The role of ethnicity in framing childhood obesity as a public health problem

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Declaration

I declare that this thesis has been completed by me, is my own work, and has not been submitted for any other degree or professional qualification.

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Abstract

The prevalence of overweight and obesity in children and adults has risen to alarming levels across the world and is also markedly increasing in developing countries. In Colombia, a multi-ethnic country, the prevalence of overweight and obesity among low-income populations is growing. Childhood obesity is a complex systemic issue that needs to be addressed across a range of areas in order to offer appropriate support to policy development. Arriving at a better understanding regarding the influence of other exposure variables in Colombia, such as ethnicity and race, as a part of that complexity, may provide additional insight. This thesis accordingly seeks to understand better the role of race and ethnicity in framing childhood obesity as a public health problem in Colombia, taking an international comparison approach.

This thesis involved the review of the use of ethnicity as a variable in childhood obesity research in five countries: Colombia, Brazil, Mexico, Canada and the United Kingdom. A systematic review was also performed to synthetise state-of-the-art research throughout the same countries. The lack of detailed research analysing ethnicity in Colombia in this context made it necessary to conduct a secondary analysis.

Results revealed that the majority of studies are not using robust conceptualisations and clear definitions of ethnicity, which might negatively impact possible interpretations of data in light of ethnic differences in childhood obesity. The systematic review indicated that most authors have focused on physiology when analysing ethnic variations in childhood obesity risk factors; consequently, policy and interventions targeting these populations are not based on robust evidence of prevalence and causality. A secondary analysis was performed to understand the relationship between ethnicity and childhood obesity in Colombia. To explain all potential ways in which ethnicity could be associated with childhood obesity, directed acyclic graphs were employed. These included paths through socioeconomic variables, food security, obesity-related behaviours or a combination of the above. The association analysis revealed differences by ethnic group: wealth index was positively associated with childhood overweight and obesity, especially among

Indigenous children. Severe levels of food insecurity were inversely associated with obesity in this same ethnic group, while in both Indigenous and Afro-descendant children, it was associated with maternal obesity. When mediation models were tested, socioeconomic factors and food insecurity proved to be mediators only for Indigenous children.

Findings of this thesis are a contribution to orientate actions to tackle childhood obesity as a public health problem, not only in Colombia but in ethnically diverse countries. Recommendations for public policy are based on actions for promoting taxation of unhealthy food and food labelling, as well as ensuring food security for ethnic minority groups, target programmes to prevent obesity in adolescent and infants, and promoting the health of mothers. Regarding practice, the development of more completed registers and health-related surveys in Colombia to enable data linking is a highly relevant recommendation. Future research in the fields of ethnicity, childhood obesity and the combination of these may benefit from insights of this thesis.

Lay Summary

Childhood obesity is considered a major health problem around the world. It needs to be properly understood if more focused actions are to be developed to prevent and manage its impact on individuals and society. Preventing childhood obesity can reduce not only the physical and mental health effects on children but also the onset of many diseases in adulthood, such as diabetes, stroke and heart attack. To achieve this, several dimensions of children's lives and environments need to be studied. One of these dimensions is children's ethnicity, which might be related to physical activity and food choice behaviours and could also determine children's social contexts. Therefore, the aim of this thesis was to identify how ethnicity has helped shape the understanding of childhood obesity as a public health problem. This thesis was based on reviewing literature, building graphs to depict connections between ethnicity and childhood obesity, and an analysing Colombian data on children's nutrition.

I found that five countries with multiple ethnic groups (Colombia, Mexico, Brazil, Canada and UK) had different ways to measure and define ethnicity, and ethnicity categories reported did not have a clear justification across studies. Overall, research on childhood obesity has been focused on physiological issues, and other dimensions beyond the individual, such as environment, communities and market, remain poorly studied.

In Colombia, the ethnicity-childhood obesity link has been poorly researched, with two studies lacking complexity in their analyses. In the secondary analysis I conducted, childhood overweight and obesity was more common in indigenous adolescent girls. Socioeconomic variables, food security levels and maternal variables were associated with childhood obesity in Indigenous and Afro-descendant children. All of these variables, particularly, maternal obesity, proved to be significant in the Indigenous children, and this finding was also significant when testing mediation models.

This thesis could inform public policies to tackle childhood obesity in ethnically diverse countries like Colombia.

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Finally, I dedicate this thesis to my mother Ligia, an amazing woman who has devoted her life to caring with limitless love, respect and a hefty dose of wit and wisdom.

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List of acronyms and abbreviations

BIA: Bioelectrical Impedance Analysis

BMI: Body Mass Index

CA: Central adiposity

CDC: Centers for Disease Control and Prevention

DAG: Directed Acyclic Graph

DXA: Dual-energy x-ray absorptiometry

ECLAC: Economic Commission for Latin America and the Caribbean

ENSIN: National Nutrition Survey for Colombia (Acronym in Spanish)

FFM: Fat-free mass

FFMI: Fat-free mass index

FM: Fat mass

GDM: Gestational diabetes mellitus

HbA1c: Glycated haemoglobin

HSE: Health Survey for England

ID: Identification

MetS: Metabolic syndrome

MUAC: Mid-upper arm circumference

NLSCY: National Longitudinal Survey of Canadian Children and Adolescents

NSHG: National Study of Health and Growth

QA Tool: Quality Assessment Tool (for quantitative studies)

SPE: Socioeconomic position

TAI: Trunk adiposity index

TBF: Total body fatness

TER: Trunk-to-extremity skinfold ratio

TF: Trunk fatness

T2D/T2DM: Type 2 diabetes

SEM: Structural Equation Modelling

SES: Socioeconomic status

SUM: Sum of skinfolds

SFT: Skinfold thicknesses

PCTs: Primary Care Trusts

PRISMA-P: Preferred Reporting Items for Systematic Review and Meta-analysis Protocols

UK: The United Kingdom

WC: Waist circumference

WHO: World Health Organization

Preface

I came to Edinburgh after completing an undergraduate degree in Physiotherapy and a Master's in Epidemiology. Most of my work as a physiotherapist was in one of the largest hospitals in the country, where I worked with critically ill children. This experience led to a major shift in what I had planned for my academic career. I became interested in the prevention rather than treatment of diseases and decided to study epidemiology. Although I maintained my connection with physiotherapy by giving lectures related to treatments in childhood, my main role was as a researcher in the Epidemiology and Population Health Group (GESP), School of Public Health, Universidad del Valle, Colombia.

My research experiences within the research group were varied. My first exposure to research, and also my major experience, was in the field of environmental epidemiology. I contributed to study design, recruitment, data collection, writing and data analysis. It was an intensive two-year field work involving school-aged children. Other experiences included questionnaire design for two national health surveys, the writing up of research proposals and finally my participation in a research project on active transportation and physical activity.

This diverse experience allowed me to recognise the immense overlap in health and social inequalities in my country, compounded by a lack of policy response in the form of governmental interventions. It became evident that health research in Colombia is challenged by issues such as ethnicity, race and socioeconomic position, and I perceived that there were no substantial local advances being made in relation to these topics. Wanting to learn more about these phenomena, I decided to pursue a PhD in the United Kingdom, as I appreciated the conceptual development of several researchers in that region working in this field. I was awarded a scholarship by the Ministry of Sciences, former Colombian Administrative Department of Science, Technology and Innovation, COLCIENCIAS.

When I began my PhD, I had a chat with my principal supervisor, Raj, about the momentous choice to study abroad – from the personal and the academic point of

view, it really was a huge decision. Living abroad is a life-changing experience. There are new friends (for life!), a new home, and a new language and culture.

My thesis was shaped during these years, making it more complex, and thus, three supervisors from three research angles in the area of epidemiology and public health were required. Their constant feedback and support have been vital for the evolution of this thesis, as well as for my strength and resilience.

Although research must go on despite personal setbacks, sometimes it is hard to accomplish the goal of that phrase. Before travelling back to my country when I was seven months pregnant, I remember my supervisor Raj said I needed time to digest all the information I had gathered, and he was right. It took me almost two more years after giving birth to my son to complete this manuscript. Somehow, this gave me perspective regarding the peaks and troughs of one's academic career and life balance. During my research, I became aware and more reflective about other factors influencing children's health, like maternal lifestyles and wellbeing.

With this in mind, it is a pleasure to present this work, which has been formative in many dimensions of my life and seeks to understand the conceptualisation and operationalisation of ethnicity and race in Colombia using an international comparison approach based on the public health challenge of childhood obesity.

Chapter 1 Introduction

1.1 Context

It is well known that the prevalence of overweight and obesity in children and adults has increased to unprecedented levels across the world over the last three decades (WHO, 2016). The physiological consequences, along with the social and economic impacts at the individual and societal levels, of obesity and its comorbidities result in years of life being lost due to disability and premature death. Thus, obesity has been labelled as a major public health challenge by the World Health Organization (WHO, 2004).

Obesity in children is a special concern not only because of the consequences for the mental and physical health of children, but also because it is a predictor of adult disease. Early atherosclerotic and metabolic changes have been reported in paediatric cohorts and prospectively associated with cardiovascular risk in adults. Children with obesity additionally face psychosocial, pulmonary, musculoskeletal and neurological complications. Moreover, related health problems, such as sleep apnoea, poor self-esteem, depression and eating disorders, contribute to additional weight gain and affect academic performance (Han et al., 2010, Lakshman et al., 2012). Preventing the development of obesity in children can therefore help to prevent obesity and chronic disease in adults (Simmonds et al., 2016). Preventative measures can result in significant decreases in the current social costs, both social and economic, caused by loss of labour or workforce participation, premature mortality and pharmacological treatments for obesity complications (Simmonds et al., 2016).

Mirroring the global trend, developing countries have seen a sharp increase in the prevalence of childhood obesity over the last three decades. This has been associated with a nutritional transition consisting of shifts in diet and physical activity patterns, which has impacted the body weight of people around the world (Doak et al., 2005, Popkin et al., 2012). A study of nutritional transition in Colombia revealed the growing prevalence of overweight among economically disadvantaged populations despite overweight and obesity continuing to be more prevalent in high-income households (Parra et al., 2015c)

Research conducted during the last decade has shown the existence of a similar nutrition transition across Latin American countries (Uauy et al., 2001). Additionally, in Colombia, researchers have observed differences in the distribution of malnutrition by region, creating a 'double burden' in the country (Ronto et al., 2018). A relationship between malnutrition and ethnicity has been hypothesised in Colombia due to the distribution of ethnic minority groups in the most affected rural regions (Parra et al., 2015a).

In 2010, the prevalence of overweight (including obesity) among Colombian school-aged children was reported as being around 11% (Ministry of Health and Social Protection, 2010). However, there is a lack of available information regarding the extent to which children from different ethnic groups are affected by overweight and obesity, as well as the link with factors such as poverty. The influence of social and cultural factors driving childhood obesity on different ethnic groups needs to be tested in Colombia, as this relationship could be independent of more general assumptions.

Legislative interventions are the most effective means of reducing risk factors for chronic diseases (e.g. smoking bans in public places). So far, there has been no legislative action from the Colombian government to control the causes of obesity, such as restrictions on the marketing of non-healthy food to children, taxation of sugary drinks or similar interventions (Du et al., 2018). Currently, lower prices and higher availability of sugar-sweetened beverages in Colombia are driving consumption by children, and Colombia has been labelled as one of the countries with the highest consumption of these products (Singh et al., 2015). This situation is compounded by the deficit of urban environments (e.g. parks, public green areas) for engaging in physical activity in Colombian cities (Gómez et al., 2013, Gómez et al., 2004, Sarmiento et al., 2010). Over the last decade, nongovernmental and civil society organisations have begun to implement strategies to increase awareness regarding the nutritional content of marketed products (Ripoll-Núñez and Carrillo, 2018).

The subject of the present thesis, as well as the research questions that I present in the following chapters, address the way in which ethnicity is linked to the

understanding of childhood obesity within the context of a multicultural and multi-ethnic country such as Colombia. Furthermore, this thesis locates itself within the framework used in the field of public policy, situating the case of Colombia in a broader scenario through comparisons with four other countries: Brazil, Mexico, the United Kingdom and Canada.

1.2 Race, ethnicity and health research

Race and ethnicity are widely utilised in health research as exposure variables. The purposes of ethnic studies are to examine the causes of disease, variation in patterns of disease and the distribution of inequalities. This kind of research is often based on comparisons between ethnic groups (Nazroo, 2001, Sheldon and Parker, 1992) and should be postulated in a way that benefits the populations being studied. To avoid harming study populations, various guidelines have been proposed by journal editors and authors, while consensus statements on ethnicity and health research have also been put forward (Mir et al., 2013, Kaplan and Bennett, 2003a).

The Leeds Consensus Statement reported the highest agreement in 10 principles across four dimensions for conducting this type of research: the need to be clear about the importance and purpose for using ethnicity as an object of research; transparency about the concept, theories and assumptions regarding ethnicity; the use of meaningful data that allow analysis of the social context and health status of a determined population and focus on the evaluation of health inequalities (Mir et al., 2013). In addition, Kaplan (2003) identifies three challenges faced by researchers in this area: to account for the limitations of racial and ethnic data in terms of implying that individuals belong to fixed and mutually exclusive categories, to distinguish between race and ethnicity as risk factors or as risk markers and to avoid contributing to the division of society (Kaplan and Bennett, 2003a). Given these challenges, Kaplan developed a set of guidelines that, considered together with the Leeds Consensus Statement, inform the general purpose of this thesis (Box 1)

Box 1 Guidelines for conducting research on ethnicity and health. Kaplan et al. (2003) (Kaplan & Bennett, 2003)

1. When race and ethnicity is used as a study variable, the reason for its use should be specified.

2. In citing race and ethnicity data from any source, authors should describe the way in which individuals were assigned to racial/ethnic categories. If racial/ethnic identification was self-reported, authors should specify whether individuals answered an open-ended question or chose from a fixed set of categories.

3. Race and ethnicity should not be used as a proxy for genetic variation. Statements about genetic differences should be supported by evidence from gene studies. Genetic hypotheses should be firmly grounded in existing evidence, clearly stated, and rigorously tested.

4. In stating hypotheses and describing study results, authors should distinguish between race and ethnicity as a risk factor and race/ethnicity as a risk marker. If a researcher finds a higher prevalence of a given medical condition among individuals belonging to a determined ethnic group, it should not be assumed, in the absence of evidence, that those individuals have some quality or characteristic that makes them more susceptible to the particular condition.

5. In the interpretation of racial/ethnic differences, all conceptually relevant factors should be considered, including racism and discrimination, social class, personal or family wealth, environmental exposures, insurance status, age, diet and nutrition, health beliefs and practices, educational level, language spoken, religion, tribal affiliation, country of birth, parents' country of birth, length of time in the country of residence, and place of residence.

6. Because lack of adjustment for socio economic status or social class is the most important potential source of bias in studies of racial and ethnic differences, researchers should make every effort to adjust for these conceptually relevant measures.

7. In describing racial/ethnic groups, authors should use terminology that is not stigmatizing, does not reflect unscientific classification systems, and does not imply that race/ethnicity is an inherent, immutable attribute of an individual.

1.3 Framing childhood obesity as a public health problem

It is only relatively recently that obesity has been framed as a problem to be addressed by public health and public health policy. For more than a century, obesity was framed on the basis of individual responsibility with individualised treatments; hence, its causes and solutions have been framed within the context of the individual.

The framing of obesity has gone through a series of transformations since it was first considered a problem in the 1920s, when insurance companies began to draw attention to the link between overweight and the increased mortality seen at that time. It was not until a decade later that medical science accepted the idea of excess fat as a health problem. This was the beginning of the most detailed study of obesity up to this point, which facilitated broad knowledge of its causes and relationships with other human health conditions. In the 1960s, with the definition of body fat as an endocrine organ, the physiological view of obesity and overweight was dominant (Eknoyan, 2006; Khayatzadeh-Mahani, Ruckert, & Labonté, 2017). The framing of obesity as a problem shaped by societies was not evident until the 1990s. Earlier in this decade, a potential link with social inequality was discussed as an explanation for the increased prevalence of childhood obesity (Link and Phelan, 1996).

The burden of disease can be seen as a new frame given to obesity in more recent years. Obesity has been linked to high costs to society and hard-to-treat diseases, along with disability and mortality that appears to place a long-lasting burden on society. The 'burden' of disease is a concept used to explain what the disease causes us to lose as a society; we are losing lives, working hours, years of life and resources that could be used elsewhere. For an individual with obesity, this burden also relates to stigmatisation, low self-esteem and poor mental health.

With this increased focus on burden, obesity, especially among children, could be seen as a 'perfect storm' that challenges the economic structure of society. The burden has historically been framed as a consequence of individual behaviours, i.e. blaming individuals for what they eat and the way they move.

In recent years, however, researchers and policy makers have considered obesity in a broader way, looking beyond individual behaviours to explore factors that could produce an 'obesogenic environment'. An obesogenic environment is a geographical cluster characterised by a high offer of hypercaloric foods, low offer of fruits and vegetables and low or no access to green areas and areas for physical activity. Other variables, such as income and socioeconomic position, have come to be used to frame the problem of adult and childhood obesity, particularly in countries with rapidly increasing levels of childhood obesity. As many of these countries are multi-

ethnic, moreover, researchers began to explore and find differences in the prevalence of childhood obesity by ethnic groups (Harding et al., 2008b, Saxena et al., 2004, Ehtisham et al., 2005a)

Despite evidence supporting the hypothesis that childhood obesity is multifactorial, multi-causal and rooted in issues that lie beyond the responsibility of the individual and the health sector, public health actions designed to tackle childhood obesity are often aimed at the individual level (Waters, 2010, Salas, 2015, Vallgårda, 2018). It has been argued that most research still concentrates on modifying factors affecting dietary patterns or physical activity levels, and that approaches targeting other levels (such as the community or societal level) are more recent (Gicevic et al., 2016).

Childhood obesity and its causes represent a complex systemic issue that needs to be addressed across a range of areas if effective policy development is to be achieved (Xue et al., 2018, Huang, 2009). The understanding and framing of obesity as a complex system is still superficial but nevertheless has potential (Xue et al., 2018). It has been argued that this understanding should start by framing childhood obesity as a public health problem and recognising the multiple interacting determinants involved (Xue et al., 2018). Accordingly, this thesis will provide an analysis showing the extent to which Colombia needs to tackle childhood obesity on the basis of ethnicity as one of the components of this complex condition.

1.4 Countries of study

The process for selecting the countries of study – namely, Colombia and the comparison countries of Brazil, Mexico, the United Kingdom and Canada – was guided by my supervisors and discussion with external thesis reviewers during my first-year review. This thesis focuses on Colombia as a main country of study.

I selected Colombia not only because it is my country of origin, but also because it has been described as one of the most ethnically diverse countries in both the Western hemisphere and the world (UNHCR, UN Refugee Agency, 2014). Following the constitutional reform of 1991, Colombia was officially recognised as a multi-ethnic and multi-cultural country. This reform was a milestone in the recognition of the rights of ethnic minority groups: it allowed for the incorporation of

the ethnicity question in the 2005 census, as well as in the subsequent national health surveys. According to the latest Colombian census in 2018, Colombia has a total population of 48,258,494 (51.2 % women and 48.8% men). The population is classified into five ethnic minority groups: Indigenous, Afro-Colombian/Afro-descendant/Black ('Negro'), 'Palenqueros' (i.e. descendants of maroon communities), 'Raizal' (i.e. native islanders), 'Rrom peoples' or Roma/Gypsy and a majority labelled 'general population' (i.e. those not self-identifying as belonging to any of the listed minority groups; (National administrative department of statistics (DANE), 2018).

The total indigenous population is estimated to be 1,905,617, which represents 4.4% of the total population distributed across 87 different ethnic groups (although organisations representing these communities claim the recognition of 102 groups). The Afro-Colombian population is usually considered as comprising those who self-identify as belonging to one of the Afro categories (Afro-Colombian, Afro-descendant and Black ['Negro'], also including Palenqueros and Mulattos); the size of this population is estimated to be 4,671,160, accounting for 9.34% of the national population. Although Mulatto is not an official category, Colombian researchers have advocated for its inclusion in the official categorisation. The Roma population is estimated to be 2,649 (National administrative department of statistics (DANE), 2018). The remainder of the population, often labelled as 'General Population', are mainly composed of the Mestizo population and other ethnic/migrant populations. Again, while Mestizo is not an official category, it is a term widely used by the Colombian population. In addition, there are 68 official languages other than Spanish (66 indigenous, one Romani and one Palenquero or Afro-descendant).

1.4.1 Comparison countries

I selected four additional countries for comparison – Brazil, Mexico, Canada and the United Kingdom – on the basis of their similarities with Colombia in terms of ethnic diversity, as well as on the basis of the different public health developments in each country. Brazil, Mexico, Canada and the United Kingdom are considered ethnically diverse since each has experienced the dynamics of the migration process. Furthermore, these countries are also home to ethnic minority groups such as

Indigenous, Aboriginal population or Travellers (traditional groups of people who live a nomadic lifestyle, e.g. Irish Travellers) (Bhopal, 2014).

I was also interested in selecting countries that provide different scenarios for contrast in terms of their size, level of human development, obesity prevalence, approach to measuring ethnicity and differential experiences developing health policies. According to the latest census data from the four countries, the country with the largest population is Brazil, estimated to be 201,033,000 (Brazilian Institute of Geography and Statistics-IBGE, 2010), followed by Mexico, estimated to be 119,938,473 (National Institute of Statistics and Geography (INEGI), 2015); moreover, the United Kingdom population is estimated to be 63,182,000 (Office for National Statistics, 2011a), while that of Canada is estimated to be 35,151,728 (Canada, 2016).

With regards to the Human Development Index, Colombia is classified as 'high', while the countries of comparison are 'very high' (Canada and the United Kingdom) and 'high' (Brazil and Mexico) (United Nations Development Programme (UNDP), 2019). Colombia, Mexico and Brazil are neighbouring countries with similar population structures and differential development regarding policies to reduce health inequalities. Brazil has a special approach to measuring ethnicity based on skin colour, while Mexico uses language as a proxy for ethnicity and Canada and the United Kingdom base their ethnic classification on a combination of country of origin, geographical origin and skin colour; this topic is addressed in more detail later in this thesis. Obesity is a public health priority concern in all of the four countries (Pérez-Ferrer et al., 2018, Mendes and Santos, 2018, Rao et al., 2016, Viner and Hargreaves, 2019). The different approaches to framing obesity as a public health problem in terms of the ethnic diversity of the four countries will contribute to enriching the analysis of the Colombian case.

1.5 Aim, research questions and objectives of the thesis

The overall aim of this thesis is to understand the role played by race and ethnicity in framing childhood obesity as a public health problem in Colombia, contrasted with Brazil, Mexico, Canada and the United Kingdom.

The thesis sets out to answer the following three research questions:

1. Are the categories of race and ethnicity and their conceptualisation in Colombia similar to those in Brazil, Mexico, Canada and the United Kingdom?

2. In what ways have race and ethnicity been applied to measuring and analysing childhood obesity in Colombia, and how does this approach differ from the approaches applied in Brazil, Mexico Canada and the United Kingdom?

3. Is there variation in the racial and ethnic distribution of childhood obesity in Colombia?

These research questions were operationalised through the following specific objectives:

1. To identify how ethnicity and race are defined and measured in Colombia, contrasted with Brazil, Mexico, Canada and the United Kingdom;

2. To systematically review the ethnicity-based approaches for measuring and analysing childhood obesity in Colombia, contrasted with Brazil, Mexico, Canada and the United Kingdom;

3. To estimate the prevalence of childhood obesity by ethnic groups in relation to risk factors associated with that condition in Colombia.

1.6 Thesis outline

This thesis is structured as follows:

Chapter 2 provides a review of the core concepts of ethnicity and childhood obesity, summarising the definitions and main theories and presenting the arguments in

support of its public importance. In addition, this chapter presents a review of the categories of ethnicity and race in Colombia, contrasted with those utilised in Brazil, Canada, Mexico and the United Kingdom.

Chapter 3 systematically reviews the ethnicity-based approaches to measuring and analysing childhood obesity by identifying the following: the categories of ethnicity used by researchers and how these differ from those used in censuses, the available quantitative information regarding childhood obesity and adiposity, the variation of childhood obesity and adiposity by ethnic group and the explanations and recommendations discussed by researchers in light of these variations.

Chapter 4 is aimed at better understanding the relationship between ethnicity and childhood obesity by unpacking the potential mechanisms operating in Colombia. I revisit the systematic review presented in the previous chapter to develop a conceptual model of the potential mechanisms for the Colombian case by using a tool designed to understand cause and effect relationships, i.e. directed acyclic graphs (DAGs).

Chapter 5 is a secondary analysis of the 2010 Colombian nutrition health survey (ENSIN) based on the DAG developed in the previous chapter. This chapter is subdivided into three sections. The first is focused on the prevalence of childhood obesity by ethnic groups, while the second presents an analysis of risk factors through the association analysis of socioeconomic variables, food security and diet. The third part is an illustrative example of analysis using ethnicity to explain differences in childhood obesity. This part will test mediation models for Indigenous and Afro-descendant groups.

Chapter 6 provides a brief summary of the main findings with a focus on the three key themes: the aim of the thesis, namely how ethnicity frames childhood obesity in Colombia; a reflection on the study of ethnicity and childhood obesity in epidemiology based on the findings from chapter 5; and finally, the influence of mother weight status in relation to existing literature.

Chapter 7 is the final chapter of the thesis. It provides a critical view of the thesis, summarising its strengths and limitations. It also includes a set of recommendations for policy, practice and research.

1.7 Note on terminology

Throughout this thesis, the term ‘ethnicity’ is used to refer to both ethnicity and race. As explained in the following chapter, the definition of ethnicity that supports this research is broad and encompasses the concept of race.

When a specific ethnic code or ethnic group is specified in this thesis, it is always capitalised (e.g. White, Afro-descendant). Also, as I am including countries that speak different languages, the original ethnicity codes are presented as originally stated by the author, with quotation marks used in cases where there is no adequate translation in the English language (e.g. ‘Palenquero’, which is one of the Colombian ethnic minority groups).

When referring to obesity or childhood obesity, the topic is addressed according to the rules of person-first language. This means that the person is described as having the condition rather than being defined by that condition: e.g., ‘person with obesity/person experiencing obesity’ instead of ‘obese person’. Moreover, in the data analysis, discussion and conclusion chapters, the term ‘childhood obesity’ is used to denote the main outcome defined in the quantitative analysis, i.e. overweight including obesity or obesity.

Chapter 2 Conceptual framework

This chapter is concerned with the conceptual approaches to ethnicity and childhood obesity that orient the present thesis. It begins by explaining the definitions of race and ethnicity adopted for the research, then presents a review of the categories and conceptualisations of race and ethnicity in Colombia, Brazil, Mexico, Canada and the United Kingdom. Towards the end, it presents the frameworks that guide the study of childhood obesity conducted in this thesis.

2.1 Definitions of race and ethnicity

There is no definitive theory or definition of the concepts of race and ethnicity. Both of these concepts are constantly evolving in relation to modifications of historical and socio-political conditions (Malešević, 2011, Fenton, 2010, Bartlett, 2001). Due to this contextual dependency, it is difficult to define and operationalise these concepts; as a result, definitions and boundaries of 'race' and 'ethnicity' often overlap and the concepts are subsequently used interchangeably.

'Race' is a concept that has been used with both biological and social meanings. The biological approach categorises populations according to phenotypical features, such as skin colour, hair and facial features. This approach was particularly influential during the 19th and early 20th centuries, when it was used to justify discourses of nationalism and colonialism (Bartlett, 2001, Bhopal, 2014). According to Spencer (2006), since 19th century, race has been related to social class and culture. However, it was not until the 20th century that the term 'race' was used interchangeably with the term 'ethnicity' (Spencer, 2006).

The term 'race' is currently used for social purposes to describe how populations are affected by socio-political or socio-economic contexts in relation to their visible differences. This orientation necessarily implies biological differentiation on the basis of physical characteristics and determines fixed categories shaped by forces outside the individual (Kaplan and Bennett, 2003a). Consequently, there is an

increased consensus regarding the decline of the biological perspective of race on the basis of the universality of human characteristics (Fenton, 2010, Kaplan and Bennett, 2003a, Bhopal, 2014). 'Ethnicity', on the other hand, has been used to describe groups of people sharing common culture or descent (Bhopal, 2014). In contrast to race, ethnicity brings with it the notion of self-definition and group identification, making it the more acceptable approach through which to allocate people to a predetermined category.

This thesis is orientated by broad definitions of ethnicity that encompass race, following the framework proposed by Bhopal (2014) and Fenton (2010) (see Box 2).

Box 2: Definitions of ethnicity for this thesis
'Race' in this context is understood as "historical and common usage the group (sub-species in traditional scientific use) a person belongs to as a result of a mix of physical features such as skin colour and hair texture, which reflect ancestry and geographical origins, as identified by others or, increasingly, as self-identified." (Bhopal, 2014) 'Ethnicity' is understood as "the social group a person belongs to, and either identifies with or is identified with by others, as a result of a mix of cultural and other factors including language, diet, religion, ancestry, and physical features traditionally associated with race." (Bhopal, 2014). "…and often that the group referred to is 'other' (foreign exotic minority) to some majority who are presumed not to be 'ethnic'."(Fenton, 2010).

2.2 Definitions and conceptualisation of race and ethnicity in Colombia, Mexico, Canada, Brazil and the United Kingdom

In our modern multi-ethnic world, the need and opportunity for international comparisons using the concept of race and ethnicity are becoming increasingly important. The evolution of the concepts of ethnicity and race has been essential to the promotion of more inclusive policy aimed at reducing ethnic inequalities within nations. However, this evolution is context-dependent, and the changes may be

related to social economic and political circumstances (Malešević, 2011, Fenton, 2010).

This section attempts to compare and contrast categories of ethnicity in Colombia with those used in Brazil, Mexico, Canada and the United Kingdom. The ethnic categorisation has been extracted from the most recent national censuses in each country (this review was presented as a poster at the Society for Social Medicine 59th Annual Scientific Meeting, Dublin, 2017, see Appendix A)

I found that the countries of interest collected data on ethnicity in different ways, using either a single concept of ethnicity or a mix of several concepts. Table 1 presents the ethnicity-related question and options available for each country.

The Colombian census collects information on ethnicity based on an 'ethnic group' definition that includes self-identification. The question is 'According to your cultural background, people or physical features... Are you or Do you recognise yourself as?' People are invited to respond via six options that are mostly related to ethnic minority groups, i.e. Indigenous, 'Rrom' (Roma or Gypsy), 'Raizal of the Archipelago of San Andrés and Providencia', 'Palenquero of San Basilio' and 'Black, Mulatto, Afro-Colombian or Afro-descendant'. The sixth category is 'None of the above', which was selected by the majority of the Colombian population, i.e. White and other mixed/multiple ethnic groups such as 'Mestizo' (which is a mix of White and Indigenous).

This categorisation is in accord with the 1991 Colombian Constitution, which states that the country is multicultural and multi-ethnic (Asamblea Nacional Constituyente, 1991). The Constitution's approach highlights the need to protect ethnic minority rights. However, this has been an arduous process for these population groups, since the more explicitly mentioned rights, especially the right to land, were framed with Indigenous peoples in mind (Ojulari, 2015, Ng'Weno, 2007). In order to target actions from different sectors, there is a demand by the government to include the same ethnic question in national surveys.

The ethnicity question in Colombia has been subjected to considerable criticism. Nevertheless, the wording of the question has remained the same since its first use in the 2005 Census. The majority of the Colombian population describe themselves as being 'None of the above'; in other words, not belonging to an ethnic minority group. Geneticists and the general population label people in this category as 'Mestizo'. However, this is an attempt to generalise people from different backgrounds, i.e. mixtures of ancestries during the period of colonisation. Thus, this category does not reflect migrants from a wide variety of origins who arrived after this period. Anthropologists have debated the flexibility and ambiguity of this term (Olarte Sierra and Díaz Del Castillo Hernández, 2014). As the term 'Mestizo' denotes the mixture of European (White) and Indigenous backgrounds, the subsequent debate has centred on the negation of the Afro-descendant ancestry for the majority of Colombian people. This informs part of the broader debate around exclusion and discrimination in relation to the ethnic divisions used in Colombia (Olarte Sierra and Díaz Del Castillo Hernández, 2014, Chaves Chamorro, 2002). 'Mulatto', which means people with a White European and African background, has been proposed by sociologists as a valid category for use in labelling part of the population in this group (Barbary and Urrea, 2004).

In Brazil, the focus of ethnicity questions is on skin colour, which is an approach based on the biological concept of race (Bhopal, 2014). The categories are 'Branco', or White, 'Pardo', or Brown, 'Preto', or Black, and 'Amarelo' or Yellow (i.e. of Asian descent). The option 'Indigenous' is also included as one of these categories. According to the Brazilian Institute of Geography and Statistics (IBGE), the inclusion of the Indigenous option in this question represents an attempt to identify and locate this population group (Brazilian Institute of Geography and Statistics-IBGE, 2010).

The categorisation based on skin colour in Brazil has been adopted by different disciplines for the purpose of studying racism and inequalities, especially as regards discrimination against people of African background. Furthermore, a complementary categorisation has also been proposed based on an 11-point skin colour palette, from

the very lightest colour to the darkest, in order to study inequalities and self-rated health in Colombia, Brazil, Mexico and Peru (Perreira and Telles, 2014, Telles and Flores, 2013). While this categorisation is more widely used in research it is also beginning to be applied in health surveys in Latin America.

In Mexico, the assessment of ethnic background has been derived from the self-reporting of Indigenous ethnicity and Indigenous language speaking at home. The Afro-descendant/Afro-Mexican category was assessed recently in an interim census conducted in 2015 (National Institute of Statistics and Geography (INEGI), 2015). This review did not find assessment of ethnicity, rather than the Indigenous language, in health surveys conducted in Mexico.

Regarding the definition of ethnicity in Canada, the main question includes categories that combine geographic origin (South Asian, South-east Asian, West Asian, Latin American), nationality (Chinese, Filipino, Korean, Japanese, Arab) and skin colour (White, Black). Additionally, this question contains an open 'other' category that can be specified by the respondent (Canada, 2016).

In the United Kingdom, the Office for National Statistics recommended 'what is your ethnic group?' as a specific question for surveys. This was proposed to harmonise data collection in order to ensure comparability across surveys (Office for National Statistics, 2011a). The list of responses provided is longer than Canada's, and has been organised into five categories: 'White', 'Mixed/Multiple ethnic groups' (combinations based on skin colour), 'Asian / Asian British', 'Black / African / Caribbean / Black British' and the option of 'other ethnic group'.

Despite the above recommendation from the Office for Statistics, however, there are differences within the United Kingdom censuses regarding 'White' and 'Black' categories: Scotland separates Scottish from other British and includes separate Irish and Polish categories; England and Wales combine the UK and British categories, but include a separate Irish category, while Northern Ireland has one White category. Moreover, the African category in the Scottish question is presented in a separate section to the Caribbean or Black category.

There are additional questions addressed in the censuses of these five countries that are related to ethnicity and can be used to refine ethnicity definitions (see Table 2). For example, country of birth and country of parents' birth might be useful to assess immigration. Moreover, religion is closely related to ethnicity because it influences lifestyle and can provide a strong sense of identity (Bhopal, 2014). Similarly, language is an indirect way to assess ethnicity.

All five countries ask questions about place of birth. All, except Mexico, also ask for parents' place of birth. Colombia, Brazil and Mexico do not ask about religion; in particular, the Colombian census has excluded this question from the census since 2005. In contrast, Canada's census contains a comprehensive list of options related to the person's religion. All countries also ask about languages, with some variations. Colombia is the country that asks the least detailed questions, while Canada's census contains three questions about language: language spoken at home, other languages spoken at home and language first learned in childhood.

The Canada census contains a question about ancestry (does not appear in table 2), which is also a concept that has been closely related to ethnicity. The question is formulated in terms of the ethnic or cultural origins of the person interviewed. It states that an ancestor is usually more distant than a grandparent and gives options for Indigenous origin and European migrant origin; these include Cree, Ojibway, Mi'kmaq, Salish, Dene, Blackfoot, Inuit, Métis, Canadian, French, English, German, etc.

Table 1 Ethnicity definition and ethnicity questions in the last census of Colombia, Brazil, Mexico, Canada and The United Kingdom

Census	Colombia (National administrative department of statistics (DANE), 2018)	Brazil (Brazilian Institute of Geography and Statistics-IBGE, 2010)	Mexico (National Institute of Statistics and Geography (INEGI), 2015)	Canada (Canada, 2016)	The United Kingdom[β] (Office for National Statistics, 2011b)
Year of publication	2018	2010	2015	2016	2011
Ethnicity definition	"Ethnic group" refers to the recognition made by any person of a set of socio-economic and cultural characteristics, such as language, worldview, production methods, and kinship relations, among others, considered typical of the ethnic group with respect to other groups with other specific characteristics.	Colour or race defined by the person. Ethnicity was investigated only for people who have declared or are considered indigenous	"Ethnic group" refers to the recognition made by any person according to cultural characteristics, history and traditions:	Based on "Population group" which refers to the population group or groups to which the person belongs according to the options that appears below. The previous standard for "race (ethnicity)" is superseded by this standard.	"Ethnic group" classifies people according to their own perceived ethnic group and cultural background.
	-According to your cultural background, people or physical features...Are you or Do you recognize yourself as: 1. Indigenous? 1.1 To what Indigenous people do you belong to? 2. ROM? 3. Raizal of the Archipelago of San Andrés and Providencia? 4. Palenquero of San Basilio 5. Black, Mulatto, Afrocolombian or afro descendant? 6. None of the above?	-Your Colour or Race is? 1. White 2. Black 3. Yellow 4. Brown 5. Indigenous	According to its culture, history and traditions, Do you consider yourself Black, that is, Afro-Mexican (or) Afro-descendant? According to its culture, Do you consider yourself Black, that is, Afro-Mexican Indigenous?	-Is this person: White Chinese South Asian (*e.g., East Indian, Pakistani, Sri Lankan, etc.*) Black Filipino Latin American Southeast Asian (*e.g., Vietnamese, Cambodian, Malaysian, Laotian, etc.*) Arab West Asian (*e.g., Iranian, Afghan, etc.*) Korean Japanese Other	-What is your ethnic group? A. White: English/Welsh/Scottish/Northern Irish/British Irish Gypsy or Irish Traveller Any other White background B. Mixed/multiple ethnic groups White and Black Caribbean / White and Black / African / White and Asian Any other Mixed/multiple ethnic background C. Asian / Asian British Indian / Pakistani /Bangladeshi Chinese /Any other Asian background D. Black / African / Caribbean / Black British African / Caribbean /Any other Black / African / Caribbean background E. Other ethnic group Arab /Any other ethnic Group

β The UK: Table based on England and Wales census 2011.

Table 2 Additional questions that might help to identify the ethnic background

Country	Colombia 2018	Brazil 2010	Mexico 2015	Canada 2016	United Kingdom 2011
Place of birth /country of origin	-Where was [the respondent] born? In what year did he/she arrive in Colombia?	-What is your Federation unit (State) or foreign country of birth? Federation unit Foreign country	In what state of the Mexican Republic or in which country were you born?	- Where was this person born? *Specify one response only, according to present boundaries.* Born in Canada (list of provinces) Born outside Canada *Specify country*	-What is your country of birth? England; Wales; Scotland; Northern Ireland; Republic of Ireland; Elsewhere, write in the current name of country
Place of birth of parents /place of residence	-When you were born, in what municipality or place did your mother live?	No question about place of birth of parents	Not applicable	Where was each of this Person's parents born? Questions for mother and father Born in Canada/ Born outside Canada	No question about place of birth of parents
Religion	Questions regarding religion are excluded from the Census 2005 according to Colombian regulations (April 2005).	-What is your religion or cult? _____	Not applicable	-What is this person's religion? *Indicate a specific denomination or religion even if this person is not currently a practising member of that group. For example, Roman Catholic, Anglican, United Church, Pentecostal, Traditional (Aboriginal) Spirituality, Longhouse, Baptist, Lutheran, Church of Jesus Christ of Latter-day Saints, Jehovah's Witnesses, Presbyterian, Moravian, Evangelical Missionary Church,*	-What is your religion? *This question is voluntary* No religion Christian (including Church of England, Catholic, Protestant and all other Christian denominations) Buddhist Hindu Jewish Muslim Sikh Any other religion

Country	Colombia 2018	Brazil 2010	Mexico 2015	Canada 2016	United Kingdom 2011
Language	-Do you speak the language of your people?	-Do you speak indigenous language in the housing unit? (Including the use of sign language) - Which? (Specify the indigenous languages(s) spoken. Up to two entries) -Do you speak Portuguese in the housing unit?	Do you speak any dialect or indigenous language? What dialect or indigenous language do you speak? Do you understand any indigenous dialect or language?	-What language does this person speak most often at home? English; French Other -Does this person speak any other languages on a regular basis at home? -What is the language that this person first learned at home in childhood and still understands? English; French Other	-What is your main language? English Other (including British Sign Language)

(Continued)

Regarding questions about Indigenous status, the five countries differ significantly (see table 3). The censuses of Colombia, Brazil and Mexico contain a self-reported question. The Brazilian census has introduced a question about indigenous status on the birth certificate, as they have a separate registry for the indigenous population. Colombia, like Canada, has officially recognised the multicultural and multi-ethnic nature of its country through constitutional acts. In Colombia, this census question is designed to identify and locate Indigenous groups. The Canada census includes several questions about Indigenous status (called 'Aboriginal' in this country). This approach is based on the official acts that support the recognition of Indigenous groups (Constitution Act 1867 and Indian Act, now First Nations). There are three Indigenous groups in this country: North American Indian, Métis (who have mixed Indian and European heritage) and Inuit (formerly Eskimo). An additional **c**ategory exists for those who have Indian ancestry but are not eligible for Indian Status under the Indian Act.

Table 3 Assessment of Indigenous status in censuses

Colombia 2018	Brazil 2010	Mexico 2015	Canada 2016
- What were the ethnic or cultural origins of this person's ancestors? *An ancestor is usually more distant than a grandparent. For example, Cree, Ojibway, Mi'kmaq, Salish, Dene, Blackfoot, Inuit, Métis, Canadian, French, English, German, etc.*	-Do you consider yourself indigenous? -What ethnic group or people Do you belong to? - Has your birth been registered? 1. Yes, as a birth certificate at registry office 2. Yes, as a certificate of live birth at hospital / maternity 3. Yes, as an administrative registration of indigenous birth 4. No 5. Not known	According to your culture, do you consider yourself Indigenous?	- Is this person an Aboriginal person, that is, North American Indian, Métis or Inuit (Eskimo)? - Is this person a Status Indian *(Registered or Treaty Indian as defined by the Indian Act of Canada)?* - Is this person a member of a First Nation/Indian band?

Table 4 presents additional questions regarding migration, emigration and mobility. These questions could be useful for analysing the concept of acculturation among migrants, which is one of the components of ethnicity. As can be seen, Canada has developed questions about migration status with explicit definitions, such as 'who is landed immigrant' and 'citizenship'. A similar approach can be seen in the United Kingdom, which utilises questions on citizenship and country of birth. Canada, the United Kingdom and Brazil present a comprehensive set of questions about internal and international migration. Brazil and Canada require more detail regarding length of stay; in contrast, Colombia and Mexico are more concerned with mobility over the past five years.

In summary, the review for this section has identified different approaches used to measure ethnicity that might not allow between-country comparisons in order to analyse ethnic differences in health outcomes. Countries have different levels of granularity in terms of the categories evaluated. Canada and the United Kingdom set a more comprehensive set of questions and categories, including questions about ethnic groups, religion, migration and mobility that can be useful for analysing health outcomes using a broad definition of ethnicity. In comparison, Colombia, Brazil and

Canada have more limited options. Brazilian categories based on skin colour might create difficulty when comparing ethnic differences in health outcomes with other countries. Moreover, Mexico permits less granular ethnic classification, allowing comparison only between Indigenous and non-Indigenous groups. As the Afro-descendant category has been included recently, new comparisons could be proposed for analysing health outcomes. Finally, Colombia's ethnicity question is concerned with ethnic minority groups; although this is positive for the analysis of differences between and within these population groups, the heterogeneity of the general population has not yet been addressed.

Table 4 Migration Status and mobility in Colombia, Brazil, Mexico, Canada and the United Kingdom

Country	Colombia 2018	Brazil 2010	Mexico 2015	Canada 2016	The United Kingdom 2011
Migration status	NA	-Was any person who used to live with you living in another country on July 31, 2010? In addition this question ask for name, age, sex, year of birth, year of last departure to live in another country and country of residence on July 31, 2010.	In what state of the Mexican Republic or in What country did you live in March 2010?	-Of what country is this person a citizen? -Is this person now, or has this person ever been, a landed immigrant? "…(permanent resident) is a person who has been granted the right to live in Canada permanently by immigration authorities" -In what year did this person first become a landed Immigrant?	What is your country of birth? What passports do you hold?
Mobility	- In what municipality did you live five years ago?	-Were you born in this Municipality? -Were you born in this Federation unit (State)? - In what year did you move to Brazil? -For how long have you lived uninterruptedly in this Federation unit (State)? -For how long have you lived uninterruptedly in this Municipality? In which federation unit (state) and municipality or foreign country had you lived before moving to this municipality? - In which federation unit and municipality or foreign country were you living on July 31, 2010?	5 years ago, in March 2010, in what municipality or delegation did you live?	-Where did this person live 1 year ago, that is, on May 10, 2010? Born after May 10, 2010 Lived at the same address as now Lived at a different address in the same city, town, village, township, municipality or Indian reserve Lived in a different city, town, village, township, municipality or Indian reserve in Canada Specify name of: Community, city, town, village, township, municipality or Indian reserve. - 4 Where did this person live 5 years ago, that is, on May 10, 2006?	If you were not born in the United Kingdom, when did you most recently arrive to live here? *Do not count short visits away from the UK. Month /year* -Including the time you have already spent here, how long do you intend to stay in the United Kingdom? Less than 6 months 6 months or more but Less than 12 months 12 months or more One year ago, what was your usual address?

Defining childhood obesity

According to the WHO (2014), overweight and obesity are defined as abnormal or excessive fat accumulation that presents a risk to health. In the case of children, there are several indices and strategies used to estimate obesity and overweight, which are often based on height and weight. The current definitions of childhood obesity are indexes on the basis BMI calculated from weight and height, which are anthropometrical markers relatively easy to measure and enable studies at population level. However, there are some considerations in respect to the validity of using BMI. BMI does not distinguish between fat and lean mass. In addition, when measuring difference by ethnicity, BMI-based definitions might not be capturing the diversity of fat distribution across body composition, and thus childhood obesity definition should also take into account other markers such as skinfolds thicknesses and waist circumference.

The following are the more widely used child growth charts from which the definitions of obesity are derived:

1. International Obesity Task Force (IOTF) defines overweight and obesity according to age- and sex-specific cut-off points in children from 2 to 18 years of age. Definitions of obesity are extrapolated from adult (Body Mass Index [BMI]) cut-off points (Cole and Lobstein, 2012). By using this chart, two categories are offered: overweight (25 kg/m^2) and obese (30 kg/m^2). The approach of this definition is arose from the need to explore cut-off points for overweight and obesity in childhood extrapolating them from adult cut-off points at age 18, which makes consistent childhood obesity with the adult one. In addition, this approach used a combination of reference populations from six countries and different ethnicities to provide an international definition aimed to improve comparability. The countries included were Brazil (Second National Anthropometric Survey), United Kingdom (5 national growth surveys pool), Hong Kong (National Growth Survey), Netherlands (3rd Nationwide Growth Survey), Singapore (School Health Service Survey), and United States (Data pooled from 4 national surveys). Initially the IOTF had the disadvantage that it only works as a tool for categorisation of an individual as obese or overweight but not to calculate BMI centiles for age. However, to address this limitation, an

updated analysis of the IOTF definition added L, M and S curves to derive new cut-offs recent defined in terms of centiles at 18 years corresponding to each BMI value.

2. The World Health Organization Child Growth Standards (WHO standards) define overweight and obesity in two age spans: infants and children under 5 years, and children and adolescents between 5 to 18 years of age. For infants and children aged under 5, it provides weight-for-length and weight-for-height. Children in this age group who sit above +1 standard deviation (SD) are classified as being 'at risk of overweight', with those above +2SD classified as 'overweight' and above +3SD as 'obese'. For children and adolescents between 5–19 years, moreover, the recommendation is to use body mass index-for-age. Children and adolescents above +1SD are classified as 'overweight' (equivalent to BMI 25 kg/m^2 at 19 years), while those above +2SD are classified as 'obese' (equivalent to BMI 30 kg/m^2 at 19 years) (Grummer-Strawn et al., 2010, de Onis and Lobstein, 2010). The study which generated this definition was an analysis to update the WHO reference population, known as the 1977 National Center for Health Statistics (NCHS)/WHO international growth reference, a United States-based population. One of the main motivations to update reference population in this WHO definition was to provide data for BMI-for-age from 5 years, since the in the former reference population (NCHS/WHO) this information only started at 9 years old. Since a multicentre study to obtain a new population reference was not feasible, the approach consisted of a statistical reconstruction of the original sample using the Box-Cox power exponential method to select the best models in a scale from 5 to 19 years of age. Unlike the IOTF definition and like the next definition, the UK90, the WHO 2007 provides a full growth reference, which enables estimation of changes in BMI and other measures, and calculation of the relative position of an individual in respect to anthropometrical measures. However, the original sample used for reconstruction is based on only United States population which reduces its validity as global reference, despite some adjustments by the WHO to account for this issue.

3. British 1990 growth reference (UK90) uses BMI centile thresholds to define underweight, overweight and obesity in children aged 2–18 years (35). Using this chart, this population can be divided into three categories: 'healthy weight' (>2 –

<85th centile), ‘overweight’ (≥ 85th centile) and ‘obese’ (≥95th centile) (Cole et al., 1998). The reference curves were based on seven sources conducted between 1978 and 1990, compelling 25000 individuals: The Human Measurements Anthropometry and Growth Research Group's children’s growth studies and adult body dimensions’ studies, the Tayside Growth Study, the National Study of Health and Growth (NSHG), the Department of Health survey of the statures and weights of British adults, the Cambridge Infant Growth Study and the Whittington birth data study. The rationale for the UK90 growth was to create a reference population more diverse comparable with the children and adolescents in the UK by then, 1990`s decade, since the previous reference curves of stature and weight for the UK were from 1966. Among disadvantages of the UK90 definition is that cut-offs points were arbitrarily set and that it does not work for international comparisons. In addition, the reference might not acknowledge the increasing ethnic diversity of the UK population after the 1990´s decade due to the increase in migration rates. For instance, according to the Office for National Statistics (Migration Statistics Quarterly Report - November 2014), the net migration in the 1980´s and early 1990´s was low in comparison with the continues increasing since 1994 and the sharp rising after 1997.

4. Mexico and Colombia more frequently use the Centres for Disease Control and Prevention Charts (CDC charts). The CDC uses a modified version of the WHO standards. In children aged 2 to 19 years, the definition of obesity is based on age- and sex-specific BMI percentiles. ‘Overweight’ refers to a BMI between the 85th and 95th percentile, while those with a BMI ≥95th percentile are considered obese. These further classify children in the population from birth to age 2 (Grummer-Strawn et al., 2010). The CDC charts were developed to obtain information at population level since previous references failed to provide information on the ethnic, genetic and geographic diversity of the population of the United States. ´Before 1977 there was also a lack of information on infants and preschool children. All charts are sourced on population-based US national surveys and supplemental data sources, e.g. birth registries, longitudinal studies or hospital registries to gather reformation from children between less than 1 year of age until 19 years. In particular, the BMI chart was based on data from five surveys, i.e. NHES II (years 1963-1965) , NEHS III (years 1966-1970), NHANES I (years 1971 – 1974), NHANES II (years 1976 –

1980) y NHANES III (1988-1994). As happens with the UK90 definition, the CDC BMI chart might have limited international comparability given its specific reference population.

2.3 Frameworks for analysing links between ethnicity and childhood obesity

As this thesis attempts to analyse the way in which ethnicity has contributed to the framing of childhood obesity as a public health problem, I have chosen two frameworks that cover factors at different levels linked to obesity: the Angelo framework and the Obesity System Map.

The Angelo framework (Analysis Grid for Elements Linked to Obesity) was developed to categorise the environment according to the potential barriers affecting diet and physical activity. The basic framework divides the obesogenic environment into two dimensions: by size (into macro and micro environment) and by type of environment (i.e. physical, economic, political and socio-cultural) (Figure 1) (Sacks et al., 2012).

Figure 1 Angelo framework. Including setting, sectors and environmental elements.

