions recalled by Cape Verdean mothers to latest pregnancy.

		Frequency (n)	Percent (%)
	Gestat diabet,ashtma	1	2,1
	Chronic anemy ,hypertension	1	2,1
	Athma since arriving	1	2,1
	Gestationa diabetes	3	4,3
	Morbid obesity followed hosp	1	2,1
	Hypertension	1	2,1
	Hypertension and desc placent	1	2,1
	Total	32	68.1

Table 7. Single parent families distribution on subset of 47 households

Single parent families		Frequency (n)	Percent (%)
	no	25	53,2
	yes	22	46,8
	Total	47	100

Regression model including SC (standardized coefficient, β) and UC (unstandardized coefficient, B):

Table 8. Influence of maternal Z-score WC on children's height Z-scores using multiple regression.

	Model 1			Model 2			Model 3				
	B	SE	*p*	B	SE	*p*	B	β	SE	*p*	*95% CI*
Constant	2.158	1.100	0.057	1.441	1.010	0.161	1.986		1.010	0.056	-0.056 to 4.028
Sex child											
Girl (ref)	1.00										
Boy	-0.371	0.288	0.204	-0.337	0.258	0.199	-0.432	-0.226	0.253	0.096	-0.944 to 0.080
Age child	-0.205	0.137	0.143	-0.373	0.133	0.008	-0.392	-0.429	0.129	0.004	-0.652 to -0.132
Z-score WC mother	0.159	0.191	0.409	0.070	0.173	0.690	-0.025	-0.019	0.173	0.887	-0.375 to 0.326
Age mother				0.057	0.017	0.002	0.034	0.293	0.020	0.090	-0.006 to 0.074
Birth order							0.172	0.340	0.085	0.049	0-0.343
R^2 adjusted		0.031			0.221				0.277		

Model 1 is adjusted for child sex and age and tests for intergenerational influences of maternal chronic early life environment, model 2 and model 3 control for child's own environmental exposures ; SE : standard error, N=45, F(4.368), p<0.05, R2= 0.359 adjusted R2 =0.277, SC (standardized coefficient, β) and UC (unstandardized coefficient, B)

Table 9. Influence of maternal WHtRatio on children's height Z-scores Cape Verdean ancestry living in Portugal using multiple regression.

	Model 1			Model 2			Model 3				
	B	SE	*p*	B	SE	*p*	B	β	SE	*p*	*95% CI*
Constant	1.081	1.472	0.467	1.580	1.342	0.246	2.646		1.371	0.0061	-0.128 to 5.420
Sex child											
Girl (ref)	1.00			1.00			1.00				
Boy	-0.354	0.286	0.224	-0.348	0.259	0.187	-0.454	-0.237		0.080	-0.964 to 0.057
Age child	-0.213	0.136	0.125	-0.381	0.134	0.007	-0.406	-0.444	0.129	0.003	-0.666 to -0.145
Mother WHtR	2.120	1.826	0.252	-0.247	1.815	0.892	-1.291	-0.105	1.798	0.477	-4.928 to 2.347
Age mother				0.059	0.019	0.003	0.038	0.322	0.020	0.069	-0.003 to 0.079
Birth order							0.185	0.365	0.084	0.034	0.014 to 0.355
R^2 adjusted		0.043			0.218				0.286		

Model 1 is adjusted for child sex and age and tests for intergenerational influences of maternal chronic early life environment, model 2 and model 3 control for child's own environmental exposures; SE : standard error, N=45, F(4.523), p<0.05, R^2= 0.367, adjusted R^2 =0.286, SC (standardized coefficient, β) and UC (unstandardized coefficient, B)

Table 10. Influence of maternal Z-score height on children's height Z-scores Cape Verdean ancestry living in Portugal using multiple regression.

	Model 1			Model 2			Model 3				
	B	SE	*p*	B	SE	*p*	B	β	SE	*p*	*95% CI*
Constant	1.923	0.955	0.050	1.082	0.945	0.259	1.686		0.937	0.079	-0.206 to 3.578
Sex child											
Girl (ref)	1.00			1.00			1.00				
Boy	-0.336	0.260	0.203	-0.258	0.244	0.296	-0.359	-0.191	0.237	0.137	-0.837 to 0.119
Age child	-0.162	0.119	0.180	-0.256	0.116	0.034	-0.280	-0.326	0.111	0.016	-0.505 to -0.056
Z-score Mother height	0.380	0.154	0.017	0.316	0.146	0.036	0.309	0.277	0.139	0.032	0.029 to 0.588
Age mother				0.043	0.016	0.010	0.020	0.169	0.018	0.291	-0.017 to 0.057
Birth order							0.180	0.355	0.078	0.026	0.023 to 0.337
R^2 adjusted	0.123			0.234			0.306				

Model 1 is adjusted for child sex and age and tests for intergenerational influences of maternal chronic early life environment, model 2 and model 3 control for child's own environmental exposures ; SE : standard error, N=47, F(5.057), $p<0.05$, R^2= 0.381, adjusted R^2 =0.306, SC (standardized coefficient, β) and UC (unstandardized coefficient, B)

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Table 11. Influence of maternal Z-score BMI on children's height Z-scores Cape Verdean ancestry living in Portugal using multiple regression.

	Model 1			Model 2			Model 3				
	B	SE	*p*	B	SE	*p*	B	β	SE	*p*	*95% CI*
Constant	1.760	1.039	0.098	0.744	1.011	0.466	1.464		1.1031	0.163	-0.619 to 3.546
Sex child											
Girl (ref)	1.00			1.00			1.00				
Boy	-0.332	0.277	0.238	-0.243	0.256	0.348	-0.344	-0.183	0.251	0.177	-0.851 to 0.162
Age child	-0.157	0.128	0.226	-0.261	0.122	0.039	-0.291	-0.338	0.118	0.018	-0.530 to -0.052
Z-score Mother BMI	0.078	0.176	0.660	0.124	0.162	0.450	0.040	0.034	0.161	0.803	-0.285 to 0.366
Age mother				0.050	0.017	0.004	0.026	0.222	0.020	0.199	-0.014 to 0.066
Birth order							0.179	0.353	0.085	0.042	0.007 to 0.350
R^2 adjusted	0.002			0.160			0.223				

Model 1 is adjusted for child sex and age and tests for intergenerational influences of maternal chronic early life environment, model 2 and model 3 control for child's own environmental exposures ; SE : standard error, N=47, F(3.646), $p<0.05$, R^2= 0.308, adjusted R^2 =0.223, SC (standardized coefficient, β) and UC (unstandardized coefficient, B)

Table 12. Influence of maternal WHtRatio on children's BMI Z-scores Cape Verdean ancestry living in Portugal using multiple regression.