Environment size / Environment type	Micro environment (settings)		Macroenvironment (sectors)	
	Food	Physical Activity	Food	Physical Activity
Physical	What is/is not available?			
Economic	What are the financial factors?			
Policy	What are the rules?			
Sociocultural	What are the attitudes, beliefs, perceptions and values?			

Adapted from: Childhood obesity. Prioritizing areas for action in the field of population-based prevention of childhood obesity. (2012) (Sacks et al., 2012)

Microenvironments are those settings that are geographically separated and relatively small in which individuals can practice any activity related to weight (diet or physical activity). Examples of these environments include schools, neighbourhoods and workplaces. Macroenvironments are settings comprising a group of places, services or structures that may influence weight, physical activity or diet. Examples

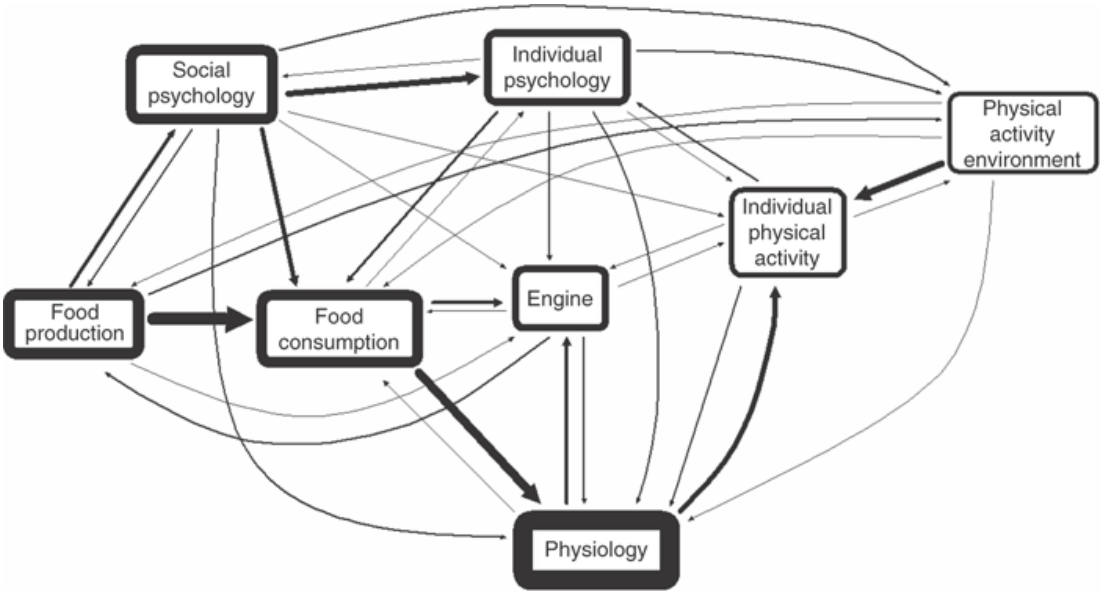
of these environments are groups of industries belonging either to the private or public sectors (Sacks et al., 2012).

Physical environments include nature and man-made structures that can potentially influence health behaviours related to obesity; examples of these environments include urban design, the transportation system, land use, terrain and climate. Economic environments refer to costs related to food and physical activity; examples of these environments include food insecurity, income and education. Policy environments encompass rules related to food and physical activity. These rules come from official institutions (e.g. governments) or other settings, such as schools or the household. Finally, socio-cultural environments are related to the attitudes, beliefs, and values influencing the dietary habits and physical activity of a community or society (Kirk et al., 2010, Sacks et al., 2012).

Moreover, the Obesity System Map was developed by the Foresight Programme in 2007 to compile the drivers of obesity and their interrelations (Butland et al., 2007). Under this framework, obesity is understood as a complex matter, where eight dimensions (or 'clusters') interact in negative and positive directions to generate obesity. The obesity system map has a central core loop, or 'engine', with energy balance at the centre of all of these interactions (Vandenbroeck et al., 2007, Butland et al., 2007).

Figure 2 presents a simplified version of the applied framework for the study of childhood obesity (Finegood et al., 2010a). It features a number of interactions between clusters (arrows), along with interconnections among the variables in a cluster (borders). As can be seen from the figure, the biological variables are highly interconnected. Furthermore, the clusters of food production and food consumption are strongly related to physiological variables in comparison to their relationship with the physical activity clusters.

Figure 2 Reduced version of the Obesity System Map. Eight dimensions and central engine.



Source: Finegood et al. Implications of the Foresight Obesity System Map for solutions to childhood obesity. 2010. The Interactive version of the Obesity System map is available at http://www.shiftn.com/obesity/Full-Map.html

Next chapter: As the above conceptual framework has shown, there are a variety of definitions and approaches in the fields of ethnicity and childhood obesity. The next chapter shows how these have been applied in research within the five countries of interest to study ethnic differences in childhood obesity. The following is a systematic review investigating the prevalence of childhood obesity, the definitions and methods used in relation to ethnicity, and the interpretation of results provided by researchers.

Chapter 3 A systematic review of ethnicity-based approaches to analysing childhood obesity in Colombia, contrasted with Mexico, Brazil, Canada and the United Kingdom

The WHO lists childhood obesity as among the most serious global public health challenges of the 21st century. The effect of childhood obesity on adult health is well documented not only because of its strong association with chronic diseases in adulthood but also because of its medical and psychosocial consequences in children (Lakshman et al., 2012). Upper- and middle-income countries present the highest prevalence of childhood overweight, which is more frequent in economically disadvantaged populations within these countries (Hu, 2008, Roberts et al., 2012, Ogden et al., 2011, Zilanawala et al., 2014). However, although developing countries tend to have a lower prevalence of obesity and overweight in the general population, childhood obesity has increased sharply in these areas over the last two decades (Filozof et al., 2001). Within Colombia, underweight coexists with obesity (Kasper et al., 2014, Uauy et al., 2001); although obesity continues to be more prevalent among high-income households, it is also increasing rapidly among lower-income households (Parra et al., 2015a).

Differences in childhood obesity by socioeconomic status are well documented (Stamatakis et al., 2009, Zilanawala et al., 2014, Krieger et al., 2010, Armstrong et al., 2003). However, other exposure variables, such as ethnicity and race, have been less comprehensively studied (Marmot et al., 2013). One reason for this could relate to the ways in which ethnicity data are collected and interpreted. A number of issues regarding the collection of information about ethnic groups have been raised in studies of health inequality and ethnicity (Organization, 2010, Saunders et al., 2013). In particular, the Economic Commission for Latin America and the Caribbean (ECLAC) has repeatedly drawn attention to the lack of ethnic information in national health records, which results in the invisibility of ethnic groups, especially Indigenous and African-Caribbean descendants (Antón and Del Popolo, 2008, Del

Popolo, 2008). Thus, policy and interventions targeting these populations are not based on robust evidence related to prevalence and causality.

For most South American countries, ethnic codes were first included in censuses two decades ago. For instance, in Colombia, the current system of ethnic categorisation was initially included in the Colombian census of 2005 and then in subsequent national health surveys. Two national surveys of nutritional health were conducted in 2005 and 2010 (ENSIN surveys). These surveys involved a nationally representative sample of people aged 0–64 years and asked a comprehensive set of questions pertaining to nutritional status assessment, cardiovascular risk factors, breastfeeding practices and food safety. Both surveys constitute a milestone in obesity research in Colombia due to their potential to reveal obesity rates and risk factor burdens, both in the overall population generally and in various subgroups more specifically. One of the primary aims of the ENSIN survey is to evaluate the social and environmental determinants associated with nutritional status; the Colombian government expects to consult academic bodies working in a wide range of fields to inform health policy making.

Comparing and contrasting the ways in which other ethnically diverse countries such as Mexico, Brazil, Canada and the United Kingdom have tackled the issue of childhood obesity, along with the approaches they have used to do so, can provide additional insight into the prevention, treatment and healthcare delivered to children who are or at are at risk of becoming obese; accordingly, the results of such comparisons can be used to inform policies designed to tackle childhood obesity.

This systematic review follows an *a priori* protocol based on Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols (PRISMA-P, 2015) (Shamseer et al., 2015). However, as this systematic review focuses on the use of ethnicity-based approaches for a specific health outcome rather than on evaluating therapeutic efficacy, it was necessary to further develop the protocol using additional literature, guidelines, and lessons learnt about the ethnicity variables in the census and national health surveys in each country of interest. This document was compiled in accordance with PRISMA-P 2015 (Moher et al., 2015).

3.1 Aim and objectives

Aim: To systematically review the use of ethnicity-based approaches in childhood obesity research in Colombia, contrasted with those in Brazil, Mexico, Canada and the United Kingdom.

Objectives: To identify, compare and contrast:

1. the categories of ethnicity used in the literature, and those used in the 2005 National Colombian Census, with those used by researchers in Mexico, Canada and the United Kingdom;
2. the data on childhood obesity and adiposity by ethnicity available in Colombia, Brazil, Mexico, Canada and the United Kingdom;
3. the variation in childhood obesity and adiposity by ethnic group in Colombia, Mexico, Brazil, Canada and the United Kingdom;
4. the explanations presented by researchers for ethnic variations in childhood obesity and adiposity; and
5. the interventions proposed by researchers in light of those variations.

3.2 Review methods

3.2.1 Eligibility of studies

I first identified population-based studies, both published and unpublished. The eligibility of these studies was evaluated on the basis of study design, age group, outcome, ethnicity and country of interest. Box 3 summarises the inclusion and exclusion criteria.

Box 3 Inclusion and exclusion criteria		
Aspect	Inclusion	Exclusion
1.Study design	Cross sectional or cohort studies	Trial, case control, animal studies and studies made in people in institutions and clinic population
2. Age group	Studies including population less than 18 years of age	Studies focused on adult ages only
3. Outcome	Childhood obesity and adiposity	Childhood obesity and adiposity not reported
Aspect	Inclusion	Exclusion
4. Ethnicity	At least comparisons between two ethnic groups	Studies in one ethnic group, migrants from countries of interest

Aspect	Inclusion	Exclusion
5. Country of interest	Studies including Colombia, Brazil, Mexico, Canada or the UK	Studies not considering these countries
Other	Published and unpublished original research	Ineligible form of publication
	--	Those studies retrieved that not meet all of the above criteria

(Continued, Box 3)

3.2.2 Inclusion criteria

1. Study design: My aim was to retrieve original research investigating the prevalence of childhood obesity and overweight or analysing adiposity measurements by ethnic groups. A cross-sectional design is the most suitable study design for use in obtaining information about the quantification of disease in a specific place and time (Bhopal, 2008). Therefore, I only included cross-sectional studies and those study designs that were cross-sectional in principle: for example, cohort studies that could be seen as cross-sectional in the initial stages, or those reported as national health surveys or health registries. I also included cross-sectional studies undertaken in school settings because of their relevance to childhood obesity research.

2. Age group: I included all studies reporting childhood obesity and adiposity in people less than 18 years of age (<18y). As authors tend to report the age span in many ways, I included papers recording expected variations in reported age categories: i.e. early childhood (birth to eight years), middle childhood (eight to twelve years) and adolescence (twelve to eighteen years). These categories also include subcategories labelled according to stages of child development: infants, toddlers, pre-schoolers, young teens, teenagers, girls and boys (WHO, 2005).

3. Outcomes: I included any study that presented information about obesity and overweight or adiposity measurements. While researchers define obesity in a number of different ways, this is most commonly done on the basis of growth charts. Within the countries of interest, the most common growth charts and definitions of obesity I expected to encounter were the IOTF, WHO Child Growth Standards, British 1990 growth reference (UK90) and CDC charts; the latter are more frequently used by

researchers from Mexico and Colombia. In addition, I considered all available methods of body composition assessment; for instance, those related to weight, such as waist circumference, waist-to-hip ratio, skinfold thickness, bioelectrical impedance analysis (BIA), along with other adiposity indexes and studies that use methods such as densitometry, air displacement, dilution method and dual energy X-ray (DXA) (Hu, 2008).

4. Ethnicity: In order to explore comparisons within and between ethnic groups in each country, I selected studies that compared two or more ethnic groups. While considering the heterogeneous ways in which ethnicity is evaluated in the countries of interest, this systematic review was performed on the basis of the broad definitions of ethnicity and race proposed by Fenton (2010) and Bhopal (2014). Thus, I included studies that addressed any category related to ethnicity and race, such as ethnic group (e.g. Indigenous, Gypsy); country of origin, geographic origin (e.g. South Asian), skin colour (e.g. White) and mixed categories. The definitions of race and ethnicity on which this study was based are the same as those outlined in chapter 2, section 2.1.

5. Countries of interest: This systematic review sought to compare and contrast Colombia with Brazil, Mexico, Canada and the United Kingdom.

6. Language: There were no language restriction since it was expected that the articles would be written in English, Spanish and Portuguese language due to the country of origin, and I have reading proficiency for these languages.

7. Other: In addition to original research articles, I also included doctoral theses and technical reports from governments and international organisations.

3.2.3 Exclusion criteria

Studies were deemed ineligible on the basis of their form of publication, study design, country of study, age group, outcome and ethnicity-relevance.

1. Study design: Firstly, I excluded studies that did not provide prevalence of childhood obesity or childhood adiposity description, along with those conducted among people in institutions (e.g. military adolescents and children enrolled in special nutritional programmes) and studies analysing the prevalence of childhood obesity or adiposity measurements in children with any medical condition affecting growth and nutritional status. The ineligible study designs were classified into five categories: trial study, case control study, animal study, people in institutions and clinical population.

2. Age group: I did not include any study that focused only on adults (≥18 years of age).

3. Outcome: Even if other criteria were met, I excluded studies that did not report measurements of childhood adiposity or obesity, as mentioned above.

4. Ethnicity: Even if other criteria were met, I was interested in studies that compared ethnic groups within countries of interest. Accordingly, I excluded studies carried out on a single ethnic group. I also excluded studies comparing an ethnic group of interest with a different ethnic group living in another country (e.g. Mexican Mestizos living in Mexico with Mexican migrants living in the United States). Another excluded group was that of studies comparing two ethnic group settlements located in two or more countries. For instance, South America and North America have Indigenous peoples located in both countries, generally at the borders (e.g. North American Aboriginals living in Canada and the United States, or specific indigenous settlements located in the borders of Ecuador and Colombia). These studies were excluded because they did not compare two different ethnic groups living in the same country of interest.

5. Country of study: Any study that did not consider population from Colombia, Brazil, Mexico, Canada or the United Kingdom was deemed ineligible.

6. Others: Ineligible forms of publication, irrelevant studies, and any form of publication not reporting original research. The ineligible forms of publication were classified into six categories: letters to the editor, conference abstracts, technical notes, commentaries or editorials, expert clinical view reports, and book reviews/review articles.

6b. Not relevant studies: Finally, I assigned studies that did not meet most of the criteria to the 'not relevant' exclusion category.

3.2.4 Information sources

I searched for published and unpublished studies without language or timeframe restrictions. The information sources used to locate studies of interest were principally electronic databases, pages from ministries of health or national statistics, and other potentially relevant internet sources (e.g. national and international organisations).

Searching was conducted through MEDLINE, EMBASE, Global Health (CABI), the World Health Organization Library database (WHOLIS), and the Latin American and Caribbean Health Sciences Literature (LILACS). MEDLINE and EMBASE are well known for being the principal sources used to search for topics related to biomedicine. Both databases are complementary and the combination thereof has been widely recommended (Kelly and St Pierre-Hansen, 2008, Dunikowski, 2005, Wilkins et al., 2005). On the other hand, MEDLINE has been found to yield better performance than other databases (EMBASE included) in searches for the topic 'Aboriginal' (Kelly and St Pierre-Hansen, 2008), which is an additional strength for this systematic review. Both databases were accessed at the University of Edinburgh Library via the Ovid search engine. MEDLINE was accessed on 10 June 2017 and EMBASE on 12 June 2017.

I selected Global Health (CABI) for a number of reasons. First, this database covers more information from developing countries, and is therefore complimentary to databases such as MEDLINE and EMBASE, which are dominated by North American and European content (Aalai et al., 2009). My research included three

developing countries, namely Colombia, Brazil and Mexico (World Bank, Countries and Economies, current 2016 fiscal year). Second, despite being well known for covering infectious diseases, parasitology and tropical medicine, this database additionally covers subject matter including nutrition/obesity and public health. Third, it also includes unique material, meaning that the chance of overlap with MEDLINE is lower. Fourth, I am interested in published and unpublished material, and this database incorporates grey literature (e.g. dissertations, annual reports), making it very useful for my purposes. CABI was accessed at the University of Edinburgh Library via the Ovid search engine on 12 June 2017.

WHOLIS is a free access database that encompasses the '…collective electronic memory for all World Health Organisation (WHO) documentation' (WHO website, Searching the WHO Library Database (WHOLIS) July 2015). This enables the retrieval of government body documents and individual records for articles in WHO periodicals. WHOLIS was accessed at the University of Edinburgh Library via the Global Health library-IAHx engine on 10 June 2017.

LILACS (Abbreviation of Portuguese *Literatura Latino-Americana e do Caribe em Ciências da Saúde*, i.e. Latin American and Caribbean Literature on Health Sciences) is a free-access database that indexes more than 600 journals from the Latin America and Caribbean region. It allows for searching in three languages (English, Portuguese and Spanish). There are two major advantages to using this database: first, most of the papers from the Latin America and Caribbean region are indexed in this database only; second, it also includes masters and doctoral theses, allowing me to cover more grey literature from Latin America (Clark and Castro, 2002). LILACS was accessed by the Virtual Health Library (VHL), BIREME via the iAH engine on 15 June 2017.

3.2.5 Search strategy

Following the scoping reviews conducted in previous thesis chapters, I created a list of search terms. The search terms and search strategy were discussed with my supervisors and the librarian allocated by the university programme. It has been documented that success in using the LILACS database is associated with the ability

to carry out a search in languages spoken in South America (Kwon et al., 2014). Given that Spanish is my native language and I also have proficiency in written Portuguese, I translated the search terms into these two languages (Portuguese terms were validated by a native Portuguese-speaking health professional) (see Appendix B: Search terms).

The complete list of search terms used is as follows:

Population: those related to childhood years, from birth to adolescence

Outcome: those related to childhood obesity

Exposure variable: generic and specific terms related to ethnicity and race

Contextual factors: those related to settings – Colombia, Brazil, Mexico, Canada and the United Kingdom – and type of study.

Based on this list, I used the following search terms in the database search:

- Population (separated by Boolean operator 'OR'), to be combined (using 'AND') with
- Generic terms of exposure variable (separated by 'OR'), to be combined (using 'AND') with
- Outcome terms (separated by 'OR'); to be combined (using 'AND') with contextual factors.

As appropriate, I also used truncation or 'wild card' symbols to search for alternative spellings, especially for those specific terms related to ethnicity and race (e.g. African-descendant was searched as 'Afr* adj2 descen*' and pre-schoolchildren was searched as 'pre$school') (Appendix B: Searching strategy in five databases).

3.2.6 Data management

All records I obtained from the databases were stored as a '.txt' file and imported into EndNote (Endnote X7). I created a master library backup and backed up the database every 12 hours during the screening process. Duplicate records were initially removed using the EndNote 'find duplicates' tool, while the remaining duplicates were removed manually during the screening phase. Each study was allocated an ID made up of the lead author's surname, date and country under study. I stored eligible studies in EndNote separately from non-eligible studies. Ineligible

studies were stored into separate subgroups that were labelled according to the exclusion criteria.

Regarding ethical issues, this is a systematic review of literature which was considered as Level 1 according to the University regulations, in other words, that "the study does not present any complex ethical issues and does not require further scrutiny" (Research Ethics Subgroup, Centre for Population Health Sciences) (Appendix B. Self-Audit Checklist for Level 1 Ethical Review)

3.2.7 Selection process

Each study was assessed against eligible and non-eligible criteria in three phases: title and abstract screening, first full-text screening and second full text screening. The full text was screened twice in order to identify two sets of papers for the narrative synthesis, as follows:

-those papers stating the use of ethnicity as a primary variable, and

-those papers stating the use of ethnicity as a covariate.

Finally, I decided to include the studies with ethnicity as a primary variable in my narrative synthesis, as this set of papers allowed me to access more detailed information with regard to my objectives.

Difficulties assessing full texts were resolved by discussion with both supervisors.

3.2.8 Quality assessment

The quality of the individual studies was assessed using an adapted version of the Quality Assessment Tool for Quantitative Studies (QA Tool) (2003)(Thomas et al., 2003) and additional literature on the topic, as discussed in the following quality assessment criteria.

Selection bias

-'Are the individuals selected to participate in the study likely to be representative of the target population?' Individuals may not be representative if they are referred from a source (e.g. clinic) in a systematic manner (scored 'N', No) or self-referred (scored 'N', No). Moreover, participants are more likely to be representative of the

target population if they are randomly selected from a comprehensive list of individuals in the target population (scored 'Y', Yes) (Adapted from QA Tool).
-'Is the percentage of selected individuals who agreed to participate higher than 60%?' This refers to the acceptable percentage of subjects that agreed to participate in the study (scored 'Y', Yes/ 'N', No) (Adapted from QA Tool).

Ethical approval

If applicable, reporting of ethical approval and informed consent being obtained was considered an indication of higher quality. If these details were mentioned elsewhere, I sought to examine the original source.

-Was ethical approval obtained?
-Was informed consent obtained?

Ethnicity definitions

The presence of detailed definitions of ethnic and racial codes, as well as of childhood obesity could be an indication of higher quality (Lee, 2009, Bhopal, 2004, Kaplan and Bennett, 2003b). 'In particular, I looked for the author's statements regarding the following information:

- the reason for using ethnicity as a study variable;
- the way in which individuals were assigned to ethnicity categories;
- the reference of ethnic codes; and
- the limitations and weaknesses of using those ethnic codes.

3.2.9 Data collection methods

Tools for primary outcome measures must be described as reliable and valid. I included a question related to valid sources from which data may be collected. Self-reported data is a less valid source for collecting information on body composition (e.g. completing a questionnaire, a survey, answering questions during an interview, etc.) (Elgar and Stewart, 2008). I also included a question related to whether a reliable system for measuring adiposity had been established, i.e. whether the assessment/screening process includes objective data that are retrieved by researchers

(e.g. anthropometric measurements). The reliability and validity of methods used can be reported in the study or in a separate study. Questions screened were as follows:

- Are the measures made by the researchers?
- Did the authors use objective measurements?
- Is the childhood adiposity definition based on well-known international growth charts?

3.2.10 Data extraction

Data extraction was conducted using six data extraction forms created in Excel 2013. The information extracted was as follows:

1. Study characteristics: encompassing information about start and finish date, source of population, design and type of survey, aim of the study, target population, sampling, response rate, total number of subjects, and age span.
2. Quality assessment: quality assessment criteria based on the QA Tool
3. Ethnicity report: covering questions about what was expected from authors' reporting of ethnicity (Bhopal, 2004, Kaplan and Bennett, 2003b, Lee, 2009). Reasons for use of ethnicity as a primary variable, definition of ethnicity stated, way in which ethnicity information was collected (e.g. self-reported, parent's report), reference of ethnic categorisation, and redefinition of ethnic codes if applicable.
4. Methods and measures used to study childhood obesity and/or adiposity.
5. Quantitative results related to childhood obesity and adiposity by ethnic groups, encompassing a variety of analyses provided for BMI (categorical and continuous) and waist circumference or body fat.
6. Explanations and recommendations provided by authors when ethnic differences in childhood obesity and/or adiposity are identified. These recommendations are related to both interventions and future research.

3.2.11 Narrative approaches

The various studies set out to measure different outcomes related to childhood obesity and ethnic codes; accordingly, the study findings could not be compared quantitatively and a meta-analysis could not be performed. Findings were therefore

synthesised in the form of a narrative synthesis in line with the study objectives. The narrative synthesis was undertaken in stages based on Popay et al. (Popay et al., 2006) and took the following considerations into account:

1. An initial description of the results of included studies and an assessment of study quality. I interrogated the findings by exploring relationships between study characteristics, paying attention to what has been aimed for in regard to ethnicity, the study length, the influence of reference populations, settings, sampling and size.

   There are no official guidelines for judging the quality of reporting ethnicity; however, I followed what has been described in three references: 'Principles for research on ethnicity and health: the Leeds Consensus Statement' (Mir et al., 2013); 'Use of race and ethnicity in biomedical publication' (Kaplan et al., 2003; (Kaplan and Bennett, 2003b); and 'Glossary of terms relating to ethnicity and race: for reflection and debate' (Bhopal, 2004). Furthermore, all quality assessment criteria were analysed by establishing patterns in terms of the number of quality criteria met per study.
2. A description of the categories of ethnicity used by researchers and how they differ from those used in reference material such as censuses. I supported the analysis of ethnicity reporting presented in two main references: 'Use of race and ethnicity in biomedical publication' (Kaplan et al., 2003; (Kaplan and Bennett, 2003b), and 'Migration, ethnicity, race, and health in multicultural societies' (chapter 2; (Bhopal, 2014), which provides insights into the terminology and classifications used for migrants and ethnic and racial groups.
3. A description of the available quantitative information on childhood obesity by ethnicity, as well as a description of the variation in childhood obesity by ethnic group in each country of interest. I synthesised this information according to the nature of the results. Studies were organised to explore any differences in BMI, whether categorically or quantitatively. Measures of adiposity and body composition, such as waist circumference and body fat, were complimentary to the analysis of quantitative results.
4. Explanations and recommendations for interventions and future research. I organised this synthesis according to the dimensions of the Foresight Obesity

System Map (Finegood et al., 2010b, Butland et al., 2007). This model recognises obesity as a complex system of factors that interact with each other and exert positive and negative influences. The factors have been allocated to six dimensions, namely physiology, food production, food consumption, social psychology, individual psychology, physical activity environment and individual physical environment. This model allowed me to group the various factors discussed by the authors into these dimensions. Thus, I was able to observe gaps and clusters in relation to what the model proposes.

I also used the Angelo framework to classify these explanations and recommendations in relation to broad environmental categories, i.e. physical, economic, legislative and sociocultural (Sacks et al., 2012).

3.3 Results

As can be seen from the flow diagram in Figure 3, I identified 8,105 potentially relevant titles using electronic searches, along with one additional title from an official website of the Colombian Ministry of Health. Of these, 2109 titles were duplicates, leaving 5,997 titles for further screening. After title and abstract screening was complete, I was left with 318 full texts to be assessed for eligibility; of these, 277 full texts did not meet the inclusion criteria, leaving 41 full texts that were selected and included in the narrative synthesis.

There were studies analysing the same datasets (n=16). In this case, I included the most recent as a reference study. More than one study was taken into account just in case it reported relevant and unique information complimentary to the reference study (Appendix B: studies from repeated datasets not included in the narrative synthesis). Box 4 provides further information about the excluded studies.

Box 4 Excluded studies and reasons for exclusion

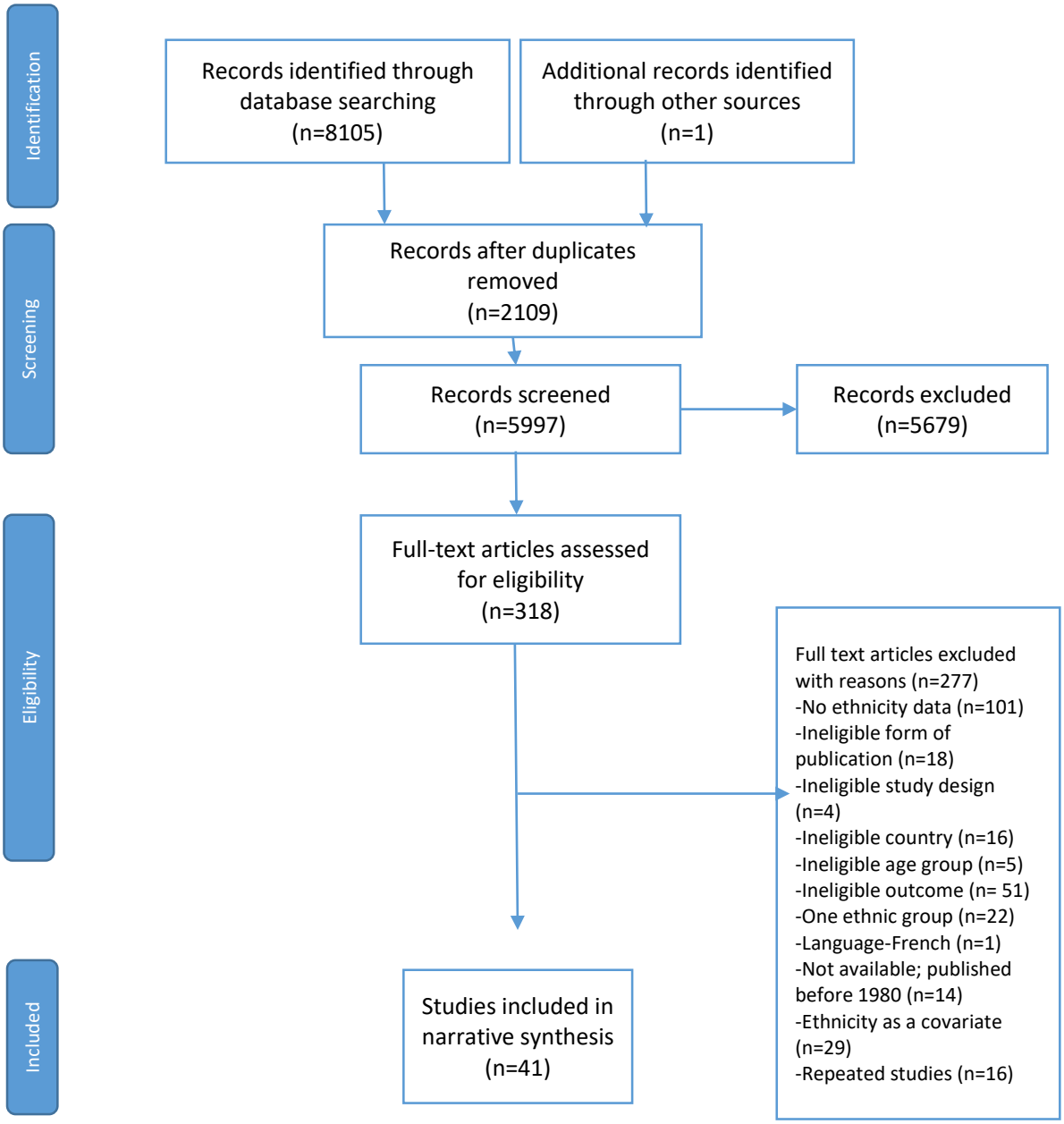
Childhood obesity research undertaken in a single ethnic group. 138 studies were carried out in only one ethnic group (120 excluded from abstracts screening and 18 from full text screening). More than half of these studies were from Brazil, followed by Canada, and Mexico. Five studies were from Colombia (one study on African-descendant population, the rest on indigenous peoples). The studies were mostly focused on indigenous peoples living in settlements (Brazil, Canada and Colombia) or comparisons between the same indigenous groups living in rural and urban settings (Mexico). The most common issue evaluated was nutritional status; however, there were a number of studies documenting comparisons of anthropometric indices of nutritional status and growth patterns/trajectories. The Colombian studies also examined relationships with breast-feeding and dietary habits. Research based on comparisons between ethnic groups is an usual approach; however, there is a room for discussion about the potential contribution of studies based on one ethnic group. For example, the study of anthropometric indices differences could enrich the evidence to develop child growth charts more accurately.

Ineligible countries. I retrieved 86 studies that almost met the eligibility criteria, except by the country (73 excluded from abstracts screening and 13 from full text screening). These studies were mainly from the United States. The common research topic was the body composition among 'Mexican-American' children living in the United States compared with Mexican children living in their country of origin. There were also common key-words within titles and abstracts related to genetic profile, food insecurity and built environment.

Grey literature. By using databases such as WHOLIS and LILACS I was able to retrieve Ph.D./Masters theses and official reports or working papers from international organisations and governments. I obtained 259 theses after titles screening. Of these, four theses were eligible for the full text screening phase. Although LILACS encompasses the academic production form all Latin America and the Caribbean, the source of these theses were Brazilian universities on the whole.

Other I retrieved 59 documents on advocacy, monitoring and evaluation among others that did not meet the whole exclusion criteria. However, these documents are relevant for the aim of the thesis and further examination, in due course, will be worthwhile. The Economic Commission for Latin America and the Caribbean (ECLAC) provided a large number of documents for these sets.

Figure 3 Adapted study flow diagram. Based on PRISMA-P. Studies retrieved till June 2017



3.3.1 Characteristics of the included studies

Most of the studies were conducted at the national level. The principal source of population data was national health datasets (n=12), while the main type of survey used was school-based surveys (n=16). Most of the studies were cross sectional (n=28), with the rest being prospective cohort studies. National health surveys provide data on a spectrum of issues affecting health; therefore, there are a number of

potential analyses that could be performed using this design that could benefit ethnicity research. Since childhood obesity is linked to interactions between multiple factors, such as lifestyle, I was expecting information to be available regarding a range of factors additional to ethnicity (results shown in Appendix C, 3.3.1 Characteristics of included studies, Table 3.3.1).

The majority of the studies, including the sole Colombian one, were aimed at determining body composition (n=14) or nutritional status (n=10) along with any other factor associated with childhood obesity. Nonetheless, these were centred around a few topics, e.g. risk factors for childhood obesity, age and sex. For instance, three studies were aimed at exploring ethnic differences according to risk factors such as physical activity, television viewing and diet (Harding et al., 2008b, Ng et al., 2010, Torre-Diaz et al., 2014) while six studies were aimed at determining nutritional status by socio-economic status and four targeted comparisons by sex and age (Dinsdale et al., 2014a, Ehtisham et al., 2005a, Shaw et al., 2007, Wardle et al., 2006a).

There was a lack of clarity in some of the aims with regard to the statements of exposure of interest and the study population. For example, there were aims related to exploring any outcome of childhood obesity by assessing 'some of its determinants' or 'sociodemographic variables' and 'certain/relevant populations' or 'sub-populations'. In addition, ethnicity as a subject of study was not explained in detail by several authors; overall, ethnic comparisons were explicitly mentioned in 20 out of 33 studies. Ideally, the research aims should be specific enough to help readers recognise both the author's intention and the orientation of the research.

The majority of studies used either a multistage, stratified and cluster sampling design or, in the case of school-based research, a randomised selection of schools and class groups. In the Colombian study, the authors reported no representativeness by ethnic groups. Moreover, some authors used alternative designs to sample specific ethnic groups. To illustrate, two out of four studies carried out in Brazil used special sampling: Diniz et al. (2008) used a proportional sample by ethnic group and locality

combined with an intentional sample based on school size (Diniz et al., 2008a), while Mondini et al. (2009) used a convenience sample that included all children present at the Indigenous settlement (Mondini et al., 2009). Other studies are based on oversampled specific ethnic groups (those who used data from the Health Survey for England, i.e. Karlsen et al. and Saxena et al. (Karlsen et al., 2014b, Saxena et al., 2004) or oversampled by setting or region with a known population of a particular ethnic group (Dinsdale et al., 2014a, Harding et al., 2008b, Taylor et al., 2005).

Within this selection of studies, Colombia had one of the largest samples (162,331 individuals). Most of the remaining studies were conducted with samples of between 5,000 and 11,000 individuals. Four studies were conducted with small samples (less than 150 children); these tended to be studies analysing indigenous peoples in Brazil and Mexico (Fagundes et al., 2004, Torre-Diaz et al., 2014). The higher response rate reported in the majority of studies demonstrates that ethnic minorities groups are willing to participate in research, meaning that the problem of valid recruitment could be related to methodological or logistical matters (Bhopal, 2014). The sample design and recruitment strategies suggested by these authors may be used by Colombian researchers.

3.3.2 Quality assessment of the included studies

The individual quality assessment for all studies is presented in Table 3.3.2, (see Quality assessment, Appendix C). The quality was higher among criteria related to data collection methods for childhood obesity and ethical approval than was the case for reporting of ethnicity. In this selection, 21 studies met the criteria for representativeness, while 14 reported response rates over 80%. All studies met all criteria pertaining to ethical considerations. Most of the studies were derived from national health surveys, which are usually carefully planned to ensure representativeness and high response rates. Those studies that failed to report failed to report on ethical considerations were mainly from Brazil (five out of six) and Mexico (three out of four).

The reporting of ethnicity was poor for two out of four domains. A statement regarding the reason for the use of ethnicity as an object of study and the way in

which ethnic codes were assigned was provided in between 75% and 80% of studies. In contrast, sources of ethnic codes were reported in 31% of the studies, while statements of limitations and weaknesses were made in just 18% of the studies. More than 80% of studies adequately reported the data collection methods used to measure childhood obesity. Quality assessment of the data collection methods was carried out in more than 80% of studies. Analysing by country, I found that the Colombian study had one of the better scores (9 criteria out of 12). All studies from Mexico, the UK and Canada, along with three from Brazil, also scored over seven, with four studies from Brazil scoring under seven criteria. It should be noted that this quality assessment is based on a checklist and does not provided detailed information regarding the aspects evaluated. A complementary analysis is presented in sections 3.3 and 3.4 of this document.

3.3.3 Categories of ethnicity used by researchers

The first objective of this review was to identify, synthesise and compare and contrast the categories of ethnicity used in the research, along with how they differ from those used in the 2005 National Colombian Census in comparison to Mexico, Canada and the United Kingdom.

The reason for using ethnicity as a study variable should be stated in order to evaluate whether or not the target population is being harmed. According to the Leeds Consensus Statement, the purpose of research on ethnicity and health should be for the well-being and betterment of populations being studied (Mir et al., 2013).

Ethnicity reporting was heterogeneous within the studies (See Table 3.3.3, Appendix C). Reasons were mentioned in most of the cases (n=33); however, these stated reasons were superficial in 10 studies, including the Colombian ENSIN survey. Moreover, six studies did not provide a reason for using ethnicity in relation to overweight/obesity, as occurred with the other Colombian study by Ortega-Bonilla et al.(Ortega-Bonilla and Chito-Trujillo, 2015), who evaluated schoolchildren in the state of Cauca. In general, among the studies that did not provide reasons to support the evaluation of ethnicity regarding overweight and obesity, the ethnicity variable was only one of many sociodemographic variables used to describe the distribution

of overweight and obesity. Statements considered ‘superficial’ were those general statements about ‘evidence of ethnic differences in health and the need to evaluate the outcome by ethnic group’ that were made without providing a comprehensive rationale linking ethnicity and the outcome under study. Genetic reasons were stated in five studies (four from Brazil and one from Canada), with surveillance and monitoring reasons cited in four studies.

Most of the ethnic groups were classified according to the methods used in censuses, including the Colombian study. The ways in which individuals were assigned to ethnic codes were stated in 26 studies. The assignment was conducted using a multiple-choice self-report question based on self-identification (n=14), either combined or not with a parent’s report (n=11). Observer assignment was used in one UK study (Chinn et al., 1998a), which combined it with the language spoken at home. Similarly, one Canadian study (Banerjee et al., 2015) asked about a second language spoken at home along with confirmation of surname origin.

The ways in which researchers from Mexico allocated ethnicity were not at all clear. Three out of four studies from Mexico were based on the Mexican National Nutrition Survey (carried out in 1998, 1999 and 2007), which asked about Indigenous language(s) spoken at home. When reporting results, Mexican researchers categorised respondents into Indigenous and non-Indigenous categories. One of the Mexican studies (Mendez et al., 2016) was more specific in the ethnicity categories employed, focusing on only one kind of Indigenous group/ancestry, Mayan (in comparison with half-Mayan and non-Mayan), defined on the basis of the parental surnames of the individuals. The regions in which this study was conducted, Merida-Yucatan, explains the specific approach adopted since this area used to be inhabited by the Mayan civilisation.

After self-report, the second most common method was country of birth of self, parents or grandparents (n=10). There were ethnic codes based on family origin (n=3, UK) and skin colour (n=5, Brazil). In addition to the two studies in Colombia, six studies used previously known Indigenous/Aboriginal status as a proxy for

ethnicity (four studies from Mexico, two from Brazil and five from Canada). Despite the debate around the impact of varying perceptions of ethnic identity on self-reporting of ethnicity, this approach is widely used, acceptable and accurate (Bhopal, 2014). Nonetheless, for political, economic or socio-cultural reasons, ethnic categories and perceptions can change over time. This implies that researchers should revisit the concepts and classifications they use and offer clear reasons for using specific approaches or systems of ethnic coding.

In all studies, I observed differences between the ethnic codes collected and the ethnic codes eventually reported. For instance, Colombian ENSIN researchers redefined the original five categories of ethnicity into three (Afro-descendant, Indigenous and general population). The other Colombian study by Ortega-Bonilla et al. (2015), used the same three categories, with the exception that general population was not reported. Instead of this category, Ortega-Bonilla et al. reported an ethnic category called 'Mestizo', a specific mix of White and Indigenous, which would cover most of the general Colombian population. Similarly, authors from the UK who used census categories (e.g. 1991 Census) redefined the original nine categories into six ethnic minority sub-groups, with the remaining ethnic groups being classified under the 'General population' category. By contrast, Mexican and several Canadian studies (n=4); (Anderson et al., 2010, Katzmarzyk and Malina, 1998a, Ng et al., 2010, Quon et al., 2012b) focused on the Aboriginal/Indigenous population, with the remaining ethnic groups being categorised as 'Non-aboriginal' or 'Non-indigenous'. However, Canadian studies from 2015–2016 (Banerjee et al., 2015, Razak et al., 2007, Rodd and Sharma, 2016, Tu et al., 2015) focused primarily on South Asian/non-South Asian, White/non-White, and South Asian/White comparisons. In most cases, the authors did not report whether the ethnic codes were redefined in respect to the original study (n=24), nor the source of ethnic categories used (n=18) or the justification for redefinition (n=9 out of 16 studies that reported redefinition). This presents additional evidence for the general lack of clarity around the reporting of ethnicity. For those who justified discussing statistical issues or simply reported on the basis of their interest in a determined ethnic group, granular ethnicity categories seemed to provide a better means of managing ethnicity

classifications. However, it has also been debated that granular categories are more prone to misclassification than others; further discussion on this subject is needed.

3.3.4 Definitions, methods and measurements for childhood adiposity and obesity

The second objective was to compare and contrast the available data on childhood obesity and adiposity by ethnicity in Colombia, Brazil, Mexico, Canada and the United Kingdom (See Appendix C, Table 3.3.4 for information about the child growth charts used to define childhood obesity along with the methods and the anthropometric measurements used in each study). Most of the studies used well-known child growth references for defining BMI z-scores and/or defining childhood obesity based on BMI cut-off points. Seventeen studies calculated z-scores by comparing them with specific growth charts. Of these, the UK 1990 was the most widely used growth chart for the calculation of z-scores; this was to be expected given that most of the selected studies were from the UK. Specifically, Colombia was the only country to use the WHO Child Growth Standards (slightly modified by the Ministry of Health), whereas the remainder used the WHO 2006/2007 (n=3), CDC 2000 (n=3) and NCHS/CDC (n=2). The above observations reveal a trend for countries other than the UK to base their analyses primarily on comparison with US growth charts. In other words, Mexico, Brazil and Colombia are not using reference populations theoretically close to their body composition.

Twenty studies used definitions of overweight and obesity on the basis of BMI. Among those studies, eight categorised overweight by additionally including cases with obesity. One of the studies in Mexico (Gonzalez-de Cossio et al., 2009) used weight-for-height specifically to define overweight since the entire sample of children were aged under five years. More than 50% of the studies (i.e. seven, two, one, and one in the UK, Mexico, Canada and Brazil, respectively) used the IOTF definition. In ethnically diverse countries, using the IOTF definition might represent an advantage, since this definition is derived from six countries' populations.

The studies used internationally accepted methodologies for the measurement of weight and height, and there is no description of alternative methods used by specific

ethnic groups. All studies that measured waist circumference used the same standard methodology, and no modifications to the technique were considered with regard to ethnicity. The measurement of height and weight are necessary in order to derive adiposity variables such as BMI or weight-for-height. Most of the studies (n=19) used electronic scales to measure weight; two studies reported the use of mechanical scales, while the other three studies did not report the type of scale used. Similarly, 19 studies used a stadiometer as tool for measuring height, with three studies reporting the use of a wood ruler or measuring board for children < 2 or < 3 years old. Measuring tape affixed to a wall was used in five studies. Only one study cited reports by parents as the source of weight and height variables (Quon et al., 2012). Moreover, methods in the De la Torre-Diaz study from Mexico (2014) were unclear, since the authors briefly mentioned a protocol without referencing it.

By considering either the categorical or continuous use of the anthropometric variables, 27 studies evaluated BMI, four weight-for-height, eight waist circumference, 11 skinfold thicknesses and 10 body fat percentage. One study in the UK (Nightingale et al., 2013) and another in Brazil (Ribeiro et al., 2009a) evaluated up to four of the above markers, while most of the studies used one (n= 14). Among studies evaluating body fat percentage, three studies (all in Brazil) estimated this marker by using skinfolds' equations, with three using bioimpedance (two in Brazil, one in the UK) and four using other methods (one in Brazil, three in UK) such as Near-infrared Interactance NIR (Sampei et al., 2003), dual-energy X-ray absorptiometry (Ehtisham et al, 2005; Shaw et al., 2007), and plestymography (Stanfield et al., 2012b). This later method consists of the estimation of body fat in relation to the air displacement in a chamber caused by the introduction of a subject.

Twenty-nine out of the thirty-two studies adjusted the association between adiposity markers and ethnicity for sex and age (statistical adjustment or stratification). Fewer than half (n=13) adjusted for additional covariates. Eight studies included covariates related to socioeconomic status, two evaluated covariates related to maturity status, one adjusted for migration status (generation) and one other for risk factors such as physical activity and TV watching. These numbers reveal a limited exploration of the

influence of relevant variables in the ethnicity-adiposity relationship among the selected studies.

3.3.5 Variation in childhood obesity and adiposity by ethnic group

The third objective chosen to compare and contrast was the variation in childhood obesity and adiposity by ethnic group in Colombia, Mexico, Brazil, Canada and the United Kingdom. This set of results is presented in three sections: prevalence of overweight and obesity, findings of BMI as a continuous variable, and findings of waist circumference as a continuous variable and body fat. (The Colombian study did not present findings for the latter two sections).

Prevalence of overweight and obesity

The ways in which researchers reported results for childhood obesity by ethnic group were not consistent. As all studies had their own aims and objectives (and sets of available data) and covered a range of different age spans. To facilitate comparisons among the studies, along with more cohesive presentation of the results, the below tables show the studies by country separately. Tables 5 to 9 present the prevalence of overweight and/or obesity by country. With the exception of six studies (Colombia [n=2], Mexico [n=1], Canada [n=1] and the UK [n=2]), confidence intervals for prevalence of overweight or obesity were not reported. Most of the studies from Colombia, Brazil and Mexico did not report prevalence by sex; however, all the studies from the UK took this stratification into account, with the exception of (Zilanawala et al., 2015).

Overall, the results suggested a differential distribution of overweight and obesity among ethnic categories. In general, these differences trended towards higher prevalence in ethnic minority groups, although the opposite pattern was observed in Mexico. In addition, marked sex differences for ethnicity regarding overweight/obesity were observed in studies from the UK.

In Colombia, for one study (ENSIN 2010) (Table 5), the comparison between Afro-descendant, Indigenous and ‘Other’ ethnic groups revealed a trend for lower

prevalence of overweight in the Afro-descendant group, both among young and older children. In particular, children aged <5 years from Indigenous ethnic groups showed higher prevalence of overweight and obesity than those from other ethnic groups, but lower prevalence of obesity in older children. In contrast, the other Colombian study by Ortega-Bonilla et al. (2015) described a slightly higher prevalence of overweight in Afro-descendant children in comparison with the Indigenous and Mestizo children, with the latter showing the lowest prevalence. However, this trend was not consistent with the prevalence of obesity in the same study, which was higher among Mestizo children. Neither of these Colombian studies provided information on the statistical significance of the differences reported. Beyond the above comparison of differences in overweight/obesity by ethnic groups in each Colombian study, it was noticeable a vast difference in the prevalence of overweight including obesity between the Indigenous groups from both Colombian studies (15.1% in the ENSIN 2010 vs. 3.5% in the Ortega-Bonilla et al.`s study). In fact, the much lower prevalence in the Ortega-Bonilla et al`s was not properly discussed by the authors. The setting in each study might explain the discrepancy in prevalence of overweight including obesity. Whereas the Ortega-Bonilla et al.`s study covered specifically schooled children from rural areas in only one of the 32 geographic states of the country, the ENSIN 2010 sampled individuals from both rural and urban areas covering the whole country. It might be possible that Indigenous Children living in Urban areas in the ENSIN account for more cases of overweight given the influence of urban food options and likely poverty conditions, and/or that rural schooled children are more physically active. Another potential explanation might lay on the fact that "Indigenous" is a category which although compiles ethnic groups sharing native ancestry have different cultural backgrounds that might differently impact body adiposity.

In Brazil, four studies reported the prevalence of overweight or obesity (Table 6). Three of these studies reported the overweight category by also including cases of obesity, while the remaining study reported only on obesity. The studies by Araujo et al. (2010) and Ribeiro et al. (2009) are comparable since they reported similar ethnic codes based on skin colour. While both studies found a non-significant statistical difference in the prevalence of obesity between White and Black populations, the

prevalence in the Araujo et al. study was 3.5 (White colour) and 2.7 (Black colour) times higher than that described by Ribeiro et al. This wide gap could be due to variations in sample size or age range, which were much higher in the Araujo et al. study. On the other hand, overweight, which was evaluated by Araujo et al. but not by Ribeiro et al., was more reported in children with White skin in comparison with other skin colours, including Black. Furthermore, the results of Monteiro et al. (2010) accorded with the higher prevalence of overweight among White children found by Araujo et al. and among females by Ribeiro et al. (2009). However, Monteiro et al. (2010) reported a more marked gap in respect to the same prevalence in the other comparison groups (Brown and Black colour children) (18.2% vs 9.4% and 8.0 %).

Table 5 Prevalence of overweight and obesity in the Colombian studies

Study ID	Ethnic codes	Age (years)	Total study population (*n*)	Overweight		Obesity		Overweight including obesity	
				%	95%CI	%	95%CI	%	95%CI
ENSIN 2010	Indigenous	0 to 4*	2353	27.4	23.8 - 31.3	6.8	5.2-8.8	--	--
	Afro-descendant		1972	18.1	16.2 - 20.2	4	3.1-5.1	--	--
	Other		13204	20.1	19.2 - 21	5.3	4.8-5.8	--	--
	Indigenous	5 to 17	6130	15.1	13.2 - 17.1	1.6	1 - 2.2	16.7	14.7 - 18.8
	Afro-descendant		5424	11.7	10.6 - 12.8	3.5	2.9 - 4.1	15.2	13.9 - 16.5
	Other		37981	13.6	13.1 - 14	4.3	4 - 4.6	17.9	17.3- 18.4
Ortega-Bonilla 2015	Indigenous	4 to 19**	3197	3.5	--	0.1	--	3.6	--
	Afro-descendant		356	4.5	--	0.3	--	4.8	--
	Mestizo (Indigenous + White)		3111	2.8	--	0.6	--	3.4	--

*: Overweight/obesity based on weight-for-height. ** Prevalence are not provided by the article but could be calculated from frequencies shown in the article.

Table 6 Prevalence of overweight and obesity in studies from Brazil

Study ID	Ethnic codes	Age	Total population (*n*)	Overweight (including obesity)%	Obesity %	
Mondini 2009	*Aruak*	<1	52	10.64	--	
		1 to 5	71	2.86	--	
		6 to 10	78	10.26	--	
		0 to 10	201	7.69	--	
	Karibe	<1	68	15	--	
		1 to 5	85	3.61	--	
		6 to 10	116	7.76	--	
		0 to 10	269	8.11	--	
Araújo 2010	White	11 to 19	23647	25.3*l	8.2	
	Black		7607	22.2	8.1	
	Brown		23058	21.1	6.3	
	Yellow		2241	20.6	6	
	Indigenous		2418	22.3	6.2	
Ribeiro 2009	White colour	6 to 11	900 (F=472, M=428)	--	(F) 2.7¥	(M) 2.3¥
	Black colour		543 (F=263, M=280)	--	(F) 0.7	(M) 2.9
Monteiro 2010	White	13 to 19	143	18.2		
	Brown		895	9.4		
	Black		50	8.0		

-- Not provided; ¥ p > 0.05; * p<0.05; λ: vs. the other groups; F: Female; M: Male

The studies from Mexico showed a marked trend for a lower prevalence of overweight, overweight including obesity, or obesity specifically in Indigenous children vs. non-Indigenous or Mestizo categories (Table 7). For instance, the non-Indigenous adolescents and young children evaluated by Bonvecchio et al. (2009) and Hernandez et al. (2003) respectively were over-represented in overweight (including obesity) categories, with 27.3% and 20.4.% of subjects, in comparison with 18.6% and 1.2.% in Indigenous children (Bonvecchio et al., 2009, Hernandez et al., 2003). This trend for lower prevalence in children categorised as Indigenous was evident throughout the different age ranges (<5, 5–11, and 12–18 years) evaluated in each study.

The above findings for Mexico contrast with Canadian studies, which reveal a marked trend for the higher prevalence of overweight and obesity among Aboriginal children. All Canadian studies reported on overweight not including obesity (Table 8); two of these studies additionally reported the prevalence of obesity. Age ranges were similar across the Canadian studies. Anderson et al. found a much higher prevalence of overweight or obesity in Aboriginal children in comparison with the 'Caucasian' or non-Aboriginal categories. In addition, Quon et al. (2012), who compared categories of migrant generations, described a higher prevalence of obesity in Aboriginal subjects (23.1% for children, 13.7% for adolescents), although statistical significance was not provided. In addition, Banerjee et al. specifically compared South-Asian and non-South Asian groups in Canada, finding a much higher prevalence of overweight and obesity in South Asian-descendant children.

Table 7 Prevalence of overweight and obesity in studies from Mexico

Study ID	Ethnic codes	Age (years)	Total population (n)	Overweight %	Obesity%
Bonvecchio 2009	Indigenous	12 to 18	3890	15 (13.63-16.8)	4 (3.2-4.7)
	Non-indigenous		29564	18.6 (17.9-19.4)*	8.7 (8.1-9.3)*
De la Torre-Díaz 2014	Mestizo	10.4±1.2	61 (F=29, M=32)	18*	21.3*
	Tarahumara	10 ± 2.0	50 (F=23, M=27)	10	6
Overweight including obesity					
Hernández 2003 Mexico	Indigenous	5 to 11	1151	12.1	
	Non-indigenous		9750	20.4	
Bonvecchio 2009	Indigenous	12 to 18	3890	19(7.2-20.9)	
	Non-Indigenous		29564	27.3 (26.4-28.2)*	
Gonzales-de Cossio 2009 D	Indigenous (1988)§	<5	445	4.8	
	Non-Indigenous (1988) §		6492	6.2	
	Indigenous (1999) §		834	5.8	
	Non-Indigenous (1999) §		7590	7.8	
	Indigenous (2006) §		861	5.5	
	Non-Indigenous (2006) §		6937	7.8	
De la Torre -Díaz 2014	Mestizo	10.4±1.2	61 (F=29, M=32)	39.3*	
	Tarahumara	10 ± 2.0	50 (F=23, M=27)	16	

-- Not provided; * p<0.05; D: overweight/obesity based on weight-for-height; §: year of survey; F: Female; M: Male

Table 8 Prevalence of overweight and obesity in studies from Canada

Study ID	Ethnic codes	Age (years)	Population (*n*)			Overweight %		Obesity %	
			Total	Fem	Male	Fem	Male	Fem	Male
Ng 2004	Aboriginal	12 to 17	198	--	--	41 (37.3-44.6)$^{\beta}$ *		17.7 (14.7 - 20.6) $^{\beta}$ *	
	Non-aboriginal		4448	--	--	29.8 (27.7 - 31.8)		9.7 (8.6 - 10.9)	
Anderson 2010§ ***	Aboriginal(Mat I)	9.9(1.1)10.9(1.4)SD	75	19	56	47	42*	--	--
	Caucasian(Mat I)	10.6(1.3)/11.7(1.3)	78	24	54	20	20	--	--
	Aboriginal(MatII)	12.6(0.9)/14.4(1.0)	58	39	19	25	25	--	--
	Caucasian(MatII)	12.6(1.0)/13.9(0.7)	70	41	29	20	6	--	--
	Aboriginal(MatIII)	14.9(1.5)/16.4(1.3)	65	42	23	50*	47	--	--
	Caucasian(MatII)	14.4(1.1)/16.1(0.9)	70	56	14	25	48	--	--
Quon 2012	1st generation	6 to 11	209	--	--	14.4	17.1	12.6	118.9
	2nd generation		601	--	--	11.1	16.1	15.4	17.8
	Mixed generation		975	--	--	14	13.1	13.1	16.4
	3rd generation		11730	--	--	15.2	16.8	14.8	19.1
	Aboriginal		772	--	--	18.1	18.4	19.9	23.1
	1st generation	12 to 17	175	--	--	18.6	11.1		12
	2nd generation		477	--	--	7.6	11.6	6	10.4
	Mixed generation		825	--	--	10.4	12.4	6	7.7
	3rd generation		10025	--	--	10.8	13.8	6.7	11.2
	Aboriginal		653	--	--	13.6	13.2	8.5	13.7
						All		All	
Banerjee 2014	South Asian	10 to 12	260	--	--	25.8		11.1	
	Non-South Asian		474	--	--	17.1		5.9	

-- Not provided; §: Results by categories of maturity; β: Confidence interval (95%); * p<0.05; ** p <0.05 for trend across ethnic groups;
*** Prevalence extracted from a graphic; λ: Vs. the other groups; SD: Means Standard Deviation

In the United Kingdom, all six studies in Table 9 reported the prevalence of either overweight or obesity, with overweight (obesity inclusive) reported in three studies. In general, the UK studies found a higher prevalence of overweight or obesity among ethnic minority groups. Moreover, throughout these studies, there appears to be a pattern by sex between ethnicity and overweight/obesity. In girls, overweight (including obesity) was more prevalent in Black-African or Afro-Caribbean ethnicity; by contrast, boys of Indian ethnicity showed a higher prevalence. Zilanawala et al. also found the highest prevalence of obesity in Black Caribbean and African ethnic groups in children aged five years from the MCS, although no stratification by sex was implemented in that study (Zilanawala et al., 2015). In addition, Wardle et al. (2006) and Dinsdale et al. (2014) (National Child Measurement Programme), whose studies are not listed in Table 9 due to their complex presentation of results in graphical form, reported time trends in prevalence of overweight and obesity. Wardle et al. found that Black girls had higher prevalence of overweight (including obesity) than White or Asian girls across annual examinations during five years of follow-up. Asian boys presented a higher prevalence of overweight in all years in the same study, although without reaching statistical significance. Meanwhile, according to the report from the National Child Measurement Programme, in Children of reception year there is an observable trend for higher prevalence (16-18%) of obesity in boys and girls of Black-African ethnicity between 2006 and 2012. In addition, a significant increase in the prevalence of obesity from 2007 to 2012 was seen in year 6 boys of White and Black African ethnicities, as well as in girls of White, Pakistani and Bangladeshi ethnicities. This latter observation emphasises that, despite marked differences in the prevalence of obesity for some ethnic groups when compared to White ethnic groups, all these groups exhibit parallel increases of obesity.

Table 9 Prevalence of overweight and obesity in studies from the United Kingdom

Study ID	Ethnic codes	Age (yrs)	Population (*n*)			Overweight %				Obesity %			
			Total	Fem	Male	Fem	95%CI	Male	95%CI	Fem	95%CI	Male	95%CI
Saxena 2004	Afro-Caribbean	2 to 20	695	373	322	33t	--	22.6**	--	13**	--	5.1**	--
	Indian		571	267	304	24t	--	29.6**	--	2.1**	--	7.9**	--
	Pakistani		894	458	436	25.7**	--	26.2**	--	8t	--	9**	--
	Bangladeshi		712	335	377	20.7**	--	14.2**	--	5.8**	--	2.8**	--
	Chinese		310	150	160	13t	--	14.4**	--	1.2**	--	4.7**	--
	Irish		641	337	304	25.6**	--	17.3**	--	8.3**	--	3.3**	--
	General population		1866	916	950	22.3**	--	21.7**	--	5.8**	--	5.8**	--
Harding 2008	White UK	11 to 13	1234	589	645	19.7	--	19.4	--	6.6	--	6.2	--
	White Other		720	318	402	20.4	--	22.4	--	6.9	--	9.2	--
	Black Caribbean		940	453	487	27.2*§	--	15	--	12.6*§	--	10.1	--
	Black African		1105	593	512	27.5*§	--	16.8	--	10	--	8.2	--
	Indian		491	218	273	20.6	--	18.3	--	4.1	--	7	--
	Pakistani/ Bangladeshi		628	222	406	17.6	--	19.5	--	4.1	--	8.4	--
	Mixed		566	279	287	24.4	--	20.9	--	8.6	--	8	--
Overweight including obesity %													
Taylor 2006	Bangladeshi	11 to 14ξ	587	267	320	29	22-36	34	28-40	14	10.0-19	20	16-24
	White British		538	267	271	37	31-44	36	30-43	25	20.0-32	22	18-27
	Black African		263	151	112	47	37-58	28	20-37	31	23.0-40	11	6.0-20
	Indian		242	139	103	35	26-44	47	39-55	20	14-27	26	18-34
	Pakistani		166	73	93	28	19-40	28	19-38	13	8.0-21	13	6.0-25
	Black Caribbean		145	73	72	38	29-48	36	24-50	20	12.0-31	21	13-32
	Other		541	280	261	37	33-41	41	35-47	24	19-25	21	17-26
	Bangladeshi		587	267	320	21	16-26	25	21-30	7	5.0-10	6	4.0-9.0

	White British	11 to 14 ð	538	267	271	32	26-40	27	21-33	11	8.0-15	7	5.0-11
	Black African		263	151	112	40	32-48	17	12.0-25	12	6.0-22	3	1.0-10
	Indian		242	139	103	27	19-38	36	28-45	11	7.0-15	8	5.0-14
	Pakistani		166	73	93	19	14-26	16	9.0-26	6	3.0-14	3	1.0-8
	Black Caribbean		145	73	72	34	26-44	24	15-36	10	6.0-19	11	6.0-19
	Other		541	280	261	30	26-34	29	23-35	12	9.0-16	9	5.0-15
Shaw 2007	South Asian	5 to 18	339	171	168	18.7	--	34	--	7		6	
	African-Caribbean		253	137	116	21.2	--	17	--	12.4* λ	--	12.9	--
	White		654	368	286	14.9	--	11.2	--	5.2	--	6.3	--
Balakrish-nan 2008	White European	5 to 7	13116	6460	6656	21.3	20.3-22.3	20.1	19.2-21.1	9.7	9.0-10.5	9.7	9.0-10.5
	South Asian		3025	1484	1541	18.9	16.9-21.0	30.9	28.6-33.3	11.1	9.5-12.8	16	14.2-17.10
	Afro-Caribbean		223	108	115	24.1	16.4-33.3	25.2	17.6-34.2	10.2	5.2-17.5	11.3	6.2-18.6
	Unrecorded		29641	6426	6851	18.8	17.9-19.8	19.3	18.4-20.3	9.1	7.4-8.8	9.2	8.5-9.9
										Obesity % (all)			
Zilanawala 2015	White	5	15003							5.5			
	Indian		518							4.7			
	Pakistani		926							6.5			
	Bangladeshi		376							10.7			
	Black Caribbean		487							11.4			
	Black African		459							11.1			
	Other		511			6.2		41	35-47	24	19-25	21	17-26

-- Not provided; ** p <0.05 for trend across ethnic groups; * p<0.05; λ: Vs. the other groups; §: Compared with White groups; ξ: UK90 definition; ð: IOTF definition;

3.3.6 Contrasting Colombian findings with the other countries

Findings from Colombia regarding overweight in the Afro-descendant ethnic group can be contrasted with those reported in the UK, where African-descendant ethnic groups (Black-African or Black-Caribbean) tended to be over-represented in overweight/obesity categories. The findings for overweight and obesity in Indigenous children aged < 5 years are also opposite to the trend found in Mexican children of the same age categorised as Indigenous in the Gonzales-de Cossio et al. (2009) study. Methodological variations could be behind this discrepancy, since the ENSIN 2010 used BMI and the Mexican study used weight-for-height as adiposity markers.

Table 3.3.6, Appendix C, complements the information discussed above by providing data on estimates of effect for the associations between overweight/obesity and ethnic groups. One study from Brazil, two from Mexico, two from Canada and four more from the UK performed logistical regressions to estimate these associations. Hernandez et al. (2003) found in Mexico that, compared with Indigenous children, non-Indigenous children had odds 1.86 times higher of overweight (including obesity), although this association did not persist after adjusting for zone of residence, socio-economic status, maternal schooling and age. Similarly, Mendez et al. did not find a significant association of overweight with being of half-Mayan or Mayan descendant (non-Mayan descendant as reference) in age-adjusted models in children aged 6-12 years. Balakrishnan et al. (2008) found a positive association of overweight (including obesity) or obesity with the South Asian ethnic category, but not with the Afro-Caribbean ethnic group, in models adjusted for sex and age. By contrast, Harding et al. reported a positive association of overweight or obesity with Black-African and Black-Caribbean ethnic groups, and not with South Asian ethnic groups (Indian, Pakistani), with the exception of children from the Bangladeshi ethnic group, who were more likely to be obese but not overweight. Partially in agreement with Harding et al. (2008), Taylor et al.'s (2005) study reported that children from the Black-African, but not the Black-Caribbean, ethnic group were more likely to be overweight (including obesity), but not obese. However, with regard to children from South Asian ethnic groups, Taylor

et al. found inverse associations between overweight (including obesity) and Indian or Pakistani ethnic groups. Meanwhile, the two Canadians studies that report effect estimates present inconclusive data: Banerjee et al. (2014) reported higher odds of overweight (including obesity) in South Asian-descendant children (vs. non-South Asian), which is generally in line with most of the British studies. However, the study by Rodd et al. (2016) showed lower odds of overweight in Canadian non-White children compared to White adolescents. It is likely that age range differences (which are much broader in the Rodd et al. study, at 3-19 years) between these two studies might explain the discrepant associations. Moreover, in contrast to the previously described trend for lower odds of overweight or obesity in White groups observed in the British studies, Monteiro et al. reported in their Brazilian study that White colour adolescents had a 1.82 times higher probability of being overweight than Brown colour adolescents. These authors did not find an association with Black colour skin when compared to Brown colour, while White and Black colour adolescents were not compared.

3.3.7 Body Mass Index as continuous variable

Appendix C, Tables 3.3.7a to 3.3.7c present findings from the studies that evaluated BMI as a continuous variable (including z-score) by country. The studies from Colombia and Mexico did not evaluate BMI as a continuous variable.

The four studies in Brazil listed in Table 3.3.7a (Appendix C) have heterogeneous ethnic codes, which hinders comparability. Despite finding higher values of BMI in girls of 'Caucasian' origin vs. Japanese origin, Sampei et al. (2003) did not find a significant difference for this observation. In line with this, Ribeiro et al. found similar values for BMI z-score in subjects with White and Black colour skin. Diniz et al. (2008) evaluated BMI values between children from three types of European origin across several age groups, finding minimal differences. In this study, the over-stratification by age does not allow for the inference of conclusive patterns, and only values for the lowest and highest categories of age are listed in the table. Interestingly, Fagundes et al. (2004) found differences for higher values of BMI z-score between two Indigenous cultures (higher in *Ikpeng* than in Indigenous people from Alto-Xingu).

The studies from Canada present inconclusive findings on ethnicity and BMI z-score as a continuous variable. The two studies in Table 3.3.7.b (Appendix C), as with observations for prevalence of overweight/obesity, show a trend for higher BMI or BMI z-score in Aboriginal children from both sexes when compared with 'Caucasian' or migrant categories (generations). In sharp contrast, Tu et al. found that Aboriginal ethnicity was associated with a decreasing BMI trajectory in comparison with White children during a follow-up from 0 to 14-20 years of age. Furthermore, Katzmarzyck et al. (1998) found comparable values of BMI between children categorised as 'First Nations' and those of European origin, although the sample size of this study was small.

In the five studies from the UK that evaluated BMI as a continuous variable (including z-score) in several ethnic groups, a similar trend emerged to that reported for the prevalence of overweight/obesity in the same country (Table 3.3.7c, Appendix C). Again, Black-African or African-Caribbean groups showed higher values of BMI or BMI z-score. However, there is no clear gender difference with regard to ethnicity, since two of these studies did not stratify by sex. Another two studies from the UK focused on specific comparisons between White vs. South Asian or Pakistani ethnic groups. Ehtisham et al. (Ehtisham et al., 2005a) found higher BMI in South Asian children from both sexes, although not a higher BMI z-score, whereas Henderson et al.(Henderson et al., 2011) reported comparable BMI and a non-significant difference in BMI z-score for the White and Pakistani groups. These opposite findings could be a result of differences in age ranges, as well as the grouped ethnic category used by Ehtisham et al. (2005).

3.3.8 Waist circumference as continuous variable and body fat

None of the studies in Colombia and Mexico evaluated waist circumference with regard to ethnicity. Table 3.3.8a, Appendix C, summarises data on waist circumference reported by two studies from Canada, one from Brazil, and six from the UK. All of these studies used the same standard methodology to measure waist circumference, with no modifications to the technique required with regard to ethnicity.

In Canada, Anderson et al. (2010) reported increased values of central adiposity in Aboriginal children from both sexes in comparison with a 'Caucasian' group across categories of maturity. Similarly, another study by Anand et al. (2016) in Canada found that South Asian-descendant new-borns had a higher waist circumference compared with Whites (Anand et al., 2016). In the studies from the UK, there was a common finding of lower waist circumference values in either South Asian children as a grouped category or in children from a specific place of origin within this geographical area (Pakistani, Bangladeshi or Indian) vs. White or other ethnicities; this is an opposite pattern to the above findings described in the Canadian studies. Only two out of the five UK studies included Black as an ethnicity code, and one of them found higher waist circumference in this ethnic group than in the White group. Meanwhile, Chula-Castro et al. in Brazil described comparable values and prevalence of waist circumference and abdominal obesity when children of White and non-White skin colour (Black/Brown/Yellow/Red) were compared.

Table 3.8b (Appendix C) summarises data for body fat percentage reported by five studies from Brazil and three more from the UK. In Brazil, the heterogeneous use of ethnicity codes or categories does not allow for general comparability. Lopes et al. (1999) and Diniz et al. (2008) did not find major differences in body fat percentage as a continuous variable when different European origins were compared. However, there was a higher proportion of female Brazilian children of Polish origin with high body fat in the Diniz et al. study; the same was true for male children of German origin in that study. Sampei et al. (2003) found higher body fat percentage in girls of Caucasian origin than in those from Japanese origin. Meanwhile, Ribeiro et al.

(2009) did not find significant differences in body fat percentage by skin colour (Black and White). Fagundes et al. (2004) found higher body fat in Indigenous *Ikpeng* children in comparison with Indigenous children from Alto Xingu. These results from each study are in line with those reported for the prevalence of overweight/obesity or BMI as a continuous variable, with the exception of Lopes et al. (1999), who only evaluated body fat percentage (Lopes and Pires Neto, 1999a). In the three studies from the UK, children categorised as South Asian presented a higher body fat percentage than White children.

Moreover, it is important to contrast findings on general (BMI and body fat percentage) and central adiposities (waist circumference) in these limited studies (one in Canada, four in the UK) with a simultaneous evaluation of these anthropometric markers. In Canada, in the Anderson et al. study (2010), the values for both BMI and waist circumference were consistently increased in Aboriginal vs. 'Caucasian' ethnic groups. In the UK, no clear pattern or trend emerges with regard to the predominance of central adiposity or general adiposity as an explanation for differences between ethnic groups. BMI z-score values were no different between children aged 7-11 years from Pakistani and White ethnic groups, whereas waist circumference (as mentioned above) was lower among Pakistani children. In the Ethtisham et al. (2005) study, children aged 14-17 years of South Asian ethnicity had higher BMI and waist circumference than those of White ethnicity. On the other hand, Nightingale et al. (2013) reported lower values in both adiposity markers for children 9-10 years old from the South Asian ethnic group when compared with the White ethnic group. This latter study found a higher body fat percentage in children of South Asian ethnicity.

3.3.9 Explanations for ethnic variations in childhood adiposity and recommendations for tackling these variations

The fourth and fifth objectives were to compare and contrast the explanations presented by researchers for ethnic variations in childhood obesity and adiposity, along with the interventions proposed by researchers in light of those variations. Table 10 summarises explanations and recommendations in public health interventions or health policy and their advice for future research, organised

according to the Obesity System Map dimensions and Angelo Framework components. The details of the explanations and recommendations discussed by the authors are presented in table 3.3.9, Appendix C, arranged in the same order of country and year of publication shown in previous tables.

Most authors reported explanations and recommendations on the basis of ethnic variations in childhood obesity and adiposity. Those who made such reports based their discussion on conceptual approaches rather than empirical evidence from their own data. For instance, the Colombian study neither explained ethnic variation of childhood obesity nor proposed specific recommendations for tackling it. Instead, the study made recommendations for the general population on improving diet and physical activity levels.

By using the Obesity System Map and the Angelo Framework to organise the information provided by the authors, I have identified a cluster of explanations and recommendations related to physiological aspects. For instance, most authors pointed out adiposity differences by ethnic groups, especially during puberty. Black or Afro-descendant/Afro Caribbean girls seem to have an earlier onset of puberty (around 10 years of age) (Lee et al., 2014). Differences in length of limbs were also debated for this ethnic group. Another recurrent topic in the physiology-related explanations was the higher metabolic risk and insulin resistance in South Asian groups (Stanfield et al., 2012; Nightingale et al. 2013); the UK studies developed a comprehensive analysis regarding these topics. Moreover, BMI was questioned by several authors in terms of the body composition differences between ethnic groups. For instance, Karlsen et al (2013), who analysed the Health Survey for England between 1998 and 2009, questioned whether there is a correlation between BMI and height; if so, overweight could be overestimated in taller groups (Black/African/Caribbean) and underestimated in shorter groups (Chinese boys and Bangladeshi girls).

In those studies that found ethnic differences in childhood obesity among Indigenous or Aboriginal groups, there are few explanations provided for this phenomenon. According to Ng et al. (2004), the highest prevalence of overweight found among Aboriginal youth could be attributed to the time they spent watching television (>15 hour/week, twice that of the baseline group), in addition to the lower prevalence of

physical activity participation, which was also influenced by obesity status. Researchers also identified lower household education among Aboriginal groups, which could reinforce other risk factors.

Less attention was given to food production or dimensions of individual psychology, either as recommendations for interventions to tackle childhood obesity or as recommendations for future research. On this subject, the most common topic discussed by authors was culturally appropriate interventions. There was also discussion about the challenges presented by ethnicity-focused research, particularly the methodological orientation of the studies; for example, the lack of research that seeks explanations more than description, the use of longitudinal approaches, and the need for more accurate sample design.

Table 10 Explanations, recommendations and future research issues discussed by researchers in relation to Obesity System Map and the Angelo framework

Explanations categories	Number of mentions		
	Explanations for ethnic differences	Recommendations for intervention	Future research
▪ Based on dimensions of Obesity System Map			
Food production	0	0	0
Food consumption	5	3	1
Social psychology	5	3	3
Individual psychology	1	0	0
Physical activity environment	2	2	1
Individual physical activity	1	4	1
Physiology	19	5	9
Energy balance	0	0	1
▪ Other explanation categories based on Angelo framework			
Economic environment			
Socio economic position /Household income/	2	3	2
Sociocultural environment			
-Family environment	4	1	0
-Culturally appropriate intervention	NA	6	1
-Racist victimization	1	0	1
-Violence	1	0	0
▪ Others			
Methodological			
-General mention of methodological orientation	4	2	4
-Body composition differences	4	0	3
-Obesity/overweight definition differences	0	NA	1

-Age and sex differences	0	3	1
Health behaviour (general)	0	0	2
Migration susceptibility	0	0	1
Environment intervention (no related to physical activity)	NA	1	2

NA: Not applicable

3.4 Conclusions

Approaches to studying ethnicity were considerably heterogeneous across the countries evaluated. Most of the ethnic groups were classified by the methods used in censuses, including the Colombian studies, and the ways in which individuals were assigned to ethnic codes relied primarily on self-reporting. In general, there was a lack of clarity regarding the reasons for using ethnicity as a study variable, the source for ethnic codes and any justification for redefining ethnic codes. The studies in Colombia focused on ethnic minority groups and reported childhood overweight and obesity among Indigenous, African-descended and general population (or Mestizo) groups only. Taking into account the experience from Canada and the United Kingdom, it could be desirable to consider a more granular classification derived from the general category if possible.

Available information on childhood obesity and adiposity by ethnicity in Colombia stands in contrast to that in Brazil, Mexico, Canada and the United Kingdom. There were only two references found in Colombia describing childhood obesity by ethnic groups: these were the ENSIN study, carried out in 2010, and the Ortega-Bonilla et al. study conducted in a specific geographical state of Colombia called Cauca, which is located in the Southwest and is characterised by a large population of Indigenous ethnic groups. Both Colombian studies analysed overweight and obesity based on cut-off points of BMI by age and three categories of ethnicity. As the information obtained from the Colombian studies is essentially descriptive, there is rationale for expanding this analysis in future by providing effect estimates and adjustments, as the following chapter will show. On the other hand, there were several studies of childhood obesity and adiposity available in the other countries of interest. For instance, most researchers from the latter four countries analysed childhood obesity in a variety of ways, often combining BMI and other measures of adiposity. The

most common covariates were sex and indicators of socioeconomic status. The process of maturity was an object of discussion given its relevance to the body fat distribution of adolescents, especially girls.

Most of the studies used well-known child growth references to define childhood obesity. The studies used internationally accepted methodologies to measure weight, height and waist circumference and there was no description of alternative methods used by ethnic groups. Furthermore, it should be noted that Colombia, Brazil and Mexico were not using reference populations theoretically close to their body composition. Among the Latin-American countries, only one study in Brazil evaluated waist circumference with regard to ethnicity.

There was differential distribution of overweight, obesity and body fat by ethnic categories across the studies from the five countries evaluated. In general, these differences revealed a higher prevalence of overweight in ethnic minority groups vs. White or general population categories, including Afro-descendant and Indigenous children from Colombia, although there were specific discrepancies. For instance, an opposite trend (of lower prevalence of overweight) was reported among Indigenous children (vs. non-Indigenous) from Mexico, likely due to increased levels of physical activity among Indigenous children In addition, the Canadian study by Tu et al.(Tu et al., 2015) found that Aboriginal children showed a decreasing trajectory in BMI values across their lifespan (infancy till adolescence) in comparison with White children; this finding stands in contrast to other Canadian studies, a fact that was not discussed by the authors. Meanwhile, marked sex differences for ethnicity regarding overweight and obesity were observed in studies from the United Kingdom.

Another observation worthy of note is the existence of opposite waist circumference patterns in similar ethnic groups situated in different countries, as occurred among South Asian descendants in Canada and the UK. Abdominal adiposity was higher in South Asian new-borns in Canada but tended to be lower in older South Asian children in the British studies. However, it is unknown to what extent the difference in age ranges might explain these opposite patterns, or whether the higher waist

circumference trend among the Canadian South-Asian new-borns could be modified at later age stages.

This systematic review mostly included research studies. Other kind of documents such as national reports or surveillance data were only included in the UK context, because the other countries of eligibility didn`t tend to provide this kind of information. Thus, strengths and limitations around the use of research studies must be discussed. With regard strengths, in comparison with reports, research studies tend to provide statistical adjustments to explore the influence of covariates in overweight and obesity estimates, while reports tend to be more descriptive than inferential. However, research studies can have a wide range of sample sizes and those with small samples have more uncertainness for prevalence estimates. In the same way, unlike reports, some populations evaluated in research studies belonged to specific and different areas or regions in the same country, being only locally representative, or even not representative when convenience samples in schools were used. This was particularly observed in the studies from Brazil. Both issues on sample size and representativeness make difficult to generalise the findings and patterns observed in the systematic review. In fact, the heterogeneity of the research studies leaded me to avoid planning any complementary or additional quantitative analysis such a meta-analysis and obtain biased pooled estimates. Therefore, a narrative synthesis of the studies selected taking into account their specific context was the best approach.

In terms of the explanations discussed by researchers for ethnic variations in childhood obesity and adiposity, along with the interventions proposed by researchers in light of those variations, most authors discussed ethnic differences in childhood obesity and adiposity on the basis of physiological issues. Ethnic differences in adiposity by ethnic groups were attributed to variations in the process of maturity, especially among Black/Afro-descendant/Afro Caribbean girls, who have an earlier onset of puberty. Researchers also discussed the lower socio-economic status among Aboriginal/Indigenous groups, which could reinforce other risk factors. Less attention was given to other aspects linked to childhood obesity,

such as food production or individual psychology. The recommendations for interventions and future research followed the same line of reasoning. Finally, there was no discussion about ethnic differences in the Colombian studies, given their lack of inferential approach.

Next chapter

The above systematic review of research from the five countries of interest has allowed me to develop a better understanding of the ways in which researchers have used ethnicity to study childhood obesity. However, I found that data from Colombia has not been analysed from a complex perspective, i.e. in a way that involves variables for describing the individual and the environment, as proposed by the Angelo framework and the Obesity System Map. Furthermore, analysis by ethnic groups was not primary to the objectives of either of the Colombian studies included. With this in mind, the next two chapters are concerned with understanding the relationship between childhood obesity and ethnicity in Colombia. The following chapter is an attempt to create a framework suitable for the Colombian context that takes aspects of the individual and the environment into account. This framework will guide the secondary analysis of Colombian data in the following chapter.

Chapter 4 A framework for understanding the relationship between ethnicity and childhood obesity in Colombia

4.1 Context

Results from the systematic review reported in the previous chapter demonstrated that there is little published research on ethnicity and childhood obesity in Colombia. I identified two studies: the report of the National Nutrition Health Survey (ENSIN 2010) and the study by Ortega-Bonilla et al. (2015) which included school children living in rural areas at the southwest of Colombia. The ENSIN study showed a higher prevalence of overweight and obesity among Afro-descendant and Indigenous children less than five years old than those observed for the general population in the same age group. Reasons for the variation in this prevalence were not stated. This report did not present the prevalence by other factors, such as sex, socioeconomic status or any other obesity-related factors (ENSIN 2010). However, the study by Ortega-Bonilla et al. (2015) showed a lower prevalence of excess weight by sex and three ethnic groups (Indigenous, Afro-descendant and Mestizo) and sex in children from 4 to 19 years of age. This was a descriptive study of the prevalence that did not assess specific age categories or other obesity-related factors.

Another conclusion derived from the systematic review was that researchers linked ethnicity and obesity predominantly through physiological factors. For example, authors offered explanations about differences in body composition by ethnic group, hereditary factors and genetic conditions that might predispose to childhood and adulthood obesity and differences in children development resulting in earlier onset of puberty with higher weight among Afro-descendant girls in this period. Therefore, the evidence on ethnic differences in childhood obesity beyond physiological factors remains not fully understood. There is room for further exploration of the effect of environmental, psychological and community factors in this relationship.

Keeping in mind the differences already reported in Colombia and the lack of information in this country regarding explanations for those differences, this chapter aims to understand the relationship between ethnicity and childhood obesity better by

unpacking the potential mechanisms operating in Colombia. I reanalysed discussions and explanations from papers included in the systematic review and reassessed relevant literature in childhood obesity to develop a conceptual model of these potential mechanisms in the Colombian context.

4.2 Aim and research questions

This chapter aimed to understand the relationship between ethnicity and childhood obesity better by answering the following research questions:

1. What are the main factors related to ethnicity involved in the development of childhood obesity in an ethnically diverse country like Colombia?
2. In what ways are these factors connected to develop childhood obesity in an ethnically diverse country like Colombia?
3. What are the potential pathways of factors linking ethnicity and childhood obesity in an ethnically diverse country like Colombia?

4.3 Approach to understand the relationship between ethnicity and childhood obesity better.

When researchers are studying causal relationships or potential predictors of the variation in health status, they might end up plotting their understanding of the possible connections between variables of interest using graphical models in which variables of interest (exposure variables) are interconnected and linked to determined outcome. The simplest structure connects two variables (i.e. exposure variable→outcome); however, using more than two variables could explain more complex relationships; this depends on the available evidence on the health event under study. These structures are linked using a Directed Acyclic Graph (DAG), which links variables. The simplest way to plot the relationship between a set of variables is seeing it as a causal structure (Pearl, 2009).

As the chapter aims to understand the relationship between ethnicity and variations of childhood obesity in Colombia better, I sought to study a wide range of framed obesity risk factors for childhood obesity, if available.

Due to further exploration and discussion with my supervisors, I became interested in DAGs to consider the complex dynamics between these risk factors. Although in principle related to mathematics, the use in epidemiology was extended to study causality (Robins, 2001) (Greenland et al., 1999). DAGs permit the identification of all potential paths to conceptualise a hypothesised cause-effect relationship.

For this study, DAGs serve the purpose of studying the potential causal paths between ethnicity and framed risk factors for childhood obesity in the specific context of Colombia. DAGs are not the only graphs to study a cause-effect relationship – there are other types of graphs, such as causal loops, which can reflect the complexity of a relationship under study. However, DAGs allowed me to organise the connections in the simplest way possible to understand the relationship of interest beyond the traditional considerations in epidemiology (e.g. exposure variable, outcome variable, confounders). This enabled me to seek other explanations, such as potential mediation and paths analysis, which I believe enhance understanding of a topic in epidemiology.

Components of a DAG

As can be seen in Box 5 (next page), DAGs have their own nomenclature. The DAG relationships are shown as arrows linking two or more variables (or nodes). As it is acyclic, the assumption is that there is no reverse link between variables. The nomenclature is useful to identify the order of variables in a path, reflecting the understanding and explanations offered by researchers about potential causal mechanisms. A kinship terminology is used to describe relationships between variables, they are called a parent, child or ancestor.

4.4 Methods

I developed a DAG of the potential factors linking ethnicity and childhood obesity in Colombia using the 2010 Colombian National Nutrition Survey (ENSIN 2010). The development of the DAG was an iterative process in which an initial version obtained from the literature review was discussed with supervisors and colleagues at scientific events on several occasions (Appendix poster presented at a conference).

Box 5 Terminology used in DAGs

DAG terminology	Epidemiology terminology for similar ideas
Ancestors	Distal causes
Back door pathway	Confounding variable(s) creating the association
Block/blocking	Eliminating an association through, for example, adjusting, stratifying etc.
Blocked path	An association that has been eliminated as it has been controlled for e.g. by adjusting for confounders
Blocking	Presence of confounding or selection bias
Child	Effect, outcome
Collapsibility	The measure of the association is not affected by removing variables in a model
Collider	a variable that is caused by both the exposure and outcome under study
Collider stratification bias	See M-bias
Conditioning	General term to include stratification, standardisation and adjustment in a model (conditioning means holding a variable constant)
Descendants	Effects on a potential causal path including mediators
D-connected	The postulated causal path is open (see open path and path)
D-separation or D-unconnected (directional separation)	The postulated causal path is closed
Endogenous selection	See M-bias
Identification	Analysis of associations to separate error/ bias/confounding from causal effects
M-bias	Berkson's bias/selection bias. It arises from, for example, adjusting for a collider (see above)
Nodes	Variables
Open path	Potential causal relationship, i.e. association
Parent	Proximate cause
Path	The route to potential causality, i.e. from A to B
Vertices	Variables

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4.4.1 Producing the DAG

To label and organise groups of variables (nodes) required by a DAG, I employed the seven thematic clusters proposed by the United Kingdom (UK) Foresight Obesity System Map (Butland et al., 2007). Although the framework was developed for researchers in the UK, I became interested in using it to analyse the Colombian case, as this approach incorporates most of the potential relationships between multiple factors at various levels of analysis (i.e. individual, environmental, and societal or cultural).

Furthermore, I was informed by the narrative synthesis of the systematic review reported in the previous chapter to establish the potential relationships between nodes. As there were two eligible studies from Colombia, I also included a subsample of five more Colombian studies exploring nutrition and childhood obesity in a single ethnic group to obtain more information on other potential risk factors for obesity documented in Colombia. This subsample was originally gathered for the systematic review, but the studies were not eligible for the narrative synthesis because they did not provide comparisons between groups.

I plotted my understanding of the relationship between factors following steps that have been suggested in the literature (Box 6) (Evans et al., 2012, Knueppel and Stang, 2010). These steps comprise background knowledge and statistics-based approaches to generate estimators for the cause-effect relationship. For the scope of this chapter, I did not estimate any quantitative estimator; instead. I followed three steps. First, I revisited the systematic review to select potential variables related to ethnicity involved in the development of childhood obesity in an ethnically diverse country like Colombia. Second, I reasoned about the way these factors connected to develop childhood obesity in an ethnically diverse country like Colombia. Third, I plotted the potential pathways of factors linking ethnicity and childhood obesity in an ethnically diverse country like Colombia.

Box 6 Steps to produce a DAG (Evans, Chaix, Lobbedez, Verger, & Flahault, 2012)

Drawing up a set of plausible background-knowledge DAGs:

1. Starting with one of these DAGs as a working DAG, identifying a minimal variable set, S, sufficient to control for bias on the effect of interest
2. Estimating a collapsible estimator adjusted on S, then adjusted on S plus each variable not in S in turn ("add-one pattern") and then adjusted on the variables in S minus each of these variables in turn ("minus-one pattern")
3. Checking the observed add-one and minus-one patterns against the pattern implied by the working DAG and the other prior DAGs
4. Reviewing the DAGs, if needed
5. Presenting the initial and all final DAGs with estimates

4.4.2 First step: a selection of risk factors from studies included in the systematic review

The study of risk factors for this research follows the classification proposed in the Foresight project through the Obesity System Map (McPherson et al., 2007). This framework presents all of the potential risk factors that influence each other to affect the energy balance that, eventually, results in the development of obesity.

This was based on Colombian studies retrieved in the systematic review: two studies included in the narrative synthesis and those not included with a relevant outcome and studying at least one ethnic group. Table 11 shows the variables extracted from each study and the potential links to be plotted.

Table 11 Data extraction from systematic review about risk factors and potential links connecting ethnicity and childhood obesity

Thematic cluster	Node	Potential link	Author
Social determinants of health	Education level	-Lower household education status among aboriginal population	Ng et al., 2004
	Kind of family	Indians were least likely than any other group to be in a lone parent household	Harding, 2008
Social psychology	Environment safety perception	Mestizo children less likelihood of playing outdoors	Torre-Diaz et al., 2014 Mexico
Individual psychology	Acculturative stress	First generation immigrants experience more acculturative stress, especially during adolescence	Quon et al., 2012
	Racist victimization	Experience of forms of racist victimization predisposes to higher BMI among adults (gap in children)	Karlsen et al., 2013
Obesity related behaviours			
Food consumption	Hypercaloric diet	-Mestizo children have a diet higher in saturate fat than Urban Tarahumara children - Novel sweet items were notably introduced to the diet of South Asian descendant children in Bradford	Torre-Diaz et al., 2014 Mexico; Balakrishnan 2008; Harding et al., 2008

		- Food consumption excess among Black Caribbean girls was associated with adverse adolescent behaviour	
Physical activity	TV watching	-Mestizo children spent more time indoors (vs Indigenous) -Aboriginal youth spent more time watching TV (vs non-Aboriginal)	Torre-Diaz et al., 2014 Mexico; Ng et al., 2004
	Environment	Participation in physical activity might have barriers for Aboriginal youth	Ng et al., 2004
Physiology	Subcutaneous Fat Distribution	Higher central distribution of fat in Native Americans	Katzmarczyk et al., 1998
	Non-transmissible chronic disease family history	South Asian adolescents have higher frequency of a positive familiar history of diabetes, high prevalence of having an affected parent	Ehtisham et al, 2005
	Development of adiposity	-Potential earlier development of adiposity in Black girls -Puberty might explain increased variability in BMI with Black African/Caribbean entering puberty earlier than other ethnic groups	Wardle et al., 2006; Lee et al., 2014
	Weight gain trends across childhood	Black UK children have the greatest infant weight gain.	Griffihs et al., 2011
	Metabolic sensitivity to adiposity	Physiological event still unclear but might reflect exposures differing by ethnic group operating in early life (South Asian vs White European)	Nightingale et al., 2013
Genetics/Epigenetics	Thrifty phenotype (reduction in fetal growth and chronic conditions later in life)	Epigenetic predisposition of Aboriginal women to Gestational Diabetes and high birth weight infants	Anderson et al., 2010
	Transgenerational effects	body composition differences in South Asian	Stanfield et al. , 2012

		off-spring appear to replicate those in mothers	
Maternal/Family environment	Meals habits	Indians were less likely to skip breakfast, suggesting a link with a family environment that protects against adverse dietary practices	Harding, 2008

(continued table 11)

4.4.3 Second step: studying risk factors for childhood obesity from the Foresight Obesity System Map

Despite the conceptualisation of obesity as a disease (Bray et al., 2017), for this research, I have used the term 'risk factors' to refer to those factors or variables grouped by clusters according to the Obesity System Map, including ethnicity and childhood obesity. It is not, however, my intention to study obesity as a disease, as I aim to understand the patterns of risk factors that might differ by ethnic group in affecting children's health. The clusters of risk factors are as follows: societal influences, food consumption, individual psychology, individual physical activity and physical activity environment (Finegood et al., 2010a, Butland et al., 2007). Accordingly, in this research, I have attempted to address the multifactorial nature of childhood obesity through the study of interconnections between multiple risk factors as long as this kind of data is available for Colombia.

Beyond biological conditions, contextual risk factors influencing individual health, such as food production and food security, were of particular interest for this research because of their potential links with the documented nutrition transition in Colombia via socioeconomic status (Porter et al., 2017, Popkin et al., 2012, Parra et al., 2015a, Ronto et al., 2018).

Ethnic differences in childhood obesity have been associated with lower socioeconomic status, low level of education, low income and disparities in healthcare access, not only in developing but also in developed countries (Nazroo, 2003, Almeida-Filho et al., 2004, Almeida-Filho et al., 2005, Almeida-Filho et al., 2003, Taveras et al., 2010). In Colombia, the social determinants of health have not

been studied robustly in a way that considers the connections between ethnicity and childhood obesity (Kasper et al., 2014, Agudelo-Suárez et al., 2016).

The food production node includes all sectors involved in the food industry, such as agriculture production, food processing and the foodservice sector (Porter et al., 2017). It also includes the external factors affecting their interdependences, such as the economic environment and the societal pressure for growth and profitability (Foresight Model, 2007)(Butland et al., 2007). All these factors might shape the dynamics within sectors and subsequently, the decisions made by consumers in terms of food choices and physical activity behaviours.

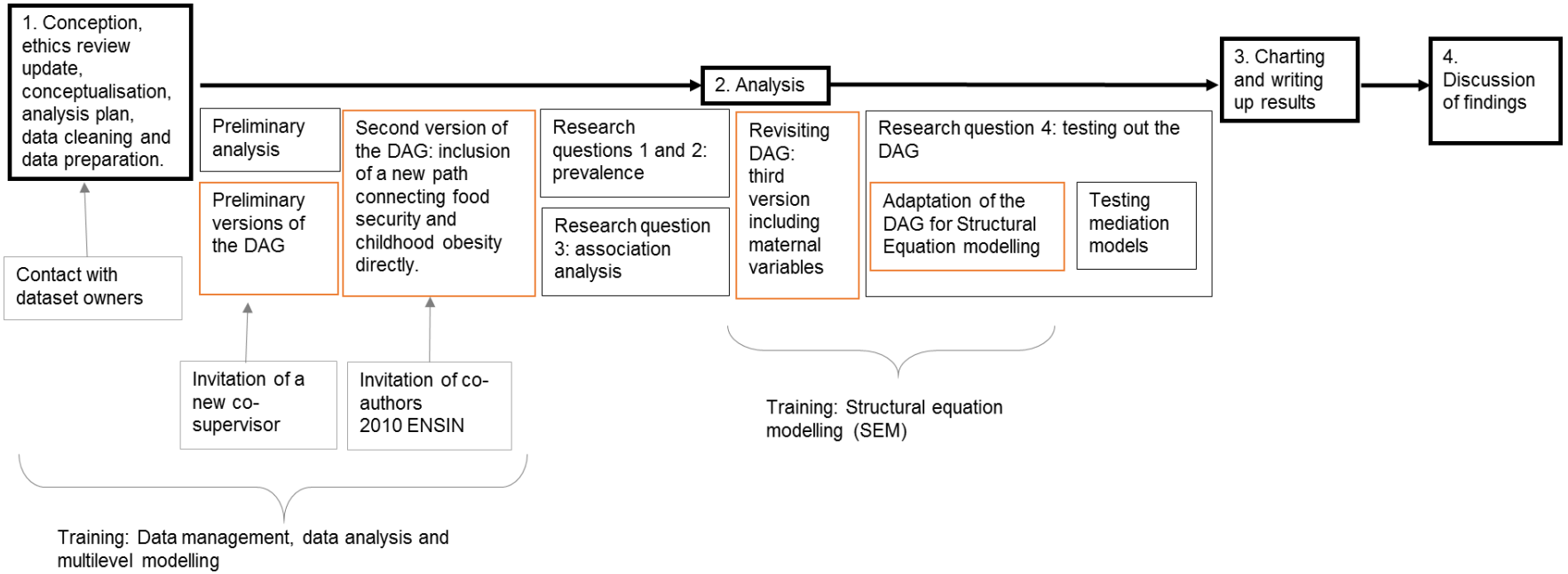
The mechanisms linking food production and food security are based on the agricultural sector and the production of commodities. Colombia is a tropical country with diverse climate zones, fertile soils and great biodiversity (Hodson de Jaramillo et al., 2017). However, high levels of food insecurity have been documented as a result of the concentration of land tenancy, armed conflict and policies affecting the commodities market (Gómez et al., 2015, Richani, 2012). This could affect the availability of healthy food and alter food choices in vulnerable population groups. Furthermore, unhealthy foods are the most inflation resistant; prices of carbonated soft drinks tend to decrease while prices of vegetables and fruits increase (Hojjat and Hojjat, 2017). Thus, I am hypothesizing a direct relationship between food production and food security, which can also be mediated by place. Through this path, socioeconomic status is a common parent for the food security and place and so onwards for the obesity-related behaviours.

Another path of interest is related to cultural factors shaping health behaviours. As mentioned, the understanding of obesity as a disease, its cure, its consequences and its causes might be influenced by cultural factors that can be loosely related to belonging to a determined ethnic group. This, in turn, may be influenced by the market. For instance, marketing has a dual influence on weight considerations – on the one hand, marketing supports the idea of the "ideal" body weight, and on the other hand, encourages the consumption of unhealthy food and drinks. This is one of the best examples of social psychology shaping the conception of whether or not obesity is a disease.

These risk factors and potential links were discussed in many academic contexts. Then, several DAG versions were also discussed with supervisors both in terms of their scientific coherence and ability to show the interdependencies in the simplest way possible. Appendix D shows these draft DAGs and an illustration of the steps involved in their creation.

The process of creating the DAG (Figure 4) somehow reflected the process of conducting this research in terms of continuous evolvement and adjustment. The DAG development required several adjustments, even during the data analysis phase, to get the final version. The exploratory analysis and the subsequent analysis for research questions two and three made it possible to postulate new connections between the factors operating in Colombia. For instance, through additional discussion with supervisors and colleagues that have been working on the same topic in Colombia, a new pathway directly linking food security and childhood obesity was added. Moreover, maternal variables that proved to be relevant after the association analysis were also plotted as potential mediators of the relationship under study. Finally, the DAG was adjusted to test a mediation model in terms of the statistical graph showing all the potential indirect paths.

Figure 4 Developing of the DAG regarding the research process.*



* The main four processes are represented by thick black arrows and boxes. Steps related to the creation of the DAG are shown in an orange box. Brackets indicate training to support the analysis phase.

4.4.4 Third stage: What are the potential pathways of factors linking ethnicity and childhood obesity in an ethnically diverse country like Colombia?

Figure 5 shows the final version of the directed acyclic graph created to study relationships between ethnicity and childhood obesity in Colombia. According to this figure, ethnicity might cause overweight or obesity in children through the following six paths.

1: Path passing through socioeconomic status and food security influencing childhood obesity directly (light green arrows)

2 and 4: Path passing through socioeconomic status and placing influencing food security and obesity-related behaviours (red arrows)

3: Path passing through socioeconomic status and food security influencing food exposure.

5 and 6: Path passing through socioeconomic status and individual psychology influencing obesity-related behaviours (light blue arrows).

Age and sex are considered confounders (thin black arrows) of the relationship between ethnicity and childhood obesity.

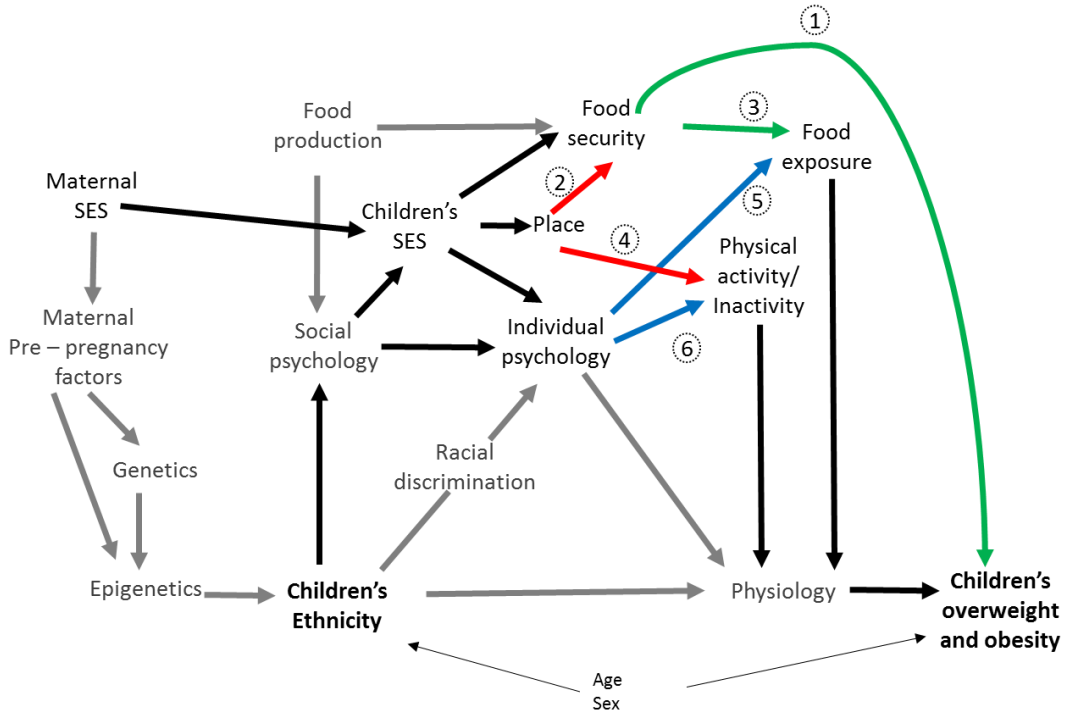
There are additional paths connecting variables (or ancestors) by grey arrows. These refer to factors affecting children's health indirectly, for example, maternal health and socioeconomic factors that can affect the development of a child before or during conception. Some examples of these factors are maternal lifestyle, family environment and environmental exposures to toxins that can affect the child growth and development via genetic/epigenetic mechanisms (Zheng et al., 2019).

There is also a grey path for mechanisms explaining childhood obesity through experiences of racism. This link has been studied from two viewpoints: Biologically – a link between stress (individual psychology) and the increase in markers of inflammation that increase the risk of obesity (Cedillo et al., 2020, Jones et al., 2020), and sociologically – through the structural racism that affects the environment

for ethnic minority groups, for example limiting the availability of healthy food and built environment to promote physical activity).

This thesis cannot test maternal exposures, genetic and epigenetic factors and racism pathways given the lack of Colombia-specific data regarding these variables.

Figure 5 Directed Acyclic Graph of the potential relationships between ethnicity and childhood overweight and obesity in Colombia: the case for general population*



*Unmeasured variables in the 2010 Colombian Nutrition Survey are shown in grey font.

Next chapter

The DAG constitutes a framework to understand potential interconnections between ethnicity and childhood obesity in Colombia. These have been sourced from studies included in the systematic review and literature on obesity and ethnicity. The following chapter presents three ways to analyse data within this framework. First, an analysis of the prevalence of childhood obesity by ethnic groups will contextualise its importance as a public health problem in the Colombian case. Second, an analysis of the association of several risk factors with childhood obesity

in each ethnic group will help to understand particularities for Indigenous, Afro-descendants and general population children in Colombia. Third, the testing of food security, socioeconomic and maternal variables through mediation models will evaluate these connections between ethnicity and childhood obesity from another viewpoint.

Chapter 5 Ethnicity and childhood obesity in Colombia: secondary analysis of the 2010 Colombian nutrition health survey

Childhood obesity rates are increasing substantially in both low and middle-income countries (Abarca-Gómez et al., 2017). Even countries like Colombia, which continues to deal with problems of undernutrition, are now facing a growing obesity problem. The findings of the systematic review I conducted and reported in the previous chapter, based on 41 studies, have suggested that ethnic differences in childhood obesity can also be observed in the five selected countries that were compared with Colombia. While the authors of the included studies offered a number of explanations for the relationship between ethnicity and childhood obesity, most of them focussed only on biological factors. In comparison, only one study from Colombia reported figures pertaining to this relationship, namely the survey report of the 2010 Colombian Nutrition Health Survey (ENSIN 2010).