	Model 1			Model 2				
	B	SE	*p*	B	β	SE	*p*	*95% CI*
Constant	0.458	1.179	0.700	-0.330		1.133	0.773	-2.620 to 1.960
Sex child								
Girl (ref)	1.00			1.00				
Boy	0.071	0.229	0.757	0.031	0.020	0.214	0.886	-0.401 to 0.463
Age child	-0.231	0.109	0.040	-0.238	-0.317	0.101	0.024	-0.443 to -0.034
Mother WHtR	2.546	1.463	0.089	2.558	0.252	1.360	0.067	-0.190 to 5.306
Single parent families				0.574	0.365	0.210	0.009	0.149 to 0.999
R^2 adjusted	0.096			0.219				

Model 1 is adjusted for child sex and age and tests for intergenerational influences of maternal chronic early life environment, model 2 controls for child's own environmental exposures, SE : standard error, N=45, F(4.083), $p<0.05$, R^2= 0.290, adjusted R^2 =0.219, SC (standardized coefficient, β) and UC (unstandardized coefficient, B)

Table 13. Influence of maternal Z-score WC on children's BMI Z-scores Cape Verdean ancestry living in Portugal using multiple regression.

	Model 1			Model 2				
	B	SE	*p*	B	β	SE	*p*	*95% CI*
Constant	1.717	0.874	0.056	0.977		0.867	0.267	-0.775 to 2.729
Sex child								
Girl (ref)	1.00			1.00				
Boy	0.059	0.229	0.798	0.017	0.011	0.215	0.937	-0.417 to 0.451
Age child	-0.219	0.109	0.051	-0.227	-0.302	0.102	0.032	-0.433 to -0.020
Z-score WC mother	0.264	0.152	0.090	0.242	0.230	0.142	0.097	-0.046 to 0.530
Single parent families				0.552	0.350	0.212	0.013	0.123 to 0.980
R^2 adjusted	0.096			0.207				

Model 1 is adjusted for child sex and age and tests for intergenerational influences of maternal chronic early life environment, model 2 controls for child's own environmental exposures , SE : standard error, N=45, F(3.872), $p<0.05$, R^2= 0.279, adjusted R^2 =0.207, SC (standardized coefficient, β) and UC (unstandardized coefficient, B)

Table 14. Influence of maternal Z-score height on children's leg length Z-scores Cape Verdean ancestry living in Portugal using multiple regression.

	Model 1			Model 2				
	B	SE	*p*	B	β	SE	*p*	*95% CI*
Constant	1.100	0.973	0.264	0.349		0.982	0.724	-1.632 to 2.330
Sex child								
Girl (ref)	1.00			1.00				
Boy	0.163	0.265	0.541	0.233	0.125	0.254	0.365	-0.280 to 0.745
Age child	-0.143	0.121	0.246	-0.226	-0.265	0.121	0.069	-0.470 to 0.018
Z-score height mother	0.350	0.157	0.031	0.292	0.264	0.151	0.060	-0.013 to 0.597
Age mother				0.039	0.334	0.017	0.025	0.005 to 0.072
R^2 adjusted		0.078				0.164		

Model 1 is adjusted for child sex and age and tests for intergenerational influences of maternal chronic early life environment, model 2 controls for child's own environmental exposures , SE : standard error, N=47, F(3.248), $p<0.05$, R2= 0.236, adjusted R2 =0.164, SC (standardized coefficient, β) and UC (unstandardized coefficient, B)

Table 15. Influence of maternal Z-score WC on children's sum 2sk Z-scores Cape Verdean ancestry living in Portugal using multiple regression.

	Model 1			Model 2				
	B	SE	*p*	B	β	SE	*p*	*95% CI*
Constant	-0.129	0.798	0.872	-0.507		0.836	0.547	-2.197 to 1.182
Sex child								
Girl (ref)	1.00			1.00				
Boy	0.618	0.209	0.005	0.593	0.396	0.207	0.006	0.178 to 1.105
Age child	-0.039	0.100	0.697	-0.043	-0.060	0.099	0.665	-0.242 to 0.156
Z-score WC mother	0.272	0.138	0.056	0.261	0.259	0.137	0.064	-0.016 to 0.538
Single parent families				0.282	0.187	0.205	0.176	-0.132 to 0.695
R^2 adjusted		0.179				0.197		

Model 1 is adjusted for child sex and age and tests for intergenerational influences of maternal chronic early life environment, model 2 controls for child's own environmental exposures , SE : standard error, N=45, F(3.688), $p<0.05$, R^2= 0.269, adjusted R^2 =0.196, SC (standardized coefficient, β) and UC (unstandardized coefficient, B)

Table 16. Influence of maternal WHtRatio on children's sum 2sk Z-scores Cape Verdean ancestry living in Portugal using multiple regression.

	Model 1			Model 2				
	B	SE	*p*	B	β	SE	*p*	*95% CI*
Constant	-1.592	1.064	0.142	-2.012		1.082	0.070	-4.199 to 0.176
Sex child								
Girl (ref)	1.00			1.00				
Boy	0.636	0.207	0.004	0.614	0.408	0.204	0.005	0.202 to 1.027
Age child	-0.052	0.098	0.602	-0.055	-0.077	0.097	0.570	-0.251 to 0.140
WHtR mother	2.927	1.319	0.032	2.934	0.302	1.299	0.029	0.309 to 5.558
Single parent families				0.306	0.203	0.201	0.135	-0.100 to 0.712
R^2 adjusted		0.198				0.223		

Model 1 is adjusted for child sex and age and tests for intergenerational influences of maternal chronic early life environment, model 2 controls for child's own environmental exposures ; SE : standard error, N=45, F(4.155), p<0.05, R^2= 0.294, adjusted R^2 =0.223, SC (standardized coefficient, β) and UC (unstandardized coefficient, B)

Appendix F. Chapter 6

Test differences between PT2009 and CVPT2013 on maternal age, birth weight, breastfeeding duration, maternal education and occupation:

Table 1. Normality Tests for maternal age, child birth weight in Cape Verdean children ancestry in 2013.

Tests of Normality[a]

	Kolmogorov-Smirnov[b]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
BW kg	,065	52	,200*	,982	52	,599
Age of the mother	,130	52	,027	,937	52	,008
Breastfeeding duration (months)	,131	52	,027	,897	52	,000

*. This is a lower bound of the true significance.

a. provenience of database = CVPT13

b. Lilliefors Significance Correction

Table 2. Normality Tests for maternal age, child birth weight in Portuguese children ancestry in 2009.

Tests of Normality[a]

	Kolmogorov-Smirnov[b]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
BW kg	,039	1463	,000	,985	1463	,000
Age of the mother	,054	1463	,000	,994	1463	,000
breastfeding duration (months)	,204	1463	,000	,708	1463	,000

a. provenience of database = PT09

b. Lilliefors Significance Correction

Table 3. Descriptive information on child's birth weight, maternal age and breastfeeding duration in Portuguese children in 2009.