This report was aimed at highlighting the main topics related to nutrition and health in the country. However, providing detailed information on ethnicity and health was beyond its scope. Regarding ethnic differences in childhood obesity, this report revealed a higher prevalence of overweight and obesity among Afro-descendant and Indigenous children under five years of age than was observed for the general population in the same age group. Reasons for this variation in prevalence were not provided, in part because this report did not explore the prevalence by other factors, such as sex or socioeconomic status (ENSIN 2010). The most recent ENSIN survey was carried out from 2015 to 2016. As data from this survey was not made available until late 2019, I was not able to analyse or discuss this dataset in the present chapter.

While keeping in mind the ethnic differences in childhood obesity already reported in Colombia in 2010, the aim of this chapter is to reach a better understanding of the relationship between ethnicity and childhood obesity by unpacking the potential mechanisms operating in Colombia via a secondary analysis of the ENSIN 2010. I approached the secondary analysis by estimating the prevalence of childhood obesity and studying the associated potential risk factors on the basis of paths described in

the directed acyclic graph developed in the previous chapter. An approach of this kind has the potential to inform further discussion about the purposes, design and interpretation of future nutritional surveys conducted in Colombia or in other ethnically diverse countries. It might also contribute to informing obesity-related policy in these settings.

This research followed a protocol employing various statistical strategies that are described in the following pages, according to the STROBE Statement for cross-sectional studies (Vandenbroucke et al., 2007)

The secondary analysis is divided into three parts:

1. The analysis of the prevalence of childhood obesity by sex and ethnic groups in Colombia. The prevalence of risk factors for childhood obesity.
2. Analysis of risk factors for childhood obesity in each ethnic group.
3. Test of mediation models of the relationship between ethnicity and childhood obesity through food security in Afro-descendant and Indigenous children.

5.1 Aim and research questions

The aim of the secondary analysis is to better understand the relationship between ethnicity and childhood obesity in Colombia through a secondary analysis of the Colombian Nutrition Health Survey (ENSIN) conducted in 2010.

This research addressed the following research questions regarding the distribution of childhood obesity in Colombia and the study of associated risk factors:

1) Are there ethnic differences in the prevalence of childhood obesity in Colombia?
2) Are there ethnic differences in the prevalence of established risk factors for childhood obesity in Colombia?
3) Does the association between the established risk factors for childhood obesity and childhood obesity itself differ by ethnic group in Colombia?
4) Do socioeconomic risk factors such as wealth, maternal weight status and food security contribute alone or in an interconnected fashion to the development of childhood obesity within ethnic groups?

5.2 Conceptual approach

The approach to studying childhood obesity and ethnicity in Colombia through its national nutrition survey was driven by the basic principles for conducting ethnicity and health research (Bhopal, 2014). In this section, I define and rationalise the main approaches used for the secondary analysis. I present the conceptualisation of ethnicity, the definition of childhood obesity, the DAG risk factors for childhood obesity, and finally the conceptual perspectives I adopted when conducting the data analysis.

5.2.1 Conceptualisation of ethnicity for the secondary analysis

The categorisation of ethnicity in the Colombian nutrition survey comes from a self-ascribed approach based on the ethnic question from the 2005 Colombian census. This question addressed ethnicity on the basis of skin colour, cultural background and sense of group belonging.

The definition of ethnicity utilised in the 2005 Colombia census is closest to the definition of ethnicity supporting this thesis: it comprises both physical features and cultural background, and also incorporates the sense of self-identification (Fenton, 2010, Bhopal, 2014). In Colombia, the census enables the identification of five ethnic minority groups – i.e., Indigenous ('Indigena'), Afro-descendant ('Afro-Colombiano', 'Negro', 'Mulatto'), Maroon ('Palenquero de San Basilio'), 'Raizal', 'Rrom' (Roma) – and another category usually referred to as 'general population' (or 'none of the above', as it is originally stated in the 2005 census).

One of the principles underpinning ethnicity and health research is that the categorisation of ethnicity used in research should be clearly defined, with due acknowledgment of its boundaries and limitations. I have noted in previous chapters that the categorisation of ethnicities in Colombia is mainly designed to identify ethnic minority groups, as well as that the majority of the Colombian population falls into the category of 'none of the above'. In this research, I define the Colombian ethnic minority groups as Indigenous, Afro-descendant, Palenquero, Raizal and Roma; here, the Indigenous categorisation is the same category used in the 2005 census and ENSIN.

For the purposes of this research, the Afro-descendant population are the group of people who identified themselves as Afro-Colombian, 'Negro' or 'Mulatto' in ENSIN. The Palenquero population are often included into the Afro-descendant or Afro-Colombian category; however, I did not include them in this category because, in terms of the study of obesity, there is not enough evidence regarding their cultural practices, lifestyle and health behaviours to associate them with the Afro-descendant group. Moreover, the Raizal (Afro-Caribbean population living in the Archipelago) and Roma populations are the groups of people who have identified themselves as such and correspond to the same categories used in ENSIN and the 2005 census.

5.2.2 Definition of childhood obesity

A number of studies have investigated the best way to define childhood obesity in ethnicity and health research. Such research could involve the use of references or field methods to measure adiposity and body composition. In the systematic review reported in chapter 3, methods used included national nutrition surveys, field measures based on anthropometry (e.g. weight-for-height, waist circumference and skinfold thicknesses), as well as surrogate measures of these adiposity markers such as indexes or equations (Hu, 2008). In any case, the selection of the best measurement to define childhood obesity depends on a balance being stuck between the research aims, the funding and the time available to conduct the study.

Measures based on weight and height are particularly controversial for ethnicity and obesity research. There is increasing evidence of differences in body fat distribution across ethnic groups. International standards based on height and weight might not reflect these differences, particularly those based on BMI, which might underestimate adiposity status in some ethnic groups (Ntuk et al., 2014, Nightingale et al., 2011). In children, there is an additional challenge associated with defining obesity given the rapid-growth related changes impacting adiposity, such as those observed in early childhood and puberty (Hu, 2008, Kyle et al., 2015).

For this research, the definition of childhood obesity relies on the anthropometric measurements already available in the dataset. For the 2010 ENSIN, these measurements were weight and height; hence, this research is restricted to the use of

surrogate measures such as weight-for-height z-scores or body mass index, along with the respective child growth reference centiles.

This research is based on the revised Extended International Body Mass Index Cut-Offs to define childhood obesity (Cole and Lobstein, 2012). This standard was proposed by the World Federation for Obesity, formerly known as the International Obesity Task Force Index (IOTF). The standard defines overweight and obesity according to age- and sex-specific cut-off points in children aged between two and eighteen years. These cut-off points are extrapolated from the adult body mass index cut-off points (Cole and Lobstein, 2012, Cole et al., 2000). By using this standard, a population of children could be classified according to thinness, overweight, obesity and morbid obesity. The two categories of interest for the present study are those related to overweight and obesity.

The rationale for choosing the extended IOTF standard relates to the reference population used to develop the cut-off points. To build this standard, the World Obesity Federation used six representative data sets from countries with different population distributions in terms of ethnicity and cultural background: Brazil, the United Kingdom, Hong Kong, the Netherlands, Singapore and the United States. The inclusion of the Brazilian population presents an advantage when analysing Colombian data, given Brazil's proximity to the Colombian population and the comparable body composition cultural background, especially for the Afro-descendant and Indigenous population.

5.2.3 Studying the distribution of childhood obesity and its risk factors in Colombia

Two of the research questions addressed in this chapter are related either to the prevalence of childhood obesity or the prevalence of risk factors. The other two questions pertain to the study of links between those risk factors, ethnicity and childhood obesity through association analysis.

In this research, the study of prevalence and association analysis represents an attempt to address my research questions from theories of disease distribution coined

by Krieger: these theories are the psychosocial, the social production of disease and/or political economy of health, and the eco-social (Krieger, 2001). As noted in the introduction to this chapter, most authors examining the relationship between ethnicity and childhood obesity have prioritised biological factors in their analyses. By drawing from Krieger's theories, I acknowledge that health is shaped not only by biological but also by social determinants.

Exploring the prevalence of childhood obesity among different ethnic groups is my attempt to understand how public health priorities could be determined in an ethnically diverse society (Bhopal, 2014). Furthermore, I also looked at the prevalence not merely for studying the proportion of children affected by obesity in Colombia in 2010, but also to explore this prevalence while taking sex differences into account. There is an interplay between ethnicity and sex that cannot be explored separately. Sex and ethnicity have been associated with childhood obesity from both the biological and the sociological point of view. For instance, age-related changes in adiposity like those observed in puberty can be mistaken for increased rates of obesity among girls, especially Afro-descendant girls (Henderson et al., 2011, Lee, 2009, Lee et al., 2014). On the other hand, sex-related inequities explaining obesity might result from the cumulative disadvantage experienced by women of some ethnic groups from an early age, resulting in poor lifestyle behaviours and poor nutrition (Bowleg, 2012, Jones-Johnson et al., 2014, Markus and Kenneth, 2007, Ferraro and Kelley-Moore, 2003).

Studying the association between risk factors, ethnicity and childhood obesity through the use of directed acyclic graphs also represents an attempt to answer my research questions from the perspective of theories of the distribution of disease. I am not aiming to explore causes of childhood obesity in Colombia, but rather intend to explore the potential interconnections between risk factors and ethnicity, showed in figures 6 to 8 (paths extracted from DAG, figure 5) , in order to illustrate the patterns of risk factors that shape the health of the Colombian population across and between ethnic groups.

Figure 6 Detailed path passing through food security*

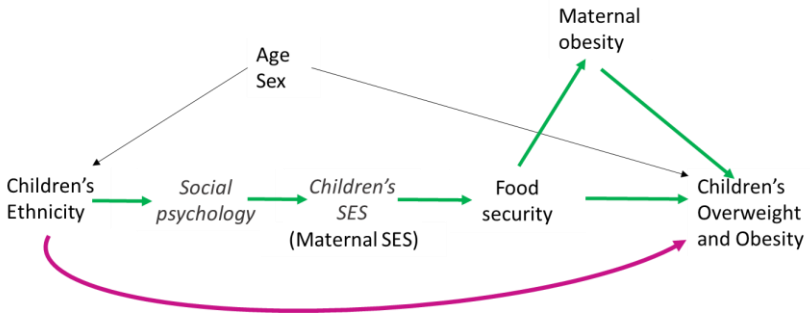


Figure 7 Detailed path passing through food security and place*

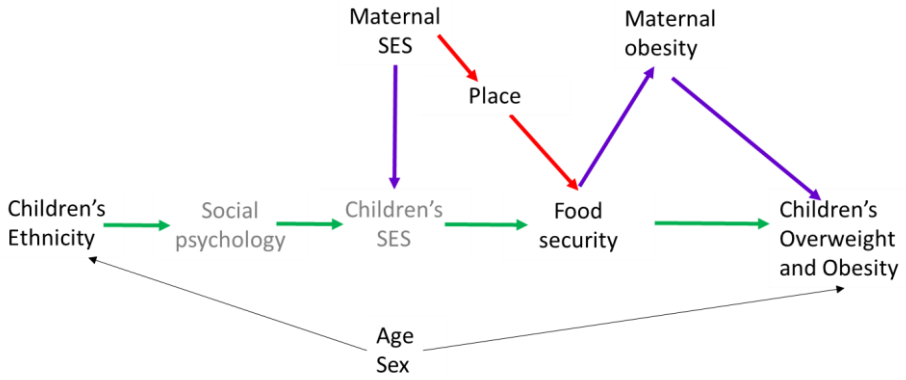
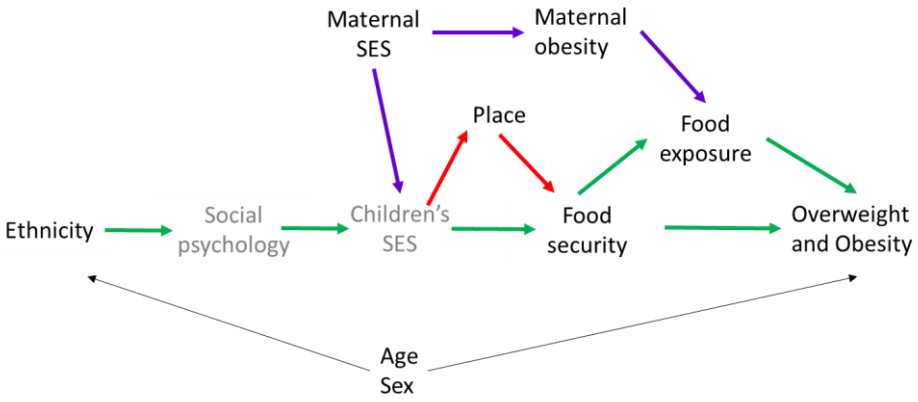


Figure 8 Detailed path passing through food security, place and food consumption*



*For figures 6 to 8, unmeasured variables in the 2010 ENSIN are shown in italics or grey. Maternal SES is used as a proxy of children's SES and is shown in brackets. The direct effect between ethnicity and childhood obesity is represented by the purple arrow in figure 6 and the indirect effect through food security and maternal obesity is represented by green arrows. Sex and age are confounders of this relationship and are represented by black arrows.

5.3 Methods

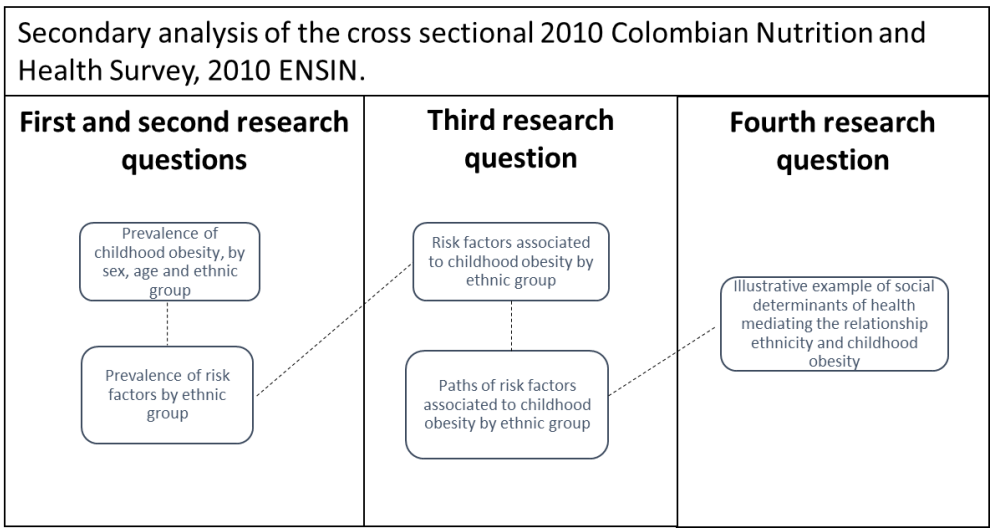
5.3.1 Study design

This research presents secondary analysis of the 2010 Colombian Nutrition and Health Survey (2010 ENSIN) in all children aged 2 to 18 years. This is a cross-sectional research based on a series of quantitative approaches looking at the distribution of childhood obesity and its risk factors across different ethnic groups in Colombia.

The DAG presented in the previous chapter and the current research were conducted in parallel as shown in figure 4, chapter 4. Conducting the secondary analysis enabled me to better understand the data available from Colombia, and it was also an additional input to update the DAG.

Figure 9 presents the study design and methods in relation to my research questions. For the present research, my approach involved estimating the prevalence of childhood obesity through a definition well-suited to international comparisons, i.e. the Extended International Body Mass Index Cut-Offs. For this research, I also estimated the prevalence of obesity by age groups and sex. Using different childhood ages enables separation of the physiological changes influencing weight gain during different periods of childhood, which have been postulated as confounders in analysing weight gain across children's developmental stages.

Figure 9 Study design and methods in relation to research questions.



5.3.2 Description of the 2010 Colombian Nutrition Survey (2010 ENSIN)

The data used for this research came from the 2010 Colombian National Nutrition Survey (2010 ENSIN). ENSIN 2010 was a cross-sectional survey funded by Colombia's government through several national organisations: the Ministry of Health and Social Protection, the Colombian Family Welfare Institute, the National Institute of Health, and the Association for Colombian Family Wellness. This is the third cross-sectional household interview survey of its kind carried out in Colombia, involving a nationally representative sample of people aged 0-64 years. The surveys (2005, 2010 and 2015) sought to estimate the prevalence of nutritional problems and selected health conditions in the Colombian population (data from ENSIN 2015 was not available until late 2019). The survey is the principal source in Colombia that informs the process of policy making and the development of interventions to tackle nutritional deficiencies in the country. The field work was conducted concurrently with the 2010 Colombian Demographics and Health Survey (as part of the Demographics and Health Survey Project by the United States Agency for International Development, DHS, USAID).

The 2010 ENSIN collected information on sociodemographic data and eight nutrition-related components: anthropometric measurements, breastfeeding and complementary infant feeding, frequency of food consumption, household food security, physical activity, time watching television and playing video games, body-weight perception and biomarkers.

The survey was based on a complex sample design that was stratified to take into account the division of the national territory in 2010. This was a probabilistic, stratified, clustered, and multi-stage sampling process. The survey design aimed to provide nationally representative estimates of the nutrition status of non-institutionalised people from 0 to 64 years old. Resource restrictions limited the number of people targeted for the biomarker and obesity-related behaviour components. The design also included an oversampling of the low-income population.

All measurements and methods followed a standard and validated procedure and were conducted in the same way across ethnic groups. According to the original survey, a group of nutritionists were specifically trained to take anthropometric measures. Weight and height were measured with standardised equipment. Weight was measured to the nearest 0.1 kg using a digital floor scale (SECA model 872; Brooklyn, NY) with capacity of 200Kg and a mother/child function; it was also properly adjusted for the Colombian geographical latitude. Participants were instructed to wear light clothing and remove shoes. Height was measured to the nearest 1.0 cm using portable stadiometers (Shorr Productions®) (see Appendix E, table 5.3.2 for further information on measurements and methods, ENSIN 2010). Table 12 shows the five sub-datasets that were part of the dataset sent to me by the data owners in Colombia. All data were sent in STATA format (.dta file).

Table 12 Components of 2010 ENSIN data set

Sub-data set*	Number of observations	Number of variables	Date
Anthropometry	204,459	218	January 2011, 21.48hrs
Food insecurity	50670	160	Date not available
Frequency of consumption	17897	109	14th February 2011, 15.33hrs
Physical Activity	14,465	169	February 2011, 15.33hrs
Television watching and body weight	45,285	136	13th May 2011, 10.37hrs

*All sub-data sets contained information on adults and children.

The Colombian organisations conducting the study were granted ethical approval for the 2010 ENSIN survey by the Association for Colombian Family Wellness, which was the coordinating organisation for ENSIN. Verbal consent was obtained from interviewees in relation to anthropometric measurements and the accompanying demographic survey.

5.3.3 Included population

I included all records of children between 2 to 18 years of age and linked data on mothers' weight status, along with complete information on height, weight and ethnicity. I excluded records of girls who were pregnant at the time of the survey, as this would affect the estimation of obesity status and thus the main outcome of this study.

5.3.4 Variables

Outcome and exposure variables

For the purposes of the secondary analysis, ethnicity and childhood obesity were the variables of main interest. These variables are described in table 13 in terms of their operational definition, type, measurement and source (e.g. sub-dataset). Some of the variables were redefined from the original survey by grouping categories into new ones. In all cases, this re-categorisation was conducted on the basis of the conceptual framework or for statistical purposes. In some cases, categorical variables were introduced in order to get reference categories (category=0) as standard for comparison on the basis of the literature.

The main outcome was overweight and obesity combined, defined as Body Mass Index (BMI) over 25kg/m^2 extrapolated from those at age 18, according to the Extended International (IOTF) BMI cut-off point for age and sex (Cole and Lobstein, 2012). I decided to use the IOTF standard because it is based on international reference populations (including one from Brazil), making it preferable for international comparisons of childhood obesity.

The main exposure of interest was ethnicity, which was grouped into three categories: Indigenous, Afro-descendant and reference population. The reference population category was made up of observations recorded as 'other' in the original data set. Three ethnic minority groups (*Roma*, *Palenquero* and *Raizal*) were excluded from this research because of the small number of people in these groups.

Table 13 Outcome and exposure variables for the secondary analysis

Variable name	Operational definition	Variable type and scale	Measurement	Source
Outcome				
Overweight including obesity	Child's BMI over 25kg/m^2 extrapolated from BMI at age 18 according to the Extended International IOTF BMI cut off points.	Binary	1=overweight and obesity 0= non-overweight and obesity	ENSIN: Sub-dataset on anthropometry

Exposure variable				
Ethnicity	Self-ascribed ethnic group reported by parents	Nominal Categorical	1=Indigenous 2=Afro-descendants 3=reference population	Redefined from ENSIN: Sub-dataset on anthropometry

(Continued table 13)

Risk factors

There were a set of other exposure variables grouped on the basis of sociodemographic characteristics and the thematic clusters of the Foresight Obesity System Map, defined as risk factors of childhood obesity (Table 14).

1) Sociodemographic variables such as sex and age were used to control the relationship between ethnicity and childhood obesity. Age was redefined from the continuous variable available in the original survey; thus, I created four age categories indicative of different periods of childhood (early childhood (2-5 years), middle childhood (6-10 years), pre-adolescence (11- 13 years), and adolescence (14-18 years)). These age groups are useful in the study of obesity as they take into account the growth-related changes that occur across childhood. Children less than two years of age were not included because of the different approach to measuring childhood obesity that this would require.
2) Household variables were used as a proxy for children's sociodemographic status, i.e. wealth index, health care scheme, family type and family size.

The Wealth Index was already available in the dataset, and was estimated by the owners of the data in Colombia on the basis of guidelines provided by the Demographic and Health Surveys Program (DHS) of the United States Agency for International Development (USAID). This index, which is widely used in DHS, World Bank and UNICEF reports, is a composite index of variables related to household characteristics, the possession of things and animals, and the ownership of land. It also includes source of drinking water, toilet facilities, and possessions such as televisions, motorised and non-motorised transport, and agricultural land. The final score is divided into five quintiles, in which the lowest or first quintile

represents the poorest population and the highest or fifth quintile represents the richest (Rutstein, 2008, Rutstein and Johnson, 2004).

Health care scheme refers to the universal health insurance scheme that has been implemented in Colombia since the Law 100 of 1993 (chapter 2, article 6; (Colombia, 1993). This law set up the legal structure of Colombia's health care and established two insurance schemes: the subsidised and the contributory regime. The subsidised regime is available for people without the ability to pay, while the contributory regime is for people who are able to pay and formal sector employees. The targeting method for the subsidised regime is the System of Identification of Social Program Beneficiaries (SISBEN, for its Spanish acronym). It is estimated through the SISBEN index, which is a function of a set of variables assessing household vulnerability. Indigenous communities are covered by the subsidised regime, which is run by the Indigenous councils in accordance with the Law 100. Other ethnic minority groups have been gradually incorporated into the subsidised regime since the Law was published. Moreover, the contributory scheme is paid for by employees and employers from the formal economy sector and also includes people from two special schemes: the military forces and the state oil company (ECOPETROL; acronym in Spanish).

Other household variables such as family size and family type were also included. These were extracted from the parents' reporting of the number of people living at home and the classification of families in Colombia. Family size was an ordinal variable of three categories: less than three, four to six and more than six people. Family type was reported as traditional nuclear family, lone parent family, or children belonging to a larger family including other members (also called extended family).

3) Food security was assessed through a food security score available in the dataset, grouped into four categories of analysis: i.e., secure, mild, moderate and severe food insecurity. In the original survey, this was assessed through the Food Security Scale-ELCSA, which was previously validated and linguistically adapted for the Colombian population (ELCSA, 2012, Melgar-Quiñonez et al., 2010)

4) Place was assessed using two variables: first, the region allocated to each individual in the original data set (i.e. capital city, Atlantic, Eastern, Central, Amazonia and Orinoquia, and Pacific regions); second, rural or urban area of residency. Sub-regions of residency, of which there were 16 in total, were also considered; however, as the purpose of this thesis is to address international audiences, I decided to include region in the main text and display univariate and multivariate analysis for sub-regions in the appendices.

Table 14 Variables for studying the prevalence of childhood obesity by sex, age, the prevalence of risk factors for childhood obesity and for the association analysis.

Variable name	Operational definition	Variable type and scale	Measurement	Source/redefined for the purposes of this research?
Socio demographic variables				
Sex	Child's sex	Binary	1=girls 0=boys	ENSIN: Sub-dataset on anthropometry/No
Age group	Child's age group	Nominal categorical	1=2-5 years 2=6-10 years 3=11-13 years 4=14 to 15 years	ENSIN: Sub-dataset on anthropometry/Yes
Wealth Index	Household's wealth index quintile	Ordinal categorical	0= Fourth quintile 1=Lowest quintile 2=Second quintile 3=Middle quintile	ENSIN: Sub-dataset on anthropometry /No
Health care scheme	Health insurance reported by parent	Ordinal categorical	0= Contributory and special scheme 1= No health scheme 2=Subsidised	ENSIN: Sub-dataset on anthropometry /Yes
Family type	Family structure according to the listed members of the house, already grouped in the dataset	Ordinal categorical	0= Nuclear family 1=Lone parent family 2=Extended family	ENSIN: Sub-dataset on anthropometry /Yes
Family size	Number of members of the family	Ordinal categorical	0= Less than 3 people 1= 4 to 6 people	ENSIN: Sub-dataset on anthropometry /Yes

			2= More than six people	
Variable name	Operational definition	Variable type and scale	Measurement	Source/redefined for the purposes of this research?
Food security				
Food security	Level of food security estimated through the ELCSA score	Ordinal categorical	0=Secure 1= Mild food insecurity 2=Moderate food insecurity 3=Severe food insecurity	ENSIN: Sub-dataset on food insecurity /No
Place				
Area	Rural or urban area of residency		0=Rural 1=Urban	ENSIN: Sub-dataset on anthropometry /No
Region	Colombian region in which the child's household is located, reported by parent	Nominal categorical	1=Bogota, capital district 2= Atlantic 3=Eastern 4=Central 5=Pacific 6=Amazonia	ENSIN: Sub-dataset on anthropometry /No

(Continued)

Table 15 shows maternal variables. I used two sets of maternal variables; a set of sociodemographic variables as a proxy of child's socioeconomic status and set of variables measuring adiposity in the mother.

Maternal obesity was assessed through two variables: maternal obesity (i.e. obese (BMI≥30) and non-obese (BMI<30)) and increased waist circumference or central obesity (WC; yes (WC≥80 cm) and no (WC<80 cm)). In the original survey, waist circumference was measured using a steel flexible tape with a filed notch and patch zero indicator (Rosscraft®), measured midway between the uppermost border of the iliac crest and the lower border of the costal margin (rib cage). The tape was placed around the abdomen at the level of this midway point, avoiding the compression of the skin.

Table 15 Maternal Variables

Variable name	Operational definition	Variable type and scale	Measurement	Source/redefined for the purposes of this research?
Maternal socio demographic variables as a proxy of child's socioeconomic status				
Maternal age (mean and SD)	Mother's age in years	Continuous	0= Contributory and special scheme 1= No health scheme 2=Subsidised	ENSIN: Sub-dataset on anthropometry /Yes
Mother's educational level	Education level reached by the mother, reported by mother or adult interviewed	Ordinal categorical	0= Higher education 1=No education 2=Primary School 3=Secondary School	ENSIN: Sub-dataset on anthropometry /Yes
Mother's Occupation	Productive or main activity performed by mother, paid or unpaid.	Ordinal categorical	0= Employed 1=Unemployed 2=Studying 3=looking after the house	ENSIN: Sub-dataset on anthropometry /Yes
Maternal obesity				
Maternal obesity	Body Mass Index equal to or greater than 30	Binary	0=No 1= Yes	ENSIN: Sub-dataset on food anthropometry /Yes
Maternal increased waist circumference	Measurement of the circumference equal to or greater than 80cm	Binary	0=No 1= Yes	ENSIN: Sub-dataset on anthropometry /Yes

Other variables such as food exposure, television watching and body weight perception were used in the regression analysis; however, they were not included in the part 3 because they were only available for sub-samples. Further information about the size of the sample used for the secondary analysis is presented in the first part of the results section.

Food consumption

To evaluate food exposure, I studied not only food frequency but also two different sets of variables that have been associated with obesity. First, two variables containing information on meals eaten (breakfast, lunch or dinner) and number of meals a day per individual, including other small meals in between (snacking) (Willett, 2012). Second, two variables pertaining to diet quality: healthy food and unhealthy food scores (Willett, 2012). The healthy food score was a discrete variable created from the 1 to 10 categories of frequency of consumption (ordered from low to high consumption) of raw vegetables, roasted vegetables and fresh fruit. It ranged from 3 to 30; the higher the score, the healthier the diet. The unhealthy food score was created from the 1 to 10 categories (ordered from high to low consumption) of frequency of consumption of sugary drinks, crisps and confectionery, biscuits, street food, fried food and fast food. It ranged from 6 to 60; the higher the score, the unhealthier the diet. In the original survey, food consumption was measured using the 24-hour Dietary Recall by applying a structured interview asking about all foods, beverages and dietary supplements consumed by the respondent in the past 24 hours.

Individual physical activity and inactivity

Television watching was used as a proxy of the child's levels of inactivity. It was reported by the parent and evaluated through quintiles of hours per day. Each quintile is equivalent to the following categories: lowest quintile indicates less than or equal to 1 hour, second quintile indicates from 1 hour up to 2 hours a day, third quintile indicates between 2 hours and 2.85 hours a day, fourth quintile indicates between 2.86 hours to 4 hours a day, and the highest quintile more than 4 hours a day. In the original survey, it was assessed by asking one question: 'During the last seven days, did (child's name) watch television or play video games?' Respondents who provided a positive answer were also asked about the frequency of the event: 'How many days?', followed by 'How much time did (child's name) usually spend during one of those days watching television or playing video games?'. If the interviewed parent or guardian could not answer the last question due to the variability of the report from day to day, the interviewer would then ask: 'What is the total amount of time that (child's name) spent over the last seven days watching television or playing video games?'(Gomez et al., 2007a).

5.3.5 Data cleaning

The data cleaning process for this research was demanding. As mentioned above, the dataset included five more sub-datasets that required an additional merging process. I merged the datasets using the identification number for each individual. Once the datasets were merged, the cleaning process was conducted based on the identification of outliers, inconsistencies, incomplete or incorrect records.

I also checked biologically implausible values (BIVs) and errors for the variables of height, weight and body mass index (BMI). I created dummy variables for BMI using different cut-off points and standard deviations (SD), i.e. -4SD, +5 SD, ± 5SD and ±6SD, to flag potential BIVs. I subsequently analysed individual cases comparing high or low values of height in comparison with BMI and looking at their ethnicity to evaluate whether there was a pattern led by ethnic code. Each cut-off point resulted in fewer than 1% of the population being missed and any pattern related to ethnicity was detected in the potential records with BIVs (see Appendix E, BIVs) . I also performed a sensitivity analysis calculating the prevalence and multivariate model for the first path; none of the cut-off points altered the effect estimates. Results suggested that it was appropriate to carry on with the analysis using the outcome of obesity and overweight based on the -5 and +5 standard deviations of the BMI z-score. Thus, 44 observations were removed from the sample.

5.3.6 Data management for thesis purposes

The Colombian Institute of Family Wellbeing provided me with the data collected from the 2010 ENSIN survey. The data management process was based on the regulations outlined by this institution and the University of Edinburgh.

Regarding ethical issues, this is a secondary analysis of an anonymised and de-identified dataset and was thus considered to be at Level 1 according to the University regulations: in other words, ‘the study does not present any complex ethical issues and does not require further scrutiny’ (Appendix E: Self-Audit Checklist for Level 1 Ethical Review for secondary analysis).

Special considerations regarding statistical package and analysis strategy

I conducted statistical analyses using the statistical software STATA 14, serial number 301406264676 (Stata Corp. 2015. Stata Statistical Software: Release 14. College Station, TX: Stata Corp LP).

Given the multistage nature of the data collection, I applied weights based on the stratification used during sampling. These weights were related to the probability of each individual being selected according to the location of their residence in the segment (or street) and according to their location when members of the family were listed. Weights were applied to correct for unequal selection probabilities and non-response. The sample weights were provided in the dataset, and all analysis was run through the Survey Prefix Command (SVY command) available in the STATA software, which accounts for this type of analysis. This approach has been used in previous published analysis derived from the 2010 ENSIN (Gomez et al., 2007b, Parra et al., 2015b).

5.3.7 Data analysis strategy

Part 1: Analysis strategy for the first and second research questions: prevalence of childhood obesity and risk factors by ethnic group

To address the first research question, I described the prevalence of overweight and obesity in the three ethnic groups, stratified by sex and age group: 2 to 5 years (early childhood), 6 to 10 years (middle childhood), 11 to 13 (pre-adolescence) and 14 to 18 (adolescence). I used 95% confidence intervals (CI) to evaluate the differences between the ethnic groups and the reference population. I implemented a similar approach to address the second research question, estimating the prevalence of risk factors by ethnic group. For both research questions, the denominator was the number of people in each ethnic group (i.e., 7,681 Indigenous, 6,672 Afro-descendants and 46,956 reference population), except for models including television watching and food exposure, which were performed on sub-samples containing 3,453 Indigenous, 3,578 Afro-descendants and 25,693 reference population for

television watching, and 1,237 Indigenous, 1,121 Afro-descendants and 7,801 reference population for food exposure. This analysis was performed using the statistical software package STATA 14.

Part 2: Analysis strategy for the third research question: association between established risk factors and childhood obesity by ethnic group

To address this association, I performed a logistic regression analysis. The dependent variable was obesity and overweight combined, with independent variables as mentioned above. The logistic regression was adjusted by age and sex.

I fitted the logistic regression model using a backwards and block-wise selection method. Beyond trying to get the simplest (often called parsimonious) multivariate models, my purpose was to show the influence on childhood obesity exerted by the exposure variables of interest (i.e. SES, food security and maternal obesity); therefore, if these variables were not significantly associated in the univariate analysis ($p>0.150$), I decided to force them in the final models to determine their influence on each pathway studied. Additionally, for the wealth index variable, I conducted sensitivity analysis with different reference categories to visualise the effect of being in either the highest or lowest quintile. Models were adjusted by age and sex.

5.4 Results

The results section first presents the number of people included in the analysis, along with a description of the demographic characteristics of this population. The results are then presented in the same order as the research questions.

5.4.1 Population of children included in the secondary analysis

As each pathway required the combination of different datasets containing different numbers of people, the final analytical sample for each model was not the same. Appendix F (Flow diagram of the final analytical sample) shows the final analytical sample for analysing each group of variables according to the paths proposed. The

largest sample was obtained for analysing (n=61,355) after cleaning and applying exclusion criteria.

5.4.2 Baseline characteristics of children included

Table 16 describes the sociodemographic characteristics of the Colombian children in the sample aged 2-17 years by ethnic group: i.e. Indigenous, Afro-descendant and reference population. The largest group was the reference population (76.5%), followed by the Indigenous children and Afro-descendant children (12.5% and 11%, respectively). The first column presents the sociodemographic characteristics divided into two categories, i.e. those at a child level and those at a household level; the latter acts as a proxy for the children's socioeconomic status.

Regarding the child-level variables, there were no apparent marked differences by sex or age groups among the ethnic groups; however, across all ethnic groups, boys accounted for slightly over 50 percent of the population. In terms of age groups, the largest age group across all ethnic groups was children 6 to 10 years of age. In comparison with the other ethnic groups, the Indigenous group had a very high percentage of children belonging to the subsidised health care scheme (78.1%, with a further 10.9% belonging to the contributory regime), while the percentage of Afro-descendant children without any health care scheme was slightly higher than for other ethnic groups (17.4%, with 27% belonging to the contributory regime and 54% belonging to the subsidised regime). This was in contrast to 11.3% without health care scheme, 39% belonging belonging to the contributory scheme and 49.7% belonging to the subsidised regime in the reference group. Children's education was similar across ethnic groups.

The sociodemographic profile obtained from household variables showed a higher percentage of Afro-descendant and Indigenous children belonging to families of more than six members, as well as the poorest category of socio-economic conditions, when compared with the reference population.

Table 16 Baseline sociodemographic characteristics of children 2 to 17 years of age, Colombian 2010 ENSIN

	Indigenous (n= 7,681) μ	Afro-descendants (n= 6,762) μ	Reference Population (n=46,956) μ
	n μ (%)	n μ (%)	n μ (%)
Children's sociodemographic variables			
Sex			
Boys	3,856(51.2)	3,497(51.1)	23,628(50.6)
Girls	3,825(48.8)	3,265(48.9)	23,328(49.4)
Age group			
2-5	1,948(23.3)	1,687(24)	11,294(23.7)
6-10	2,568(33.2)	2,212(32)	14,970(31.4)
11-13	1,429(18.8)	1,275(19.2)	9,085(19.8)
14-18	1,736(24.8)	1,588(24.8)	11,607(25.1)
Health Care Scheme			
Contributory or Special Scheme	801(10.9)	1491(27.9)	14,970(39)
No health scheme	624(11)	1,150(17.4)	5,537(11.3)
Subsidised	6,241(78.1)	4,087(54.7)	2,6217(49.7)
Education Level			
Preschool	469(7.7)	422(8.6)	2,686(7.9)
Primary School	3,270(55)	2,722(50.4)	16,580(46)
Secondary School	17,98(36.4)	1,891(39.9)	15,419(44.5)
Technical /vocational	9(0.3)	25(0.6)	217(0.8)
Higher education	16(0.5)	22(0.4)	270(0.9)
Household variables as a proxy of children's socioeconomic status			
Family type			
Nuclear	3,786(52.3)	3,425(50.6)	25,879(55.7)
Lone parent	25(0.4)	26(0.3)	135(0.3)
Extended	3,846(47.3)	3,285(49.1)	20,734(44)
Family size			
Less than 3 people	493(9.2)	779(11.5)	6,740(14.6)
4 to 6 people	3,280(49.7)	3,788(56.7)	28,874(62.4)
More than 6 people	3,908(41.1)	2,245(31.8)	11,342(23)
Wealth Index			
Lowest quintile (or poorest)	6,231(65)	3,566(41.6)	12,657(20.8)
Second quintile	980(19.2)	1,419(21)	12,493(22.6)
Middle quintile	307(8.9)	863(16.8)	9,911(21.5)
Fourth Quintile	123(5.1)	555(12.4)	7,031(19.4)
Highest quintile (or richest)	40(1.9)	359(8.2)	4,864(15.7)

μ Unweighted number of people
Baseline characteristics of all population included in Table 5.4.2, Appendix F

5.4.3 Part 1: Results for the first research question: What is the prevalence of childhood obesity by ethnic groups in Colombia?

Table 17 lists the prevalence of obesity and overweight by age groups. Within age groups, the prevalence is presented by ethnic group and sex.

The prevalence of childhood obesity differs by ethnicity and sex across different age groups. For pre-school children aged 2-5 years, the highest prevalence of overweight including obesity was among Indigenous girls and boys (13.1% and 12.5%, respectively), followed by girls and boys in the reference population (11.8% and 9%, respectively). This was almost twice the prevalence in Afro-descendants in the same age group (6.5% boys, 6.9% girls).

In the next two age categories, namely 6 to 10 and 11 to 13 years old, this prevalence ranged from 9% to 16% in all groups with no differences by sex; however, the prevalence was lower among both ethnic minority groups in comparison with the reference population (15.9%, aged 6-10 years).

Finally, for children aged 14 to 18 years, the highest prevalence of overweight and obesity was among Indigenous and Afro-descendant girls aged 14 to 18 years (over 20% for Afro-descendant girls compared with 23.8% for Indigenous girls). In this category, boys across ethnic groups exhibited a lower prevalence.

Table 17 Prevalence of overweight and obesity by age, sex and ethnic groups in children 2 to 17 years, Colombian 2010 ENSIN

Age group	Ethnicity	Total number of children μ	Children with overweight and obesity			
			Girls		Boys	
			n μ	% (95% CI)	n μ	% (95% CI)
2-5	Indigenous	1,945	107	13.1 (9.7 - 17.6)	107	12.5 (8.8 - 17.4)
	Afro-descendant	1,687	54	6.9 (5.1 - 9.3)	57	6.5 (4.8 - 8.8)
	Reference Population	11,273	633	11.8 (10.7 – 13.0)	507	9.0 (8.0 - 10.0)
6-10	Indigenous	2564	98	9.8 (7.3 - 13.1)	99	10.7 (7.7 - 14.8)
	Afro-descendant	2207	134	13.8(11.3 - 16.8)	102	10.2 (8.2 - 12.7)
	Reference Population	14,957	1,094	15.9 (14.8 - 17.0)	1,039	14.5 (13.5 - 15.6)
11-13	Indigenous	1428	93	11.2 (7.7 - 16.0)	55	10.2 (6.7 - 15.2)
	Afro-descendant	1274	97	13.8 (11.0 - 17.3)	60	10.4 (7.9 - 13.6)
	Reference Population	9077	735	16.1 (14.8 - 17.5)	598	13.5 (12.3 - 14.9)
14-18	Indigenous	1735	228	23.7 (19.1 - 29.1)	67	6.7 (4.3 - 10.4)
	Afro-descendant	1586	154	20.4 (17.4 - 23.8)	82	10.1 (8.1 - 12.7)
	Reference Population	11603	1,050	17.9 (16.6 - 19.2)	637	10.6 (9.7 - 11.7)
	Total	61,355	4,477	15.2 (14.7 - 15.8)	3410	11.6 (11.1– 12.1)

5.4.4 Results for the second research question: prevalence of established risk factors for childhood obesity by ethnic group

Findings for the second research questions are divided into three subcategories: namely, those related to sociodemographic risk factors (including food security), food consumption and television watching.

Sociodemographic risk factors

Table 18 presents the potential risk factors for childhood obesity by ethnic group. Both Indigenous and Afro-descendant children had broadly comparable proportions of cases with moderate or severe food insecurity (around 25%), which were much higher in comparison with the reference population (less than 18%). While most Indigenous children were located in rural areas (66.1%), a high percentage of Afro-descendant children (67.9%) were settled in urban areas, a proportion almost as high as the reference population (72.8%). Most Indigenous and Afro-descendant children were living on the Atlantic or the Pacific Coast, while children of the reference population lived in central and eastern areas. The largest group living in the Amazonia was Indigenous children. This pattern was expected given the historical geographic distribution of ethnic minority groups in Colombia.

With respect to mothers' educational levels, Indigenous mothers reported the lowest level of education, with only 4.8% having higher education and almost half reporting primary school as the maximum education level reached. By contrast, a little more than half of Afro-descendant and reference population mothers had attained higher education level (university or technical/technological degrees). Regarding employment, around 60% of Indigenous mothers listed their occupation as 'looking after the house'; this can be compared with 53% and 51% of Afro-descendant and reference population mothers, respectively, who also reported being more likely to be employed. Obesity was more prevalent in the Afro-descendant mothers (22.6%) than in Indigenous (17.9%) and reference population mothers (19.1. However, this difference appeared not to be explained by central adiposity, since the prevalence of increased waist circumference was similar across the ethnic groups (approximately 64%).

Table 18 Sociodemographic risk factors for childhood obesity by ethnic group, Colombian 2010 ENSIN.

	Indigenous (n= 7,676) μ	**Afro-descendants (n= 6,760) μ**	**Reference Population (n=46,919) μ**
	n μ (%)	n μ (%)	n μ (%)
Levels of food security			
Secure	1,333(14.5)	1,329(21.2)	15,645(34.8)
Mild food insecurity	2,240(33.7)	2,071(30.8)	18,813(39.4)
Moderate food insecurity	1,719(24.4)	1,595(23.5)	8,405(17.6)
Severe food insecurity	2,388(27.3)	1,766(24.5)	4,000(8.2)
Place			
Area			
Rural	5,205(66.1)	2,498(32.1)	14,320(27.2)
Urban	2,475(33.9)	4,263(67.9)	32,543(72.8)
Region			
Bogota capital district	18(1.8)	42(1.7)	3,135(17.3)
Atlantic	1,315(35.8)	2,054(31.9)	10,411(20.5)
Eastern	116(2.8)	238(4.4)	8,755(21.1)
Central	413(11.7)	635(16.3)	12,895(27.1)
Pacific	860(36.6)	3,590(45)	4,105(11.4)
Amazonia	4,959(11.3)	203(0.7)	7,655(2.7)
Maternal variables			
Maternal age (mean and SD)	35.7(13.4)	35.4(7.8)	35.6(7.7)
Mother's educational level			
No education	808(14.6)	620(11.8)	5,030(14.6)
Primary School	3,471(49)	253(4.1)	982(2)
Secondary School	1,803(31.6)	1,966(32.9)	13,139(30.2)
Higher education	256(4.8)	2,588(51.2)	20,365(53.1)
Mother's Occupation			
Employed	2,680(37.9)	2,432(44.9)	17,480(46.9)
Unemployed	25(0.6)	43(0.9)	443(1.3)
Studying	46(0.8)	44(0.8)	349(1.0)
Looking after the house	3,410(60.7)	2,841(53.4)	20,812(50.8)
Maternal obesity (Yes, BMI≥30)	897(17.9)	1,215(22.6)	7,685(19.1)
Increased waist circumference (Yes, WC≥80)	3,383(66.3)	3,197(64.4)	2,3361(64.6)

μunweighted number of people

Food consumption

Table 5.4.4 (Appendix F) shows the distribution of food exposure by ethnic group. This part of the analysis was conducted on a sub-sample of 10,159 children. In comparison with the Indigenous or reference populations, the Afro-descendant children tended to show a more consistent pattern of unhealthy habits, as there was a higher prevalence of cases in which children ate only one meal a day, along with high consumption of crisps and savoury snacks and street food (on a daily basis). The daily consumption of sweetened drinks, biscuits, and fried food is comparable among Afro-descendant and reference population children and lower among Indigenous children. In addition, the Indigenous children showed lower daily consumption of raw vegetables (10%), although this healthy practice did not reach more than 20% in the other ethnic groups.

Physical activity and inactivity levels

Television watching was used as a proxy of physical inactivity levels. It was analysed in a sub-sample of 32,724 children aged between 5 and 17 years. Time was divided into quintiles, with the lowest quintile being equivalent to less than an hour a day and the highest quintile equating to more than four hours a day. Table 19 presents the distribution per quintile by ethnic group. Most children from the Indigenous population spend less than 1 hour a day watching television (31.5%, in comparison with 11% spending more than 4 hours a day). By contrast, the percentage of children who watched for more than 4 hours a day was highest for children in the reference group (17.9%, in comparison with 11% of Indigenous and 16.5% of Afro-descendant children).

Table 19 Television watching as a proxy of physical inactivity by ethnic group, ENSIN 2010

	Indigenous (n= 3,453) [μ] n [μ] (%)	Afro-descendants (n= 3,578) [μ] **n [μ] (%)**	Reference Population (n=25,693) [μ] **n [μ] (%)**
Time spent watching television (quintiles of hours a day)			
Lowest quintile (≤1hour/day)	900(31.5)	953(24.5)	5956(22)
Second quintile	1,031(27.5)	1,027(27.3)	7,014(26.8)
Third quantile	172(9.8)	344(9.9)	2341(9.2)
Fourth quantile	869(20.1)	774(21.8)	6,019(24)
Highest quintile (**>**4 hours/day)	481(11)	480(16.5)	4,363(17.9)

[μ]unweighted number of people

5.4.5 Part 2: Results for the third research question: associations between established risk factors for childhood obesity and childhood obesity itself by ethnic group in Colombia

Analysis of risk factors by ethnic group

Table 5.4.5 (Appendix F) presents the univariate analyses performed for each ethnic group in relation to sociodemographic factors, including those for the mother and household. Findings from the univariate analysis indicate that girls were more likely to experience childhood obesity than boys (odds ratio 1.33-1.49) across the three ethnic groups studied. Older children also had higher levels of childhood obesity compared to younger children, a pattern that was found to be stronger for Afro-descendant children (2.49 times higher odds). In Indigenous children, however, the above association did not reach statistical significance.

On the other hand, having a lower wealth index (i.e. being more deprived; highest index as reference) was inversely and significantly associated with childhood obesity in all ethnic groups, although this protective pattern was stronger in the Afro-descendant children (OR 0.24, equivalent to 4.16 x higher odds for childhood obesity in the highest wealth index compared to the lowest). Belonging to a larger family was also found to be a significant protective factor for childhood obesity in all ethnic groups (O.R 5.0 for families with more than six members compared to families of less than three members). The same pattern and similar effect estimates were found for the association between not belonging to any health scheme or belonging to a subsidised health scheme (when compared with the contributory/special scheme) and childhood obesity.

In terms of maternal variables, at a univariate level, although increasing maternal age was positively associated with childhood obesity among Afro-descendant and reference population children, the effect estimates for this relationship were very weak (OR 1.04-1.01). Lower maternal educational level (compared with mothers that have undertaken higher education as a reference) was inversely related to the odds of

childhood obesity in all ethnic groups. With regard to the mother's occupation, children of women who reported their employment status as 'looking after the house' were less likely to experience childhood obesity in the Afro-descendant and reference population groups, but not in the Indigenous group, when compared with children of employed mothers. Furthermore, for Afro-descendant children, having a student mother vs. an employed mother was inversely associated with childhood obesity. Children of mothers with either maternal general obesity or central obesity (vs. children of mothers without those statuses) were around 2.0- 2.5 times more likely to be obese themselves across all ethnic groups. It is of note that a stronger association between mother's central obesity and childhood obesity emerged among the Afro-descendant children (OR 3.0), although confidence intervals were slightly wider (2.23-4.02), perhaps due to the smaller sample size in this group.

Children in a home with severe, moderate or mild food insecurity (compared with those living in a home with food security) were less likely to be obese. A dose-response to this could be seen across the food insecurity categories.

5.4.6 Multivariable analysis to identify the effect of food security

The next stage involved fitting a series of multivariate models. Once the multivariate analysis was performed, I obtained the most parsimonious model explaining childhood obesity by ethnic group. The first parsimonious model was arrived at by forcing food security into the model alongside the other risk factors. Table 5.4.6 (Appendix F) shows the variables that reached statistical significance and thus became part of the final model, while those that did not reach this significance level are listed as 'not included'. For all populations except Indigenous children, being female and being older were positively associated with childhood obesity. Moreover, the strongest associations of sex, age and childhood obesity were observed in Afro-descendant children. For both Afro-descendant children and the reference population, there was a positive and statistically significant gradient of association between wealth index quintiles and childhood obesity. Having an extended family, in comparison with having a lone parent family, was associated with childhood obesity among the reference population only; furthermore, being part of a family with four or

more members was negatively associated with the likelihood of childhood obesity among the reference population and positively associated with childhood obesity among Afro-descendant children.

In the reference population, children who belonged to a subsidised health scheme (contributory or special as reference), whose mothers looked after the house, and who received (rather than did not receive) food assistance were less likely to experience childhood obesity. These variables were not found to be associated with childhood obesity in Indigenous and Afro-descendant children. Maternal variables of obesity status (BMI>30 and waist circumference > 80 cm) and educational level were related to childhood obesity in all ethnic groups, although with different patterns: while children with mothers affected by obesity or central obesity were more likely to be obese, a lower maternal educational level was inversely associated with childhood obesity. Maternal obesity was most strongly associated with childhood obesity in the reference population, while maternal central obesity exhibited stronger effect estimates for that outcome among Indigenous and Afro-descendant children.

Food security needed to be forced into the final model for Indigenous children only. Moreover, severe food insecurity was inversely associated with the likelihood of childhood obesity among the Afro-descendant and reference populations. In other words, the better the level of food security, the higher the likelihood of being affected by overweight and obesity in these two ethnic categories.

5.4.7 Multiple analysis to identify the effect of food security and place

Table 5.4.7 (Appendix F) presents the final parsimonious model, forcing food security and place, for explaining the association of risk factors and childhood obesity by ethnic group. Adding variables of place did not affect the associations already explained above. This was particularly true of the similarities that emerged for associations between sociodemographic and maternal variables in the context of childhood obesity. For instance, being female, being older, and having a mother affected by obesity or with increased waist circumference were all factors associated with a higher likelihood of childhood obesity across all ethnic groups. Moreover, a positive gradient of association between wealth index and childhood obesity was observed when place was added to the model.

Regarding family, household and maternal variables, the model was also similar to that discussed above. Except for those in the Indigenous group, children were less likely to be affected by obesity if they belonged to a family of four or more members, had a less educated mother, and experienced severe food insecurity. Having a subsidised health scheme (contributory or special as reference) and having 'looking after the house' as the mother's reported occupation were also inversely associated with childhood obesity, but only in the reference population.

When variables of place were added, the odd ratios for food security became similar to those in the previous model: in short, the better the level of food security, the higher the likelihood of having obesity for all populations except for Indigenous children.

Place was evaluated through region of Colombia and rural or urban area of residency. In the Afro-descendant and reference population, with exception of the Atlantic region, children living in any geographical region outside of the capital city (Bogota) were more likely to be affected by obesity. Another group-specific association was that between living in an urban area and a higher likelihood of childhood obesity, which was only observed in Indigenous children.

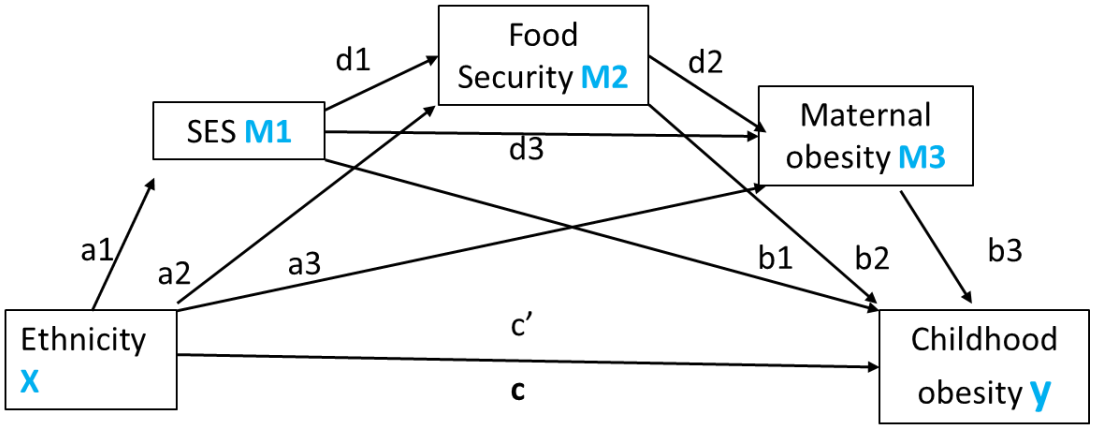
Next part: Thus far, I have analysed the relationship between ethnicity, risk factors and childhood obesity across Indigenous, Afro-descendant and reference population children. Wealth index, maternal weight status and food security were the variables with the strongest associations observed in each group. The next section is concerned with analysing these variables in a way that accounts for the interconnections between them. The aim is to determine whether these variables contribute alone or in an interconnected fashion to the development of childhood obesity within ethnic groups.

Part 3: Mediation and the relationship between ethnicity and childhood obesity in Colombia

In testing mediation models, the goal is to test the direct effect of ethnicity on childhood obesity (c) and the indirect effect operating through mediators, e.g. socioeconomic status, food security and maternal obesity (see Figure 10). The assumption is that the mediators are somehow correlated, albeit not necessarily through a causal relationship; for example, while socioeconomic status may influence food security, and may also influence maternal obesity status, the common cause is ethnicity, which is the variable of interest (or causal factor) for this analysis. This model indicates the three indirect effects that were estimated as the product of regressions linking ethnicity and socioeconomic status (a1b1), ethnicity and food security (a2b2), and ethnicity and maternal obesity (a3b3), along with the specific indirect effects of each one (Hayes, 2013). Further information about mediation models in relation to other measures in epidemiology can be found in box 7.

Other variables such as food exposure and television watching were used in the regression analysis, part 2; however, these were not included to test mediation models because they were only available for sub-samples within the data.

Figure 10 Three serial mediation model for the relationship between ethnicity and childhood obesity proposed for the Colombian case



Nomenclature	Name	Description
X	Exposure variable	Ethnicity (Subgroup analyses comparing either Indigenous and others, or Afro-descendant and others)
Y	Outcome variable	Overweight and obesity combined
M1, M2, M3	Mediator variable	M1: socioeconomic status (SES) M2: food security M3: maternal obesity
a1, a2, a3	Specific indirect effects	Specific indirect effect of the exposure on mediators.
b1,b2,b3		Specific indirect effect of mediators on the outcome
d1,d2,d3		Specific indirect effect of each mediator between each other
c'	Total direct effect	total direct effect of ethnicity in childhood obesity
c	Total effect	Total effect of the model

Figure 10 depicts the mediation model hypothesised for the relationship between ethnicity and childhood obesity through three mediators. It corresponds to the first path of the DAG shown in Chapter 4. In this graph, ethnicity is linked to childhood obesity through two different paths: in short, ethnicity may influence childhood obesity either directly or through mediators (socioeconomic status, food security and maternal status).

Through the mediation model, I attempt to answer the following analytical questions:

1) Is socioeconomic status mediating the relationship between ethnicity and childhood obesity? Ethnicity→SES→ obesity (a1b1)
2) Is food security mediating the relationship between ethnicity and childhood obesity? Ethnicity→food security→ childhood obesity (a2b2)

3) Is maternal obesity mediating the relationship between ethnicity and childhood obesity? Ethnicity→maternal obesity→ childhood obesity (a3b3)
4) Are socioeconomic status and food security status mediating the relationship between ethnicity and childhood obesity?
   Ethnicity→SES→food security→ childhood obesity (a1d1b2)
5) Are food security and maternal obesity mediating the relationship between ethnicity and childhood obesity?
   Ethnicity→ food security→maternal obesity→childhood obesity (a2d2b3)
6) Are socioeconomic status and maternal obesity mediating the relationship between ethnicity and childhood obesity?
   Ethnicity→SES→maternal obesity→ childhood obesity (a1d3b3)
7) Are all three factors mediating the relationship between ethnicity and childhood obesity?
   Ethnicity→SES→food security→maternal obesity→ childhood obesity (a1d1d2b3)

Whether these paths have a negative or positive effect depends on the context for each ethnic group in Colombia. It has been documented (ENSIN 2010) that 40.8% of households in Colombia suffer some degree of food insecurity, with severe levels of food insecurity more often observed among the poorest households. This has also been associated with geographic area, in that less accessible areas of the country have a higher prevalence of food insecurity. This geographical pattern coincides with the location of Indigenous settlements and Afro-descendant communities (Isanaka et al., 2007, Arias et al., 2013, Quinonez et al., 2010). Moreover, most of these affected territories have also suffered due to the presence of armed conflict, which has negatively affected the availability of food and food habits, especially in the Indigenous population (Arias et al., 2013). Therefore, my hypothesis is that Indigenous children have a higher risk of obesity via food insecurity than the Afro-descendant or reference populations (Hypothesis 1)

Moreover, the indirect path also shows a secondary relationship via maternal obesity status. In Colombia, this relationship has been documented in the general population (McDonald et al., 2009). However, there is no evidence to determine whether this

relationship differs by ethnic group. In other countries, maternal obesity has been associated with higher risk of obesity and overweight in children (McNaughton, 2011, Taveras et al., 2010). Moreover, household food insecurity has been associated with maternal feeding practices, which may in turn influence both maternal weight and infant feeding practices (a description of these additional mediators can be found in the next path described in the next section) (Heslehurst et al., 2010a, McNaughton, 2011). Additionally, in Colombia, Afro-descendant women have shown a higher prevalence of obesity (measured through BMI and increased waist circumference) than the general population (2010 ENSIN). Therefore, my second hypothesis is that Afro-descendant children have a higher risk of obesity via food security and maternal obesity than Indigenous or reference population children (Hypothesis 2).

5.5 Methods

5.5.1 Special considerations regarding the statistical package

Adaptation of the DAG to test the mediation model and the structural equation analysis was performed using MPlus (Copyright (c) 1998-2017 Muthen & Muthen). MPlus is a statistical modelling program specifically designed for the testing of complex models, such as multilevel models or structural equation modelling mediators, which are difficult to manage using other statistical software. I was trained to use this software and can thus perform analyses using categorical variables and testing three series mediation models, as I planned.

5.5.2 Data analysis strategy

To address the mediation analysis, I tested the first pathway suggested by the DAG proposed in the previous chapter: that is, a pathway passing through socioeconomic status, food security and maternal obesity. I allowed for a flexible approach in light of the dataset limitations, e.g. the limited availability of variables for each node, as well as the limited number of observations with available information on those variables. I tested out the path including sociodemographic variables, food security and maternal variables, as this contained the largest and most robust sample of people with complete information on these variables. Further information about sample sizes is presented in the first part of the results. The path was tested through structural equation modelling for categorical variables as a three serial multiple

mediation model, as shown in Figure 10. Table 20 provides the description of the variables, along with the ways in which categories were organised to test the mediation model. A note on the estimators used in the mediation analysis and their interpretation is shown in Box 7.

Table 20 Table of variables for the mediation model

Nomenclature	Name of variable	Description
X	Exposure variable	Ethnicity measured through a binary variable. Independent analysis for Indigenous in comparison with others (0:other, 1:Indigenous), and Afro-descendant in comparison with others (0:other, 1:Afro-descendant)
Y	Outcome variable	Overweight and obesity combined through a binary variable (0: No, 1:Yes)
M1, M2, M3	Mediator variable	M1: socioeconomic status (SES) measured through wealth index as an ordinal variable (1:lowest quintile-poorest to 5:higuest quintile-richest) M2: food security measured through an ordinal variable (1:food security to 4: severe food insecurity) M3: maternal obesity measured through a binary variable (1=mother with obesity, 0= mother without obesity)

The total effect of ethnicity can be estimated from the product of each indirect effect, as shown in the following equation:

Equation 1. $c = c' + a1b1 + a2b2 + a3b3 + a1d1b2 + a1d3b3 + a1d1d2b3 + a2d2b3.$

The total indirect effect of ethnicity on childhood obesity in the serial multilevel model is the difference between the total effect and direct effect, as shown in the following equation:

Equation 2. $c - c' = a1b1 + a2b2 + a3b3 + a1d1b2 + a2d2b3 + a1d3b3 + +a1d1d2b3$

Box 7 Estimators used for testing mediation models and its interpretations

According to Hayes 2013, the most important feature to highlight in this type of diagram is the sign of the coefficients, especially for c and c'. It helps to identify whether the relationship between two variables is positive or negative, in other words, if a determined variable is having an influence on another one and the direction in which it occurs. The estimator for the mediation analysis of categorical and binary variables is the log odds obtained through logit regressions (Hayes, 2013).

Log odds coefficients can be interpreted according to the scale of the variable. A positive or negative coefficient should be interpreted as the positive or negative change of the log odds for every increasing in one point of the variable (or category). For instance, a given log odds of -0.4 between Afro-descendant and food security could be interpreted as 'when the ethnicity category is equal to 1 (or subgroup Afro-descendant) there is a decrease of 0.4 of childhood obesity for every one unit change in food security category. As food security is an ordered variable starting from secure to severe insecurity, it means that there is a decrease of the log odds of 0.4 from one category to another, in other words, this example illustrates that the more insecure the less probability of having obesity among the Afro descendant children.

Statistical coefficients obtained in graphs are presented in the results section using log odds coefficients, however, the log odds were exponentiated to get odds ratio to facilitate the interpretation of each path and are shown in a table comparing ethnic groups. Here is an example to interpret the exponentiated log odds (or odds ratio):

Dichotomous exposure variable: 1=Afro-descendant 0=Other
Dichotomous mediator variable: 1=mother with obesity, 0= mother without obesity
Odds ratio=1.5
An odds ratio of 1.5 indicates odds are 1.5 times higher for each unit change in the exposure variable, in other words, the odds of having a mother with obesity is 1.5 times higher among Afro-descendant in comparison with the 'other' ethnic group.

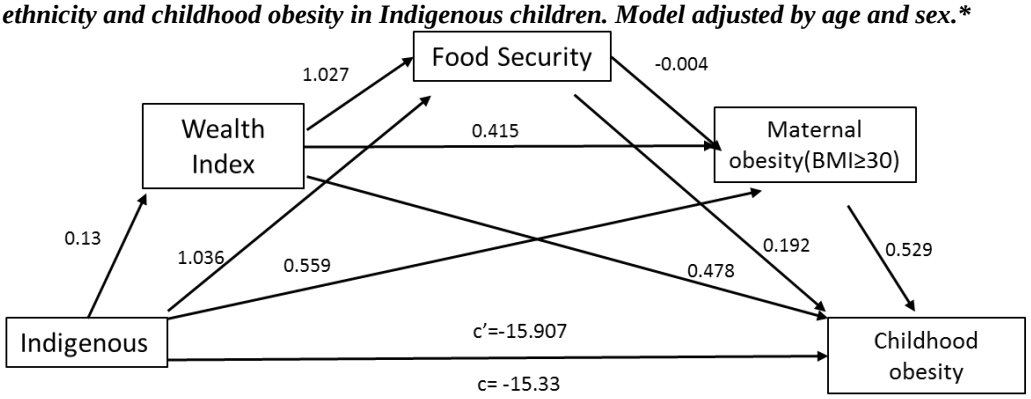
5.5.3 How does the directed acyclic graph (DAG) tested through mediation models help us to better understand the relationship between ethnicity and childhood obesity in Colombia?

Figure 11 and Figure 12 illustrate a statistical diagram presenting the coefficients for the direct effect of ethnicity (c'), i.e. Indigenous or Afro-descendant respectively, on childhood obesity, adjusted by sex and age. The figures also show the total indirect effect of individual relationships (c) and log odds coefficients for each individual indirect effect.

By proposing a mediation model, I have hypothesised that the relationship between ethnicity and childhood obesity is not direct; instead, I proposed a path including three potential mediators. As can be seen from figure 5, there is a negative effect of ethnicity on childhood obesity among Indigenous children (c'= -15.91, $p<0.05$, 95% CI - 16.10 to -15.71). This reaffirms my hypothesis that being Indigenous does not directly influence the obesity-related outcome. However, the total individual indirect effect (c) was also negative for the model tested on Indigenous children (c= - 15.33, $p<0.05$, 95% CI -15.48 to -15.18); therefore, I cannot conclude that being Indigenous, through these specific mediators, is having an effect on childhood obesity.

This finding should be interpreted carefully, given that the direct effect (c') and the total effect (c) might not reflect the truth about individual relationships that was also hypothesised in the model, such as the separate relationship with maternal obesity or food security.

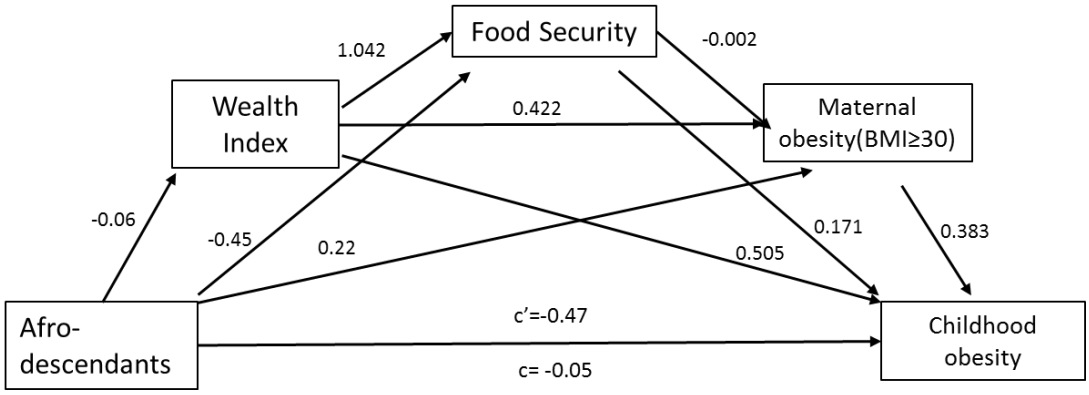
Figure 11 Three serial mediator model and the specific indirect effects for the relationship between ethnicity and childhood obesity in Indigenous children. Model adjusted by age and sex.*



*Indigenous is a dichotomous variable in which indigenous = 1, reference population =0; Wealth index is an ordered categorical variable as well as food security. Maternal obesity and childhood obesity are binary variables in obesity =1.

Figure 12 shows a similar pattern when the model is tested in Afro-descendant children. There is no direct effect of being Afro-descendant on having childhood obesity (c'= -0.47, p<0.05, 95% CI -0.080 to -0.014); nor is there a total indirect effect of being Afro-descendant, through mediators, on having childhood obesity (c= -0.050, p<0.05, 95% CI -0.084– -0.016). As was mentioned for the Indigenous group, there are further explorations regarding the effects of individual paths (shown in table 21) that may provide additional insight.

Figure 12 Three serial mediators model and the specific indirect effects for the relationship between ethnicity and childhood obesity in Afro descendant children. Model adjusted by age and sex.



*Afro-descendants is a dichotomous variable in which Afro-descendants = 1, reference population =0; Wealth index is an ordered categorical variable as well as food security. Maternal obesity and childhood obesity are binary variables in obesity =1.

Further exploration of the products of the coefficients for each path (as shown in table 21) provide insight into these alternative hypotheses. Table 21 shows the log odds for the direct effect, the total indirect effect and each indirect effect for Indigenous and Afro-descendant children. Each coefficient has been converted into an odd ratio to facilitate its interpretation. This table shows what I have already mentioned: namely, that there is a negative effect between the relationship of ethnicity and childhood obesity, either directly or through mediators. However, additional information for each path is also displayed, and alternative hypotheses could also be discussed. The paths including a single mediator are shown to be significant when individual coefficients are taken into account; however, this mediation was present only in the Indigenous group. Socioeconomic status (OR 1.06, log odds 0.06, 95% CI 0.04 to 0.05) and food security (OR 1.22, log odds 0.20, 95% CI 0.13 to 0.30), separately, proved to be significant mediators of the relationship between ethnicity and childhood obesity. Nevertheless, it was maternal obesity that emerged as the strongest and most significant mediator of the relationship (OR 1.32, log odds 0.30, CI 95% 0.25 to 0.35).

In summary, I did not find that the three serial mediation model explained the relationship between ethnicity and childhood obesity. However, I did observe that paths involving only one mediator were more useful for explaining this relationship, especially for Indigenous children. I could thus confirm my first hypothesis, namely that Indigenous children have a higher risk of obesity via food insecurity than the Afro-descendant or reference populations; in other words, that food security mediates the relationship between ethnicity and childhood obesity (odds ratio 1.22 times, in comparison with the population from the 'other' ethnic group). In addition, I found that maternal obesity is also a mediator of this relationship among Indigenous children. I was however unable to confirm my second hypothesis, namely that Afro-descendant children have a higher risk of obesity via food security and maternal obesity than Indigenous or reference population children. This negative finding in the Afro-descendant group might not be definitive, and additional studies in other Afro-descendant populations in Colombia are needed. In addition, it is important to take into account that mediation models were tested on the basis of a specific path of variables selected (food security, maternal weight status, socioeconomic status) and perhaps

other mediators may come up by exploring alternative groups of variables, or by exploring moderators in the model. However, evaluating alternative pathways in mediation was not feasible for this thesis given the high complexity to accomplish such task, and therefore the analyses I conducted represent an example of one approach among multiple ones to try to identify mediators between ethnicity and childhood obesity acknowledging the DAG discussed previously. The contrasting positive finding of food insecurity and maternal weight status as mediators between being indigenous and being overweight or obese could obey a more severe context of poverty broadly described for this ethnic group which might trigger more evident mediation factors.

Table 21 Testing the mediation model through three potential mediator for Indigenous in comparison with others and Afro-descendant in comparison with others.

Path	Indigenous (n= 7,676)µ		Afro-descendants (n= 6,760) µ	
	Log odds (95%CI)	OR(95%CI) ¥	Log odds (95%CI)	OR (95%CI)¥
Direct effect (c')	-15.91(-16.10 to -5.71**	0	-0.05 (-0.884 to -0.16)*	0.95 (0.41-1.17)
Total indirect effect (c)	-15.33(-15.48 to -15.18)**	0	-0.05 (-0.08 to -0.01)*	0.95 (0.92-0.99)
Indirect effects				
Is socioeconomic status mediating the relationship between ethnicity and childhood obesity? Ethnicity→SES→ obesity (a1b1)	0.06 (0.04 to0.05)**	1.06 (1.04-1.05)	-0.003 (-0.07 to 0.001)	0.99 (0.93-1)
Is food security mediating the relationship between ethnicity and childhood obesity? Ethnicity→food security→ childhood obesity (a2b2) §	**0.20 (0.13 to 0.30)****	**1.22 (1.14-1.35)**	-0.008 (-0.02 to 0.001)	0.99(0.98-0.99)
Is maternal obesity mediating the relationship between ethnicity and childhood obesity? Ethnicity→maternal obesity→ childhood obesity (a3b3)	**0.30 (0.25 to 0.35)****	**1.35 (1.28-1.42)**	0.009 (0.013 to 0.05 to)**	1 (1.01-1.05)
Are socioeconomic status and food security status mediating the relationship between ethnicity and childhood obesity? Ethnicity→SES→food security→ childhood obesity (a1d1b2)	0.03 (0.02 to 0.04)**	1.03 (1.02-1.04)	-0.001 (-0.03 to 0.00)	1 (0.97-1)
Are food security and maternal obesity mediating the relationship between ethnicity and childhood obesity? Ethnicity→ food security→maternal obesity→childhood obesity (a2d2b3)	-0.002 (-0.01 to 0.00)	0.99 (0.99-1)	0.000 (0.00 to 0.00)	1
Are socioeconomic status and maternal obesity mediating the relationship between ethnicity and childhood obesity? Ethnicity→SES→maternal obesity→ childhood obesity (a1d3b3)	-0.000 (-0.001 to 0.00)	1(0.99-1)	0.000 (0.00 to 0.00)	1
Are all of three factors mediating the relationship between ethnicity and childhood obesity? Ethnicity→SES→food security→maternal obesity→ childhood obesity (a1d1d2b3)	0.00 (-0.001 to 0.00)	1(0.99-1)	0.000 (0.00 to 0.00)	1

µ Unweighted number of people *$p \leq 0.05$; ** $p \leq 0.001$ p value based on Wald Test to these if the product of two paths is different from cero (e.g. a*b≠0)

¥ Log-odds (LO) estimator and confidential intervals were converted to odds ratio (OR) through the equation: OR= exp[LO]

In summary, by testing mediation models, I found that maternal obesity status plays a key role in the development of obesity among children across all ethnic groups in the association analysis. This was also observed in the mediation model, especially for Indigenous children. There were no studies found in the systematic review that investigated the relationships between obesity and maternal obesity. However, this association has been previously documented in other settings (Taveras, 2010; Zilanawala, 2014; Heslehurst, 2010). One possible explanation is that mothers tend to make decisions about food and the main activities performed by children, a phenomenon that has been recently documented in Colombia (National Survey of Demographics and Health, 2018). Thus, the maternal role model is a crucial aspect to consider when developing strategies to tackle childhood obesity.

5.6 Summary of findings of the secondary analysis

In this chapter, I sought to better understand ethnic differences in childhood obesity in Colombia through conducting a secondary analysis of the 2010 National Nutrition Health Survey (ENSIN). I approached the analysis by estimating the prevalence of childhood obesity according to age groups and sex, as well as using directed acyclic graphs to understand the links between ethnicity and other potential risk factors for childhood obesity in Colombia. In this section, I discuss the findings in light of studies from the five ethnically diverse countries of comparison included in the systematic review.

The findings demonstrated statistically significant differences in the prevalence of overweight including obesity by ethnicity. Within age groups, the highest prevalence was found among either Indigenous or reference population children. Regarding sex, moreover, girls were more likely to experience obesity than boys across all age and ethnic groups.

Among children aged 2-5 years, Indigenous children showed the highest prevalence of overweight and obesity, especially among girls (13.1%, compared with 12.5% among boys). In Colombian children aged 6-10 years and 11-13 years, the group with the higher prevalence of obesity and overweight was the reference population in both sexes (about 15%). By contrast, the highest prevalence across age groups was

found in adolescent girls aged 14 to 18 years old, especially among Indigenous girls (23.7%).

Regarding the distribution of risk factors by ethnic group, socioeconomic factors (such as wealth) and maternal socioeconomic variables (such as education level) were inversely and significantly associated with childhood obesity by ethnic group, especially among indigenous children. This reveals a pattern in which childhood obesity affects people of lower socioeconomic status. Maternal obesity, as measured through body mass index, was strongly associated with childhood obesity in the reference and Indigenous populations, while increased waist circumference or abdominal obesity was a strong predictive factor for Indigenous and Afro-descendant children.

There was no clear pattern of risk factors in terms of diet and television watching, although the reference population tended to have worse indicators of consumption of sweetened drinks and crisps and hours in front of the television screen. Moreover, the Afro-descendant population showed higher consumption of unhealthy food when compared with the Indigenous population.

The three serial mediation model has enabled an examination of how the relationship between ethnicity and childhood obesity can be modified by intervening variables. However, I did not find that the model using three serial mediators was useful in explaining this relationship. Instead, I found that some paths involving just one mediator explained the relationship on their own; this was observed for the Indigenous group only. Socioeconomic status, food security and maternal obesity proved to be separate mediators in this group (OR 1.05(95% CI=1.04-1.06), OR 1.22(95% IC=1.14-1.35), OR 1.35(IC95% 1.28- 1.42), respectively).

5.6.1 Contrasting findings with studies included in the systematic review

My findings were consistent with those from the systematic review in terms of the high prevalence of overweight and obesity in ethnic minority groups. Most explorations that I performed for the secondary analysis reveal that Indigenous children in Colombia are more likely to experience overweight and obesity and show

an unfavourable pattern of risk factors for childhood obesity; this was clear from both the association analysis and the illustrative example using mediation models. In the systematic review, I included 12 studies examining the Indigenous population: three studies from Brazil, six from Mexico and three from Canada. In most of these studies, Indigenous children showed a lower prevalence of overweight or obesity than other ethnic groups.

In Brazil, the country most similar to Colombia in terms of its population, only one study explored the Indigenous population. The authors compared children belonging to the *Aruak* and *Karibe* peoples aged from 0 to 5 years (Mondini et al., 2009). It was interesting to observe that children from both ethnic groups showed a low prevalence of overweight including obesity (2.8% *Aruak*; 3.61 % *Karibe*). Contrasting with my findings, the Brazilian study might reflect the situation that has been described for Indigenous peoples in Latin America: namely, that obesity within this age group has not been as major an issue as undernourishment and chronic undernutrition (Montenegro and Stephens, 2006). However, to some extent, morbidity in Indigenous communities depends on the contact with the general population (Montenegro and Stephens, 2006). My findings among this age group may reflect a pattern in which Indigenous people are moving into mainstream society, and thus showing rates of obesity similar to those in the general population. In particular, this could impact Indigenous people in early childhood, a time at which family environment and parental behaviours strongly influence children's lifestyles.

The lack of comparison with a reference population in the Brazilian study makes it difficult to use this information for public health purposes at a national level. I did not include specific Indigenous peoples in the secondary analysis because this information was not available in the dataset. Even if this information had been available, however, my purpose was to compare ethnic minority groups with the majority of the population in order to explore comparisons at a national level.

In Mexico, only one out of the six studies examined children under five years of age (Gonzalez-de Cossio et al., 2009). Indigenous children had a slightly lower prevalence of overweight including obesity when compared with non-Indigenous children across different Mexican Nutritional Health surveys. The 1988 survey

reported a prevalence of 4.7% (in comparison with 6.2% among non-Indigenous children); in 1999, these figures were 5.8% and 7.8%, respectively, while in 2006 they were 5.5% and 7.8%, respectively. The prevalence I have observed for Colombian Indigenous children was almost double that if the prevalence reported for the Mexican study. In my research, I used the extended IOTF BMI cut-off points, while the Mexican study used the WHO standard (based on weight-for-height ratio). Furthermore, the age group used in the Mexican study also included children less than 2 years of age. The WHO standard is appropriate for defining obesity in children aged 0 to 5 years, while IOTF is used for children over 2 years of age. These methodological differences make it difficult to compare both studies; this is because the standard selected to define obesity might affect the estimation of the prevalence, especially for combined definitions such as overweight including obesity (Gonzalez-Casanova et al., 2013).

On the other hand, the lower prevalence among Mexican Indigenous people could reflect differences in risk factors between both countries. Despite Mexico and Colombia being neighbouring countries, there may well be deep differences between them in terms of lifestyle and health policies; therefore, more evidence is necessary in this respect, especially for early childhood. Furthermore, the Mexican study analysed national surveys from the last decade, suggesting that an updated study would be useful to explore the increase in obesity that has been documented for Mexico more generally, as well as the question of whether prevalence has risen equally among then Indigenous population (Hernández-Cordero et al., 2017).

There were no other studies included in the systematic review looking at Indigenous children less than 5 years of age, nor any that conducted explorations by sex. The prevalence of overweight and obesity in Colombian Indigenous children younger than 5 years is more akin to that described for overweight in Mexican Indigenous children in older age groups (Bonvecchio et al., 2009, Torre-Diaz et al., 2014).

The prevalence of childhood obesity in middle childhood and pre-adolescence (6-10 and 11 to 13 years) is in line with studies in Mexican and Brazilian populations, but stands in contrast to studies conducted in the United Kingdom, in which most research found higher childhood overweight and obesity in ethnic minority groups

when compared with White children/the general population. In a Mexican study looking at children of 5 to 11 years of age, the prevalence of overweight was 20.4% among the reference population (non-Indigenous children) compared with 12% among Indigenous children (Hernandez et al., 2003). The same pattern of lower overweight prevalence in an ethnic minority group was observed in one Brazilian study, which compared Indigenous children, White children and children of other skin colours aged 11-19 years (Araujo et al., 2010). In this study, children identified as White exhibited a higher prevalence of overweight (25.3%) and obesity (8.2%) than other groups.

In my research, the rather contradictory findings among Indigenous populations in early childhood versus those in middle childhood and adolescence may reflect the nutrition transition that has been observed in most developing countries (Uauy et al., 2001, Parra et al., 2015b, Isanaka et al., 2007, Gracey and King). Recently, this transition has been documented for Colombia, especially among low-income populations (Parra et al., 2015b). On the other hand, higher rates of obesity in the majority of the population might reflect the documented shift in lifestyles linked to the obesity epidemic across the globe (Dutra et al., 2016, Nascente et al., 2016, Maras et al., 2015, Tagliari et al., 2016). This shift has been associated with poor health habits impacting the eating behaviours and physical activity of an increasingly urbanised population.

However, the majority population (as defined in the studies) may well be heterogeneous, meaning that interpreting results is not straightforward. For instance, Mexican studies tend to compare Indigenous with non-Indigenous children as standard, while Brazilian studies tend to use White as a standard to compare with four other categories of skin colour. If researchers are framing childhood obesity in terms of ethnicity, what are the criteria used to select the majority of the population as a standard? The standard population should be the group of children with the desirable level of health (Bhopal, 2014), in this case as regards nutrition or adiposity. But what do we know about those children in standard categories? The estimation of the prevalence of childhood obesity by ethnic group cannot provide the best perspective from which to interpret ethnic differences. This is crucial to consider

when investigating settings in which little is known about the characteristics of the ethnic groups in terms of obesity risk factors, as is the case in Colombia.

Research comparing the associations between ethnicity and weight status involving risk factors other than socioeconomic factors is lacking in the literature. In contrast to what is observed in many high-income countries, I found that wealth was positively associated with overweight, a finding that was in line with UK studies. Interestingly, the BMI gap between girls and boys in 2010 was significantly smaller among the wealthiest children and adolescents than among the poorest, especially for Indigenous people. As in high-income countries, girls from high socioeconomic strata in Colombia may be more concerned with weight control and may also have access to more resources to achieve a healthy weight than girls from low socioeconomic strata. These relationships between sex and wealth suggest a need to design wealth- and sex-specific interventions that address underlying dynamics and prevent the burden of obesity from shifting to the poor.

Moreover, the associations found at the household level may reflect the particularities of the structure and tight bonds of Latin American families. Family size was inversely associated with overweight, which is consistent with evidence from high-income countries showing that living within a family of more than three members decreases the risk of overweight among children. This finding was similar to my finding; however, the research mentioned above was not conducted by ethnic group. Additionally, it was not possible to determine the precise composition of the family (for example, the presence of more children, grandparents, etc.) that could have influenced food choices and feeding practices.

There were also significantly more obese children consuming sugary drinks and confectionery in the Afro-descendant and reference populations. The two studies from Mexico that included risk factors related to food exposure also reported positive relationships between meal types; however, the authors reported that for Indigenous respondents, there were more than 45% of missing values for this evaluation. The observed difference may therefore result from a lack of rigour in the findings (Bonvecchio, 2009; Hernández-Cordero, 2017).

5.6.1 Strengths and limitations of the secondary analysis

There are several strengths of this analysis. Firstly, this is the first analysis of the Colombian population on childhood obesity and ethnicity that examines prevalence by age and sex and includes the exploration of risk factors for childhood obesity. This is also the first study in Colombia to use directed acyclic graphs in order to study the relationship between ethnicity and childhood obesity, an approach that enables the study of childhood obesity as a complex issue, including different paths of risk factors beyond biological factors. However, testing DAGs depends on the availability of data, as well as the quality of this data.

Another strength of this research is the use of multivariate models to explain childhood obesity within each ethnic group, as this enables the association patterns from each ethnic group to be contrasted (rather than simply comparing differences in childhood obesity prevalence by ethnicity).

Using mediation models as an illustrative example of the possible explorations that could be conducted with regards to ethnicity and obesity be a promising future direction for informing health policy, especially when comparing the differences and similarities between ethnic groups.

Using proxy measures of adiposity markers to categorise adiposity status, particularly BMI, might result in adiposity being underestimated in some ethnic groups. This is critical for indexes based on weight and height that are usually applied in research at the population level. The choice of the Extended International Cut-Off Points for childhood obesity facilitated comparison with results from other studies included in the systematic review; however, most studies from Mexico and Brazil used the WHO charts, which limited the degree of comparison with populations of children that could be similar to the Colombian population.

The reference population was carefully selected. This ethnic coding excluded people from the other ethnic minority groups in Colombia (Roma, Raizal and Palenquero); these groups deserve to be analysed separately given their potential differences as

regards obesity-related practices/behaviours. The limitations associated with using the majority of the population as a reference population are related to the interpretation of data. These results should therefore be approached with caution, especially in contexts in which little is known about the characteristics of this population in Colombia. As noted above, I was unable to analyse data from other ethnic minority groups (such as Roma and Raizal) because the number of people from these ethnic groups included in the master sample was too low to enable analysis with sufficient statistical power to be performed.

All studies have limitations; in this case, the main limitations of this research were related to the ENSIN dataset. The different modules of the survey (anthropometrics, diet, physical activity) were not conducted for the same population sample, which resulted in missing values and loss of statistical power when the dataset was compiled to run the multivariate analysis. Additionally, the sampling for the 2010 ENSIN was not representative of each ethnic group, since these ethnic groups were not part of the calculation for the sample estimation of the survey. However, the survey also included an oversampling of the low-income population. In Colombia, belonging to ethnic minority groups has long been associated with low socio-economic status, especially for Indigenous populations. Thus, the oversampling may benefit the sampling of the two ethnic minority groups analysed here.

A second limitation pertained to data on diet and physical activity. This limitation was rooted in the questionnaires used in the original survey, such as the 24-hour recall. The participants, or their parents or tutors, may have reported imprecise information due to reminding issues. An additional limitation of data on diet was that it was collected from a sub-sample of children that had not necessarily also submitted data on physical activity or other risk factors, which would have enabled more complete analysis of this population.

Regarding the previously reported prevalence of childhood obesity by ethnic group previously reported for Colombia (ENSIN report 2011), the prevalence trend of childhood obesity reported in the present secondary analysis exhibits the same trend. However, I used a different approach to estimate the prevalence. In the Colombian study, the comparison of Afro-descendant, Indigenous and ‘other’ ethnic groups

revealed a trend for a lower prevalence of overweight in the first ethnic group, in both younger and older children. In particular, children aged less than 5 years from Indigenous ethnic groups showed a higher prevalence of overweight and obesity than those from other ethnic groups, but a lower prevalence of obesity in older children. The prevalence of overweight including obesity was not estimated for children less than five years of age; it was reported for three age groups, less than five years old, between 5 and 10 years and adolescents, and was also not reported by sex. Furthermore, in the Colombian report, the prevalence was estimated on the basis of WHO standards.

In my analysis, there were two main approaches that enabled me to describe this trend in more detail. My approach involved analysing the prevalence of overweight including obesity by different age groups: 2 to 5 years (to analyse pre-school age), 6 to 10 years (to analyse school age), 10 to 13 years (to analyse children going through puberty), and 14 to 18 years (to analyse adolescents). Thus, I took into account those age groups in which an adiposity rebound is expected, such as pre-school and puberty (Hu, 2008). On the other hand, although the direction of the prevalence was comparable with the Colombian study, using WHO or IOTF standards to define childhood obesity could affect the magnitude of the prevalence observed. The increased prevalence observed in the Colombian study could thus be attributed to the cut-off points of the WHO standard. The fact that this standard tends to overestimate childhood obesity prevalence has been documented in several studies, particularly a study using data from Colombia (Gonzalez-Casanova et al., 2013). One possible explanation for this difference is that the data from the WHO comes from before the obesity epidemic; by contrast, the IOTF (and the updated version used here) is based on data collected afterwards. Using IOTF standards is more appropriate for estimating prevalence in countries with an incipient obesity epidemic.

5.6.2 Conclusion of the secondary analysis

This study set out to better understand the relationship between ethnicity and childhood obesity in Colombia through conducting a secondary analysis of the Colombian Nutrition Health Survey (ENSIN) conducted in 2010. Prior to this research, the only available information about ethnicity and childhood obesity came

from a study reporting prevalence of overweight and obesity by ethnic group in Colombia without any further exploration of other variables, such as sex or socioeconomic factors.

This study adds to the body of current knowledge by providing an exploration of those risk factors, while also adopting an approach that acknowledges the complexity of obesity. Although the dataset featured limitations regarding the number of children involved in the subsamples for analysing obesity risk factors, I was still able to demonstrate the important role of socioeconomic and maternal variables in the development of childhood obesity, especially among the Indigenous population.

Because of the nature of the data available for the secondary analysis, I was not able to further explore the relationship between childhood obesity and ethnicity by using a qualitative approach. Mother obesity status proved to be a mediator of this relationship. In addition, the association analysis confirmed that the lower the education status of the mother the higher the opportunity of having a child with overweight (or overweight including obesity). Exploring these contexts beyond the quantitative approach is needed to understand situations underpinning childhood obesity. A qualitative o mixed-methods research is key to identify deeper explanations in obesity linked behaviours inside each ethnic group. These behaviours may be triggered by cultural or environment determinants that could be more evident by inquiring into perceptions, points of views, and knowledge of the subjects

An approach based on studying the prevalence of childhood obesity by ethnic group, as well as studying risk factors through directed acyclic graphs and conceptual frameworks in a way that acknowledged the complexity of obesity, proved useful in understanding the relationship between ethnicity and childhood obesity in Colombia.

Chapter 6 Discussion

The aim of this chapter is to summarise the findings of this doctoral thesis, as well as to discuss them within the context of the overall reflections and recommendations emerging from this research study.

I embarked upon this PhD thesis with the aim of understanding the role of race and ethnicity in framing childhood obesity as a public health problem in Colombia, contrasted with Brazil, Mexico, Canada and the United Kingdom. The research questions supporting this aim were as follows:

1. Are the categories of race and ethnicity, and their conceptualisation, in Colombia similar to those in Brazil, Mexico, Canada and the United Kingdom?

2. In what ways have race and ethnicity been applied to measuring and analysing childhood obesity in Colombia, and how does this approach differ from the approaches applied in Brazil, Mexico Canada and the United Kingdom?

3. Is there variation in the racial and ethnic distribution of childhood obesity in Colombia?

Colombia is a multicultural and multi-ethnic country in which a nutrition transition has been documented (Sarmiento et al., 2014, Parra et al., 2015a, Gonzalez-Casanova, 2014). Studies exploring nutrition and health in Colombia have identified a pattern such that the most disadvantaged populations seem to have the worst indicators regarding both undernutrition and over-nutrition. This disadvantage is often based on indicators from the Gini coefficient (i.e. low income, low level of education, low access to health, or other indicators based on a combination of these variables with household characteristics). Regarding these indicators, evidence suggests that ethnic minority groups experience lower levels across the board when compared with the majority of the population (Parra et al., 2015c, Gonzalez-Casanova, 2014, Dedios Sanguineti, 2017).

As a result, analyses by ethnicity are desirable, if not necessary, for most epidemiological research in Colombia. However, the current body of literature that

includes ethnicity as a variable is limited, especially that related to nutrition status (Agudelo-Suarez et al., 2016, Acosta and Meisel, 2013, Bernal and Cárdenas, 2005). I have crafted this thesis to respond to the need to understand ethnicity in the study of population health by looking at the case of a complex health event: in this case, childhood obesity. Thus, I hope to contribute to filling the methodological and theoretical gaps in research in this area, as well as to help in targeting actions to tackle childhood obesity.

The discussion is divided into five sections. First, a summary of the findings from chapter 1 to 4. Second – addressing the aim of this thesis – a reflection on the role of ethnicity in framing childhood obesity. Third, a reflection on ethnicity and childhood obesity in epidemiology. Fourth, a discussion on the influence of maternal weight status in childhood. Fifth, a discussion about the strength and limitations of this research.

6.1 Summary of findings

The first chapter presented a review of research literature addressing the concepts of childhood obesity and ethnicity. This chapter shows that obesity has been framed as a biological and individual problem for almost a century. It also shows that the increase in the global prevalence of obesity over the last three decades has given rise to a new debate about the complexity of factors influencing obesity. These new perspectives have involved the study of the environment surrounding individuals and communities; for example, the study of the built environment, or market influences on decisions around food and lifestyle.

This literature review also demonstrated that there are no similar categories and conceptualisations of race and ethnicity within the countries of interest. The definitions and theories supporting ethnic codes are continuously evolving and shaped by sociocultural, economic and/or political circumstances. In the countries reviewed, the measurement of ethnicity ranged from self-report, region or country of origin to skin colour and spoken language, along with combinations of some of these approaches. In Colombia, ethnic categorisation is based on self-reporting of the sense of belonging or not to an ethnic minority group.

The gaps in the understanding of the relationship between ethnicity and childhood obesity were also highlighted. For instance, I found several charts and definitions for childhood obesity cut-off points based on reference populations from different countries. These charts are often used to classify populations with different ethnic backgrounds to the original reference population. Children in Colombia, for example, are compared to the WHO growth reference study, the sample for which is based on children from five different countries. Despite the diversity of the population included in this chart, including one from Brazil, this might not reflect the characteristics of Colombian children specifically, which could result in an erroneous interpretation of nutrition indicators. Overall, the heterogeneity of the approach to establishing whether a child has overweight or obesity makes it very difficult to compare childhood obesity between countries.

Before exploring the ethnic variation of childhood obesity in Colombia, I decided to take a more in-depth view in order to better understand the theories and methods used to study childhood obesity in ethnically diverse countries that I could then contrast with Colombia. The inclusion criteria that allowed me to perform this contrast, and to gain insight into the Colombian case, were based around the vicinity and presence of ethnic minority groups such as Indigenous and Afro-descendant populations, the presence of other ethnic minority groups, different approaches to ethnicity and childhood obesity definitions, and varied economic performance. The findings from this section of the thesis comprise a systematic review of the literature around how authors have measured and analysed childhood obesity research in the five countries of interest. They were also the source of more focused research questions leading to quantitative analyses using Colombian data.

Through the narrative synthesis I performed for the systematic review, I was able to identify patterns regarding the reporting of ethnicity, the definitions of obesity used across the studies in paediatric populations, and the alternative analysis involving both variables. I was particularly interested in authors' explanations about their findings on ethnic differences in childhood obesity. In reality, I found little direct

focus of research findings on ethnic groups and childhood obesity. Definitions were markedly heterogeneous, especially for the reporting of ethnicity. Several studies had either unclear or no objectives focused on ethnicity. Few studies included definitions of ethnicity, and analyses of ethnicity and childhood obesity were not always justified. Similarly, in light of the ethnic differences in childhood obesity, discussions in most of the reviewed studies were superficial. Findings collected on excess adiposity were not only on the basis of BMI, but also on other adiposity measures (waist circumference, skinfolds), which might help to enrich analyses in terms of ethnic differences in body fat distribution. There was differential distribution of overweight, obesity and body fat by ethnic categories across the studies drawn from the five countries of interest. In general, these differences revealed a higher prevalence of overweight in ethnic minority groups (including Afro-descendant and Indigenous children from Colombia) vs. White or general population categories, while marked sex differences for ethnicity regarding overweight and obesity were observed in studies from the United Kingdom.

The systematic review identified only two studies in Colombia, neither of which featured deep nor inferential evaluation of the ethnicity-childhood obesity association. One was a secondary analysis of a national survey on nutrition (ENSIN 2010), while the other was a descriptive study in a local region of the Colombian Southwest (Ortega-Bonilla and Chito-Trujillo, 2015). In those studies where ethnic differences in childhood obesity were discussed, the explanations given by the authors were diverse; they primarily revolved around ethnic differences in childhood obesity on the basis of physiological issues, such as the process of maturity, especially among Black/Afro-descendant/Afro-Caribbean girls, who seem to experience early-onset puberty. Researchers also discussed the lower socio-economic status among Aboriginal/Indigenous groups, which could reinforce other risk factors. Less attention was given to other aspects linked to childhood obesity, such as food production, marketing, built environments or individual psychology.

Given the lack of information on the relationship between ethnicity and childhood obesity in Colombia, I used directed acyclic graphs to represent the potential links

between ethnicity and childhood obesity in this country. This exercise was based on the UK Foresight obesity model and took into account the insights derived from the systematic review. I ended up drawing a model with seven potential pathways. These paths were related to genetic variables, physiological variables, socioeconomic status, sociological and obesity-related behaviours. This was the framework I devised to address the secondary analysis of the biggest dataset on nutrition available at that time.

The fourth chapter evaluated the prevalence of childhood obesity across ethnic groups in Colombia, as well as the association between ethnicity and childhood obesity and the influence of risk factor variables in that association, using secondary data analysis. This chapter consisted of a multivariate analysis using logistic regression to determine the best model for the explanation of childhood obesity with ethnicity as the main exposure variable. The sample studied was children surveyed in the Colombian Nutritional survey 2010 (ENSIN 2010), which for the purposes of this research was the best information source available in the country.

The findings revealed ethnic differences in the prevalence of overweight including obesity by ethnicity. The highest prevalence was found either among Indigenous girls or reference population children of both sexes. Overall, girls were more likely than boys to experience obesity across all age and ethnicity groups.

In the association analysis, I was able to confirm that low indicators of socioeconomic factors, such as lowest wealth and low maternal education level, were associated with childhood obesity by ethnic group, especially among Indigenous children. Interestingly, other maternal variables were strongly associated with childhood overweight including obesity. For example, maternal body mass index was strongly associated with childhood obesity in the reference and Indigenous populations. Furthermore, increased maternal waist circumference was strongly associated with obesity among Indigenous and Afro-descendant children.

For the remainder of the risk factors evaluated, there were no strong associations observed. However, children in the reference group tended to consume more sugary drinks and have a more sedentary lifestyle, while, conversely, Afro-descendant

children were more likely to consume healthy food than the Indigenous group. When I analysed mediators, I confirmed that maternal obesity or socioeconomic status could explain the connections between ethnicity and childhood obesity. I also proved this for food insecurity.

6.2 How is ethnicity framing childhood obesity in Colombia?

The findings of this thesis suggest that the frame given to childhood obesity in the current literature in the countries of interest, especially in Colombia, continues to be based on individual behaviour or biological issues. Regarding ethnicity, studies have shown that there are several approaches to addressing this as a concept. As a result, the field of ethnicity and childhood obesity remains narrow in focus, dealing with complexity that can set the scene for investigating disparities among ethnic groups in detail.

In the secondary analysis, I found that a relationship between ethnicity and childhood obesity does exist. The prevalence of overweight, including obesity, tended to be higher in ethnic minority groups, while association with risk factors also tended to be more significant in these groups; Indigenous children in particular were more affected. However, adopting an approach focused on either ethnicity or the Colombian data on nutrition is insufficient, as neither can respond to the need to address obesity as a complex issue in an ethnically diverse country.

In the United Kingdom, the ethnicity variable has evolved into a more granular one according to population growth and diversification (Villarroel et al., 2019). This approach has been applied in biomedical research and has, to some extent, helped to refine obesity indicators for ethnic minorities. For example, several studies included in the systematic review (Harding et al., 2008b, Dinsdale et al., 2010, Henderson et al., 2011) used the census' ethnic classification to evaluate obesity by sub-populations of interest (e.g. Pakistani or Bangladeshi, rather than 'South Asian' as a broader category).

In Colombia, the variables used to define ethnicity have remained the same since the 2005 census. Since then, almost all national surveys have used the same categorisation. The general population, for example, is derived from a 'none of the above' category representing more than 80% of the Colombian population. Such a broad, non-specific definition is likely to include White people, Mestizo people, or other categories reflecting migrants; this is therefore a highly heterogeneous group, which provides reason to believe that the levels of overweight and obesity within this group, along with their root causes, will be equally heterogeneous. The analysis by ethnic categories contributes to an understanding of inequalities that could be used to improve population health; however, it is also limited by the lack of granularity in the measurement of ethnicity.

A similar phenomenon was observed in Mexico, where the census does not include a specific ethnic question and analyses are often performed using a dichotomous variable ('Indigenous'/'non-Indigenous'), providing even less insight into ethnic differences within the population. Until 2015, an Afro-descendant/Afro-Mexican category was incorporated in an interim census; however, figures on other ethnic groups, such as migrants, are very hard to obtain from official reports. In most countries with an Afro-descendant population, this group had the highest prevalence of childhood obesity.

I have mentioned that Colombian data on nutrition are insufficient to enable the study of obesity as a complex issue. By conducting the secondary analysis based on the DAG, I found that there were pathways postulated in the DAG – such as those passing through racism, market influences and individual psychology – that could not be addressed to study ethnicity and childhood obesity using the survey on nutrition (ENSIN). By using ENSIN data, however, I could chart pathways through socioeconomic position and diet with more detail. My findings support my hypothesis that socioeconomic status measured through proxy variables, such as education, income or food security, might mediate the relationship between ethnicity and obesity, especially in the Indigenous group. Regarding individual behaviours, I could not prove the link to childhood obesity; this is likely because these behaviours

were measured using problematic methods, such as the 24-hour diet recall interview, that can be sources of random error and might result in misclassification bias (Gibson et al., 2017). This set of data is useful for the analysis of food security, which is not common in population-level data from other countries. However, the survey's focus on individual behaviours limits the interpretation in terms of socioeconomic variables and ethnicity.

There were other datasets available in Colombia that could serve the purpose of addressing childhood obesity as a complex issue. For example, the census and surveys on land use can be useful for geo-referencing households and creating indicators that take into account characteristics of the built environment or other variables related to obesogenic environments, such as the presence of fast food restaurants. Some authors have begun to include this analysis in their work, especially for big cities (Parra et al., 2009, Sarmiento et al., 2010, Cervero et al., 2009, Gómez et al., 2013). This research is improving its ability to measure socioeconomic position through the analysis of place, indicators of household income and access to education or public services. However, the ethnicity variable continues to be analysed only superficially – for example, through division into two categories of White/non-White – or not analysed at all. Therefore, a common point of discussion in cases where low socioeconomic status is linked to a health condition is that it might reflect the ethnic division of the country, as ethnic minorities are considered vulnerable and poor. The present thesis was limited in scope by its nature; however, in future research, it would be advantageous to incorporate these additional data into analyses.

6.3 Reflections on the study of ethnicity and childhood obesity in epidemiology

As my approach involved methodologies that are traditionally used to study cause and effect, such as Directed Acyclic Graphs, my intention here is to discuss how this perspective can facilitate reasoning about relationships between complex issues like ethnicity and childhood obesity. In epidemiology, causality is usually illustrated

through Bradford and Hill criteria. These criteria attempt to establish a relationship between risk factors and health events in terms of their temporal relationship, strength of association, biological plausibility, reversibility, consistency, specificity, coherence, and analogy (Fedak et al., 2015). In this section, I will discuss my findings in light of these criteria before contrasting them with my approach towards the end of this section.

When attempting to infer causal relations, it is generally perceived that longitudinal studies provide the best data. In this doctoral thesis, there were no longitudinal analyses included, since the only representative information source for Colombian population is a survey (ENSIN 2010) with a cross-sectional design by default (Fedak et al., 2015). On the other hand, in the systematic review, I identified several longitudinal studies that revealed significant associations between ethnicity categories and development of childhood obesity. These longitudinal associations show a temporal relationship between belonging to an ethnic group and developing childhood obesity. However, in most of the longitudinal studies analysed, ethnicity was not clearly described as an independent factor for childhood obesity because of a lack of adjustment for covariates. Although my analysis in chapter 4 is cross-sectional, there is also a reflection on ethnicity and temporal relationship criteria that has to be discussed. This reflection is also directly linked to the Bradford and Hill consideration: namely, biological plausibility. I have no reason to conclude that my findings will differ from those described using longitudinal analysis in other studies.