		Child's BW kg	**Age of the mother**	**Breastfeeding duration (months)**
N		1534	1587	1586
Mean		3,24	37,95	3,44
Median		3,25	38,00	3,00
Mode		3,20	38,00	4,0
Std. Deviation		,50	5,65	3,77
Minimum		1,08	23,00	0,0
Maximum		4,95	54,00	48,0
Percentiles	25	2,95	34,00	1,00
	50	3,25	38,00	3,00
	75	3,55	42,00	4,00
a. provenience of database = PT09				

Table 4. Descriptive information on child's birth weight, maternal age and breastfeeding duration in in Cape Verdean children ancestry in 2013.

Statistics[a]

		BW kg	Age of the mother	Breastfeeding duration (months)
N		59	60	54
Mean		3,1152	34,5130	10,074
Median		3,1300	33,8650	10,500
Mode		3,00	25,44	12,0
Std. Deviation		,49318	8,02118	8,0654
Minimum		2,10	22,03	0,0
Maximum		4,04	55,89	24,0
Percentiles	25	2,7350	27,7850	3,000
	50	3,1300	33,8650	10,500
	75	3,5000	40,3400	16,000
a. provenience of database = CVPT13				

Table 5. Mann-Whitney rank sum test for child's birth weight, maternal age and breastfeeding duration in Portuguese children in 2009 and Cape Verdean ancestry children in 2013.

Ranks				
provenience of database		N	Mean Rank	Sum of Ranks
BW kg	PT09	1534	801,11	1228900,50
	CVPT13	59	690,18	40720,50
	Total	1593		
Age of the mother	PT09	1587	833,42	1322644,50
	CVPT13	60	574,73	34483,50
	Total	1647		
Breastfeeding duration (months)	PT09	1586	807,89	1281319,50
	CVPT13	54	1190,75	64300,50
	Total	1640		

Test Statistics[a]			
	BW kg	Age of the mother	Breastfeeding duration (months)
Mann-Whitney U	38950,500	32653,500	22828,500
Wilcoxon W	40720,500	34483,500	1281319,500
Z	-1,818	-4,141	-5,906
Asymp. Sig. (2-tailed)	,069	,000	,000

Table 6. Descriptive information (n) on maternal education in Portuguese children in 2009 and Cape Verdean ancestry children in 2013

		mother educational level			Total
		primary (4 years) or none	6 years	9-12 years and univ	
provenience of database	PT09	114	145	1324	1583
	CVPT13	72	60	68	200
Total		186	205	1392	1783

Table 7. Chi-square tests for maternal education in Portuguese children in 2009 and Cape Verdean ancestry children in 2013

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	264.285[a]	2	,000
Likelihood Ratio	212,421	2	,000
Linear-by-Linear Association	255,387	1	,000
N of Valid Cases	1783		

Table 8. Descriptive information (n) on maternal occupation in Portuguese children in 2009 and Cape Verdean ancestry children in 2013

		mother occupational class			Total
		manual workers	non-manual workers	Unemployed /housewife	
provenience of database	PT09	444	659	180	1283
	CVPT13	132	12	68	212
Total		576	671	248	1495

Table 9. Chi-square tests for maternal occupation in Portuguese children in 2009 and Cape Verdean ancestry children in 2013

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	156.511[a]	2	,000
Likelihood Ratio	188,819	2	,000
Linear-by-Linear Association	1,236	1	,266
N of Valid Cases	1495		

Regression model including SC (standardized coefficient, β) and UC (unstandardized coefficient, B):

Table 10. Multiple regression parameter estimates (se) of biological and environmental predictors of Cape Verdean ancestry children's height for age Z-scores

	Model 1			Model 2			Model 3				
	B	SE	p	B	SE	p	B	β	SE	p	95% CI
Constant	0.678	0.919	0.464	0.569	0.856	0.509	1.136		0.848	0.188	-0.574 to 2.846
Sex child											
Girl (Reference)	1.00			1.00			1.00				
Boy	-0.330	0.246	0.186	-0.416	0.231	0.078	-0.555	-0.289	0.227	0.019	-1.013 to -0.097
Age child (years)	-0.209	0.110	0.064	-0.232	0.103	0.029	-0.237	-0.282	0.098	0.019	-0.434 to -0.041
Age mother (years)	0.044	0.016	0.007	-0.014	0.025	0.587	-0.048	-0.414	0.028	0.090	-0.105 to 0.008
Z-score height mother	0.253	0.143	0.084	0.234	0.134	0.086	0.243	0.216	0.127	0.062	-0.013 to 0.500
Age father (years)				0.061	0.021	0.007	0.067	0.666	0.020	0.002	0.026 to 0.109
Birth order (ordinal)							0.186	0.357	0.078	0.021	0.029
R^2 adjusted		0.221			0.325					0.388	

Model 1 is adjusted for child sex and age , model 2 tests for parental biological influences, model 3 for environmental factors ; SE : standard error, N=51, F(6.291), $p<0.05$, R^2= 0.462 adjusted R^2 =0.388, SC (standardized coefficient, β) and UC (unstandardized coefficient, B)

Table 11. .Multiple regression model of biological and environmental predictors for Cape Verdean ancestry children's weight for age Z-scores.

	Model 1			Model 2			Model 3				
	B	SE	p	B	SE	p	B	β	SE	p	95% CI
Constant	0.347	0.770	0.655	0.278	0.745	0.710	0.957		0.694	0.175	-0.443 to 2.357
Sex child											
Girl (reference)	1.00			1.00			1.00				
Boy	0.447	0.206	0.035	0.394	0.201	0.056	0.227	0.145	0.186	0.230	-0.148 to 0.601
Age child	-0.179	0.092	0.058	-0.194	0.089	0.035	-0.200	-0.293	0.080	0.016	-0.361 to -0.039
Age mother	0.023	0.013	0.082	-0.013	0.022	0.547	-0.055	-0.577	0.023	0.021	-0.101 to -0.009
Z-score height mother	0.209	0.120	0.088	0.197	0.116	0.096	0.208	0.228	0.104	0.052	-0.001 to 0.418
Age father				0.038	0.019	0.045	0.046	0.562	0.017	0.008	0.012 to 0.080
Birth order							0.223	0.527	0.064	0.001	0.094 to 0.351
R^2 adjusted		0.171			0.226					0.380	

Model 1 is adjusted for child sex and age , model 2 tests for parental biological influences, model 3 for environmental factors; SE : standard error, N=51, F(6.107), $p<0.05$, R^2= 0.454 adjusted R^2 =0.380, SC (standardized coefficient, β) and UC (unstandardized coefficient, B)

Table 12. Multiple regression model of biological and environmental predictors for Cape Verdean ancestry children's BMI for age Z-scores.