The DAG that I devised indicated how genetic or epigenetic factors can make an individual susceptible to developing obesity; the absence of a longitudinal design to determine a temporal relationship would not invalidate these cross-sectional findings in terms of causality. This is because a genetic polymorphism is something a person is born with that is unmodifiable throughout one's lifespan (unless one is exposed to a mutagen agent, which is quite uncommon). This is one of the assumptions in the epidemiological tool of Mendelian randomisation, which focuses on causality (Lawlor et al., 2008). However, the contribution of the genetic/epigenetic

background to developing obesity might be small in comparison to the environmental influences that affect our behaviours across the lifespan.

A question one has to ask oneself is that of whether ethnicity should be approached as a predictor or as an aetiological factor. There are common misconceptions in the ways that prediction and aetiology have been presented thus far in the literature (van Diepen et al., 2017). In prediction, confounding factors are not an issue, since the goal is to obtain an explanatory model composed of a strong combination of disease predictors rather than to understand the disease (van Diepen et al., 2017). Accordingly, adjustment for confounders and causality inference should not be conducted in prediction studies (van Diepen et al., 2017). After considering the above premises, it can be concluded that this doctoral thesis has elements of both approaches. The secondary analysis in chapter 4 of this thesis explored the interconnections between multiple risk factors and ethnicity in order to obtain pathways leading to obesity that fit with an aetiological approach. The DAG drawn in chapter 4 challenged this approach because ethnicity is presented as a mediator. This allowed me to understand both approaches more completely and explore further interplays between risk factors operating in the Colombian context.

According to Bradford and Hill, the greater a subject's exposure to a causal factor, the higher the risk for the event or disease (i.e. a dose-response relationship). This causality criterion is quite complex to apply to ethnicity, since ethnicity by itself does not behave as a variable that increases in measure or exhibits a gradient, unless we take into account ethnic mixtures as a gradient or a progressive measure of the degree of 'purity' of an ethnic group. This has been done in other contexts; for instance, in the study by Mendez et al., obesity (along with other outcome variables) was evaluated in children across categories of Mayan origin according to paternal and maternal last names (Mayan-Mayan, Mayan-Not Mayan, and Not Mayan-Not Mayan). However, as previously mentioned in chapter 3, Mendez et al. (2016) found no association by that ordinal categorisation of Mayan ethnicity. Moreover, in the case of the two Colombian studies and the other studies from the systematic review, there were no gradient approaches to ethnicity, since ethnic groups were markedly

different without mixture categories. This is essentially because the general approach in those studies was on the basis of self-reported ethnicity, alongside other factors (such as language spoken at home and/or parents' ethnic origin).

Reversibility – the causality criterion stating that by removing the exposition, the occurrence of the outcome will decrease – is not applicable to ethnicity. This is because, as previously discussed, genetic polymorphisms are unvarying across life; i.e., one cannot remove one's ethnicity. Theoretically, according to the DAG, if ethnicity was the only variable changed in the models, the occurrence of obesity would change. However, such a study could not be conducted in reality.

Consistency of association is the other relevant causality criterion. The studies included in the systematic review showed a trend for higher prevalence of overweight or obesity in children from ethnic groups considered minorities in the populations studied. Therefore, ethnicity, in the context of marginality and the vulnerability of ethnic minorities, appears to be consistently associated with childhood obesity. However, the secondary analysis in Colombian population in chapter 4 showed marked sex differences in the association across age groups. The ethnic minority-higher overweight/obesity pattern was reproduced only in Colombian adolescent girls from Indigenous and Afro-descendant groups in comparison with girls in the general population. There were other inconclusive findings on childhood obesity in similar ethnicities across some studies from countries that are discussed in more depth later in this chapter.

The strength of the association between ethnicity and childhood obesity in the secondary data analysis of the ENSIN 2010 by sex and age groups was generally weak. However, it should be noted that a moderate association does not rule out a biomarker as a potential causal factor (Fedak et al., 2015).

The specificity criterion, defined as the increased risk posed by an exposure variable for only one disease/event and no other diseases/events, is unfeasible to reach in this context given the complex potential interactions between ethnicity and risk factors for cardiovascular diseases that have been disclosed in recent years. In this way,

ethnicity might be related to other events through effect modification of risk factors or via genetic susceptibility.

The coherence of the ethnicity-childhood obesity relationship, as an additional requirement for causality according to Bradford and Hill, is supported by theoretical models based on social determinants of health and potential genetic susceptibility related to ethnicity, as has been previously described and discussed through this thesis. On the other hand, analogy – the remaining causality criterion, which occurs when two situations share a common pattern of relationships among their constituent elements –is more difficult to contextualise for the ethnicity-childhood obesity relationship. Finding an analogous variable for ethnicity and an analogous outcome for childhood obesity is not easy without entering into a conflict of interaction. If we establish similarity for ethnicity-childhood obesity and social deprivation-cardiovascular risk, for instance, it is highly possible that both exposure variables are influencing each other, and that to talk about one of them is to talk at least partially about the other.

After locating the findings of this thesis in the context of causality, it is clear that the ethnicity-obesity relationship does not properly fit with several Bradford and Hill causality considerations. This observation reinforces the approach of this PhD thesis, namely to investigate explanatory models of childhood obesity inside ethnicity categories rather than simply reporting differences in childhood obesity by ethnic group. The decision to adopt the above approach was primarily made to provide more detailed information about what is happening within each ethnic group in terms of patterns of risk factors for childhood obesity and to contrast these patterns, which would not be evident under an ethnic difference/disparity approach. According to recent reflections by VanderWeele and Robinson (VanderWeele and Robinson, 2014) it appears that focusing on disparities by ethnic groups, and examining those disparities across adjustment models, leads to serious problems of interpretation about the effect of race on health events. One of the common pitfalls is to set ethnicity as an exposure adjusted for variables that might be in the pathway between ethnicity and the outcome variable. However, this practice underestimates ethnicity

effects or erroneously denies the alternative hypotheses linking ethnicity to the outcome variables.

Through developing DAGs, I was able to plot several pathways; by using these pathways, I was able to have meaningful discussions with supervisors and colleagues at scientific events, which helped me to refine and improve my models. Thus, I obtained the final version in which ethnicity was not a straight causal factor, but was instead one of the elements influencing the modifiable and unmodifiable factors that result in childhood obesity. This diagram guided me to analyse ethnicity in the context of childhood obesity in Colombia. By doing so, I could better understand the biological and contextual factors operating in each ethnic group. Hill stated that '[a]all scientific work is incomplete… [and] liable to be upset or modified by advancing knowledge' (Rosner, 2015). This thesis has led me to conclude that population health researchers should consider causal thinking in order to take multidisciplinary data into account, thus enabling them to analyse complex situations such as childhood obesity in the light of ethnicity. Before this PhD, I supported the quantitative approach to this kind of data. However, after constructing the DAG, I now support the idea of including a wider range of variables that can recreate the story of a particular population group. In the case of obesity research, the analysis of sociocultural practices around food and feeding and relations with market/environment may only be able to be captured through qualitative methods. This could enhance both the understanding of the problem and actions for prevention.

6.4 Influence of maternal weight status

One of the key findings in the DAG analysis was maternal overweight and obesity as a mediator for childhood obesity, specifically in the Indigenous ethnic group; this was also a trend in the Afro-descendant ethnic group. As previously mentioned, many studies have reported a relationship between maternal weight status (at the pre-pregnancy, early and late pregnancy phases) and childhood obesity. These studies highlight the role of genetic predisposition to obesity from adaptation in adipose

tissue, appetite regulation, and energy metabolism. The obesity phenotype only becomes evident in the offspring at later lifespan stages (Voerman et al., 2019)

There are also studies evaluating ethnic disparities in pregnancy weight. A Dutch study found that Dutch-origin women experienced increased weight gain during pregnancy in comparison with ethnic minority groups, although lower weight gain than Cape Verdean-origin and Surinamese-Creole-origin women (Bahadoer et al., 2015). The above differences were mainly explained by sociodemographic and lifestyle factors. Conversely, in the UK, women from ethnic minority groups (Black and South Asian) gained weight more promptly in the first trimester of pregnancy than White women (Heslehurst et al., 2010b),

As important as maternal obesity before and during pregnancy can be, current maternal obesity may also influence weight status in grown children in terms of food and feeding practices. For instance, mothers affected by obesity were more likely to prompt children to eat novel foods – considered as healthy – and this was a positive predictor for the BMI z-score of their children (Lumeng and Burke, 2006). Sugar consumption from food was also higher in both obese mothers and their children when compared with non-obese women and their children. Another study reported that the amount of food that mothers ate while sitting with their children was the strongest predictor of children`s food intake, and also that obese mothers talked less about food with their children, presumably because of stigma regarding their own weight (DeJesus et al., 2018). On the other hand, findings from studies investigating maternal or parental practices according to weight status of parents and children are inconclusive. A recent systematic review did not identify clear food parental patterns between overweight and non-overweight parents (Patel et al., 2018). In the current analysis, however, I was unable to include data on fathers' or siblings' weight; thus, I do not have insight into whether this is more likely to be a genetic issue or a family lifestyle issue (Patel et al., 2018)

The finding of this thesis concerning maternal obesity in the Colombian population as a potential predictor/mediator of childhood obesity, specifically in the Indigenous population, might have been influenced by several inter-related factors. One is displacement triggered by violence due to the long internal conflict in Colombia,

which has affected rural areas in which Indigenous communities were previously settled. The displacement of Indigenous groups is also promoted by poverty, which forces them to look for employment opportunities in urban areas. As a result of displacement and resettling in new environments, Indigenous communities are exposed to nutritional and physical activity changes. In urban environments, there is less access to fresh vegetables and fruits; additionally, these products become more expensive. Moreover, the size of Colombian cities tends to make walking or running from e.g. home to the workplace unfeasible, while cycle pathways in these cities are also not yet properly developed. In addition to the above, displaced Indigenous groups have to deal with the adoption of new food practices and the concomitant loss of their traditional ones, which could increase adiposity and thus cardiovascular risk in these resettled communities. These phenomena have been previously observed among the Inuit indigenous group in Canada (Richmond and Ross, 2009) Moreover, displacement and resettling is synonymous with poverty, since the urban areas in which Indigenous communities and other minorities achieve relocation tend to be socioeconomically deprived, with additional difficulties experienced by relocation to peripheral zones such as hills, which lack electricity and potable water. The latter conditions worsen health perspectives for the reallocated communities. These environmental factors might trigger or increase excess adiposity in Indigenous mothers and their children, as well as in other members of the family.

Another aspect that must be taken into account when considering maternal obesity as a childhood obesity-associated factor is that, in Colombia, the phenomenon of head-of-household mothers (lone parents) has increased markedly in recent years. Data from the National Administrative Department of Statistics (DANE; abbreviation in Spanish) for 2017 indicate that 56% of Colombian women are mothers who are heads of households. Moreover, the National Demographic and Health Survey (2015) (Profamilia, 2015)reported that female heads of households in cities increased from 35 to 39% between 2010 and 2016, while in the countryside, this increase was from 18% to 22 %. An analysis from the ‘Welfare, Children: A Three-city Study’ (comprising 364 children) conducted in Boston, Chicago and San Antonio found an association between maternal employment and child overweight and obesity. Increased work hours during the preschool stage, when compared with no change in

work status, increased the likelihood of having a child affected by overweight and obesity by 2.6 times; time apart from the children was found to be a mediator in this association. These findings are coherent with the fact that having consistent family routines (evening talks, bedtime stories/good night kisses, dinner/supper at the same time, breakfast together) were found to be a protective factor in relation to child overweight and obesity [OR (95% CI): 0.39 (0.20-0.73)]. By contrast, another study that used data from 45 health surveys, namely the Demographic and Health Surveys from 2010 to 2016 (n= 268763) in low- and middle-income countries, reported higher odds of normal weight (exclusion of underweight and overweight cases) in children of employed mothers. This observation was justified with reference to the fact that grandmothers might potentially be responsible for the normal feeding of the employed mothers' children. However, their analysis also lacked age stratification; it should be noted that children between 0 and 5 years have high energy needs related to growth that lead to a modest increase in weight, which may have attenuated a visible association between employed mothers and childhood overweight and obesity. There is no data in Colombia pertaining to the level of independence regarding food choices.

6.5 Strengths of the research

This study has several strengths. One of these is that this PhD thesis has made a relevant contribution to the evidence base through the novel evaluation of explanatory models for childhood obesity inside each ethnic group studied from the Colombian population, going beyond differences in childhood obesity by ethnicity. To the best of my knowledge, this is the first investigation on ethnicity and childhood obesity, identifying risk factors for childhood obesity and potential mediating factors in an intra-ethnicity way, and covering the Colombian population through inferential tools, as the two previous analyses were only descriptive.

I believe the systematic review presented in Chapter 2 to be the first to directly address ethnicity and childhood obesity, filling a gap in the lack of compiled evidence from existing literature on the topic. It is of note that this gap also applies for ethnicity and obesity in adults since I was unable to find a systematic review and/or meta-analysis in this age group; thus, I believe the findings to be useful in this context as well. The

systematic review represents the first body of contrasted literature that might serve a discussion context for future investigations from ethnically-diverse countries. The approach on five countries enabled a more focused description of how ethnicity is defined throughout different nations.

One of the strengths of the study included the secondary analysis. It used a large scale country data with an overrepresentation of poorer communities, which is key to analyse data of minority ethnic groups. Also, the analysis included the application of the latest techniques, such as DAG and testing mediation models, which are alternate ways of exploring and maximising data.

6.6 Limitations of the research

This thesis' analyses had several limitations. Firstly, the ENSIN 2010 was not designed to study ethnicity and obesity in-depth, meaning that these variables were not part of the survey's sampling strategy. Therefore, individuals categorised in one or another ethnic group may not be representative of those ethnic groups as a whole. However, the fact the sampling design of the ENSIN 2010 considered geographical region and sub-regions might have attenuated at least partially the above weakness on representativeness since Afro-descendant and Indigenous ethnic groups are more accentuated in some regions than others.

Secondly, BMI was the only marker of adiposity available in the ENSIN 2010, and the analysis would benefit from additional measurements of located adiposity, such as skin folds and abdominal obesity (waist circumference) and indexes like waist-to-height ratio. The frequency of consumption questionnaire was applied only one day, which limits the reliability of the nutritional patterns obtained.

The presence of missing data was another limitation. The sample of children in the final explanatory models for childhood obesity inside each ethnic group was underpowered, which may result in findings being missed in the analysis.

Conclusions

This thesis aimed to understand the role of race and ethnicity in framing childhood obesity as a public health problem in Colombia, contrasted with Brazil, Mexico, Canada and the United Kingdom. The research question supporting this aim drove me to undertake reviews, apply tools for understanding cause and effect relationships, and conduct a secondary analysis of Colombian data.

I found that the five countries under study used a varied way to measure and define ethnicity and childhood obesity that makes it difficult to compare. Furthermore, reporting of ethnicity codes and reasons for studying childhood obesity in terms of ethnicity is often unclear or superficial. Overall, research on childhood obesity has focused on physiological issues and other dimensions beyond the individual, such as environment, communities and family relationships, food production practices and market influences remain poorly studied.

In Colombia, there is little research on ethnicity and childhood obesity. Two studies included in a systematic review identified ethnic differences in childhood obesity. However, there was a lack of analysis of other variables like sex and context-related variables to provide a complete explanation of the differences observed.

In the secondary analysis, the prevalence of childhood obesity (including overweight) was higher among indigenous adolescent girls. Socioeconomic variables, food security levels and maternal variables were associated with childhood obesity in both Indigenous and Afro-descendant children. However, all of them, especially maternal obesity, proved to be significant for Indigenous groups. This latest finding was also significant when testing mediation models.

Most of these findings were discussed in the previous chapter. The following section discusses the possible policy, practice and research implications.

6.7 Implications of this research

Recommendations for policy

In this section, I will provide some recommendations and perspectives for policymaking in the light of the findings obtained and patterns observed. These will cover issues on taxation of food products, food security and maternal health.

Although in this PhD thesis there was no significant association between food consumption and childhood obesity among the ethnic groups analysed, I observed a pattern for higher consumption of sweetened beverages in Afro-descendant children, and recommendations on this situation are still valid. Therefore, policymaking in public nutrition in Colombia should join global trends in taxing sugar-sweetened beverages, front-of-pack labelling of food products, and subsides to promote healthy food in schools. However, I acknowledge the hard task this represents in the Colombian context. The industrial lobby is markedly strong in Colombian parliament; in fact, a law project to tax sugar-sweetened beverages did not obtain a majority for approval in 2018. The conflict of interest between industry and government is enormous since in Colombia, enterprises and industries are allowed to fund political campaigns for a presidential election.

In this thesis, Indigenous ethnicity showed a higher prevalence of obesity in girls; this needs further research in order to know its causes. However, in this thesis, I found an inverse link with food insecurity, namely the more food insecurity, the less the likelihood of childhood obesity. This finding is partially expected and partially paradoxical. Children with severe food insecurity tended to be underweight due to undernutrition, and those with food security tended to be overweight and obese. This may imply that even a good status of food security might be surrounded by obesity risk factors such as hypercaloric diets. This concepts around food security and the quality of diet and food products that has to be guaranteed might be revisited. Policymakers might focus on support practices at the community and macro-economic level that ensure food security for all groups of society under good standards for a healthy diet. These policies must target and prioritise people being displaced from their territories due to armed conflict and/or deterioration of the

environment. In Colombia, these groups are mainly ethnic minorities, especially Indigenous.

Decision-makers have to have a clear target to intervene and tackle childhood obesity in Colombia. The fact of observing a trend for the higher prevalence in adolescence across all ethnic groups studied means that reduction of the risk for obesity in childhood should start before that life stage. Therefore, interventions such as implementing subsidies to support healthy food in schools should target children aged between 5 and 10 years, and even pre-schoolers.

Among the strategies to tackle childhood obesity, it is always desirable to understand the modification of risk factors and recognise non-modifiable risk factors in the populations studied. There are many well-known risk factors for childhood obesity that generally are thought at the individual level, such as diet and physical activity level. However, so far, the approach of intervention in factors behind those common risk factors is poor in Colombia. One key characteristic in the modulation of the risk for obesity in a child is their mother across all dimensions that define mother-associated factors such as socioeconomic level, education level and biological factors inherent to genetics. Thus, policies to improve mothers' health and socioeconomic stability are needed based on the fact that a healthy, educated mother can make better decisions about child feeding and encourage healthy habits to her offspring. This need is even stronger in a country where the social phenomenon of household chief mothers is very common, as previously mentioned.

An important consideration on the above recommendations on policy making is that these perspectives demand an approach of structural level intervention. This approach needs the will and consensus of key sectors of the society: political, economic and industrial. For instance, taxing sugar-sweetened beverages requires that the industrial sector avoid practices of lobby and influences traffic, and that government and parliament have not any conflict of interest in respect to the industrial and economic sector. This scenario requires in turn to modify laws about funding of political campaigns to forbid the donations from industries and economic groups.

A long term implication for a structural level intervention resides on the key finding of mother weight status as associated factor with childhood obesity. The main way to intervene this link is guarantying free education, at least elementary and secondary school, for all population but women being a priority given marked gender inequality. Colombia lacks of free education but efforts have to be made by the parliament by promoting this educational reform, and by the government that has to redistribute the national budget by markedly assigning more funding to education and much less to army. Inexplicably, in spite of the recent peace agreement, army keeps taking most of the national budget in detriment of other sectors such as health, education, and research. An educated society on the basis of basic scholar education will be more likely to have adult individuals more aware of their health and self-care regarding diet and physical activity, and healthy behaviours can be transferred to their offspring. Individuals with scholar education might also be more likely to get graduate and postgraduate education improving their incomes and accessing to better quality food. Similarly, educated parents in charge of children feeding, who are mainly mothers, would tend to make better decisions in respect children's diet. However, subsidising basic scholar education will not be enough without a concomitant reform that insert a core subject on prevention of obesity and non-communicable chronic diseases into elementary and secondary education curriculums in Colombia.

With the above interventions a reduction in ethnicity-related obesity disparities might be reduced since Indigenous and Afro-descendant groups are in higher risk of poverty, having less access to education and therefore being less likely to socioeconomically ascend. The previously described scenario with women as the centre perfectly fits with current global frameworks such as that proposed by the World Bank Group in 2012. This framework clearly emphasises that investing in women is the base for a "smart economics".

Recommendations for research

Recommendations and perspectives for future research can be provided separately for the two fields involved in this PhD thesis: ethnicity and obesity.

Ethnicity field

Concerning the ethnicity field, several aspects could be addressed in future research to facilitate comparisons between studies from different countries and world regions. One aspect is the evaluation of potential harmonising of ethnic codes across countries, acknowledging the difficulties and limitations this might imply. On the one hand, there are similarities between grouping categories across countries that may enable this initiative of codes harmonising. For instance, Black ethnicity in Colombia and the UK are minority groups. However, sub-categories of Black ethnicity such a Black-Caribbean and Black-African, as happens in the UK, show a different socio-cultural context inside the same big category.

This limitation to harmonise ethnic codes leads me to another suggestion for future research, namely the improvement of ethnicity report. From my view, ethnicity in methods sections must be described in terms of justifications for grouping categories, labelling of the ethnic groups, and sources of ethnicity codes. Similarly, comparisons between ethnic groups should be properly sustained as it should also be the use of an ethnic group as the reference category for comparisons. Misconceptions in ethnicity comparisons should also be avoided, such as assumptions of inferiority derived from comparisons of Black vs non-Black. Thus, the socio-cultural context of each ethnic group should be finely provided to sustain such comparisons.

Obesity Field

Researchers in the field of obesity might look for the most appropriate adiposity measure to define childhood obesity for each ethnic group. This exploration was not feasible in this PhD thesis because de ENSIN 2010 did not have anthropometrical variables others than weight and height, leaving BMI as the only adiposity index available for this study. Future research on childhood obesity in Colombia needs the planning and implementation of additional adiposity markers, but this depends on funding capability. The inclusion of additional markers, if achieved, may enable the creation of new indices that better explain the ethnic diversity in adiposity. Similarly, it will facilitate to contrast findings in Colombia with studies abroad which have used adiposity indexes others than BMI such as waist-to-height ratio, central obesity, hip-to-height ratio and visceral adiposity index.

Both fields: Obesity and ethnicity

From my view, research linking both fields either by looking for characterisation of obesity in ethnic groups or comparing obesity between ethnic groups should feed on causality tools regardless of whether or not the research focuses on causality. Causality tools help to improve the thinking and understanding of the potential relationships between variables related to exposure and effects or outcomes. In this PhD thesis, DAGs were used, but there are other tools, such as causal loops, which provide information on the inter-relationship of variables. The DAG, in particular, allows me to visualise relevant variables not measured and identify weaknesses in the research design. Moreover, structural equation modelling was used as an example of imputing relationships between unobserved constructs (latent variables) from observable variables. Although this thesis did not attempt to establish whether SEM was better than association analysis, the concomitant use of SEM was useful to confirm links, and the perspective is to explore new analysis methods.

Recommendations for Practice

Some recommendations for research practice may be derived from the above-mentioned perspectives and recommendations for ethnicity and obesity fields. In general, as the only nutritional survey in Colombia, ENSIN must be enriched with additional anthropometrical makers, as previously discussed, and nutritional evaluation might consist of at least two days' recalls in order to improve the confidence of the estimates of intakes and food frequency consumption. The fact that nutritional evaluation interviews were one day long could have influenced the findings of no association between diet and childhood obesity.

Another perspective in research practice is the implementation of data linkage between the ENSIN, census and other health surveys such as the scholar health survey and the national health survey. This would enable taking advantage of the available information for participants in several of these surveys and designing more complex analyses that account for variables not available in the ENSIN. There are also other datasets suitable for linkage. For example, agricultural and livestock census, together with population georeferencing may enhance indicators of food security in Colombia. Description of the reasoning behind food choices and the

practice of physical activity, and misconceptions about body image through the application of qualitative research methods may complete the understanding needed to inform more focused public health policies.

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Appendices

Appendix A: Abstract presented at the Society for Social Medicine 59th Annual Scientific Meeting, Dublin, 2017

PP58

THE CHALLENGE OF INTERNATIONAL STUDIES IN ETHNICITY AND CHILDHOOD OBESITY RESEARCH: A CASE STUDY USING COLOMBIA, CANADA, BRAZIL, MEXICO AND THE UNITED KINGDOM

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Background This research forms part of a cross-country comparison study that seeks to understand the role of ethnicity in framing childhood obesity as a public health problem. In our modern multi-ethnic world the need and opportunity for international comparisons using the concept of race and ethnicity are both becoming increasingly important. However, definitions of ethnicity vary according to socio-political circumstances. In preparation for conducting the major study, we have examined this concept in Colombia, Brazil, Mexico, Canada and the United Kingdom. Our research questions were: 1) How are ethnicity and race defined and measured? 2) What are the concepts that underpin race and ethnicity in each of the countries? 3) Are these measures, categories and concepts sufficiently similar to allow crosscountry comparisons in the field of childhood obesity? Methods We conducted a scoping review according to Leva et al. (2012). We searched published and unpublished literature, census questionnaires, and health and nutritional surveys, without restriction of language and reported from 2005. Starting from 2005 allowed us to include the latest Colombian census and the recent censuses and surveys from the other countries. We searched web pages from Ministries of Health and statistical agencies, electronic databases (CINAHL, Medline, EMBASE, Global Health Library and LILACS). We manually searched bibliographies of relevant books on ethnicity and health.

Results We reviewed 13 questionnaires, 4 constitutional acts, 8 official reports and their related documents. We found that all of the reviewed countries use self-identification to determine ethnicity. However, each country collects their data differently, using either a single concept of ethnicity or a combination of concepts. Colombia is focused on ethnic minority populations. Mexico, Canada and the UK use a combination of country of origin, geographical origin and skin colour. Brazil establishes ethnicity on skin colour alone. Canada has one White and Black categories while the UK evaluates a wider set of subcategories. England and Wales separate Irish from British and Scotland separates Scottish from British and Irish. Black categories in the UK also include African and Caribbean origin separately.

Conclusion As a result of this scoping review we identified different approaches to ethnicity which do not allow direct quantitative comparison. Therefore, our cross-country comparison study will be focused on understanding childhood obesity within each country, comparing qualitatively. Brazil is no longer considered a useful comparison given its singular approach. This kind of conceptual analysis is necessary for cross-country studies, and could lead to more international harmonisation of exposure variables such as ethnicity and race.

Appendix B: Systematic review supplementary information

Search terms

Search terms in English

Term category	English term
Age	childhood, child, (child*), boy, girl, preschool, infant, toddler, puberty (puber*), teenager (teen*), adolescent, adolescence (adolescen*)
Childhood adiposity	Adiposity, overweight, obesity, abdominal obesity (obes*), paediatric obesity, pediatric obesity, childhood obesity,
	body mass index, BMI, body fat distribution, weight, body constitution, body composition, body fat distribution, skinfold thickness, waist – hip ratio, waist circumference, adipose tissue, weight status
Ethnicity	Ethnicity, race, Indigenous (Indigen*), Indian , Mestizo (Mestiz*), white population, Mulatto, Black population, African descendant, Afro- descendant (afr* descend*), Roma population, Romani population, Gypsy, minority ethnic groups, ancestry (ancestr*)
Country	United Kingdom, Britain, British, Canada, Canadian (Canad*), Colombia, Colombian (Colombia*), Mexico, Mexican (Mexic*), Brazil, Brazilian (Brazil*)
Study design	Prevalence, cross-sectional, cohort study, health survey, health registry

Search terms in Portuguese

Term category	Portuguese term
Age	crianças, menino(s), menina(s), infante, infância, escolares, moço, rapaz, puberdade, jovem, adolescente, pré-adolescente, adolescência (adolescên*)
Childhood adiposity	adiposidade, sobrepeso, obesidade, obesidade infantil
	Índice de massa corporal, IMC, peso corporal, circunferência da cintura, gordura corporal, drobas cutâneas (dobra* cutánea*), tecido adiposo, composição corporal, relação cintura – quadril.
Ethnicity	etnia, raça, Indígena (Indígen*), Índio, Mestiço (Mestiç*), Branco, Pardo, Amarelo, Negro, Não-Branco, Africano, Moreno, Mulato, preto, grupo racial, grupo étnico dimensão étnico-racial, povo cigano, minorias, povos indígenas, populações Indígenas, grupos étnicos minoritários, população negra, ancestralidade (ancestr*)
Country	Brasil, brasileiro (Brasileir*)
Study design	Prevalência, Pesquisa Populacional, estudo transversal, Coorte, Inquérito de saúde, registro em Saúde

Search terms in Spanish

Term category	Spanish term
Age	niño, niña, infante, infancia, escolar, pubertad (púber*), adolescente, adolescencia (adolescen*)

Childhood adiposity	adiposidad, sobrepeso, obesidad, obesidad infantil
	Índice de masa corporal, IMC, peso, circunferencia de cintura, grasa corporal, pliegues cutáneos (pliegue* cutáneo*), pliegue, tejido adiposo, relación cintura cadera.
Ethnicity	etnia, raza, Indígena (Indígen*), Indio, Mestizo (Mestiz*), Blanco, Mulato, Negro, Afrocolombiano, Afrodescendiente, Rom, Romani, Gitano (Gitan*), Africano (African*), minoría étnica, pueblo indígena, ancestro (ancestr*)
Country	Colombia, Colombiana(a) (Colombian*), México, Mexicano(a) (Mexic*), Brasil, Brasilero(a) (Brasil*)
Study design	Prevalencia, estudio transversal, estudio de cohorte, encuesta de salud, registro en salud

Searching strategy

MEDLINE, July 01 2015

1. childhood.mp.

2. exp child/ or exp child, preschool/ or exp infant/

3. child*.mp.

4. boy.mp.

5. girl.mp.

6. exp Infant, Newborn/ or exp Adolescent/ or infan*.mp.

7. toddler.mp.

8. pre$school.mp.

9. Puberty/ or puber*.mp.

10. teen*.mp.

11. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10

12. exp obesity/ or exp obesity, abdominal/ or exp obesity, morbid/ or exp pediatric obesity/

13. paediatric obesity.mp.

14. exp Body Weight/ or exp Adiposity/ or exp Body Composition/ or exp Adipose Tissue/

15. exp Body Fat Distribution/

16. exp body constitution/ or exp "body weights and measures"/ or exp body mass index/ or exp skinfold thickness/ or exp waist-hip ratio/

17. exp Overweight/

18. obes*.mp.

19. BMI.mp.

20. exp Anthropometry/

21. (weight adj status).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]

22. (waist adj circumference).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]

23. "weights and measures"/ or exp reference standards/ or exp reference values/

24. 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23

25. exp population groups/ or exp continental population groups/ or exp ethnic groups/ or exp african americans/ or exp asian americans/ or exp gypsies/ or exp hispanic americans/ or exp inuits/

26. ethnicity.mp.

27. ethnic*.mp.

28. race.mp.

29. ancestry.mp.

30. ethnic minority groups.mp.

31. Aborigin*.mp. or Indians, South American/

32. Indigen*.mp.

33. Tribe.mp.

34. European Continental Ancestry Group/

35. (Afr* adj2 descen*).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]

36. african continental ancestry group/ or exp american native continental ancestry group/

37. Black population.mp.

38. (Roma* adj population).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]

39. Mulatt*.mp.

40. Mestizo.mp.

41. 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38 or 39 or 40

42. exp Colombia/ or Colombia*.mp.

43. exp Brazil/

44. exp Mexico/ or Mexic*.mp.

45. exp Canada/ or Canad*.mp.

46. United Kingdom.mp. or exp Great Britain/

47. British.mp.

48. 42 or 43 or 44 or 45 or 46

49. exp Cross-Sectional Studies/

50. exp Cohort Studies/

51. exp Health Surveys/

52. exp Registries/

53. 49 or 50 or 51 or 52

54. 11 and 24 and 41 and 48 and 53

EMBASE, July 03 2015

1. exp childhood/ or exp infancy/

2. child*.mp.

3. exp toddler/ or exp child development/

4. exp puberty/ or exp adolescence/ or exp prepuberty/

5. puber*.mp.

6. adolesc*.mp.

7. teen*.mp.

8. exp girl/

9. exp boy/

10. pre$school*.mp.

11. infan*.mp.

12. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11

13. exp obesity/ or exp body weight disorder/ or exp overnutrition/ or exp abdominal obesity/ or exp childhood obesity/ or exp morbid obesity/

14. obes*.mp.

15. exp adipose tissue/ or exp abdominal fat/ or exp body fat/ or exp body fat distribution/ or exp fat body/

16. adipos*.mp.

17. exp body composition/ or exp body distribution/

18. overweight.mp.

19. exp body weight/ or exp anthropometric parameters/ or exp "weight, mass and size"/ or exp weight gain/

20. body mass index.mp. or exp body mass/

21. BMI.mp.

22. "weight status".mp.

23. exp waist circumference/

24. exp skinfold thickness/

25. (weight and measures).mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword]

26. 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25

27. ethnic*.mp. or exp ethnic difference/ or exp "ethnic or racial aspects"/ or exp ethnic group/

28. exp ethnicity/ or exp race/ or exp race difference/

29. exp ancestry group/ or exp asian american/ or exp asian continental ancestry group/ or exp black person/ or exp british asian/ or exp caucasian/ or exp hispanic/ or exp indigenous people/ or exp multiracial person/

30. ancestr*.mp.

31. Indigen*.mp. or exp Indigenous Health Services/

32. Aborigin*.mp.

33. exp Eskimo/ or exp First Nation/ or exp American Indian/

34. exp African American/ or exp African Caribbean/ or exp African/ or exp African Brazilian/

35. (Afr* adj2 descen*).mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword]

36. (Roma* adj population).mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword]

37. Gypsy.mp. or exp "Romani (people)"/

38. Gypsies.mp.

39. exp Mestizo/

40. exp Mulatto/

41. 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38 or 39 or 40

42. exp Colombia/ or Colombia*.mp.

43. exp Brazil/ or Brazil*.mp.

44. exp Mexico/ or Mexic*.mp.

45. exp Canada/ or Canad*.mp.

46. exp United Kingdom/

47. British.mp.

48. 42 or 43 or 44 or 45 or 46 or 47

49. exp prevalence/ or exp health survey/ or exp cross-sectional study/ or exp cross sectional study/

50. exp cohort analysis/ or exp follow up/ or cohort.mp.

51. cohort stud*.mp.

52. (health adj2 registr*).mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword]

53. 49 or 50 or 51 or 52

54. 12 and 26 and 41 and 48 and 53

Global Health (CABI), July 03 2015

1. childhood.mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes]

2. adolescen*.mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes]

3. infan*.mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes]

4. child*.mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes]

5. pre$school*.mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes]

6. childhood.mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes]

7. toddler.mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes]

8. teen*.mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes]

9. puber*.mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes]

10. exp boys/

11. exp girls/

12. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11

13. obes*.mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes]

14. overweight.mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes]

15. "weight status".mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes]

16. adipos*.mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes]

17. (weight adj gain).mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes]

18. (body adj composition).mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes]

19. "body weight".mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes]

20. "skinfold thickness".mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes]

21. "body fat".mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes]

22. "waist circumference".mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes]

23. "waist hip ratio".mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes]

24. "body mass index".mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes]

25. BMI.mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes]

26. 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25

27. ethnic*.mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes]

28. (ethnic adj2 groups).mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes]

29. race.mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes]

30. racial.mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes]

31. ancest*.mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes]

32. "continental groups".mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes]

33. Indigen*.mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes]

34. Aborigin*.mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes]

35. Mestizo.mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes]

36. Mulatt*.mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes]

37. (Afr* adj2 descend*).mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes]

38. (Black adj population).mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes]

39. (Roma* adj population).mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes]

40. Gypsy.mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes]

41. Gypsies.mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes]

42. tribe.mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes]

43. 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38 or 39 or 40 or 41 or 42

44. Colombia*.mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes]

45. Brazil*.mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes]

46. Mexic*.mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes]

47. Canad*.mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes]

48. exp UK/

49. United Kingdom.mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes]

50. British.mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes]

51. Britain.mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes]

52. 44 or 45 or 46 or 47 or 48 or 49 or 50 or 51

53. "cross sectional stud*".mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes]

54. "cohort stud*".mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes]

55. "health survey".mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes]

56. (health adj registr*).mp. [mp=abstract, title, original title, broad terms, heading words, identifiers, cabicodes]

57. 53 or 54 or 55 or 56

58. 12 and 26 and 43 and 52 and 57

59. 12 and 26 and 43 and 52

Note: Total 456 records obtained from No. 59 without including study design key words. I decided to use the No. 59.

WHOLIS, July 02 2015

(child* OR teen* OR adolescen* OR boy* OR girl* OR infan* OR toddler* OR niñ* OR pre$school OR preschool OR puber*) AND (obes* OR adipos* OR overweight OR 'body mass index' OR BMI OR 'body fat' OR 'Body Weight' OR 'weight status' OR weight OR 'body constitution' OR 'body composition' OR 'skin fold thickness' OR 'waist hip ratio' OR 'waist circumference')

LILACS – Portuguese, June 29 2015

criança OR menin$ OR infant$ OR infância OR escolar$ OR rapaz OR puberdade OR puber$ OR jovem OR "pré adolescente" OR adolescen$ OR adolescência [Words] and adiposidade OR sobrepeso OR obesidade OR "obesidade infantil" OR "índice de massa corporal" OR IMC OR peso OR "circunferência da cintura" OR "gordura corporal" OR "dobras cutâneas" OR "tecido adiposo" OR "composição corporal" OR "relação cintura quadril" [Words] and etnia OR raça OR Indígen$ OR Índio OR Mestiç$ OR Branco OR Pardo OR Amarelo OR Negro OR "Não Branco" OR African$ OR Moren$ OR Mulat$ OR preto OR "grupo racial" OR "grupos étnicos" OR "Origem Étnica e Saúde" OR "Distribuição por Etnia" OR "Distribuição por Raça ou Etnia" OR "povo cigano" OR cigano OR minoria OR "povo Indígena" OR "população Indígena" OR "grupos étnicos minoritários" OR "população negra" OR ancestr$ OR brasil OR brasileir$ AND (prevalência OR "pesquisa populacional" OR "estudo transvers al" OR Coorte OR "inquérito de saúde" OR "registro em saúde") [Words]

LILACS – Spanish, June 29 2015

niño OR niña OR infan$ OR escolar OR puber$ OR adolescen$ OR joven$ [Words] and adiposi$ OR sobrepeso OR "exceso de peso" OR obesidad OR "obesidad infantil" OR obese$ OR "Índice de masa corporal" OR IMC OR "peso corporal" OR "circunferencia de cintura" OR "obesidad abdominal" OR "grasa corporal" OR "pliegues cutáneos" OR pliegue$ OR "tejido adiposo" OR "relación cintura cadera" [Words] and etnia OR raza OR "grupos étnicos" OR "origen étnico y salud" OR "distribución por etnia" OR "Distribución por Raza o Etnia" OR racial OR Indígen$ OR Indio OR Mestiz$ OR Blanco OR "Grupo de Ascendencia Continental Europea" OR Mulat$ OR Negr$ OR Afrocolombiano OR Afrodescendiente OR "Afro descendiente" OR "Afro Colombiano" OR African OR Rom OR Romani OR Gitan$ OR Africano OR "minoría étnica" OR minorías OR "pueblo indígena" OR "población Indígena" OR ancestr$ OR Colombia OR Colombian$ OR Mexic$ AND (Prevalencia OR "estudio transvers al" OR "diseño transversal" OR "estudio de cohorte" OR cohorte OR "encuesta de salud" OR "registro en salud") [Words]

LILACS – English, June 29 2015

childhood OR child$ OR boy OR girl OR preschool OR infant OR toddler OR puber$ OR teen$ OR adolescen$ [Words] and adiposity OR overweight OR obesity OR "abdominal obesity" OR obes$ OR "paediatric obesity" OR "abdominal fat" OR "pediatric obesity" OR "childhood obesity" OR "body mass index" OR BMI OR "body fat distribution" OR weight OR "Body Weight" OR "body constitution" OR "body composition" OR "body fat distribution" OR "skinfold thickness" OR "waist hip ratio" OR "waist circumference" OR "adipose tissue" OR "weight status" [Words] and ethnicity OR race OR "ethnicity and health" OR "ethnic groups" OR "ethnic distribution" OR "race or ethnic group distribution" OR Indigen$ OR Aborig$ OR Indian OR Mestiz$ OR Mulatto OR "Black population" OR "African Continental Ancestry Group" OR "African descendant" OR "Afro descendant" OR (afr$ AND descend$) OR "European Continental Ancestry Group " OR "Roma population" OR "Rom ani population" OR Gypsy OR "minority ethnic groups" OR ancestr$ OR "United Kingdom" OR UK OR Britain OR British OR Canad$ OR Colombia$ OR Mexic$ OR Brazil$ AND (Prevalence OR "cross sectional" OR cohort OR "health survey" OR "health registry") [Words]

Self-Audit Checklist for Level 1 Ethical Review

University of Edinburgh,
Centre for Population Health Sciences
RESEARCH ETHICS SUBGROUP
Self-Audit Checklist for Level 1 Ethical Review for PGR projects

See **Intra** website for further information: http://www.cphs.mvm.ed.ac.uk/int... research_ethics_review.php

NOTE to student: *Completion of this form should be under the **oversight** of your supervisor. A good strategy would be to complete a draft as best you can, then discuss with your supervisor before completing a final copy for your supervisor to sign.*

Proposed Project: The goal of the present thesis is to understand the role of ethnicity to develop policies regarding obesity in Colombia in comparison with has been done in developed and developing countries that share similar indicators of diversity such as Brazil, Canada and the UK. The proposal has been divided into seven chapters. The first four chapters will give a review of the core ethnicity concepts and contextualization of obesity in the countries of interest. The last chapters will show the application of ethnicity in policies related to main obesity risk factors by performing two systematic reviews. The First Chapter will be a preamble about the main issues addressed in this thesis, The Second Chapter will review the core concepts related to ethnicity/race, adiposity and health policy. The Third Chapter will present the model behind categories of ethnicity /race in Colombia and the comparisons with the approach in countries selected. A scoping review will be performed by evaluating government documents and those published by international organizations such as World Health Organization. The Fourth Chapter is concern with obesity in two aspects. What is the approach to evaluate obesity in terms of methodology and analysis, and what is the variation of obesity prevalence among ethnic groups. Fifth and Sixth chapter will analyze the role of ethnicity to develop policies concern with diet and physical activity. .Finally, the Seventh Chapter will be developed a framework to understand health inequalities in Colombia taking into account the Colombian background and the experiences reviewed in the other countries regarding policies to tackle obesity. This study will contribute with the development of more inclusive policies in Colombia as well as in Brazil, Canada and the UK.

1. Bringing the University into disrepute

Is there any aspect of the proposed research which might bring the University into disrepute? YES/ NO X

2. Data protection and consent

Are there any issues of DATA PROTECTION or CONSENT which are NOT adequately dealt with via established procedures? YES/ NO X

These include well-established sets of undertakings. For example, a 'No' answer is justified *only if*:

(a) There is compliance with the University of Edinburgh's Data Protection procedures (see

(b) Respondents give consent regarding the collection, storage and, if appropriate, archiving and destruction of data;

(c) Identifying information (eg consent forms) is held separately from data;

(d) There is Caldicott Guardian approval for (or approval will be obtained prior to) obtaining/ analysing NHS patient-data.

(e) There are no other special issues arising about confidentiality/consent.

3. Study participants

a) Will a study researcher be in direct contact with participants to collect data, whether face-to-face, or by telephone, electronic means or post, or by observation? (eg interviews, focus groups, questionnaires, assessments) YES/ NO X

b) **Answer this only if qu. 3 above = 'YES':**

*In ethical terms, could any participants in the research be considered to be **'vulnerable'**?*

e.g. children & young people under age of 16, people who are in custody or care (incl. school), a marginalised/stigmatised group

Please tick one: 'vulnerable' ☐ not 'vulnerable' ☐

4. Moral issues and Researcher/Institutional Conflicts of Interest

Are there any SPECIAL MORAL ISSUES/CONFLICTS OF INTEREST? YES/ NO X

(a) An example of conflict of interest for a researcher would be a financial or non-financial benefit for him/herself or for a relative of friend.

(b) Particular moral issues or concerns could arise, for example where the purposes of research are concealed, where respondents are unable to provide informed consent, or where research findings could impinge negatively/ differentially upon the interests of participants.

(c) Where there is a dual relationship between researcher and participant (eg where research is undertaken by practitioners so that the participant might be unclear as to the distinction between 'care' and research)

5. Protection of research subject confidentiality

Are there any issues of CONFIDENTIALITY which are NOT adequately handled by normal tenets of confidentiality for academic research? YES/ NO X

These include well-established sets of undertakings that should be agreed with collaborating and participating individuals/organisations. For example, a 'No' answer is justified *only if*:

(a) There will be no attribution of individual responses;

(b) Individuals (and, where appropriate, organisations) are anonymised in stored data, publications and presentation;

(c) There has been specific agreement with respondents regarding feedback to collaborators and publication.

6. Potential physical or psychological harm, discomfort or stress

(a) Is there a FORSEEABLE POTENTIAL for PSYCHOLOGICAL HARM or STRESS for participants? YES/ NO X

(b) Is there a FORSEEABLE POTENTIAL for PHYSICAL HARM or DISCOMFORT for participants? YES/ NO X

(c) Is there a FORSEEABLE RISK to the researcher? YES/ NO X

Examples of issues/ topics that have the potential to cause psychological harm, discomfort or distress and should lead you to answer 'yes' to this question include, but are not limited to:

relationship breakdown; bullying; bereavement; mental health difficulties; trauma / PTSD; violence or sexual violence; physical, sexual or emotional abuse in either children or adults.

7. Duty to disseminate research findings

Are there issues which will prevent all relevant stakeholders having access to a clear, understandable and accurate summary of the research findings if they wish?* YES/ NO

** If, and only if, you answered 'yes' to 3 above, 'stakeholders' includes the participants in the research*

Overall assessment

- If every answer above is a definite NO, the self-audit has been conducted and confirms the *ABSENCE OF REASONABLY FORESEEABLE ETHICAL RISKS – please tick box* ✓

  *This means that regarding this study, as currently self-audited, no further ethical review actions are required within CPHS. However, if in the coming weeks/months there is any change to the research plan envisaged now (and outlined above), the study should be **re-audited** against a Level 1 form, because it may be that the change made negates the absence of ethical risks signed off here.*

- If one or more answers are YES, then risks have been identified and prior to commencing any data collection **formal ethical review** is required - either:
  - by NHS REC (NB copy of ethics application and decision letter to be sent to CPHS Ethics); or
  - if not to be formally reviewed by NHS REC, then CPHS level 2/3 ethical review required. *[If either 4 is 'yes' or 3b is 'vulnerable' then it is possible level 3 review is required.]*

Two copies of this form should be taken for inclusion in the final dissertation/thesis and the original should be returned to the CPHS Ethics administrator.

Student Name	Supervisor Name	Supervisor Name
Jenny E. Ordonez Betancourth	Raj Bhopal	Ruth Jepson
Student Signature: 23/09/14	Supervisor Signature*: 23/09/14	Supervisor Signature*: 23/09/14

*** NOTE to supervisor:** *The CPHS Ethics Subgroup will not check this form (the light touch Level 1 form means we have insufficient detail to do so). By counter-signing this check-list as truly warranting all 'No' answers, you are taking responsibility, on behalf of CPHS and UoE, that the research proposed truly poses no potential ethical risks. Therefore, if there is any doubt on any issue, it would be a wise precaution to mark it as 'uncertain' and contact the Ethics Subgroup as to whether a level 2 form might be required as well. (See Intra Ethics website – URL at top of form)*

25 March 2014

Studies from repeated datasets

Author	Published date	Selected	Title	Ethnicity as a primary variable	Dataset source	Collection data period	Size	Age span	Ethnicity categories
Griffiths, L. J. et al UK	Sept 2010(final version received). Published 2011	YES	Sex and ethnic differences in the waist circumference of 5-year-old children: Findings from the Millennium Cohort Study	Primary	Millennium Cohort Study (MCS)	Third sweep of MCS	14403	5y	White Indian Pakistani Bangladeshi Black Other
Griffiths, L. J. et al UK	2010	NO	Risk factors for rapid weight gain in preschool children: findings from a UK-wide prospective study	Covariate	Millennium Cohort Study (MCS)	Second and third sweep of MCS	11 653	3y	White Mixed Indian Pakistani Bangladeshi Black Other ethnic group
Hawkins, S. S. et al UK	2009	NO	An ecological systems approach to examining risk factors for early childhood overweight: findings from the UK Millennium Cohort Study	Covariate	Millennium Cohort Study (MCS)	Second sweep of MCS	13188	3y	White Mixed Indian Pakistani Bangladeshi Black Other ethnic group

Hawkins, S. S. et al UK	2008	NO	Regional differences in overweight: An effect of people or place?	Covariate	Millennium Cohort Study (MCS)	Second sweep of MCS	13 194	3y	White Mixed Indian Pakistani Bangladeshi Black Other ethnic group
Brophy, S. et al UK	2009	NO	Risk factors for childhood obesity at age 5: analysis of the millennium cohort study	Primary	Millennium Cohort Study (MCS)	1 September 2000 and 11 January 2002.	17,561	5y	White/European Asian African
Harding, S et al UK	28 Novembe r 2007 (accepted)	YES	Ethnic differences in overweight and obesity in early adolescence in the MRC DASH study: the role of adolescent and parental lifestyle	Primary	DASH study	Sept 2002-July 2003	6599	11-13y	White UK White other Black Caribbean Black African Indian Pakistano/Bangladeshi Mixed
Harding, S et al UK	2008	NO	Overweight, obesity and high blood pressure in an ethnically diverse sample of adolescents in Britain: The Medical Research Council DASH study	Primary	DASH study	Sept 2002-July 2004	6407	11-13y	White UK Black Caribbean Black African Indian Pakistano/Bangladeshi Mixed
Nightinga le et al UK	2013	YES	Influence of adiposity on insulin resistance and glycemia markers among U.K. children of South Asian, black African-Caribbean, and white European origin:	Primary	CHASE STUDY	Oct 2004- Feb 2007	subsa mple 100 school s	9-10y	White European South Asian origin Black African-Caribbean Other

			child heart and health study in England						
Nightingale et al. UK	2011	NO	Patterns of body size and adiposity among UK children of South Asian, black African-Caribbean and white European origin: Child Heart And health Study in England (CHASE Study)	Primary	CHASE STUDY	Oct 2004- Feb 2007	5887	9-10y	White European South Asian origin Black African-Caribbean Other
Nightingale et al. UK	2013	NO	Are Ethnic and Gender Specific Equations Needed to Derive Fat Free Mass from Bioelectrical Impedance in Children of South Asian, Black African-Caribbean and White European Origin? Results of the Assessment of Body Composition in Children Study	Primary	CHASE STUDY	September 2011 and January 2012	864	8-10y	White European South Asian origin Black African-Caribbean Other
Owen, C. G. et al UK	2010	NO	Physical activity, obesity and cardiometabolic risk factors in 9- to 10-year-old UK children of white European, South Asian and black African-Caribbean origin: The Child Heart and health Study in England (CHASE)	Primary	CHASE STUDY	Oct 2004- Feb 2007	2049	9-10y	White European South Asian origin Black African-Caribbean Other

Thomas, C. et al UK	2012	NO	Socio-economic position and type 2 diabetes risk factors: Patterns in UK children of South Asian, black African-Caribbean and white European origin	Primary	CHASE STUDY	Not provided	4804	9-10y	White European South Asian origin Black African-Caribbean Other
Whincup, P. H. et al UK	2010	NO	Early emergence of ethnic differences in type 2 diabetes precursors in the UK: The child heart and health study in England (CHASE study)	Primary	CHASE STUDY	Oct 2004- Feb 2007	4,796	9-10y	White European South Asian origin Black African-Caribbean Other
Dinsdale UK	2012	YES	National Child Measurement Programme: changes in children's body mass index between 2006/07 and 2011/12	Report	National Child Measurement Programme	2006-2012	1,056,780 measurements	4-5y 10-11y	White and Asian Chinese Indian White-British Any Other Mixed Background Any Other White Background White-Irish Any Other Asian Background White and Black African Pakistani Black-Caribbean White and Black-Caribbean Bangladeshi Any Other Black

									Background Black-African
Pallan, M. J. et al UK	2014	NO	Are school physical activity characteristics associated with weight status in primary school children? A multilevel cross-sectional analysis of routine surveillance data	Covariate	National Child Measurement Programme	2006-2007	21,269	4-5y 10-11y	White South Asian African-Caribbean Chinese and other Far East Mixed ethnicity
Townsend, N. et al	2012	NO	Age differences in the association of childhood obesity with area-level and school-level deprivation: Cross-classified multilevel analysis of cross-sectional data	Covariate	National Child Measurement Programme 2007-2008	2007-2008	788,515	4-5y 10-11y	Bangladeshi Black–African Black–Caribbean Chinese Indian Pakistani White–British White–Irish Other
Karlsen, S. et al UK	2014	YES	Ethnic variations in overweight and obesity among children over time: Findings from analyses of the Health Surveys for England 1998-2009	Primary	Health Survey for England (HSE) 1998-2009	Included because is a national report	Included because is a national report	Included because is a national report	Included because is a national report
Saxena, S. et al UK	2004	YES	Ethnic group differences in overweight and obese children and young people in	Primary	Health Survey for England (HSE) 1999	1999	5689	2-20y	General population Afro- Caribbean Indian Pakistani Bangladeshi

			England: Cross sectional survey						Chinese Irish
Higgins, V. et al UK	2012	NO	Ethnicity and childhood overweight/obesity in England	Primary	Health Survey for England (HSE) 1999-2004	1999-2004	7047	2-15y	Black Caribbean Black African Indian Pakistani Bangladeshi Chinese Irish
Whitaker, K. L. et al UK	2010	NO	Comparing maternal and paternal intergenerational transmission of obesity risk in a large population-based sample	Covariate	Health Survey for England (HSE) 2001-2006	2001-2006	4432 families, 7078 children	2-15y	White (white British and white Irish), Black/Black British (African or Caribbean), Asian/Asian British (Indian, Pakistani, Indian-Caribbean, Indian-African) or other (Chinese, Japanese, Filipino, Vietnamese, or mixed ethnic group)

Abstract at 6th European Conference on Migrant and Ethnic Minority Health, Oslo

Session Code: FA 6.6 (Oral presentations)

Framing of ethnicity in childhood obesity research: a systematic review of studies in five ethnically diverse countries (Colombia, Brazil, Mexico, Canada and the United Kingdom).

Authors: Ordonez-Betancourth, Jenny Elizabeth (United Kingdom); Jepson, Ruth (United Kingdom); Bhopal, Raj (United Kingdom)

Keywords: Ethnicity, childhood obesity, Foresight Model, Angelo Framework

Background: While there is a large body of literature on childhood obesity risk factors, there are stillgaps in the relationship between ethnicity and childhood obesity. A better understanding of this relationship may provide additional insight for interventions and policies in ethnically diverse settings. We examined the way in which ethnicity definitions have been applied for interpreting variations in childhood obesity by ethnic groups in five ethnically diverse countries.

Methods: We systematically reviewed published and unpublished cross-sectional and cohort studies without language or time frame restrictions that compared childhood obesity in at least two ethnic groups. We identified studies in Medline, EMBASE, Global Health, WHOLIS and LILACS by using a list of search terms related to childhood, generic and specific ethnic codes potentially used in each country, obesity and contextual factors. Due to the heterogeneity of the study populations and variables, statistical synthesis of the results was not possible. We therefore undertook a narrative synthesis. We looked at explanations in the text for differences in ethnicity and then code them using the Obesity Foresight Model and the Angelo Framework.

Results: Of 206 potentially eligible publications we included 32 studies. In studies reporting ethnic differences in childhood obesity we identified a cluster of 19(57%) explanations related to physiology i.e. six of genetic predisposition to obesity, four of appropriateness of embryonic/foetal and child growth, the rest related to body composition differences. Less attention was given to other aspects such as food consumption i.e. three of dietary habits, two of nutritional quality of food and drinks, and social psychology i.e. two of television viewing, one of parental control and one of body size image, and, one of sociocultural environment. Physical activity environment and individual psychology topics were cited no more than twice and explanations related to food production were not retrieved.

Conclusions: Within the countries of interest, most authors explained ethnic variations in childhood obesity on the basis of physiology aspects. However, explanations are likely to be far more complex and could include the analysis of the provision and accessibility of food.

Message: Research on childhood obesity involving ethnic groups has been framed on the basis of physiological issues. There is a need to study economic and sociocultural environment related to weight gain in children.

Appendix C: Systematic review data extraction

Characteristics of the studies included in the systematic review

Table 3.3.1 General characteristics of the studies included in the systematic review

Table General characteristics of the studies included in the systematic review

	Study ID Country, Start date, Finish Date, Publication date	Source of population data	Design and type of survey	Aim of study	Target population (TP) and sampling (S)	Response rate (%)	Total No Age (years)
Colombia	ENSIN 2010 Colombia 11/2009 11/2010 08/2011(Fonseca et al., 2011)	Colombian National Nutrition Survey, 2010	Cross sectional / National Health Nutrition Survey	**To estimate the prevalence of major nutritional problems affecting the Colombian population and some of its determinants.	TP: National rural and urban population aged 0-64 years. S: Multistage, stratified, cluster sampling design. Non-representative sample of ethnic groups.	85	162331 Age span: 0-2 2-17
	Ortega-Bonilla 2015 Start and finish date not provided	Survey of schoolchildren in selected municipalities of Cauca, Colombia	Cross sectional	To assess the trends of nutritional status in school community in some rural and remote areas of Cauca department in the South of Colombia with emphasis on excess of weight	TP: Schoolchildren S: Not given	Not given	6664 Age span 4-19
Brazil	Lopes 1999 Brazil Start and finish date not provided /1999 (Lopes and Pires Neto, 1999b)	No description of original study or survey.	Cross sectional/ School-based survey	To analyse anthropometric and body composition variables of children aged 7 - 10 years old with distinct ethnic-cultural backgrounds	TP: School children in primary education living in the state of Santa Catarina. S: Convenience. Those which participated in ethnic &cultural characterization of Brazil.	Not given	1757 Age span: 7,8,9,10
	Sampei 2003 Brazil Start and finish date not provided /2003 (Sampei et al., 2008)	No description of original study or survey.	Cross sectional/ School-based survey	(i) To compare anthropometric and body composition parameters based on ethnicity and maturation stage; (ii) to assess body mass index (BMI) and its relationship with other methods of body fat evaluation.	TP: Girls studying in private Schools in Sao Paulo S: Not given	Not given	550 Age span: 11-17
	Fagundes 2004 Brazil Start and finish date not provided	No description of original study or survey.	Cross sectional/ Research study	To assess the nutritional and body composition of two Brazilian indigenous populations by comparing their nutritional status.	TP: Children from two Indigenous peoples *(Alto Xingu* and *Ikpeng)* S: Convenience. Selected from 768 children	Not given	164 Age span: 2-9

	/2004 (Fagundes Neto et al., 2004)						
	Diniz 2008 Brazil /2006 Finish date not provided /2008 (Diniz et al., 2008b)	No description of original study or survey.	Cross sectional/ School-based survey	To analyse physical growth and body composition variables of students from German, Italian and Polish ethnic groups	TP: School children in primary and secondary education (2nd to 8th series) from three ethnic groups living in NW of Brazil S: Three stages; proportional by ethnic group and locality; intentional according to school size and, random cluster sampling.	Not given	1428 Age span: 8, 9, (…), 15
Brazil	Mondini 2009 Brazil Start and finish date not provided /2009 (Mondini et al., 2009)	No description of original study or survey.	Cross sectional / no details of type of survey	i) To evaluate the nutritional status of indigenous children of the *Aruak* and *Karibe* linguistic families; ii) to study the relationship between haemoglobin levels and children's gender, age and nutritional status.	TP: Children from two Indigenous peoples (*Aruak* and *Karibe*) living in the Uper-Xingu, Central Brazil S: All children present in the indigenous settlement.	Not given	470 Age span: <2 2-5 >5-10
	Ribeiro 2009 Brazil Start and finish date not provided 2009 (2 studies) (Ribeiro et al., 2009a, Ribeiro et al., 2009b)	No description of original study or survey.	Cross sectional / School-based survey	Study 1: To evaluate body composition of Black and White schoolchildren Study 2: To evaluate the nutritional status of schoolchildren from public schools in two cities in the West Paraná in relation to socio-economic and skin colour.	TP: School children from the west of Brazil S: Not given	61§	1443 Age span: 6-11
	Araújo 2010 Brazil 03/2009 06/2009 08 2010 (Araujo et al., 2010)	National Adolescent School-based Survey (PeNSE), 2009	Cross sectional/ School-based survey	To describe the nutritional status of adolescents in the 9th year of public and private schools and its association with socio-demographic variables.	TP: Adolescents from public and private schools of Brazilian capitals (9th year). S: Selection of primary and secondary sampling units (schools and class groups respectively)	99.4% Weight 98.8% Height	58971 Age span: 11-13 14-16 17-19*
	Monteiro 2016	Study derived from a big project to reduce pregnancy at adolescence and drugs consumption in the city of Caracol, Brazil	Cross sectional	To measure the prevalence and identify factors associated with excess weight among young people living in the city of Caracol, Piaui, Brazil	TP : Adolescents from Caracol, Brazil S: Not given	96% (calculated after exclusions and missed household)	1088 Age span: 13-19
	Chula Castro 2016	Epidemiological study in high school adolescents from Sao Jose, Santa Catarina, Brazil	Cross sectional		TP : School adolescents from Sao Jose, Santa Catarina, Brazil S: Sample determined in two stages: stratified by state public high schools and conglomerate classes, considering school shift and school grade	82.2%	930 Age span: 14-19

Mexico	Bonvecchio 2009 Mexico 1988/1999/2006 (three surveys) /2009 (Bonvecchio et al., 2009)	Three national probabilistic surveys conducted in 1988, 1999, and 2006	Cross sectional / National Nutrition Survey	To describe prevalence and trends of overweight and obesity in Mexican children	TP: Mexican schoolchildren (national) S: Randomized, stratified, cluster sampling design.	Not given	62494 Age span: 2-4 5-11 12-18
	Hernandez 2003 Mexico 10/1998 03/1999 09/2003 (Hernandez et al., 2003)	Mexican National Nutrition Survey, 1999	Cross sectional / National Health Survey	To measure the prevalence of overweight and obesity in Mexican school age children (5 - 11 years)	TP: Mexican schoolchildren (national). S: Multistage, stratified, cluster sampling design.	92%	11415 Age span: 5-11
	Gonzales-de Cossio 2009 Mexico 1988/1999/2006 (three surveys) /2009 (Gonzalez-de Cossio et al., 2009)	Three national probabilistic surveys conducted in 1988, 1999, and 2007	Cross sectional / National Nutrition Survey	To describe preschool malnutrition prevalence and trends in Mexican people	TP: Mexican schoolchildren (national). S: Multistage, stratified, cluster sampling design.	Not given	8295[µ] Age span: 0-5 6-11 12-23*
	De la Torre-Diaz 2014 Mexico /2013 (finish date not provided) /2014 (Torre-Diaz et al., 2014)	No description of original study or survey.	Cross sectional/ School-based survey	To compare the habitual diet, physical activity and nutritional status between *Tarahumara* children and Mestizos.	TP: Urban school children in Chihuahua city. S: Not given	Not given	111 Age span: 6 -14
	Mendez 2016 April-December 2012	No description of original study or survey.	Cross sectional/ Primary School-based study	To examine the association of parental income, ethnicity and nutritional status with body mass index (BMI) and height in primary school children in Merida.	TP: Urban school children in Merida city. S:Probalilitic sampling of public primary schools (No more details)	98%	3243 Age span: 6 -12
Canada	Katzmarzyk 1998 Canada 05/1995 08/1996 /1998 (Katzmarzyk and Malina, 1998b)	No description of original study or survey.	Cross sectional/ Research study	To compare Canadians of Aboriginal (First Nation and European ancestry), with respect to obesity, subcutaneous fatness and relative subcutaneous fat distribution.	TP: Children from two populations: Temagami and Bear Island (First Nation community) S: All healthy individuals aged 5 – 75.	Not calculated but reasons	Age span: 5-19
	Ng 2010 Canada 01/2004	Canadian community Health Survey Cycle 2-2, 2004	Cross sectional / National Health Survey	To determine associations of diet, physical activity and television viewing time with obesity among Aboriginal and non-	TP: respondents from all age groups living in private occupied dwellings in the ten Canadian provinces.	76.5	4646 Age span: 12 -17

	01/2005 05/2010 (Ng et al., 2010)			Aboriginal youth in conjunction with socio-economic variables.	S: Multistage, stratified, cluster sampling design.		
	Anderson 2010 Canada 2005 -2006 (indigenous study). 1991 - 1997 (Caucasian study) /2010 (Anderson et al., 2010)	i) Specific survey applied to Indigenous community; ii) 'Caucasian' population Paediatric Bone Mineral Accrual Study-PBMAS	Cross sectional/ Research studies	To assess total and central adiposity in Canadian Aboriginal and 'Caucasian' children matched by age, gender and maturity.	TP: Urban and rural Aboriginal and 'Caucasian' school children from the province of Saskatchewan. S: Convenience sample of Aboriginal children from 20 community schools (with a majority enrolment of Aboriginal children. 'Caucasian' children from two elementary school.	Not given	416 Age span: 8-17
	Quon 2012 Canada 1994/ 1995/ 02/2012 (Quon et al., 2012a)	National Longitudinal Survey of Canadian Children and Adolescents recruited in cycle 1 (NLSCY (1994/1995)	Prospective and cross-sectional/National Health Survey	To investigate the role of acculturation, as measured by generational status, on body mass index.	TP: Canadian children and adolescents in NLSCY, cycle 3 S: Cluster sampling of Canadian children new-borns who lived in private households.	88% of Cycle 1 respondents	26442 Age span: 6-11 12-17
	Banerjee 2014 2010	Project BEAT (Built Environment and Active Transportation)	Cross sectional	To assess the prevalence of overweight among 10–12-year-old South Asian children in comparison to non-South Asian children	TP: Grade 5 and 6 students in elementary schools S:Not given	73.3% (calculated)	704 Age span: 10-12 years
	Tu 2015 1994/ 1995/ 02/2012	Two sources: National Longitudinal Survey of Canadian Children and Adolescents recruited in cycle 1 (NLSCY (1994/1995) National Population Health Survey (NPHS)	Prospective surveys Follow ups to waves 8 in each cohort (14-20 years)	To identify unique body mass index trajectories from ages 1 to 20 years and associated factors	TP: NLSCY-Children up to 11 years NPHS-household residents of all ages S: NLSCY- Cluster sampling of Canadian children new-borns who lived in private households. NPHS- Stratified two-stage sample design	Not given	7253 NLSCY 901 NPHS Age span: 1-6 years for both surveys
	Anand 2016 2002-2009 (White participants FAMILY cohort) 2011-2013 (South Asian participants START cohort)	Two sources: FAMILY and START prospective birth cohorts	Longitudinal studies Follow-up of pregnant women and their newborns	To determine ethnic differences in newborns adiposity comparing South Asians (SA) to White Caucasians (Whites).	TP: FAMILY-Pregnant women and their off-spring in Hamilton area ,Ontario, Canada START- Pregnant women and their off-spring in Hamilton area ,Ontario, Canada S: Not given for any cohort nor found in references cited	Not given	400 START 389 FAMILY Age span: Newborn

	Rodd 2016 CCHS 01/2004 01/2005 CHMS 2009-2011 2012-2013	Two sources: Canadian community Health Survey (CCHS)Cycle 2-2, 2004-2005 Canadian Health Measures Survey (CHMS) 2009-2011 2012-2013	Cross sectional / National Health Surveys	To determine the most recent trends in the prevalence of overweight and obesity among	TP: CCHS- respondents from all age groups living in private occupied dwellings in the ten Canadian provinces. S: Multistage, stratified, cluster sampling design. CHMS-96% of Canadian population excluding residents from Indian reserve S: CCHS and CHMS- Multistage, stratified, cluster sampling design	CCHS:76.5 % CHMS: 75.9%	14014 (CCHS and CHMS together- No sample size by survey was provided) Age span: 3 -19
The United Kingdom	Chinn 1998 UK 1983 1993 Jun 1998 (Chinn et al., 1998b)	Three sources: A National Study of Health and Growth (NSHG) and, England-Scottish-English database (detail not provided)	Prospective and cross-sectional/ School-based survey	To estimate trends in growth for ethnic minority and inner city children and comparative representative samples from 1983 to 1994.	TP: Children in primary schools, inner city areas of England and Scotland S: Sample was weighted by a stratified selection of areas (deprived). Comparison with Scotland and English data from two quasi-representative samples.	>90	Not exact number of subjects Age span: 5–11
	Saxena 2004 United Kingdom 01/1999 12/1999 05/2003 (Saxena et al., 2004)	The Health Survey for England, 1999	Cross sectional / National Health Survey	To determine the percentage of children and young adults who are obese or overweight within different ethnic and socioeconomic groups.	TP: General population and minority ethnic groups. S: Multi-stage stratified probability sampling design. Oversampled Black Caribbean, Black African, Indian, Pakistani, Bangladeshi, Irish and Chinese. Non-representative sample of White population.		5689 Age span: 2-20
	Ehtisham 2005 UK (finish date not provided) 04/2005 (Ehtisham et al., 2005b)	No description of original study or survey.	Cross sectional/ School-based survey	To evaluate sex and ethnic differences in insulin sensitivity and body composition in healthy adolescents.	TP: Healthy White European and South Asian adolescents from schools in Birmingham. S: Not clear	Not given	138 Age span: 14-17
	Taylor 2005 England 2001 (finish date not provided) 05/2005 (Taylor et al., 2005)	The RELACHS study	Cross-sectional/school-based survey	i) To examine levels of extreme obesity, obesity, overweight and underweight amongst adolescents from different ethnic groups; ii) to explore the association between socio-economic status and body mass index.	TP: School children living in East London. S: All 42 eligible schools in the three boroughs were stratified by borough and school type (comprehensive; voluntary; other).	Not given	2482 Age span: 11-14

	Dinsdale 2014 UK 2006-2007 2012-2013 11/2014 (Dinsdale et al., 2014b)	The National Child Measurement Programme (NCMP)	Cross sectional/ School-based survey	To examine changes in obesity prevalence in different socioeconomic and ethnic groups, as well as changes in mean BMI, and the distribution of BMI by age and sex.	TP: Children in reception and year 6 from England. S: All children in reception and year 6 from 2 PCTs	>90	1,056,780 measurements Age span: 4-5 10-11
	Wardle 2006 UK 1999 (finish date not provided) 05/2006 (Wardle et al., 2006b)	The Health and Behaviour in Teenagers Study (The HABITS study)	Prospective/school-based survey	To examine the developmental trajectory of obesity in adolescence in relation to sex, ethnicity, and socioeconomic status.	TP: Schoolchildren from South London S: Random selection 36 secondary schools in 13 South London boroughs stratified by area	84	5863 Age span: follow-up of children 11-12 to 15-16
	Shaw 2007 England 1998 to 2002 05/2007 (Shaw et al., 2007)	Study to produce normative data for bone density in British children	Cross sectional/ School-based survey	To evaluate gender and ethnic differences in percentage body fat and to compare these differences with classification of obesity using body mass index criteria.	TP: Schoolchildren from Birmingham and Middlesbrough. S: Not clear but a mention about Children were recruited form White, South Asian, and African-Caribbean ethnic groups.		1251 Age span: 5-18
	Balakrishnan 2008 UK (start and finish date not provided) 03/2008 (Balakrishnan et al., 2008)	Child Health Information System (East Berkshire)	Cross sectional/ School-based survey	To determine the trends in overweight and obesity among White and South Asian children.	TP: Children at school entry (year 1). S: All children born between January 1991 and December 1999 in East Berkshire with height and weight data in Child Health Information System.	57% of children with height and weight data	29 641 Age span: 5–7
The United Kingdom	Harding 2008 UK 09/2002 07/2003 /2008 (Harding et al., 2008a)	No description of original study or survey	Cross sectional/ School based survey	To examine the influence of lifestyles on ethnic differences in excess weight in early adolescence.	TP: School children from 11 London boroughs S: Pupils aged 11-13 randomly selected from 51 Schools (high proportions of the main ethnic minority groups in these schools)	81	6599 Age span: 11-13
	Griffiths 2011 UK (pending) /2011 (Griffiths et al., 2011)	Millennium Cohort study	Prospective and cross-sectional/ School-based survey	To examined sex and ethnic differences in central fatness, as assessed by waist circumference measurements.	TP: Children born in the United Kingdom at the start of the 21th century S: Stratified clustered sampling design to over-represent children living in disadvantaged areas and from ethnic minority groups.	Not given	13590 Age: 5

	Henderson 2011 England (start and finish date not provided) /2011 (Henderson et al., 2011)	No description of original study or survey.	Cross sectional/ School-based survey	To test two hypotheses: (i) Levels of adiposity and blood pressure would be higher in British Pakistani children than in White British children; (ii) British Pakistani children of mothers born in the UK would have smaller SFTs and lower blood pressure than children of mothers born in Pakistan.	TP: School children in a deprived city in the north -east of England. S: Schools selected on the basis of high proportion of South Asian children. This study included children with completed data for triceps SFT.	Not given	341 Age span: 7-11
The United Kingdom	Nightingale 2013 England 10/2004 02/2007 Jun/ 2013 (Nightingale et al., 2013)	Child Heart and Health Study in England (CHASE)	Cross sectional/ School-based survey	To examine the associations among adiposity, insulin resistance, and glycaemia markers in children of different ethnic origins.	TP: Schoolchildren London, Birmingham and Leicester S: 200 Primary Schools sampled to allow a balanced numbers of South Asians, Black African-Caribbean and white Europeans	68	4633 Age span: 9-10
	Karlsen 2014 UK 1998 to 2009 /2013 (Karlsen et al., 2014a)	Health Survey for England (HSE) 1998 - 2009	Cross sectional / National Health Survey	To examine whether and how ethnic variations in childhood overweight/obesity have changed over time, and are affected by socioeconomic factors.	TP: English children S: Multi-stage stratified probability sampling (for sampling details of 1999 survey see Saxena 2004 in this same table.)	66-80	Not exact number of subjects Age span: 2-15
	Lee 2014 England /2011 /2013 /2014 (Lee et al., 2014)	Size and Lung function In Children (SLIC)	Cross sectional/ School-based survey	i) To examine ethnic differences in body size, proportions; ii) to establish the extent to which such differences could influence Bioelectrical Impedance Analysis calibration.	TP: School children from London S: London schools with a high ethnic mix were identified and sampled by education performance within boroughs to ensure a wide range of socio-economic circumstances.	Not given	2171 Age span: 5-11
	Zilanawala 2016	Millennium Cohort study	Prospective and cross-sectional/ School-based survey	To examine racial/ethnic disparities in mean body mass index (BMI) and in the odds of obesity/overweight in the UK and US. The contribution of sociodemographic, cultural and family routine factors are assessed.	TP: Children born in the United Kingdom at the start of the 21th century S: Stratified clustered sampling design to over-represent children living in disadvantaged areas and from ethnic minority groups.	Missingness 0-32% for explanatory factors of overweight and obesity	18280 Age: 5

Quality assessment

Table 3.3.2 Quality assessment of studies included

Study ID		Selection Bias		Ethical approval		Ethnicity report				Data collection methods for measuring childhood adiposity			Total criteria (max score: 12)
		Represen-tativeness	Response rate over 80%	Ethics	Informed consent	Reason	Assign ment	Source	Limitations and weaknesses	Are the measures made by researchers?	Objective measure-ments?	Well-known charts	
Colombia	ENSIN 2010	Y	Y	Y	Y	N	Y	Y	N	Y	Y	Y	9
Brazil	Lopes 1999	Y	Unknown	Y	Y	Y	N	N	N	Y	Y	N	6
	Sampei 2003	Unknown	Unknown	Y	Y	Y	N	N	N	Y	-	Y	6
	Fagundes 2004	N	Unknown	Y	Y	Y	Y	N	N	Y	Y	Y	7
	Diniz 2008	Y	Unknown	Y	Y	Y	N	N	N	Y	Y	N	6
	Mondini 2009	Y	Unknown	Y	Y	Y	Y	N	N	Y	Y	Y	9
	Ribeiro 1 2009	Unknown	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	11
	Ribeiro 2 2009	Unknown	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	10
	Araújo 2010	Y	Y	Y	Y	N	N	N	N	Y	Y	Y	6
Mexico	Bonve-cchio 2009	Y	Unknown	Y	Y	N	Y	Y	N	Y	Y	Y	9
	Hernan-dez 2003	Y	Y	Y	Y	N	N	N	N	Y	Y	Y	7

	Gonzales-de Cossio 2009	Y	Unknown	Y	Y	N	Y	Y	N	Y	Y	Y	9
	De la Torre-Díaz 2014	Unknown	Unknown	Y	Y	Y	N	Y	N	Y	Y	Y	7
Canada	Katz-marzyk 1998	Y	Unknown	Y	Y	Y	Y	N	N	Y	Y	N	7
	Ng Carmina 2004	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	11
	Anderson 2010	Unknown	Unknown	Y	Y	Y	Y	N	N	Y	Y	Y	7
	Quon 2012	Y	Unknown	Y	Y	Y	Y	N	N	N	N	Y	7
The United Kingdom	Chinn 1998	Y	Y	Y	Y	Y	Y	N	N	Y	Y	N	8
	Saxena 2004	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	11
	Ehtisham 2005	N	Unknown	Y	Y	Y	Y	N	N	Y	Y	Y	7
	Taylor 2005	Y	Unknown	Y	Y	Y	Y	Y	N	Y	Y	Y	9
	Dinsdale 2006	Y	Y	Y	Y	N	N	N	N	Y	Y	Y	7
	Wardle 2006	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	10
	Shaw 2007	Unknown	Y	Y	Y	Y	Y	N	N	Y	Y	Y	9
	Balakrish-nan 2008	Y	Unknown	Y	Y	Y	N	N	N	Y	Y	N	6
	Harding 2008	N	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	10

	Griffiths 2011	Y	Unknown	Y	Y	Y	Y	N	N	Y	Y	Y	8
	Hender-son 2011	N	N	Y	Y	Y	Y	Y	N	Y	Y	Y	9
	Stanfield 2012	N	Unknown	Y	Y	Y	Y	Y	N	Y	Y	Y	8
	Nightinga le 2013	Y	Y	Y	Y	Y	Y	N	N	Y	Y	N	9
	Karlsen 2014	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	10
	Lee 2014	Y	Unknown	Y	Y	Y	Y	N	N	Y	Y	Y	8
Total (Max score +32)		21	13	32	32	26	24	10	6	31	30	26	-

Reporting of ethnicity

Table 3.3.3 Reporting of ethnicity

Country / study		Reason for using ethnicity in relation to overweight/obesity	Assignment method		Redefinition of ethnic codes
Colombia	ENSIN 2010	No reason provided but general statement related to the study of determinants of health.	Parent's report of ethnic group	Reference: 2005 Census Ethnic codes: *Indígena*, Roma Raizal, Palenquero *de San Basilio*, *Negro*, *Mulato, Afro-Colombiano* or *Afro-Descendiente"*	Ethnic codes redefined: Indigenous, Afro-descendant, General Population No reasons provided
	Ortega-Bonilla 2015	No reason provided but general statement related to complement the national data reported by government institutions	Not stated	Afro-descendant, Indigenous, and Mestizo (general population)	No evidence of a redefinition
Brazil	Lopes 1999	Genetic related: Brazil has had a colonization process by different cultures, and body composition is influenced by genetic factors.	Not stated	No reference provided Ethnic codes: White, Black, German, Portuguese, Italian, Mixed	No evidence of a redefinition
	Sampei 2003	General statement about health-care planning, disease causation and clinical care: "Consideration of the variable ethnicity within diverse studies may provide aid in the planning of health measures, sometimes also revealing important data on health aetiology, diagnosis and treatment"	Not stated if self-reported Country of birth of grandparents; 1) those of Japanese origin had to have three or four grandparents born in Japan; (2) those of Caucasoid origin had to be descended from Caucasians with no ancestors of 'Negroid', Asian or other ethnic origin."	No reference provided Ethnic codes: Caucasian, Japanese	No evidence of a redefinition
	Fagundes 2004	Surveillance/Monitoring: Confirmation of low prevalence of undernutrition and obesity in Indigenous populations reported in previous studies as a monitoring of nutritional status in these populations	Not stated if self- reported. Indigenous status previously known	No reference provided Ethnic codes: *Alto-Xinguana, Ikpeng*	No evidence of a redefinition

	Diniz 2008	Genetic-related: Brazil has had a colonization process by different cultures, and body composition is influenced by genetic factors.	Not stated	No reference provided Ethnic codes: White , Black Origin: German, Polish, Italian	No evidence of a redefinition
	Mondini 2009	Surveillance/Monitoring: Importance of knowing indigenous health status and specific exposures	Not stated if self- reported. Indigenous status previously known	No reference provided Ethnic codes: *Meinaco, Waura, Yawalapiti*	No evidence of a redefinition
Brazil	Ribeiro 2009 (2 studies)	Genetic-related: Brazil has had a colonization process by different cultures, and body composition is influenced by genetic factors.	Parent's report of skin colour	Reference: National Institute of Studies and Educational Researches Anisio Teixeira (INEP, 2005) Ethnic codes: White, Black, Brown, Yellow and, Indigenous	Ethnic codes redefined: White colour, Black colour Reason: "…Low number of Black and Mulatto children, of both genders, in relation to white in some age groups, they were classified as only one group: black."
	Araújo 2010	No reason given	Not stated	No reference provided Ethnic codes: White, Black, Brown, Yellow, Indigenous	No evidence of a redefinition
	Monteiro 2016	No reason given	Self-report of skin colour	No reference provided Ethnic codes: White, Black, Brown	No evidence of a redefinition
	Chula Castro 2016	No reason given	Skin colour (Not stated if by self-report or categorisation by the interviewer)	Brazilian Institute of Geography and Statistics Ethnic codes: White, Black, Brown, yellow, red	Ethnic codes redefined: Black, Brown, yellow, or red as one category White as the other category No reasons provided
Mexico	Bonvecchio 2009	No reason given	-1988 survey: Indigenous status stated according to the household location. - 1999 and 2006 surveys: Indigenous status if at least one woman aged 12 to 49 years spoke an indigenous language	Reference: Mexican Nutrition Survey 1988, 1999, 2006 Use of Indigenous language: Yes or Not	Ethnic codes redefined: Indigenous Non-Indigenous No reasons provided

	Hernandez 2003	No reason given	Indigenous status if at least one woman aged 12 to 49 years spoke an indigenous language	Reference: Mexican Nutrition Survey 1988, 1999, 2006 Use of Indigenous language: Yes or Not	Ethnic codes redefined: Indigenous Non-Indigenous No reasons provided
	Gonzales-de Cossio 2009	No reason given	1)1988 survey: Indigenous status stated according g to the household location 2) 1999 and 2006 surveys: Indigenous status if at least one woman aged 12 to 49 years spoke an indigenous language	Reference: Mexican Nutrition Survey 1988, 1999, 2006 Use of Indigenous language: Yes or Not	Ethnic codes redefined: Indigenous, Non-Indigenous No reasons provided
	De la Torre-Díaz 2014	Surveillance/Monitoring: Trends of obesogenic behaviour in migrants. Cultural practices determine diet in social groups	Not stated	No reference provided Ethnic codes: Mestizo, Tarahumara	Ethnic codes redefined: Mestizo, Tarahumara No reasons provided
	Mendez 2016	Ethnicity might be associated with children's BMI and stature under certain socioeconomic conditions	Surname-based classification. In Mexico, people have two surnames, first from the father, second one from the mother. Mayan is a kind of Indigenous ancestry which can be tracked by surnames.	Reference: Wolañski et al., 1993; Mclorg 2005;Valencia Villalvazo et al., 2012, which are studies on ethnicity in the region of Yucatan, Mexico. Ethnic codes: Mayan-Mayan (father and mother surnames with Maya origin); Mayan-No Mayan (One parent surname with Maya origin); No Mayan-No Mayan (None of the parents surnames have Maya origin)	No evidence of a redefinition
Canada	Katzmarzyk 1998	Genetic-related/Monitoring/ disease causation: "A syndrome identified among native groups called the `New World Syndrome'. It includes metabolic diseases such as obesity, diabetes and gall bladder disease, is presumed to have a significant genetic component."	Children's self-report of ethnic group	No reference provided Ethnic codes: First Nation, European	No evidence of a redefinition

	Ng 2004	Monitoring: "It is unclear whether lifestyle behaviours of Aboriginal youth, particularly those not living in First Nations communities, are comparable to levels among Non-aboriginal youth."	Parent's report of ethnic group responding a structured question	Reference: Canadian community Health Survey Cycle 2-2, 2004 ¥ Ethnic codes: White, Chinese, South Asian, Southeast Asian, West Asian, Black Filipino, Latin American Japanese, Arab, Korean Aboriginal Peoples of North America (North American Indian, *Me´tis,* Inuit) ¥	Ethnic codes: Aboriginal, Non-Aboriginal. No reasons provided
	Anderson 2010	Evidence of ethnic differences in health: Evidence suggests that the prevalence of obesity varies by ethnicity. Recognized High risks among Aboriginal	Children's self-report of ethnic group (Indigenous group). Assistance from the parent or teacher if necessary	No reference provided. Ethnic codes: First Nations, *Métis* and Inuit.	No evidence of a redefinition
	Quon 2012	Evidence of health differences in health between natives and migrants: "The 'healthy immigrant effect' refers to the observation that the health of immigrants at the time of immigration is superior to the health of the native-born population, but worsens with time spent in the new country."	Country of birth of parents (parent and spouse) Parent's report of child's country of birth. "Aboriginal" was defined as youth born in Canada and identified by their parents as "an Aboriginal person who is North American Indian, Inuit, or Métis."	Not reference provided Ethnic codes: White, East Asian, South Asian, South East Asian, Black, Aboriginal, other	No evidence of a redefinition
	Banerjee 2014	"Overweight and obesity is thought to be one of the primary underlying factors in the increased mortality from CVD in people of South Asian origin, and the metabolic effects are apparent from childhood [6, 8]. Therefore, South Asian children could be at greater risk of developing CVD and type 2 diabetes at an earlier stage, and the need to implement prevention strategies including weight control is needed"	Self-report of a second language spoken at home and confirmation of surnames origin	Not reference provided Ethnic codes: South Asian, and non-South Asian	No evidence of a redefinition
	Tu 2015	Ethnicity evaluated as a potential sociodemographic and family characteristic associated with trajectories in increased BMI.	Not stated	Ethnic codes: White/European, Aboriginal, other)	No evidence of redefinition

	Anand 2016	"Previous studies that compared South Asians living in India with those in the United Kingdom reported that South Asian newborns had lower birthweight and had relatively more adipose tissue compared with White Caucasian (White) newborns of the same gestational age. This has been termed the 'thin-fat' phenotype and may represent an early feature of increased cardiometabolic risk, as there is a growing body of evidence associating lower birthweight with abdominal obesity, hypertension, future type 2 diabetes and cardiovascular disease."	Not stated but reference provided in which ethnicity is assessed on the basis of Self-reported Ethnicity - for self, parents and grandparents	Ethnic codes: South Asian, White Caucasian	No evidence of redefinition
	Rodd 2016	Not given	Not stated	Ethnic codes: White (American and European) and non-white	Redefinition on the basis of the following statement: : " To ensure adequate numbers and consistency across survey cycles, we pooled race/ethnicity categories as White (European-American) or non-White". Race ethnicity categories are inferred to be the expanded categories described by the Canadian Community Health Survey.
	Chinn 1998 UK	Information needs: Limited information about trends in obesity for ethnic minorities in Britain (In 1998)	Interviewer's report of country of birth and language spoken at home	No reference provided Ethnic codes: English White, English Scottish, White, Afro-Caribbean, Urdu/Punjabi, Guajarati, Other Indian	No evidence of a redefinition
	Saxena 2004	Evidence of ethnic differences in health: Evidence of increased risks for cardiovascular diseases and death in ethnic minority groups in comparison with any other ethnic group.	-Parents report of ethnic group (children aged below 13) -Children's report of ethnic group (aged 13 -15)	Reference: 1991 UK census Ethnic codes: White, Black Caribbean, Black African, Black Other, Indian, Pakistani, Bangladeshi, Chinese, Any other ethnic group, Not know/not given	Ethnic codes redefined: General population, Afro-Caribbean, Indian Pakistani, Bangladeshi, Chinese, Irish No reasons provided

	Ehtisham 2005	Evidence of ethnic differences in health: Higher prevalence of type 2 diabetes in South Asians in the UK	Self-report of country of birth for three generations	No reference provided Ethnic codes: White European, South Asian	No evidence of a redefinition
	Taylor 2005	Evidence of ethnic differences in health: Variation in obesity by ethnic groups	Self-reported of ethnic group Self-reported of country of birth and the main languages spoken at home.	Reference: 2001 UK census Ethnic codes: White (British, Irish, Any other White background), Mixed (White and Black Caribbean, White and Black African, White and Asian, Any other mixed background), Asian (Indian, Pakistani, Bangladeshi, Any other Asian Background), Black or Black British (Caribbean, African, Any other Black background), Other ethnic groups (Chinese, Any other ethnic group, not stated)	Ethnic codes redefined: Bangladeshi, White British, Black African (Black African and Black Somali), Indian, Pakistani, Black Caribbean, Other (Black British, White Greek, White, Turkish, White Orthodox Jewish, White Kurdish, Vietnamese) Reason: Ethnic codes were modified in order to include some additional options for self-assigned ethnic group following community consultation and piloting
The united kingdom	Dinsdale 2006	Evidence of ethnic differences in health: Evidence based on NCMP and HSE show variation in obesity by ethnic groups	¥ Self-report of ethnic group	¥ Reference: 2001 UK census ¥Ethnic codes: White (British, Irish, Any other White background), Mixed (White and Black Caribbean, White and Black African, White and Asian, Any other mixed background), Asian (Indian, Pakistani, Bangladeshi, Any other Asian Background), Black or Black British (Caribbean, African, Any other Black background), Other ethnic groups (Chinese, Any other ethnic group, not stated)	Ethnic codes redefined: White, Asian, Black Reasons: "When the NCMP data are split by detailed ethnic group the confidence limits around the estimates of obesity prevalence are large, as is the amount of year on year variation within ethnic groups. This makes it difficult to assess whether there has been a significant linear trend over time"

	Wardle 2006	Evidence of health differences by ethnic and SES: "Ethnicity and socioeconomic status are consistently associated with risk of obesity"	Self-reported of ethnic group by using a 'simplified' question because of the age of students involved. The question included the three main ethnic groups represented in the 1991 U.K. census	¥ Reference: 1991 U.K. census ¥ Ethnic codes: White, Black Caribbean, Black African, Black Other, Indian, Pakistani, Bangladeshi, Chinese, Any other ethnic group, Not know/not given	Ethnic codes redefined: White, Black/Mixed, Black, Asian/Mixed, Asian Reason: The "Other" ethnic group was excluded from the analyses because it was heterogeneous and too small to subdivide.
	Shaw 2007	"We have previously demonstrated ethnic differences in percentage body fat between South Asian and White European adolescents which are associated with evidence of increased insulin resistance in the South Asian subjects. It is not currently known at what age these ethnic differences in body composition may be seen"	Not clear if self- reported Country of birth of parents	No reference provided Ethnic codes: White British, Non-white, Bangladeshi, Black African, Black Caribbean and Black British	No justification given
	Balakrishnan 2008	Evidence of ethnic differences in health: Variation in obesity by ethnic groups	Not stated	No reference provided Ethnic codes: White, European, South Asian. Afro-Caribbean	No evidence of a redefinition
The united kingdom	Harding 2008	Evidence of ethnic differences in health: Variation in obesity by ethnic groups	Children's report of ethnic group in conjunction with country of birth of parents and grandparents (three born in home countries)	¥ Reference: 2001 UK census ¥Ethnic codes: White (British, Irish, Any other White background), Mixed (White and Black Caribbean, White and Black African, White and Asian, Any other mixed background), Asian (Indian, Pakistani, Bangladeshi, Any other Asian Background), Black or Black British (Caribbean, African, Any other Black background), Other ethnic groups (Chinese, Any other ethnic group, not stated)	No evidence of a redefinition

	Griffiths 2011	Evidence of ethnic differences in health: Variation in obesity by ethnic groups	¥ Parent's report	¥ Reference: 2001 UK census ¥Ethnic codes: White (British, Irish, Any other White background), Mixed (White and Black Caribbean, White and Black African, White and Asian, Any other mixed background), Asian (Indian, Pakistani, Bangladeshi, Any other Asian Background), Black or Black British (Caribbean, African, Any other Black background), Other ethnic groups (Chinese, Any other ethnic group, not stated)	Ethnic codes redefined: White, Indian, Pakistani, Bangladeshi, Black, Mixed/Other Reason: To create a smaller manageable number of categories for reporting.
	Henderson 2011	Evidence of ethnic differences in health: Higher risk for developing Type 2 diabetes in South Asians living in Europe	Parent's report of ethnic group. Those reported "Pakistani" generation of the child was determined by mother's and maternal grandmother's country of birth	¥ Reference: England and Wales census for 2001 ¥Ethnic codes: White (British, Irish, Any other White background), Mixed (White and Black Caribbean, White and Black African, White and Asian, Any other mixed background), Asian or Asian British (Indian, Pakistani, Bangladeshi, Any other Asian Background), Black or Black British (Caribbean, African, Any other Black background), Chinese or other ethnic group (Chinese, Any other).	Ethnic codes redefined: White, Pakistani No reason provided

The United Kingdom	Stanfield 2012	Evidence of ethnic differences in body composition: "South Asian children and adults have more adipose body composition compared with those of European ancestry"	Self-report of ethnic group. Only infants with mother and father both classified as either 'Asian or Asian British' or 'White' were eligible to participate (minimizing the potential influence of mixed ethnic background on infant body composition).	¥ Reference: 2001 UK census ¥Ethnic codes: White (British, Irish, Any other White background), Mixed (White and Black Caribbean, White and Black African, White and Asian, Any other mixed background), Asian (Indian, Pakistani, Bangladeshi, Any other Asian Background), Black or Black British (Caribbean, African, Any other Black background), Other ethnic groups (Chinese, Any other ethnic group, not stated)	Ethnic codes redefined: White British, South Asian Reason: Authors only wanted to compare South Asian and White ancestry groups. The avoided mixed groups
	Nightingale 2013	Evidence of ethnic differences in health: "Ethnic differences in type 2 diabetes risk between South Asians and White Europeans originate before adult life and are not fully explained by higher adiposity levels in South Asians"	Parent's report of ethnic group Children's reported (1% of participants) of country of birth of parents and grandparents, cross-checked with observer assessment of ethnicity.	No reference provided Ethnic codes: White European (White British, White Irish, White European or a combination of these) South Asian Black African-Caribbean (Black African, Black Caribbean, Black British, Black Other or a combination of these) Other ethnic origin (Mixed ethnic origin and all other categories of individual)	No evidence of a redefinition
The united kingdom	Karlsen 2014 UK	Evidence of ethnic differences in health: Variation in obesity by ethnic groups	Self-report of ethnic group Self –report of family origin and cultural background Country of birth of parents (i.e., Ireland) for respondents responding "White"	¥Reference: HSE 1999 & 2004 Ethnic codes: White, Mixed ethnic group, Black or Black British, Asian or Asian British, Any other group. Family origin and cultural background included:	No evidence of a redefinition

				Black Caribbean, Black African, Indian, Pakistani, Indian Caribbean, African, Indian, Chinese, Japanese, Filipino and Vietnamese, Mixed ethnicities (White and ethnic minority backgrounds)	
	Lee 2014	Evidence of ethnic differences in body composition: UK studies in older children and adolescents have shown that, when used in multi-ethnic populations, calibration equations need to include ethnic-specific terms, but whether this holds true for younger children remains to be elucidated.	Parent's report of ethnic group	No reference provided Ethnic codes: White (European, Hispanic or Latino and Middle Eastern), Black African/Caribbean, South Asian (Indian, Pakistani, Sri Lankan and Bangladeshi), Other (any other ethnicities such as Chinese or Filipino, or mixed ethnic origins (e.g. South Asian/White)	No evidence of a redefinition
	Zilanawala 2016	Racial and ethnic differences in family routines, such as regular bedtimes and child nutrition, have been observed and these factors are associated with risk of obesity in children	Mother's reports of her child's race/ethnicity using UK census categories	UK census Ethnic codes: White, Indian, Pakistani, Bangladeshi, Black Caribbean (including mixed White and Black Caribbean), Black African (including mixed White and Black African) and other	No evidence of a redefinition

Definitions, methods and measurements

Table 3.3.4 Definitions, methods and measurements used to determine childhood obesity

Study ID_ Country	Child growth charts used for obesity definitions			Methods for measures of weight and height		Measurements					Other measurements		
	Body Mass Index		Other measures										
	Reference populations BMI (for Percentiles or Z scores)	Definition stated	Reference populations (for Percentiles or Z scores)	Weight	Height	Weight-for-Height	BMI	Waist circumference	Skinfold thick-nesses	Body fat (%)	Skinfold thick-nesses' equations	BIA	Other
ENSIN 2010 Colombia	WHO 2006 (< 5 years old)	NCHS, WHO, Ministry of Health Obesity, Overweight At risk of overweight:	NCHS (Weight-for-Height)	Electronic scale	Stadiome-ter	N	Y	N	N	N	--	--	--
Ortega-Bonilla 2015 Colombia	WHO 2014	WHO Obesity Overweight		Not reported	Not reported	N	Y	N	N	N	-	-	-
Lopes 1999 Brazil	--	--	--	Scale (kind was not reported)	Measuring tape	N	Y	N	Y	Y	Y	--	--
Sampei 2003 Brazil	NCHS	NCHS Overweight (including obesity)	--	Electronic scale	Measuring tape	N	Y		Y	Y	--	--	Near-infrared Interac-tance NIR
Fagundes 2004 Brazil	CDC 2000	Overweight	--	Electronic scale	Wood ruler (Children < 3 years) Measuring tape(older children)	N	Y	N	Y	Y	Y	--	--
Diniz 2008 Brazil	--	--	--	Electronic scale	Measuring tape	N	Y		Y	Y	Y	--	--

Mondini 2009 Brazil		IOTF Obesity Overweight (including obesity)	--	Microelectronic scale (for children under 2 years , weight of children was obtained after subtracting mother's weight from weight from mother with the child	Horizontal wood anthropo meter (children < 2 years old) Vertical stadio-meter (older children)	N	Y	N	N	N	--	--	--
Ribeiro 2009 Brazil (2 studies)	CDC 2000	--	NCHS (Weight-for-Height)	Electronic scale	Stadio-meter	Y	Y	N	Y	Y	--	--	--
	CDC 2000	--	--	Electronic scale	Stadio-meter	N	Y	N	N	N	--	--	--
Araújo 2010 Brazil	WHO 2007	WHO 2007 Obesity Overweight		Electronic scale	Stadio-meter	N	Y	N	N	N	--	--	--
Monteiro 2016 Brazil	WHO 2007	WHO 2007 BMI > 1 Z score Overweight (including obesity)	-	Electronic scale	Stadio-meter	N	Y	N	N	N	_	_	_
Chula Castro 2016 Brazil	_	_	Not clear if reference population used for WC. Authors stated they used a cut-off point suggested by Taylor to define abdominal obesity (WC z score ≥ 1)	_	_	N	N	Y	N	N	_	_	_
Katzmarzyk 1998 Canada		Obesity Overweight NHANES II	--	Spring scale	Stadio-meter	N	Y		Y	N	--	--	--
Ng 2004 Canada	--	--	--	Portable scale	Measuring tape	N	Y	N	N	N	--	--	--

Anderson 2010 Canada	Not clear	IOTF Overweight Obese Abdominal adiposity	NHANES (WC)	Electronic scale	Stadio-meter	N	Y	Y	N	N	--	--	--
Quon 2012 Canada	CDC 2000	CDC 2000 Obesity Overweight	--	Reported by parents	Reported by parents	N	Y	N	N	N	--	--	--
Banerjee 2015 Canada	IOTF	Obesity Overweight (Not stated if the above categories are mutually exclusive)	__	Mechanical scale	Stadio-meter	N	Y	N	N	N	_	_	_
Tu 2015 Canada	No reference population used	No definition nor categories used. Authors estimated trajectories of BMI from 1 to 20 years	_	Reported by parents for children aged ≤ 11 years Self-reported for children older than 11 years	Reported by parents for children aged ≤ 11 years Self-reported for children older than 11 years	N	Y	N	N	N	_	_	_
Anand 2016 Canada	_	_	_	_	_	N	N	Y	Y	N	_	_	Hip circumference
Rodd 2016 Canada	WHO 2014	WHO 2014 Obesity Overweight	NHANES (WC) NHANES (Waist-for-Height ratio)	_		N	N	Y	N	N	_	_	Waist-for-Height ratio
Bonvecchio 2009 Mexico		IOTF Obesity Overweight (including obesity)	--	Electronic scale	Stadio-meter	N	Y	N	N	N	--	--	--
Hernandez 2003 Mexico	--	IOTF Obese Overweight	--	Electronic scale	Stadio-meter	N	Y	N	N	N	--	--	N

Gonzales-de Cossio 2009 Mexico	NCHS/WHO	WHO/NCHS WHO 2006 Overweight including obesity	NCHS/WHO (Weight-for-height)	Electronic scale	Measuring board (Length in children < 2 years) Vertical stadio-meter (older children)	Y	N	N	N	N	--	--	--
De la Torre-Díaz 2014 Mexico	--	CDC 2000 Obesity Overweight	--	A protocol is mentioned but not referenced. Information not provided	Protocol is mentioned but not referenced	N	Y	N	N	N	--	--	--
Mendez 2016 Mexico	WHO 2007	WHO 2007 Obesity Overweight and overweight including obesity	--	Electronic scale	Portable stadio-meter	N	Y	N	N	N	--	--	--
Chinn 1998 UK	--	--	England Data 1994	Mechanical scale	Stadio-meter	Y	N	N	Y	N	--	--	--
Saxena 2004 UK		IOTF Obesity Overweight (including obesity)	--	Electronic scale	Stadio-meter	N	Y	N	N	N	--	--	--
Ehtisham 2005 UK	UK 1990 growth reference	IOTF Overweight (including obesity)		Electronic scale	Portable Stadio-meter	N	Y	Y	Y	Y	--	--	DXA scanner
Taylor 2005 UK	UK 1990 growth reference	UK 1990 growth reference Obesity Overweight (including obesity)	--	Electronic scale	Portable Stadio-meter	N	Y	N	N	N	--	--	--
Dinsdale 2006 UK	UK 1990 growth reference	UK 1990 growth reference Obesity	--	Not reported	Not reported	N	Y	N	N	N	--	--	--
Wardle 2006 UK	UK 1990 growth reference	IOTF Obesity Overweight	UK 1990 growth reference (Waist circumference)	Electronic scale	Free-stan-ding Stadio-meter	N	Y	Y	N	N	--	--	--

Shaw 2007 England	UK 1990 growth reference	IOTF Obesity Overweight	--	Hospital balance scale	Stadio-meter	N	Y	N	N	Y	--	--	(DXA) on a GE Lunar DPX-L scanner
Balakrishnan 2008 UK	UK 1990 growth reference	UK 1990 growth reference Obesity Overweight	--	Mechanical scale	Stadio-meter r	N	Y	N	N	N	--	--	--
Harding 2008 UK	UK 1990 growth reference	IOTF Obesity Overweight (including obesity)	--	Electronic scale	Portable Stadio-meter	Y	Y	Y	N	N	--	--	--
Griffiths 2011 UK	--	--	Reference data from British Standards Institute (1977-1987)	Electronic scale	Height was not variable for this study	N	N	Y	N	N	--	--	--
Henderson 2011	UK 1990 growth reference	--	UK 1990 growth reference	Electronic scale	Stadio-meter	N	Y	Y	Y	N	--	--	--
Stanfield 2012 UK	--	--	--	Electronic scale	Rolla-meter	N		Y	Y	Y	--	--	Plestymograp hy
Nightingale 2013 UK	--	--	--	Electronic scale	Stadio-meter	N	Y	Y	Y	Y	N	Y	--
Karlsen 2014 UK	--	IOTF Obesity Overweight	--	Electronic scale	Stadio-meter	N	Y	N	N	N	--	--	--
Lee 2014 UK	UK 1990 growth reference	--	--	Electronic scale	Stadio-meter	N	Y	N	N	Y	--	Y	--
Zilanawala 2015 UK	IOTF	IOTF Obesity Overweight	--	Standardised protocols mentioned. No details provided	Standard-ised protocols mentioned No details provided	N	Y	N	N	Y	_	_	_

Effect estimates for associations between ethnicity and overweight /obesity

Table 3.3.6 Effect estimates for associations between ethnicity and overweight/obesity

Study ID and country	Ethnic codes	Age (yrs)	Population (*n*)			Overweight					Obesity		
						Female		Male		All	Female	Male	All
			Total	Fem	Male	Crude OR 95%CI	Adjusted OR 95%CI	Crude OR 95%CI	Adjusted OR 95%CI	Adjusted OR 95%CI	Adjusted OR 95%CI	Adjusted OR 95%CI	Adjusted OR 95%CI
Monteiro 2016 Brazil	Brown	13-19	143							1			
	White		895							1.82 (1.21-2.72)			
	Black		50							0.88 (0.33-2.35)			
Hernández 2003 Mexico §	Indigenous	5-11	1151							1			1
	Non-indigenous		9750							1.86 (1.41-2.46)			0.91 (0.67-1.23)
Mendez 2016 Mexico	Non Mayan	6-12	1742							1			1
	Half Mayan		1092							0.87 (0.67-1.13)			1.35 (0.97-1.66)
	Mayan		409							1.14 (0.76-1.32)			1.25 (0.86-1.53)

Banerjee 2014 § Canada	Non-South Asian	10 to 12	474	269	205	1	1	1	1	1.0			
	South Asian		260	129	131	1.47 (0.92-2.35)	2.58 (1.60-4.16)	0.92 (0.51-1.66)	2.45 (1.32-4.55)	1.32 (0.87-2.01)			
Rodd 2016 § Canada	White	3 to 19	11233			1	1	1	1	1	1	1	1
	Non-White		2781			0.83 (0.73-0.95)	0.81 (0.71-0.93)	0.84 (0.75-0.95)	0.82 (0.73-0.93)	1.15 (1.06-1.25)	0.86 (0.71-1.04)	1.06 (0.91-1.23)	1.17 (1.05-1.31)
Balakrishnan 2008 UK § *	White European	5 to 7	13116	6460	6656	1		1		1			1
	South Asian		3025	1484	1541	0.86 (0.75-0.99)		1.77 (1.56-2.00)		1.27 (1.16-1.39)			1.45 (1.28-1.63)
	Afro-Caribbean		223	108	115	1.17 (0.75-1.83)		1.34 (0.87-2.04)		1.24 (0.91-1.68)			1.10 (0.72-1.69)
	Unrecorded		29641	6426	6851	0.86 (0.79-0.94)		0.95 (0.87-1.03)		0.93 (0.87-0.99)			0.90 (0.82-0.99)
Harding 2008 UK	White UK	11 to 13	1234	589	645		1		1		1	1	
	White Other		720	318	402		1.1 (0.4-1.6)		1.4 (1.00-1.8)		1.3 (0.65-2.0)	2.2 (1.4-3.7)	
	Black Caribbean		940	453	487		1.4 (1.1-1.9)		0.75 (0.52-1.1)		1.9 (1.3-3.0)	1.7 (1.1-2.8)	

	Black African		1105	593	512		1.5 (1.09-1.9)		0.9 (0.6-1.3)		1.8 (1.2-2.9)	1.6 (0.99-2.5)	
	Indian		491	218	273		1.3 (0.8-1.8)		1.4 (0.9-1.8)		--	--	
	Pakistani/ Bangladeshi		628	222	406		0.95 (0.6-1.45)		1.2 (0.85-1.7)		--	1.85 (1.2-3.3)	
	Mixed		566	279	287		1.35 (0.9-1.9)		1.25 (0.75-1.6)		1.4 (0.8-2.45)	1.4 (0.75-2.4)	
Taylor 2005 UK §	Bangladeshi	11 to 14	587	267	320		0.72 (0.45-1.16)		1.14 (0.77-1.67)		0.86 (0.45-1.63)	1.02 (0.61-1.72)	
	White British		538	267	271		1		1		1	1	
	Black African		263	151	112		0.95 (0.52-1.75)		1.96 (1.20-3.13)		1.23 (0.65-2.38)	1.37 (0.71-2.63)	
	Indian		242	139	103		0.56 (0.36-0.87)		0.53 (0.29-0.99)		0.64 (0.26-1.54)	0.48 (0.18-1.30)	
	Pakistani		166	73	93		1.32 (0.82-2.13)		0.56 (0.64-0.88)		1.04 (0.44-2.44)	0.42 (0.12-1.39)	

	Black Caribbean		145	73	72		0.95 (0.55-1.64)		0.78 (0.41-1.30)		0.78 (0.42-1.44)	1.33 (0.60-3.03)	
	Other		541	280	261		0.87 (0.60-1.23)		1.05 (0.64-1.72)		1.10 (0.70-1.69)	1.12 (0.47-2.70)	
Zilanawala 2015 UK	White	5	15003							1			1
	Indian		518							0.71 (0.52-0.97)			0.79 (0.43-1.47)
	Pakistani		926							0.78 (0.59-1.02)			1.13 (0.82-1.56)
	Bangladeshi		376							0.82 (0.56-1.22)			1.98 (1.24-3.15)
	Black Caribbean		487							1.37 (0.98-1.91)			2.34 (1.65-3.32)
	Black African		459							1.76 (1.33-2.33)			2.43 (1.59-3.70)
	Other		511							0.84 (0.60-1.18)			1.08 (0.67-1.74)

§ Overweight including obesity; * Data are prevalence odds ratio.