	Model 1			Model 2			Model 3				
	B	SE	p	B	SE	p	B	β	SE	p	95% CI
Constant	0.858	0.849	0.444	1.136	0.888	0.198	0.574		0.818	0.487	-1.078 to 2.227
Sex child											
Girl (reference)	1.00			1.00			1.00				
Boy	0.147	0.213	0.493	0.076	0.212	0.722	0.078	0.051	0.194	0.692	-0.314 to 0.70
Age child	-0.204	0.103	0.055	-0.20	0.101	0.049	-0.229	-0.331	0.093	0.018	-0.416 to -0.041
Age mother	0.022	0.013	0.100	0.001	0.018	0.979	0.010	0.105	0.017	0.564	-0.024 to 0.043
Z-score AC mother	0.242	0.131	0.072	0.189	0.131	0.157	0.191	0.208	0.120	0.119	-0.052 to 0.434
Birth order				0.135	0.074	0.076	0.113	0.281	0.068	0.107	-0.025 to 0.251
Marital status single							1.00	0.370			
other							0.647		0.217	0.005	0.210 to 1.085
R^2 adjusted		0.131			0.175				0.306		

Model 1 is adjusted for child sex and age , model 2 tests for parental biological influences, model 3 for environmental factors ; SE : standard error, N=48, F(4.458), $p<0.05$, $R^2= 0.395$ adjusted $R^2 =0.306$, SC (standardized coefficient, β) and UC (unstandardized coefficient, B)

Table 13. Multiple regression model of biological and environmental predictors for Cape Verdean ancestry children's waist circumference Z-scores.

	Model 1			Model 2			Model 3				
	B	SE	p	B	SE	p	B	β	SE	p	95% CI
Constant	0.915	0.699	0.199	1.328	0.681	0.059	1.520		0.659	0.027	0.181 to 2.858
Sex child											
Girl (reference)	1.00			1.00			1.00				
Boy	0.553	0.187	0.005	0.471	0.179	0.013	0.460	0.328	0.172	0.011	0.111 to 0.809
Age child	-0.108	0.082	0.195	-0.121	0.077	0.125	-0.160	-0.270	0.076	0.044	-0.315 to -0.005
Age of mother	-0.006	0.012	0.642	-0.023	0.014	0.093	-0.022	-0.258	0.013	0.104	-0.048 to 0.005
Z-score height mother	0.348	0.119	0.006	0.327	0.112	0.006	0.291	0.337	0.109	0.011	0.070 to 0.512
Birth order				0.138	0.058	0.022	0.143	0.386	0.055	0.014	0.030 to 0.255
Father non-manual (reference)							1.00				
Father other categories							0.824	0.51	0.403	0.049	0.005 to 1.643
R^2 adjusted	0.301			0.380					0.430		

Model 1 is adjusted for child sex and age , model 2 tests for parental biological influences, model 3 for environmental factors; SE: standard error, N=42, F (6.153), $p<0.05$, R^2= 0.513 adjusted R^2 =0.430, SC (standardized coefficient, β) and UC (unstandardized coefficient, B)

Table 14. Multiple regression model of biological and environmental predictors for Cape Verdean ancestry children's sum of 2 skinfolds Z-scores (triceps and subscapular).

	Model 1			Model 2			Model 3				
	B	SE	p	B	SE	p	B	β	SE	p	95% CI
Constant	-0.918	0.779	0.245	-0.950	0.754	0.214	-2.098		0.934	0.030	-3.983 to -0.213
Sex child											
Girl (Reference)	1.00			1.00			1.00				
Boy	0.598	0.196	0.004	0.556	0.191	0.006	0.569	0.381	0.185	0.004	0.196 to 0.941
Age child	-0.040	0.095	0.676	-0.051	0.092	0.584	-0.035	-0.052	0.089	0.693	-0.216 to 0.145
Age mother	0.020	0.012	0.118	-0.015	0.021	0.484	-0.015	-0.169	0.020	0.455	-0.056 to 0.025
Z-score AC mother	0.264	0.120	0.033	0.247	0.116	0.039	0.207	0.229	0.114	0.078	-0.024 to 0.438
Age father				0.035	0.017	0.051	0.031	0.404	0.017	0.073	-0.003 to 0.065
Birth weight							0.387	0.243	0.197	0.056	-0.010 to 0.785
R^2 adjusted		0.227			0.277					0.322	

Model 1 is adjusted for child sex and age , model 2 tests for parental biological influences, model 3 for prenatal factors ; SE : standard error, N=49, F(4.800), $p<0.05$, R^2= 0.407 adjusted R^2 =0.322, SC (standardized coefficient, β) and UC (unstandardized coefficient, B)

Table 15. Multiple regression model of biological and environmental predictors for Cape Verdean ancestry children's sum 2 skinfold Z-scores with maternal WHtRatio.

	Model 1			Model 2				
	B	SE	p	B	β	SE	p	95% CI
Constant	-1.915	0.983	0.058	-1.573		1.019	0.130	-3.628 to 0.482
Sex child								
Girl (Reference)	1.00			1.00				
Boy	0.724	0.193	0.001	0.686	0.459	0.194	0.001	0.295 to 1.078
Age child	-0.011	0.095	0.906	-0.012	-0.017	0.095	0.903	-0.203 to 0.180
Age mother	0.003	0.013	0.836	-0.007	-0.083	0.016	0.637	-0.039 to 0.024
WHtR mother	2.650	1.280	0.044	2.332	0.254	1.302	0.080	-0.293 to 4.957
Birth order				0.079	0.199	0.066	0.238	-0.054 to 0.213
R^2 adjusted		0.246					0.253	

Model 1 is adjusted for child sex and age , model 2 tests for environmental factors, SE : standard error, N=49, F(4.259), p<0.05, R^2= 0.331 adjusted R^2 =0.253, SC (standardized coefficient, β) and UC (unstandardized coefficient, B)

Table 16. Multiple regression model of biological and environmental predictors for Cape Verdean ancestry children's AC Z-scores.

	Model 1			Model 2				
	B	SE	p	B	β	SE	p	95% CI
Constant	-0.542	1.033	0.602	-0.604		1.00	0.552	-2.630 to 1.423
Sex child								
Girl (Reference)	1.00			1.00				
Boy	0.989	0.262	0.000	0.926	0.438	0.257	0.001	0.409 to 1.444
Age child	-0.157	0.116	0.180	-0.173	-0.184	0.113	0.133	-0.401 to 0.055
Age mother	0.013	0.016	0.409	-0.029	-0.224	0.028	0.297	-0.085 to 0.027
BF% mother	0.021	0.013	0.097	0.021	0.204	0.012	0.091	-0.004 to 0.046
Age father				0.044	0.392	0.024	0.068	-0.03 to 0.091
R^2 adjusted		0.278					0.314	

Model 1 is adjusted for child sex and age , model 2 tests for parental biological influences; SE : standard error, N=53, F(5.754), p<0.05, R^2= 0.380 adjusted R^2 =0.314, SC (standardized coefficient, β) and UC (unstandardized coefficient, B)

Table 17. Multiple regression model of biological and environmental predictors for Cape Verdean ancestry children's Leg length Z-scores.

	Model 1			Model 2				
	B	SE	p	B	β	SE	p	95% CI
Constant	-0.867	0.963	0.372	-2.415		1.194	0.048	-4.810 to -0.020
Sex child								
Girl (Reference)	1.00			1.00				
Boy	0.221	0.250	0.380	0.217	0.114	0.242	0.376	-0.270 to 0.703
Age child	-0.076	0.114	0.507	-0.068	-0.081	0.110	0.538	-0.290 to 0.153
Age mother	0.038	0.016	0.019	0.036	0.310	0.015	0.021	0.006 to 0.067
Birth weight				0.500	0.263	0.240	0.042	0.018 to 0.982
R^2 adjusted		0.056				0.112		

Model 1 is adjusted for child sex and age , model 2 tests prenatal factors; SE : standard error, N=57, F(2.765), $p<0.05$, R^2= 0.175 adjusted R^2 =0.112, SC (standardized coefficient, β) and UC (unstandardized coefficient, B)

Appendix G. Paper published

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

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Summary. Portugal has one of the highest rates of childhood overweight and obesity 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 struggle with discrimination and racism, factors that would probably be associated with a higher prevalence of overweight and obesity. 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 aged 6–12 years living in the Cova da Moura neighbourhood of the Greater Lisbon Metro Area. The Portuguese national survey was conducted between 2009 and 2010 at public and private schools in mainland Portugal and included height, weight, skinfolds and arm and waist circumferences. From these survey data body mass index (BMI) and 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 prevalence values were defined based on the references established by the International Obesity Task Force. The results show significant differences in height between Cape Verdean and Portuguese boys and girls. 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) were lower than those of the Portuguese

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(33% for boys and 31.7% for girls). Logistic regression models showed that Cape Verdean children had a lower risk of being overweight or obese when accounting for breast-feeding, birth weight, maternal education and occupation. Despite living in a deprived neighbourhood these Cape Verdean children seemed to have grown more healthily than Portuguese ancestry children. The challenge for policymakers 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.

Introduction

Portugal, like many European countries, has registered a steep increase in overweight and obesity 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 overweight and obesity (Padez *et al.*, 2004, 2005, 2009; Carvalhal *et al.*, 2007; Valente *et al.*, 2010). In the last National Study of Childhood Obesity in 2008 (Rito *et al.*, 2012) Portuguese school children aged 6–8 years showed an obesity prevalence of 16.8% for boys and 13.7% for girls when using World Health Organization (WHO) reference standards (de Onis *et al.*, 2007). These values place Portuguese children as having one of the highest rates of obesity in Europe, with the WHO European Childhood Obesity Surveillance Initiative revealing an obesity prevalence range for the whole of Europe of 6.0–26.6% for boys and 4.6–17.3% for girls (Wijnhoven *et al.*, 2012).

Concomitantly, Portugal is still home to 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 such as 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 in obesity among marginalized ethnic groups in other settings (Cole *et al.*, 2000; Hui & Bell, 2003; Moore *et al.*, 2003; Ulijaszek, 2003). 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 co-exist in Cape Verde (UNICEF & ICCA, 2011). Data from an enquiry into the prevalence of anaemia and associated factors (IPAC) in Cape Verdean children in 2009 showed that 5% of under-5-year-olds were above 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 Greater Lisbon Metro Area showed that there were no differences in 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 the present study was to assess the health and nutritional status indicators of Cape Verdean children aged 6–12 years living in the Greater Lisbon Metro Area (urban setting) of Portugal using 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 the Cova da Moura neighbourhood of the Greater Lisbon Metro Area (Fig. 1). Cape Verdean children aged 6–12 years with Cape Verdean ancestry and attending public schools within the neighbourhood were recruited. Ancestry was assessed by semi-structured interview, and those with one Cape Verde grandparent on the paternal or maternal side and parents who were born in Cape Verde were assigned 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 those with parents who were both Portuguese.

Study design and setting

The first dataset (CVPT92) was collected between 1992 and 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 has been published previously (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). A more recent database (CVPT13) was collected in 2013/14. This sample comprised 89 children (41 boys and 48 girls with mean age of 8.61 ± 1.4 3 years). All projects on the Cape Verdean community were conducted in almost the same schools in Cova da Moura neighbourhood, meaning they covered the same area over time. The numbers are not known for the first dataset (CVPT92) but for the 2009

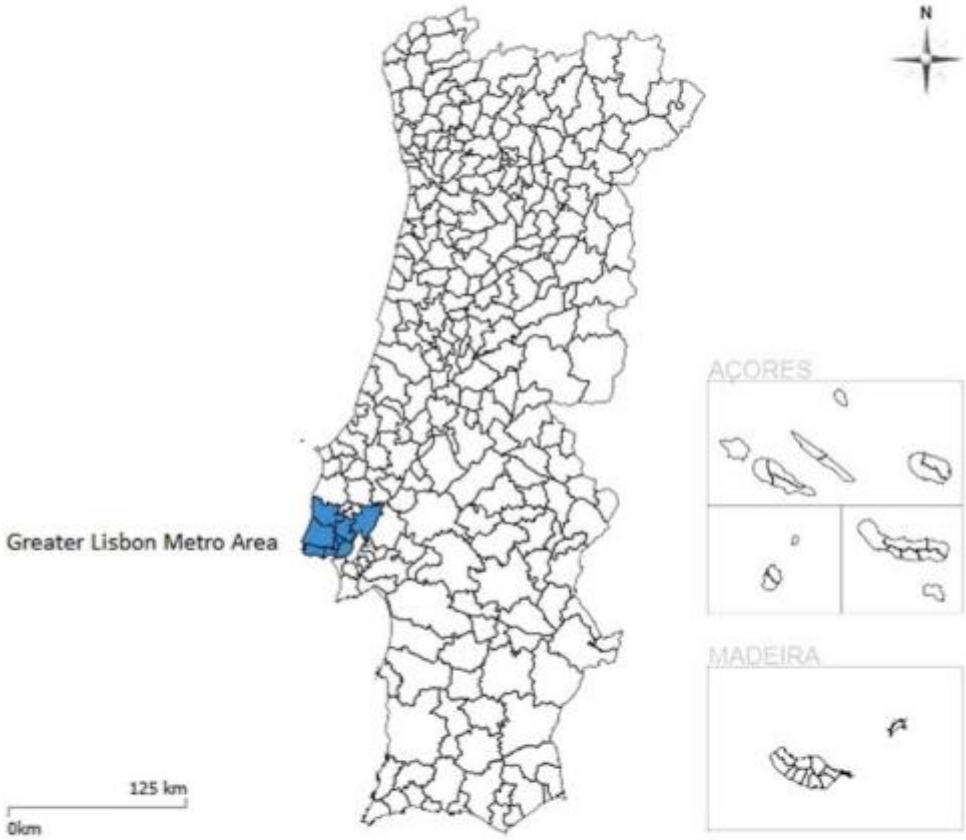

Fig. 1. Geographical position of Greater Lisbon Metro Area in Portugal (map from www.pordata.pt).

study all children from the schools were recruited (226) and 221 were measured, giving a 98% participation rate. Also for the later dataset (2013), 107 children were recruited and 101 were measured, which gives a 94% participation rate.

These Cape Verdean samples were compared with a nationally representative database (PT09) of 10,619 Portuguese children with 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) were analysed from the national database to ensure that children from the same area of Portugal were compared. With this national study (PT09) a final sample of 17,509 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 areas for Cape Verdean migrants in Lisbon dating from the 1970s. The neighbourhood had an estimated population of approximately 4800 in 2008 (INE, 2002). Recent data from the local socio-cultural association Moinho da Juventude estimates that about 6000 people now live in the neighbourhood (Associação Cultural Moinho da Juventude, 2012). Sixty per cent of these are of African origin, mainly Cape Verdean, with half being under the age of 20 years. The 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 living in the neighbourhood (fieldwork observations). There are daily sellers that stop by the neighbourhood to sell fresh fish and fruit, and many even sell ingredients used to prepare traditional Cape Verdean dishes. Local associations working in the neighbourhood have developed several support programmes for local child-minders, professional development and help with documentation or revenue issues (Associação Cultural Moinho da Juventude, 2012).

Ethical approval

The first database on Cape Verdeans dates from 1992 and was approved by the ethics committee of San Carlos 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 the ethics council of Instituto de Higiene e Medicina Tropical, Universidade Nova de Lisboa, Lisbon, Portugal. The study protocol and informed consent for the Portuguese national database 2009 (Bingham *et al.*, 2013) was approved by the Direcção Geral de Inovação e Desenvolvimento Curricular (DGIDC).

Variables

The anthropometric profile of each child included: height (cm), weight (kg), sitting height (cm), triceps, subscapular and biceps skinfolds (mm) and abdominal, arm and waist circumferences (cm). Participants were measured lightly dressed and barefoot or with light socks. All measurements were performed following standardized 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 as below −2 standard deviations for WHO (Frisancho, 2008). A semi-structured interview was conducted with children's parents/guardians in order to assess maternal and parental ages, 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, and triceps and subscapular skinfolds. For sociodemographic variables, parental education, occupation, ancestry, birth weight and breast-feeding data were available in the PT09 and CVPT13 databases (see Table 1).

Table 1. Descriptive characteristics (mean/median ± SD/IQR[a] and ANOVA[a]) of Portuguese and Cape Verdean boys

Variable	CVPT92 $n = 96$	CVPT09 $n = 70$	CVPT13 $n = 41$	PT09 $n = 815$	Difference[xy] χ^2	F	p-value
df						3	
Age decimal (years)[y]	8.17	8.84	8.54	8.34	5.432		ns
	7.31–9.47	6.91–9.95	7.34–9.59	7.23–9.29			
Height (cm)[x]	129.35 ± 8.71	132.75 ± 10.67	134.25 ± 9.76	129.63 ± 8.54		6.160	<0.001
Z-score for height[x]	0.05 ± 0.82	0.22 ± 0.89	0.58 ± 1.05	0.16 ± 0.88		3.652	0.012
Sitting height (cm)[x]	69.41 ± 4.43	68.22 ± 4.22	69.55 ± 4.85	68.48 ± 4.11		2.302	ns
Z-score for sitting height[x]	0.14 ± 1.09	−0.47 ± 0.95	−0.04 ± 1.05	−0.07 ± 0.92		5.751	0.001
Weight (kg)[y]	28.10	28.10	28.60	28.10	0.324		ns
	24.72–32.56	24.68–35.08	24.95–31.80	24.43–33.30			
Z-score for weight[y]	−0.24	−0.35	−0.22	−0.16	2.549		ns
	−0.66–0.32	−0.78–0.23	−0.71–0.19	−0.65–0.36			
BMI[y]	16.57	16.09	15.73	16.66	12.648		ns
	15.47–18.64	15.37–17.46	15.06–17.28	15.52–18.60			
Triceps skinfold (mm)[y]	8.85	8.70	7.10	8.00	17.655		0.001
	7.22–14.15	6.95 to 11.60	6.15–10.50	6.60–10.42			
Z-score for triceps skinfold[y]	0.06	−0.05	−0.42	−0.13	17.341		<0.001
	−0.29–0.85	−0.43 to 0.51	−0.82–0.34	−0.55–0.40			
Subscapular skinfold (mm)[y]	5.50	5.20	4.60	5.60	16.199		0.001
	4.90–8.78	4.60–6.60	4.05–6.25	4.72–7.20			
Z-score for subscapular skinfold[y]	−0.08	−0.19	−0.50	−0.04	19.133		<0.001
	−0.33–0.73	−0.55–0.31	−0.72–0.16	−0.40–0.50			

[a]Mean/SD are presented where the data were normally distributed and ANOVA was applied ([x]). Median/IQR (interquartile range) are presented where the data were non-normally distributed and the Kruskal–Wallis rank sum test was applied ([y]); ns: non-significant values; df: degrees of freedom from ANOVA test.

Statistical procedures

Data were analysed with SPSS version 22.0. Descriptive statistics included a chi-squared analysis to compare the prevalence of under- and over-nutrition between the samples. Analysis of variance (ANOVA) allowed the comparison of anthropometric scale measures between the samples. Appropriate *post hoc* statistics were calculated to identify which differences were significant. The Portuguese (PT09) and Cape Verdean databases (CVPT13) were used in subsequent analysis because they shared common variables like parental education, occupation and breast-feeding duration, which 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 so they were excluded from the analysis of the factors associated with overweight and obesity. Logistic regression was performed between PT09 and CVPT13 for comparison and this permitted determination of the biological (birth weight and breast-feeding status) and socio-demographic (maternal education and occupation) factors associated with overweight and obesity 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 was demonstrated using Hosmer–Lemeshow statistics. Models were built by entering age, sex and ancestry with Portuguese as reference at Step 1. Subsequently at Step 2 significant socio-demographic variables from an unadjusted analysis were included. This strategy allowed the identification of 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 were significant differences for height and height Z-scores, Z-scores for sitting height, triceps and subscapular skinfolds and Z-scores for these measures between Cape Verdean and Portuguese boys aged 6–12 years between the four databases. There were fewer differences for Cape Verdean girls (Table 2), with only height and triceps skinfolds/triceps Z-scores revealing significant differences compared with the Portuguese sample ($p < 0.05$).

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

A Kruskal–Wallis rank sum test using a chi-squared statistic of independence was performed to determine the association between variables with a non-parametric distribution. Subsequently, Mann–Whitney tests were performed for associations given

Table 2. Descriptive characteristics (mean/median ± SD/IQR[a] and ANOVA[a]) of Portuguese and Cape Verdean girls

Variable	CVPT92 $N = 68$	CVPT09 $N = 100$	CVPT13 $N = 48$	PT09 $N = 827$	Difference[xy] χ^2	F	p-value
df						3	
Age decimal (years)[y]	7.82	8.46	8.48	8.35	3.586		ns
	6.84−9.48	6.99−9.98	7.61−9.59	7.23−9.33			
Height (cm)[y]	128.05	132.70	130.85	128.90	11.458		0.01
	120.1–133.5	122.6–139.2	123.60–139.4	122.4–135.1			
Z-score for height[x]	−0.03 ± 0.78	0.31 ± 0.91	0.12 ± 0.90	0.08 ± 0.92		2.337	ns
sitting height (cm)[x]	68.39 ± 4.48	68.09 ± 4.74	69.00 ± 5.09	68.33 ± 4.38		0.462	ns
Z-score for sitting height[x]	0.62 ± 0.96	0.25 ± 1.73	0.38 ± 0.94	0.44 ± 0.94		1.721	ns
Weight (kg)[y]	26.80	29.80	26.95	27.80	5.022		ns
	22.78–32.45	24.70–36.05	23.83–35.30	24.1–33.7			
Z-score for weight	−0.01	0.20	−0.05	0.11	3.501		ns
	−0.32–0.60	−0.38–0.89	−0.45–0.41	−0.42–0.73			
BMI[y]	16.39	16.89	16.22	16.72	2.378		ns
	15.38–18.69	15.03–19.43	15.37–17.81	15.49–18.98			
Triceps skinfold (mm)[y]	10.40	11.00	10.30	9.20	23.172		<0.001
	8.43−14.55	8.25−14.00	8.20−13.84	7.52−12.00			
Z-score for triceps skinfold[y]	0.14	0.13	−0.01	−0.23	22.089		<0.001
	−0.34–0.88	−0.52–0.67	−0.42–0.56	−0.68–0.37			
Subscapular skinfold (mm)[y]	6.65	6.50	6.30	6.56	0.745		ns
	5.22–8.23	5.20–8.95	5.10–8.95	5.20–9.20			
Z-score for subscapular skinfold[y]	−0.05	−0.20	−0.19	−0.09	2.478		ns
	−0.38–0.40	−0.42–0.98	−0.49–0.28	−0.42–0.51			

[a]Mean/SD are presented where the data were normally distributed and ANOVA was applied ([x]). Median/IQR (interquartile range) are presented where the data were non-normally distributed and the Kruskal–Wallis rank sum test was applied ([y]); ns: non-significant values; df: degrees of freedom from ANOVA test.

as significant by the Kruskal–Wallis test to determine which groups were significantly different. The results are shown accounting for Bonferroni adjustment for the final *p*-value. For boys the *Z*-score for triceps skinfold (χ^2 (3, 1020) = 17.341, $p \leq 0.01$) was significantly lower for CVPT13 (median = −0.42, IQR (25–75%) = −0.82–0.34) compared with the Portuguese (median = −0.13, IQR = −0.55–0.40) and the Cape Verdean 1992 databases (CVPT92: median = 0.06, IQR = −0.29–0.85). For the subscapular *Z*-score (χ^2 (3, 1020) = 19.133, $p \leq 0.01$), CVPT92 (median = −0.08, IQR = −0.33–0.73) had significantly higher medians than the CVPT13 (median = −0.50, IQR = −0.72–0.16) and PT databases (median = −0.04, IQR = −0.40–0.50).

The girls' height from the CVPT09 database (median = 132.7, IQR = 122.6–139.2) was significantly higher (χ^2 (3, 1041) = 11.458, $p \leq 0.01$) compared with the Portuguese (median = 128.9, IQR = 122.4–135.1) and their counterparts measured in 1992 (CVPT92: median = 128.1, IQR = 120.1–133.5). However, no significant differences were found 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, the triceps *Z*-score (χ^2 (3, 1041) = 22.089, $p \leq 0.01$) was higher for CVPT09 (median = 0.13, IQR = −0.52–0.67) compared with the Portuguese (median = −0.23, IQR = −0.68–0.37) and lower than the CVPT92 databases (median = −0.01, IQR = −0.43–0.56).

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 from the three different databases. Overweight prevalence was lower in the 2013 sample compared with 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 in Lisbon

When comparing Cape Verdean children with the Portuguese national study (Fig. 2), significant differences were found only for over-nutrition among boys ($\chi^2(3)$ = 16.827, n = 1022, $p \leq 0.001$) (data not shown). There was more overweight and obesity among Portuguese boys (20.3% and 12.7%, respectively) when compared with Cape Verdean boys in 2013 (9.8% and 0%, respectively, for the 2013 database; $p \leq 0.001$) and even when compared with Cape Verdean children in the same year 2009 (11.4% overweight, 7.1% obesity; $p < 0.05$). However, more stunting was also observed in Portuguese boys even if the percentage was small (four 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 (Fig. 3). However some trends could be observed. For example, more Portuguese girls were classified as overweight (22%) or obese (9.7%) in comparison with Cape Verdean girls (12.5% and 4.2%, respectively, non-significant).

The results of the logistic regression using the Hosmer–Lemeshow test revealed that the model fitted the data well (Model 6: χ^2 = 1.440, p = 0.994) (Table 3). Breast-feeding

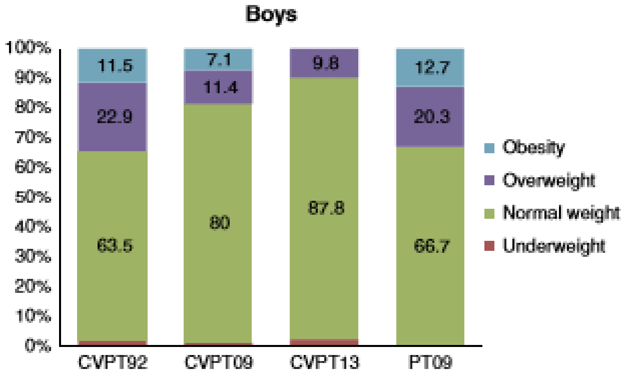

Fig. 2. Over- and under-nutrition rates for boys using IOTF and WHO cut-off points on Cape Verdean ancestry and Portuguese databases.

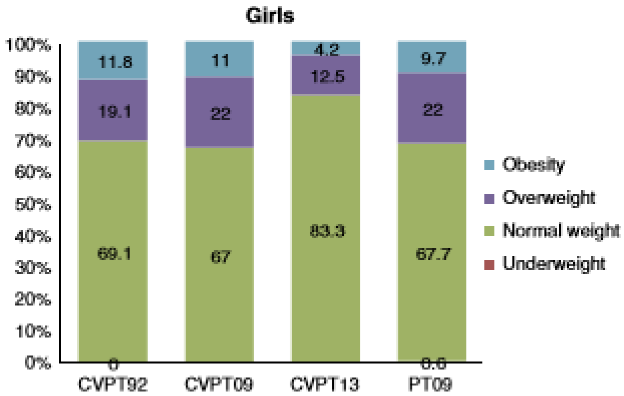

Fig. 3. Over- and under-nutrition rates for girls using IOTF and WHO cut-off points on Cape Verdean ancestry and Portuguese databases.

(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. The variables entered in the model did not fully explain the difference between the Portuguese and the Cape Verdean samples. A lower risk of overweight and obesity was identified for the Cape Verdean sample compared with 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 breast-fed on this association (Model 6). Further, in addition to being Cape Verdean, other significant protective factors for overweight and obesity were identified in the final step of the model: being breast-fed, lower birth weight, having a mother with more years of education, and having a mother with an occupation that resulted in her spending more time at home, such as being unemployed or a housewife. Maternal occupation was also related with lower risk when the mother stayed at home.

Table 3. Odds ratios (95% CIs) from logistic regression model of socio-demographic and biological predictors of overweight and obesity for children of Portuguese and Cape Verdean ancestry[a]

	n	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Child decimal age (years)	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							
Portuguese (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)
Breast-feeding							
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 (≤4 years) (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)

Data sources: Portuguese children, PT09; Cape Verde ancestry children, CVPT13.

[a]Odds ratios and 95% confidence intervals for the significant predictors of children being overweight and obese (by IOTF standards) vs normal weight; the model excludes 546 cases because of missing data.

Probability of being overweight and obese in Portuguese database is significantly different from that in the reference category at the following levels: $*p < 0.05$; $**p < 0.01$.

Discussion

On comparing the Cape Verdean ancestry populations with the nationally representative Portuguese dataset during the economic crisis in 2008 it was found that linear growth (height) among Cape Verdean children samples increased over time, especially for boys. In contrast there were no 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 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 in height between the 1992 and 2009/2013 samples. The findings further reveal a lower risk of overweight and obesity of Cape Verdean ancestry children compared with the Portuguese, even after adjusting for potentially confounding factors (age, sex, maternal age, birth weight, whether the child was breast-fed, maternal education and maternal occupation). In addition to being Cape Verdean other significant protective factors for overweight and obesity identified in the model were being breast-fed, being of lower birth weight, having a mother with more years of education and having a mother who spends 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' economies (Martorell & Zongrone, 2012), and this 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 the positive environmental conditions Portugal has experienced over the past 40 years compared with their country of origin. Entrance to the EU in 1986 brought rising wages, better infrastructure and higher household incomes. Moreover, there were important improvements in Portuguese society in, for example, 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 programmes 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 migrant effect' in which the population that migrates is usually in better health condition due to younger age and being at work (DesMeules *et al.*, 2004; Ronellenfitsch & Razum, 2004; Buron *et al.*, 2008; Garcia-Gomez & Oliva, 2009).

However, in earlier studies conducted in 1989 and 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 (2004) found a negative trend in height and weight for Portuguese and Cape Verdean for boys between 1993, 1999 and 2001. This is consistent with the present results, as the author explained it might be because boys are more susceptible to adverse environmental conditions. This was studied by Stinson (1985), who found that differences in growth among boys and girls were reflected first in boys' physical growth and development. The same author (Varela-Silva, 2004) suggested that it might also be that the pace of the developmental 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 experience 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 socioeconomic deprivation (Wamani *et al.*, 2007).

Furthermore, living conditions in Portugal have been translated into height increases for Cape Verdeans compared with those born in Cape Verde (Gama, 2002). The current findings show that Cape Verdean children are not disadvantaged in linear growth compared with other Portuguese children of similar age living in a similar environment or compared with 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 that, even after controlling for a range of socio-demographic and biological factors, this Cape Verdean community have 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 with 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 breast-fed (OECD, 2009) while in Cape Verde 60% are exclusively breast-fed until 6 months (UNICEF, 2015). There is mixed evidence in the literature surrounding the association between breast-feeding and risk of overweight and obesity, although others do document a similar relationship to that found in this study in Portugal. For example, a study of Portuguese mothers showed that breast-feeding a child for 3–6 months or more than 6 months was associated with a decreased risk of overweight (Padez *et al.*, 2005). The logistic regression analysis revealed that breast-feeding behaviour explains some of the difference in risk for overweight and obesity between Cape Verdean ancestry and other Portuguese children. After including the breast-feeding variable in the model there was a change in the ancestry parameter effect of close to 18%. This could therefore be an important cultural factor influencing the risk for overweight and obesity. Observations from fieldwork show that this community is still following a fairly traditional diet assured by the local businesses that supply food and a wide range of services. Moreover, the neighbourhood's social support systems have helped protect children from Westernizing influences by keeping them in the physical space and also watching out for them. Children can safely 'play' outside despite the sometimes unsafe episodes that happen in this space. This might result in more physically active children when compared with the Portuguese whose screen 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, which could limit the representation of these samples at the different time points. Moreover, the Portuguese sample was restricted to the Lisbon district and might mask people of different socioeconomic status. Furthermore, missing information from the 1992 dataset might have affected the representation of the sample. Nevertheless one of the authors (VR) was present at data collection for all the datasets referred to in this paper, and he can give assurance that similar strategies were followed for the recruitment of participants and data collection.

In conclusion, Cape Verdean children seem to have benefited from the better living conditions they experienced in Portugal. This trend is more pronounced for the 2013 sample, and is positive and significant for boys for height. Even though coming from a deprived neighbourhood, these children have better nutritional status than Portuguese children. The next task for policymakers should be to improve the socioeconomic status of these households while preserving their cultural practices and 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).

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