Body Mass Index as continuous variable

Table 3.3.7a Findings on BMI as continuous variable in studies from Brazil

Study ID and country	Ethnic codes	Age (years)	Population (*n*)			BMI (Kg/m^2)			
						Z score(SD)		Mean(SD)	
			Total	Fem	Male	Fem	Male	Fem	Male
Sampei 2003 Brazil	Caucasian (Premenarcheal)	10 to 11	179	179	--	--	--	18.9 (3.4)	--
	Japanese (Premenarcheal)		122	122	--	--	--	18.3 (3.1)¥	--
	Caucasian (Postmenarcheal)	16 to 17	177	177	--	--	--	21.8 (2.9)	--
	Japanese (Postmenarcheal)		72	72	--	--	--	21.4 (2.8)¥	--
Fagundes 2004 Brazil	Indigenous Alto Xingu	2 to 9	95	--	--	0.55 (0.6)	-0.67 (0.64)	16.6 (0.9)	16.8 (1.1)
	Indiineous Alto Ikpeng		69	--	--	-0.03 (0.9)*	0.09 (0.8)*	15.6 (1.3)*	16.0 (1.0)*
Diniz 2008 Brazil	German origin	8 to 15§	590	302	288	--	--	28.1(5.6)/51.7(14.9)	26.8 (4.9)/59.6 (15.3)
	Polish origin		438	227	211	--	--	27.4(4.7)/59.1(10.9)	27.6(6.0)/58.1(11.5)
	Italian origin		400	197	203	--	--	27.9(7.4)/57.3(13.8)	29.0(4.9)/58.4(15.2)
Ribeiro 2009 Brazil	White colour	6 to 11	900	472	428	-0.15(1.08)	0.02(1.03)	--	--
	Black colour		543	263	280	-0.04(1.04)¥	-0.00(0.99)¥	--	--

* p <0.05; ¥ p> 0.05; § Data are presented for two age groups: youngest/oldest

Table 3.3.7.b Findings on BMI as continuous variable in studies from Canada

Study ID and country	Ethnic codes	Age (years)	Population (*n*)			BMI (Kg/m^2)			
						Z score(SD)		Mean(SD)	
			Total	Fem	Male	Fem	Male	Fem	Male
Katzmarzyck 1998 Canada	First Nation	5 to 19	38	17	21	--	--	19.4(3.4)	20.1(4.0)
	European		129	57	72	--	--	18.8(4.4)*	18.5(3.5)*
Anderson 2010 §	Aboriginal (Mat I)	9.9(1.1)/ 10.9(1.4)	75	19	56	-0.2(0.9)	-0.07(1.0)	20.2(4.1)	20.6(4.3)
	Caucasian (Mat I)	10.6(1.3)/11.7(1.3)	78	24	54	-0.7(0.7)*	-0.6(0.8)*	17.8(3.2)*	18.2(3.4)*
	Aboriginal (Mat II)	12.6(0.9)/14.4(1.0)	58	39	19	-0.0(0.9)	-0.06(0.9)	20.7(3.8)	20.6(3.9)
	Caucasian (Mat II)	12.6(1.0)/13.9(0.7)	70	41	29	-0.3(0.7)	-0.4(0.5)*	19.7(3.4)*	19.1(2.4)*
	Aboriginal (Mat III)	14.9(1.5)/16.4(1.3)	65	42	23	0.9(1.0)	0.8(1.2)	24.9(4.4)	24.4(5.5)
	Caucasian (Mat III)	14.4(1.1)/16.1(0.9)	70	56	14	0.2(0.9)*	0.4(0.8)*	21.6(3.8)*	22.6(3.6)*
Quon 2012	1st generation	6 to 11	209	--	--	56.05(33.66)	66.31(32.23)	--	--
	2nd generation		601	--	--	56.58(32.97)	62.23(32.32)	--	--
	Mixed generation		975	--	--	58.74(31.51)	59.86(32.03)	--	--
	3rd generation		11730	--	--	60.20(31.76)	63.71(31.89)	--	--
	Aboriginal		772	--	--	66.34(30.53)	68.10(31.23)	--	--
	1st generation	12 to 17	175	--	--	55.46(28.21)	58.93(30.12)	--	--
	2nd generation		477	--	--	53.55(27.97)	59.28(28.66)	--	--
	Mixed generation		825	--	--	54.62(27.56)	58.26(27.97)	--	--
	3rd generation		10025	--	--	56.95(27.27)	61.72(28.49)	--	--
	Aboriginal		653	--	--	61.91(27.19)	63.87(28.68)	--	--

§ Results by categories of maturity; *p<0.05; SD: means Standard Deviation

Table 3.3.7c Findings on BMI as continuous variable in studies from the United Kingdom

Study ID and country	Ethnic codes	Age (years)	Population (*n*)			BMI (Kg/m^2)			
						Z score(SD)		Mean(SD)	
			Total	Fem	Male	Fem	Male	Fem	Male
Ehtisham 2005 UK	White European	14 to 17	64	33	31	0.42(0.2)	0.56(0.2)	21.8(0.5)	21.9(0.7)
	South Asian		65	33	32	0.89(0.2)¥	0.79(0.3)¥	23.9(0.8)*	24.0(1.1)*
Wardle 2006 UK	White	11 to 12	2607	1010	1597	0.39(1.17)	0.45(1.12)	19.6(3.5)	18.9(3.1)
	Black/Mixed Black		1046	464	582	0.87(1.16)	0.54(1.24)	21.1(4.2)	19.3(3.9)
	Asian/Mixed Black		428	175	253	0.20(1.30)	0.40(1.32)	16.2(3.6)	19(3.4)
	Other/Mixed		189	87	102	0.35(1.30)	0.61(1.25)	19.7(4.3)	19.4(3.5)
Shaw 2007 England§*	South Asian	5 to 18	339	171	168	-0.10(1.14)/0.09(1.28)	-0.28(1.38)/0.66(1.32)	--	
	African-Caribbean		253	137	116	0.61(1.03)/1.08(1.16)* §	1.21(1.59)/0.60(0.60)* §	--	
	White		654	368	286	0.23(0.82)/0.36(0.89)	0.40(1.06)/0.93(1.04)	--	
Studies reporting findings in the whole sample									
Henderson 2011 UK	Pakistani	7 to 11	132	--	--	0.18(0.98)*		17.6 (3.4)	
	White		209	--	--	0.27(1.43)		18.0 (2.8)	
Nightingale 2013 UK	White European	9 to 10	1109	--	--	--		18.3(18.1-18.5)**	
	South Asian		1266	--	--	--		17.9(17.7-18.1)**	
	Black African-Caribbean		1176	--	--	--		19(18.8-19.2)**	
	Other ethnic origin		1082	--	--	--		18.6(18.4-18.8)**	
Lee 2014 UK	White	5 to 11	574	--	--	0.34(0.11)		--	
	Black African/Caribbean		488	--	--	0.74(1.3)*β		--	
	South Asian		311	--	--	-0.07(1.4)		--	
	Other		202	--	--	0.42(1.3)		--	

§ Findings are shown for youngest age group/ oldest age group; * p <0.05; ¥ p> 0.05; l vs. the other groups; β Compared with White groups; ** p <0.05 for trend across ethnic groups

Waist circumference as continuous variable

Table 3.3.8a Findings on waist circumference (continuous variable)

Study ID and country	Ethnic codes	Age (years)	Population (*n*)			Waist circumference (cm)			
						Z-score mean (SD)		Mean(SD)	
			Total	Fem	Male	Fem	Male	Fem	Male
								All	
Chula Castro 2016 Brazil	White	14 to 19	574					710. (7.7)	
	Black/Brown/Yellow/Red		342					72 (8.3)	
Studies reporting findings by sex									
Anderson 2010 Canada β	Aboriginal (Mat I)	9.9(1.1)/ 10.9(1.4)	75	19	56	-0.05(0.8)	0.05 (1.0)	71.6 (10.4)	72.8 (12.2)
	Caucasian (Mat I)	10.6(1.3)/ 11.7(1.3)	78	24	54	-0.90(0.6)*	-0.6(0.7)*	61.7 (7.7)*	64.6 (8.3)*
	Aboriginal (Mat II)	12.6(0.9)/ 14.4(1.0)	58	39	19	0.15(0.8)	0.32)0.7)	74.1 (9.7)	76.2 (8.8)
	Caucasian (Mat II)	12.6(1.0)/ 13.9(0.7)	70	41	29	-0.51(0.6)*	-0.32(0.5)*	66..0 (7.9)*	68.2 (5.6)
	Aboriginal (Mat III)	14.9(1.5)/ 16.4(1.3)	65	42	23	0.92(1.1)	1.1(1.2)	83.5 (13.1)*	86.0 (15.3)
	Caucasian (Mat III)	14.4(1.1)/ 16.1(0.9)	70	56	14	-0.2(0.7)*	0.4(0.6)¥	69.3 (8.2)*	77.2 (7.8)¥
								All	

Anand 2016 Canada	White Caucasian	Newborns	389					29.9 (0.1)	
	South Asian		400					31.1 (0.1)	
Ehtisham 2005 UK	White European	14 to 17	64	33	31	--	--	68.1 (1.5)	73.4 (1.7)
	South Asian		65	33	32	--	--	71.9 (2.1)*	79.9 (2.8)*
Studies reporting findings in whole samples									
Griffiths 2011 UK	White	5.00	11576	--	--	0.55(1.02)		53.7(4.1)	
	Indian		328	--	--	0.15(1.67)* β		52.6(6.6)* β	
	Pakistani		548	--	--	0.12(1.68)* β		52.5(6.4)* β	
	Bangladeshi		207	--	--	0.32(1.91)		53.3(7.7)* β	
	Black		412	--	--	0.78(1.44)* β		54.9(6.2)* β	
	Mixed/ Other		519	--	--	0.36(1.24)		53.2(4.9)* β	
Hender-son 2011 UK	Pakistani	7 to 11	132	--	--	0.50 (1.11)		61(8.7)	
	White		20.9	--	--	0.69 (1.33)*		62.9(8.1)	
Stanfield 2012 UK	White British	6 to 12 weeks	30	--	--	39.8(3.0)		--	
	South Asian		30	--	--	38.2(2.6)*		--	
Nightingale 2013 UK	White European	9 to 10	1109	--	--	--		64(63.5-64.6) ξ	
	South Asian		1266	--	--	--		63.1(62.6-63.6) ξ	
	Black African-Caribbean		1176	--	--	--		64.2(63.7-64.8) ξ	
	Other ethnic origin		1082	--	--	--		64.3(63.8-64.9) ξ	

-- Not provided; § Results by categories of maturity; * p <0.05; ¥ p> 0.05; ** P-value Vs. other groups; β Compared with White groups; ξ p <0.05 for trend across ethnic groups

Body fat

Table 3.3.8b Body fat percentage

Study ID and country	Ethnic codes	Age	Population (*n*)			Body fat percentage			
						Mean(SD)		High body fat (% of cases)	
			Total	Fem	Male	Fem	Male	Fem	Male
Lopes, 1999 Brazil	German	7 to 10	434	218	216	20.68(5.47)/ 20.21(7.00)¥	17.62(6.65)/ 17.33(7.30)¥	2	3
	Portuguese		439	232	207	19.69(5.79)/ 21.81(7.08)¥	15.11(5.14)/ 15.39(6.14)¥	2	4
	Italian		443	228	215	20.37(5.74)/ 23.50(7.05)¥	16.97(6.34)/ 17.96(7.53)¥	2	4
	Mixed		350	100	250	18.43(3.90)/ 21.35(6.99)¥	15.82(5.18)/ 17.05(6.67)¥	1	4
Sampei 2003 Brazil	Caucasianλ	10 to 11		179		21.4(5.3)	--	--	--
	Japaneseλ			122		19.9(4.7)*	--	--	--
	Caucasian §	16 to 17		177		30.1(5.0)	--	--	--
	Japanese§			72		29.1(4.6)*	--	--	--
Fagundes 2004 Brazil	Indiineous Alto Xingu	2 to 9	95	NG	NG	2.5(1.4)	2.1(1.0)	--	--
	Indigineous Alto Ikpeng		69	NG	NG	3.8(1.7)*	2.0(1.2)¥	--	--
Diniz 2008 Brazil	German	8 to 15	590	302	288	21(6.8)/22.4(6.2)	14.8(4.8)/16.4(6.3)	16.2	11.1
	Polish		438	227	211	20.5(7.6)/24.9(5.4)	17.4(6.8)/14.5(6.7)	21.4	7.1

	Italian		400	197	203	20.2(4.5)/27.3(5.3)	15.4(6.5)/15(8.3)	19.4	6.6
Ribeiro 2009 Brazil	White colour	6 to 11	900	472	428	--	--	2.3	40(9.3)
	Black colour		543	263	280	--	--	5.7¥	7.5¥
Ehtisham 2005 UK	White European	14 to 17	64	33	31	26.0(0.7)	14.8(1.0)	--	--
	South Asian		65	33	32	30.6(1.0)*	20.8(1.3)*	--	--
Shaw 2007 England	South Asian	5 to 18	339	171	168	--	--	65.5*l	33.3*l
	African-Caribbean		253	137	116	--	--	41.9	19.3
	White		654	368	286	--	--	59.3	23.6
Nightingale 2013 UK ð	White European	9 to 10	1109	--	--	27.1(26.5-27.7) ξ		--	--
	South Asian		1266	--	--	29.1(28.5-29.7) ξ		--	--
	Black African-Caribbean		1176	--	--	29.5(28.9-30.1)		--	--
	Other ethnic origin		1082	--	--	28.6(28-29.2) ξ		--	--

ð Findings reported for the whole sample; * p <0.05; ¥ p> 0.05; l vs. the other groups; β: Compared with White groups; ξ p <0.05 for trend across ethnic groups, λ Premenarcheal;, § Postmenarcheal.

Explanations and Recommendations provided by authors

Table 3.3.9 Explanations and recommendations offered by authors

Study ID and country		Explanations for ethnic variations in childhood obesity and adiposity	Recommendations related interventions to tackle ethnic variations in childhood obesity	Recommendations related future research
Colombia	**ENSIN 2010**	**Social determinants of health: Explanation based on general population figures: nutritional transition in Colombia and low socio economic position.**	**Food consumption and individual physical activity: Recommendations based on general population figures: healthy diet and physical activity.**	**No recommendations given**
Brazil	Araujo 2010	Not explanations given	Recommendations based on population figures: 1. Age group: The need to develop interventions designed to reach infancy and adolescence. 2. Age group: Development of local and national health policies focused on infants and adolescents. 3. Methodological issues: School is a relevant setting for implementing interventions targeting nutrition problems.	No recommendations given
Mexico	Bonve-cchio, A. 2009	Not explanations given	Recommendations based on general population figures: 1. Culturally adapted interventions: "...To design culturally acceptable effective interventions to prevent childhood obesity…" 2. Life cycle approach: "Prevention (…)	No recommendations given

			should include a clear understanding of the local determinants of childhood obesity and a life cycle approach."	
Mexico	Hernan-dez 2003 Mexico	No explanation given	1. Physiology: A general mention about the formulation of health policies and preventive programmes in Mexican school age children.	No recommendations given
	Gonzalez-de Cossio, T.	No explanation given	Recommendations based on general population figures: 1. Social determinants of health, food consumption and physiology: "to improve the quality of programs that address nutrition in order to reduce the gaps between socioeconomic groups and, particularly, point to the need to promote and protect lactation and infant feeding practices as a priority for Mexico's public policy agenda."	No recommendations given
	Torre-Diaz, M. de L. de la. 2014	Empirical evidence 1. Food consumption: **Diet high in saturated fat among Mestizo children in comparison with urban Tarahumara children 2. Individual physical activity: **Urban Tarahumara children spent more time on recreational physical activity than Mestizo children. 3. Social psychology and Physical activity environment: **Mestizo children spent more time indoors (watching TV or playing videogames) than Tarahumara children.	Recommendations based on general population figures: 1. Individual physical activity and food consumption: **To implement strategies to promote physical activity and adequate diet among schoolchildren in the study area.	No recommendations given

		Mestizo children living in central areas have less opportunities to play outdoors because of violence problems or traffic situation in more compact urban zones. Tarahumara children usually live in peripheral and less urbanized zones.		
	Katzmar-zyk, P. T. 1998	Authors stated that there is a need " to better document the genesis of the central pattern of subcutaneous fat distribution among "Native Americans""	No recommendations given	No recommendations given
Canada	Ng 2004	1. Social psychology: "Almost half of the aboriginal youth watched TV for ≥15h/week, two times the proportion estimated among the Non-aboriginal youth." 2. Physical activity environment: "Obesity status may affect physical activity participation differentially between both groups." 3. Social determinants of health: Lower household education status among aboriginal population	1. Physical activity environment: "To identify barriers to physical activity participation." 2. Physical activity environment: "To promote culturally appropriate activities that are appealing and inclusive." 3. Physical activity environment: "To develop programmes that enhance self-efficacy and family-based programmes delivered by aboriginal health counsellors that empower youth communities."	No recommendations given
Canada	Anderson K.D 2010	Explanations based on evidence 1. Physiology: 'Thrifty genotype', an ancient survival mechanism to optimize foetal nutrition and healthy birth weights that could predispose Aboriginal women to gestational diabetes mellitus (GDM) and high birth weight infants which is associated with childhood obesity, insulin	1. A mention about specific interventions targeting indigenous populations taking into account what the authors suggested about future research	1. Individual physical activity, Physical activity environment, social determinants of health: "…assess both adiposity and its distribution and be directed at understanding the impact of an array factors (i.e., genetics, sex, maturity, nutrition, physical

	resistance and early onset of T2D. 2. Methodological issues: Secular trends of childhood obesity in Canada that could have an effect on their findings given that data from Aboriginal children come from 2005 and data from Caucasian children come from 1991 to 1997.		activity, culture, socioeconomic status and the built environment) on adiposity…"
Quon, Elizabeth C. 2012	1. Individual psychology: BMI changes observed in first-generation immigrants and "It is possible that a greater disparity between original and dominant cultures in first-generation immigrants is related to more acculturative stress, especially during the transitional time of adolescence."	Researchers and policy makers 1. Culturally adapted interventions: To address the needs of immigrants based on what has been learnt adapting prevention and intervention strategies in Aboriginal children. 2. Culturally adapted interventions: "…to continue adapting the existing interventions to address acculturation issues in Aboriginal youth". Paediatricians and other health professionals 1. To recognize the risk of obesity in immigrant children 2. Social psychology: to educate immigrant families about "achieving lifestyles in their new country"	1. Social psychology: To explicitly measure acculturation rather than infer through generational status (by using cultural identity questionnaires, language proficiency and/or preference, or neighbourhood ethnic or immigrant composition). 2. Social psychology: To analyse time since immigration 3. Methodological issues: To use a "...longitudinal design to understand the temporal pattern and begin to infer causality" 4. Social psychology: To measure risk factors in relation to immigration, acculturation and weight gain. 5. To uncover factors underlying for Canadian Aboriginal

				peoples' increased risk for obesity and related morbidities
	Chinn, S. 1998	Explanations based on evidence 1. Physiology: Increases in weight for height and a decrease in triceps skinfolds among White girls is unexplained, except by changes in fat distribution. 2. Authors figured out that the trend found in Afro-Caribbean children from Britain was different from the US trend (NHANES/references from1993 - 1995). However, they stated that although "...Afro-Caribbean tend to accumulate more subcutaneous tissue on the trunk than the limbs. (Malina RM, 1996)" this explanation was not studied in this opportunity	No recommendations given	No recommendations given
	Saxena 2004	No explanation given	1. Age group: Prevention in early childhood. 2. Social determinants of health: “Healthier diets and more exercise require resolve from government and other agencies across the spheres of health, transport, education, media, and culture.”	
The United Kingdom	Balakrish-nan, R. 2008	Explanations based on evidence 1. Food consumption: Changes in dietary patterns after migration: "novel sweet items were notably introduced to the children’s diet in Bradford (e.g. breakfast cereals and fizzy drinks), whereas	1. Food consumption: "South Asian, especially boys, (…) may be a priority for specific initiatives identifying and promoting healthy diets that are appropriate to South Asians, culturally sensitive and target both the children and parents."	No recommendations given

		traditional items (chapatti, curry) persist." (Edwards S. et al 2006)		
The United Kingdom	Ehtisham, S 2005	1. Methodological issues: The sample was formed by self-selected volunteers and a selection bias could be occur. However the White adolescents should be similarly affected. 2. Physiology: South Asian had a higher frequency of a positive familiar history of diabetes, high prevalence of having an affected parent which was not seen in White adolescents. 3. Physiology: South Asian girls had higher fasting plasma glucose levels than any other group. 4. Physiology: South Asian adolescents were more insulin resistant and had more adverse lipid profile. However ethnic differences in insulin sensitivity were no longer seen when body fat was included as a covariate.	1. Individual physical activity and physiology: The increased adiposity and central fat distribution seen in South Asian adults was also seen in South Asian adolescents, therefore, interventions aimed at primary intervention of the metabolic and cardiovascular consequences of adiposity in high risk population should be targeted at children.	1. Physiology: To interpret data on body composition and insulin sensitivity in childhood in the context of sex and ethnicity 2. Body composition and age and sex differences: To interpret BMI in the context of body composition 3. To identify how early sex and ethnic differences are apparent.
	Taylor S, 2006	1. Physiology: The high prevalence of obesity and overweight in South Asian groups may represent underestimate since lower BMI cut-off levels for obesity in South Asian adults have proposed (WHO 2004)	1. Culturally adapted interventions: Effective, culturally appropriate interventions around obesity, nutrition and physical activity targeted at populations such as this.	1. Physiology: Longitudinal follow-up of body composition amongst young people in this multi-ethnic population.

		Explanations based on comparisons with HSE study (Saxena 2004); 1. Methodological issues: The sample was representative of a deprived urban population area whereas the HSE survey aims to be nationally representative. 2. Methodological issues: HSE sampled a wider age range and this could mask different patterns of ethnicity and obesity in different age cohorts.		
The United Kingdom	Wardle 2006 UK	1. The ethnic difference was restricted to girls, phenomenon that has been poorly understood. 2. Physiology: Mechanisms could include the earlier development of adiposity in Black girls and it is supported by the flatter slope for the trends in waist measurements in Black students.	1. Physiology: Surveillance of the anthropometric status of young people in Britain is of critical importance for monitoring the progression of the obesity problem and evaluating the success of public health interventions.	1. Methodological issues: To use largest samples to be able to identify differences in one specific group avoiding broad classification of ethnicity (e.g., Black and Mixed Black in the same group). 2. Age group: The need to examine the trajectory of adiposity earlier in childhood, because the high risk period may be getting earlier.

Shaw, N 2007 UK	1. Physiology: Unadjusted differences are due to body weight and not stature. If the data are reanalysed with adjustment for height rather than weight, the differences in body composition for the girls from the age of 9 years are no longer significant. 2. Physiology: These discrepancies may be explained by environmental and genetic interactions on nutrition, linear growth and proportion of body fat. 3. Physiology: Ethnic differences in percentage body fat can be seen from the age of 5 years.	No recommendations given	1. Physiology and Body composition: To investigate longitudinal changes in body composition by ethnic group. 2. Physiology and environment: To identify genetic and environmental factors that lead to differences in body composition at a young age.
Harding, S 2008	Empirical explanations provided by the complimentary analysis: 1. Food consumption: Parental behaviours were more adverse in White UK and White Other than other ethnic groups. 2. Food consumption: Excess among Black Caribbean girls were associated with adverse adolescent behaviours. 3. Family environment: Indians were less likely to skip breakfast, suggesting a link with a family environment that protects against adverse dietary practices. 4. Social psychology: Indians were least likely than any other group to be in a lone parent household. 5. Food consumption: Obesity promoting	1. A combination of child and parent-focused interventions should be considered regardless of ethnicity.	1. To investigate whether the differences in the nature of migration contribute to differences susceptibility. 2. To understand energy balance rather than the frequency of self-assessed servings by using comprehensive measures of habitual diets and energy intake. 3. More research about strategies promoting behaviour change among ethnic minority children

		dietary behaviours were less common in first generation children		
	Griffiths, C 2011	Increasing evidence of ethnic differences in obesity and body composition remain limited and inconclusive. Empirical evidence: 1. Physiology: Authors have reported that Black UK children have the greatest infant weight gain. Evidence comparable with that reported from United States	No recommendations given	1. Physiology: BMI is a reasonable proxy for body fatness at a population level, it is less reliable when examining ethnic group differences. 2. Physiology: To include a range of anthropometric measurements, including waist circumference. 3. Physiology: To study genetic and environmental risks factors for central fatness in early childhood as well as its associations with adverse health outcomes in the short and in the large term
The United Kingdom	Henderson, E 2011	1. Physiology: Differences in pubertal stages might have influenced the results given that both adiposity and blood pressure change during puberty.	No recommendations given	1. To obtain individual level measure of SES from all participants. 2. Studies assessing adiposity in South Asian children using only BMI or waist circumference may need to apply South Asian specific cut-offs when classifying children as overweight or obese. 3. Utilization of a population-specific reference population

			for South Asian children and adults (to apply it with care given the likely heterogeneity between South Asian groups). 4. To study differences in health behaviours in South Asian families according to the migrant status of both mothers and fathers.
Stanfield, K 2012	1. Physiology: The greater relative adiposity of South Asian infants is a consequence of their lower average FFM. 2. Physiology: Explanation based on evidence: Studies in adults have showed that the greater insulin resistance of South Asian, measured by homeostasis model assessment, was explained by their high ratio of FM to FFM. Having more FM and less FFM in comparison with White European ancestry may play a key role in the increased risk of insulin resistance and T2DM. 3. Physiology: Post-natal weight gain had a greater determining effect on resultant FM of 8-week-old infants. 4. Physiology: The body composition differences in off-spring appear to replicate those in mothers, indicating a transgenerational effect.	1. Life cycle approach: The early origins of differences needs to be taken into account when developing interventions aimed at reducing later-life ethnic differences in adiposity and the subsequent risk of T2DM	1. Physiology: Large longitudinal studies correlating the changes in FM and FFM from birth to adulthood with the development of precursors to insulin resistance and T2DM. 2. Physiology: Studies aimed at understanding ethnic differences in birthweight and gestation

The United Kingdom	Nightingale, C 2013	1. Physiology: Reasons for the altered metabolic sensitivity to adiposity remain unclear. However, it may reflect the influence of other exposures differing by ethnic group and operating in childhood, infancy, or foetal life. Such factors may include dietary factors or physical activity both observed to differ between South Asian and White European population. 2. Physiology: Influence of growth and nutrition in utero (e.g.; on pancreatic development) or specific genetic influences.	1. Age group: Age Efforts to control excessive weight gain and fat-tissue accumulation need to be established as a priority in childhood, especially among South Asians 2. Physiology: Control of adiposity alone will not abolish the South Asian-White European differences in insulin resistance and glycated haemoglobin; findings particularly important in the Indian subcontinent.	1. Physiology: To study ethnic differences in fat free mass
The United Kingdom	Karlsen, S 2013	Explanations based on evidence: 1. Physiology: Correlation between BMI and height. This may overestimate the proportions of overweight in taller groups (Black Caribbean boys and Black African girls) and underestimate that in shorter groups (Chinese boys and Bangladeshi girls). 2. Social psychology: Ethnic variation in body shape perception 3. Social determinants of health: Interrelationships between socioeconomic and lifestyle factors in their impact on BMI: It seems likely that these variations are driven by differences in the effects of lifestyle mechanisms rather than differences in lifestyles themselves.	1. Culturally adapted interventions: culturally appropriate educational policies, which encourage healthy lifestyles among Black and minority ethnicity young people. 2. Social psychology: Education related to body shape perception	1. Racist victimization: To investigate the relationship between experience of forms of racist victimization and higher BMI among children

	4. Racist victimization: Positive relationship between experience of forms of racist victimization and higher BMI among adults (not investigated in children).		
Lee, S 2014	1. Physiology: Variability in the size or the length of the limbs is likely to have a bigger influence on impedance than similar variability in the truck. 2. Physiology: Observed increased in ethnic variability after 10 years of age was likely to be caused by different onsets of puberty, with Black African/Caribbean entering puberty earlier than other ethnic groups.	No recommendations given	1. Methodological issues: To address the full spectrum of ethnicity in terms of the ethnicity category 'Other' and 'Mixed'. According to the authors, 'Other' was poorly defined and was likely to include a wide range of ethnicity as well as those of 'Mixed' ethnicity.

Appendix D: Supplementary material for chapter 4

Abstract presented at The European Congress on Obesity.

EASO's annual scientific congress. 2017

Using Directed Acyclic Graphs (DAGs) for studying links between ethnicity and childhood obesity in an ethnically diverse country such as Colombia

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Background: The prevalence of childhood obesity in Colombia is increasing. Although there is information on its distribution by socio economic status in children and adolescents, little is known about other determinants, such as ethnicity. Furthermore, evidence from high-income countries has often been used to design policies and interventions oriented to these age groups. In preparation for a secondary analysis of the Colombian National Nutrition Survey we created DAGs for identifying and studying the potential links between ethnicity and risk factors for childhood obesity.

Methods: The DAG was developed from a systematic review of risk factors in five diverse countries Colombia Brazil, Mexico, Canada and the United Kingdom). We developed a search strategy using terms related to childhood obesity, contextual factors and the ethnic codes used in each country, without language or time restrictions. We searched Medline, EMBASE, Global Health, WHOLIS and LILACS for published and unpublished cross-sectional and cohort studies in the countries of interest. Studies had to compare risk factors for childhood obesity in at least two ethnic groups. We also included a subsample of Colombian studies exploring childhood obesity in one ethnic group. Given the heterogeneity of the study populations, we performed a narrative synthesis structured according to the UK Foresight Obesity System Map.

Results: From 7437 papers reviewed, we identify 74 potentially relevant. Of these, 32 were included in the narrative synthesis. We also identified 138 potentially relevant studies conducted in a single ethnic group. Of these, a subsample of five Colombian studies were also included (one study focused on African-descendant population, three on distinct

indigenous peoples). We identified six potential pathways linking childhood obesity and ethnicity and influencing obesity-related behaviours among Colombian children: 1) through socioeconomic status and food security influencing food exposure; 2) through socioeconomic status and place influencing food exposure; 3) through socioeconomic status and place influencing physical activity; 4) and 5) through socioeconomic status and individual psychology influencing food exposure and physical activity, and 6) genetic and epigenetics factors through ethnicity influencing physiological factors. The DAG also addresses other unmeasured variables that could operate in the Colombian context, such as those related to food production and racial discrimination.

Conclusion: We present a framework sourced from the literature in childhood obesity and ethnicity in five ethnically diverse countries. In Colombia these relationships are poorly documented and the use of causal approaches such as DAGs may strengthen the analysis of obesity studies

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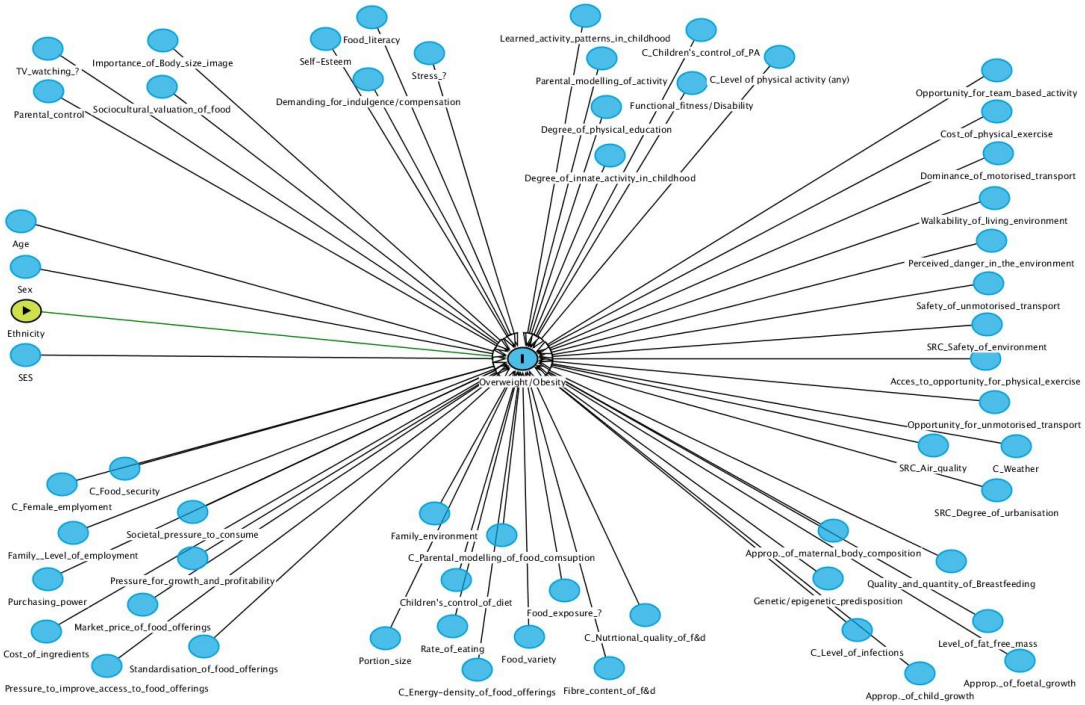
Producing a DAG

First step: Selection of risk factors

First plot using DAGitty V2.3 showing potential risk factors according to Foresight Obesity System Map's clusters.




```
Daggity Code dag {
"C_Children's_control_of_PA" [pos="0.633,-0.088"]
"C_Energy-density_of_food_offerings" [pos="0.417,1.066"]
"C_Level of physical activity (any)" [pos="0.709,-0.039"]
"C_Nutrtional_quality_of_f&d" [pos="0.579,0.968"]
"Children's_control_of_diet" [pos="0.397,0.904"]
"Demanding_for_indulgence/compensation" [pos="0.312,0.001"]
"Fibre_content_of_f&d" [pos="0.545,1.063"]
"Food_exposure_?" [pos="0.501,0.923"]
"Functional_fitness/Disability" [pos="0.625,0.008"]
"Genetic/epigenetic_predisposition" [pos="0.756,0.901"]
"Overweight/Obesity" [outcome,pos="0.461,0.506"]
"Self-Esteem" [pos="0.271,-0.072"]
"Stress_?" [pos="0.371,-0.046"]
"TV_watching_?" [pos="0.003,-0.054"]
Acces_to_opportunity_for_physical_exercise [pos="0.908,0.505"]
Age [pos="-0.023,0.257"]
Approp._of_child_growth [pos="0.844,1.073"]
Approp._of_foetal_growth [pos="0.941,1.050"]
Approp._of_maternal_body_composition [pos="0.761,0.815"]
```

```
C_Female_emplyoment [pos="0.016,0.732"]
C_Food_security [pos="0.077,0.703"]
C_Level_of_infections [pos="0.784,0.994"]
C_Parental_modelling_of_food_comsuption [pos="0.441,0.823"]
C_Weather [pos="0.937,0.663"]
Cost_of_ingredients [pos="0.001,0.997"]
Cost_of_physical_exercise [pos="0.919,0.059"]
Degree_of_innate_activity_in_childhood [pos="0.545,0.139"]
Degree_of_physical_education [pos="0.542,0.051"]
Dominance_of_motorised_transport [pos="0.920,0.135"]
Ethnicity [exposure,pos="-0.018,0.419"]
Family__Level_of_employment [pos="0.027,0.819"]
Family_environment [pos="0.376,0.784"]
Food_literacy [pos="0.315,-0.111"]
Food_variety [pos="0.467,1.007"]
Importance_of_Body_size_image [pos="0.114,-0.069"]
Learned_activity_patterns_in_childhood [pos="0.522,-0.113"]
Level_of_fat_free_mass [pos="0.910,0.978"]
Market_price_of_food_offerings [pos="0.094,0.949"]
Opportunity_for_team_based_activity [pos="0.919,-0.015"]
Opportunity_for_unmotorised_transport [pos="0.916,0.583"]
Parental_control [pos="0.004,0.024"]
Parental_modelling_of_activity [pos="0.537,-0.036"]
Perceived_danger_in_the_environment [pos="0.913,0.292"]
Portion_size [pos="0.328,1.009"]
Pressure_for_growth_and_profitability [pos="0.143,0.865"]
Pressure_to_improve_access_to_food_offerings [pos="0.060,1.059"]
Purchasing_power [pos="0.003,0.903"]
Quality_and_quantity_of_Breastfeeding [pos="0.875,0.870"]
Rate_of_eating [pos="0.393,0.988"]
SES [pos="-0.019,0.499"]
SRC_Air_quality [pos="0.857,0.662"]
SRC_Degree_of_urbanisation [pos="0.919,0.742"]
SRC_Safety_of_environment [pos="0.909,0.443"]
Safety_of_unmotorised_transport [pos="0.911,0.369"]
Sex [pos="-0.019,0.340"]
Societal_pressure_to_consume [pos="0.143,0.782"]
Sociocultural_valuation_of_food [pos="0.113,0.015"]
Standardisation_of_food_offerings [pos="0.153,1.024"]
Walkability_of_living_environment [pos="0.916,0.216"]
"C_Children's_control_of_PA" -> "Overweight/Obesity"
"C_Energy-density_of_food_offerings" -> "Overweight/Obesity"
"C_Level of physical activity (any)" -> "Overweight/Obesity"
"C_Nutrtional_quality_of_f&d" -> "Overweight/Obesity"
"Children's_control_of_diet" -> "Overweight/Obesity"
"Demanding_for_indulgence/compensation" -> "Overweight/Obesity"
"Fibre_content_of_f&d" -> "Overweight/Obesity"
"Food_exposure_?" -> "Overweight/Obesity"
"Functional_fitness/Disability" -> "Overweight/Obesity"
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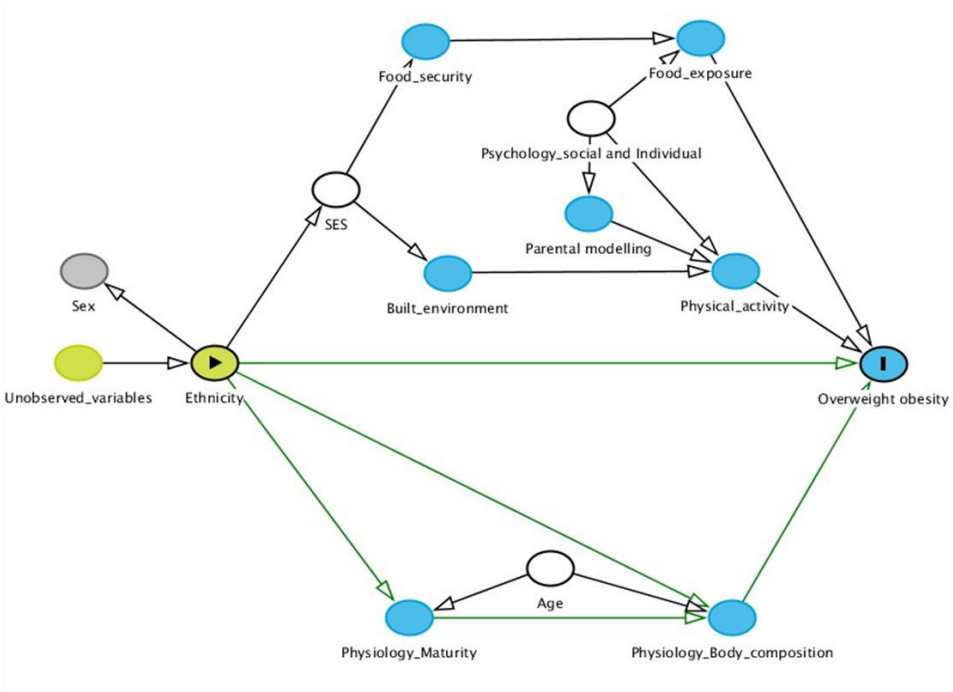
"Genetic/epigenetic_predisposition" -> "Overweight/Obesity"
"Self-Esteem" -> "Overweight/Obesity"
"Stress_?" -> "Overweight/Obesity"
"TV_watching_?" -> "Overweight/Obesity"
Acces_to_opportunity_for_physical_exercise -> "Overweight/Obesity"
Age -> "Overweight/Obesity"
Approp._of_child_growth -> "Overweight/Obesity"
Approp._of_foetal_growth -> "Overweight/Obesity"
Approp._of_maternal_body_composition -> "Overweight/Obesity"
C_Female_emplyoment -> "Overweight/Obesity"
C_Food_security -> "Overweight/Obesity"
C_Level_of_infections -> "Overweight/Obesity"
C_Parental_modelling_of_food_comsuption -> "Overweight/Obesity"
C_Weather -> "Overweight/Obesity"
Cost_of_ingredients -> "Overweight/Obesity"
Cost_of_physical_exercise -> "Overweight/Obesity"
Degree_of_innate_activity_in_childhood -> "Overweight/Obesity"
Degree_of_physical_education -> "Overweight/Obesity"
Dominance_of_motorised_transport -> "Overweight/Obesity"
Ethnicity -> "Overweight/Obesity"
Family__Level_of_employment -> "Overweight/Obesity"
Family_environment -> "Overweight/Obesity"
Food_literacy -> "Overweight/Obesity"
Food_variety -> "Overweight/Obesity"
Importance_of_Body_size_image -> "Overweight/Obesity"
Learned_activity_patterns_in_childhood -> "Overweight/Obesity"
Level_of_fat_free_mass -> "Overweight/Obesity"
Market_price_of_food_offerings -> "Overweight/Obesity"
Opportunity_for_team_based_activity -> "Overweight/Obesity"
Opportunity_for_unmotorised_transport -> "Overweight/Obesity"
Parental_control -> "Overweight/Obesity"
Parental_modelling_of_activity -> "Overweight/Obesity"
Perceived_danger_in_the_environment -> "Overweight/Obesity"
Portion_size -> "Overweight/Obesity"
Pressure_for_growth_and_profitability -> "Overweight/Obesity"
Pressure_to_improve_access_to_food_offerings -> "Overweight/Obesity"
Purchasing_power -> "Overweight/Obesity"
Quality_and_quantity_of_Breastfeeding -> "Overweight/Obesity"
Rate_of_eating -> "Overweight/Obesity"
SES -> "Overweight/Obesity"
SRC_Air_quality -> "Overweight/Obesity"
SRC_Degree_of_urbanisation -> "Overweight/Obesity"
SRC_Safety_of_environment -> "Overweight/Obesity"
Safety_of_unmotorised_transport -> "Overweight/Obesity"
Sex -> "Overweight/Obesity"
Societal_pressure_to_consume -> "Overweight/Obesity"
Sociocultural_valuation_of_food -> "Overweight/Obesity"
Standardisation_of_food_offerings -> "Overweight/Obesity"
Walkability_of_living_environment -> "Overweight/Obesity"

Second step: studying risk factors.

Creation of first versions of DAGs

Figure 1 Directed Acyclic graph for the relationship between ethnicity and childhood overweight and obesity. Nutrition Health Survey, ENSIN, Colombia 2010.



Second version of the Dag: What is the relationship between childhood obesity and ethnicity?

Figure 1 shows a work in progress DAG based on thematic clusters of the Obesity System Map (Foresight Project, UK). The DAG will guide the secondary analysis of the 2010 Colombian Nutrition Survey to better understand the relationship between ethnicity and variations of childhood obesity in this country. According to this figure, ethnicity might cause overweight or obesity in children through the following six paths:

1 and 1A: Path passing through socioeconomic status, food security and food exposure (orange)

2: Path passing through socioeconomic status, place and food exposure (red)

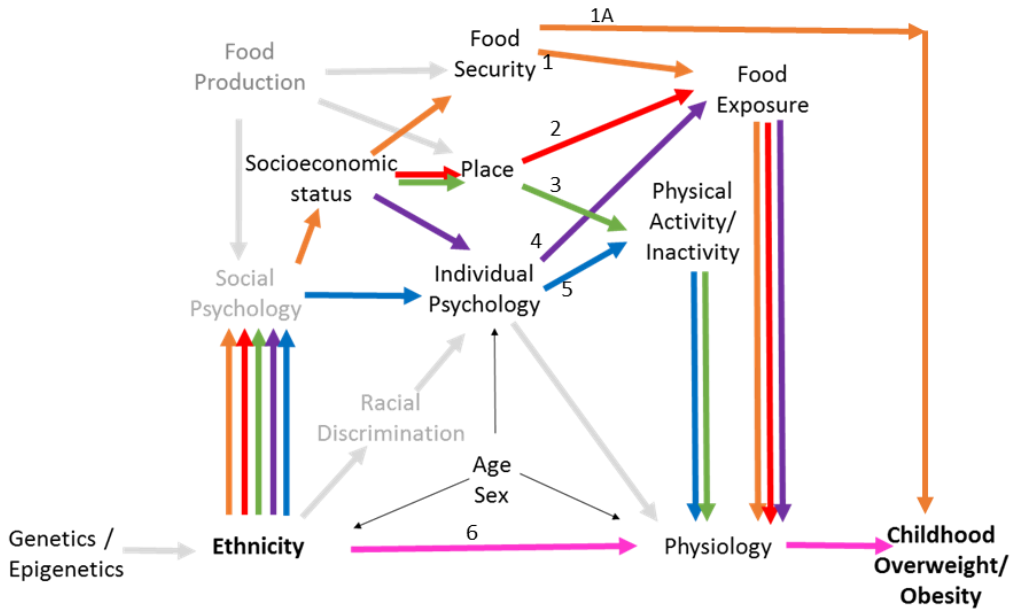
3: Path passing through socioeconomic status, place and physical activity (green)

4: Path passing through socioeconomic status, individual psychology and food exposure (purple)

5: Path passing through socioeconomic status, individual psychology and physical activity (blue)

6: Genetic/Epigenetics/biological factors through ethnicity influencing physiological factors (pink)

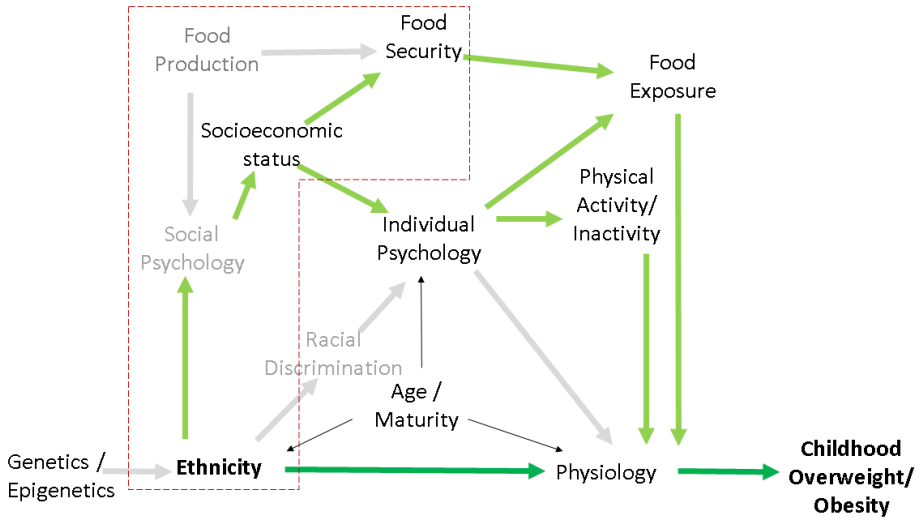
Figure 13 Directed Acyclic Graph of the potential relationships between ethnicity and childhood overweight and obesity in Colombia: the case for general population*



* Unmeasured variables in the 2010 Colombian Nutrition Survey are shown in grey font.

Alternative version of the DAG showing potential relationship between ethnicity and childhood obesity for girls and mothers.

Directed Acyclic Graph of the potential relationships between ethnicity and childhood overweight and obesity in Colombia: the case for girls and mothers



*Unmeasured variables in the 2010 Colombian Nutrition Survey are shown in grey font. Variables from mothers are shown in the dotted box.

Appendix E: Supplementary information for secondary analysis

Measurements and methods, ENSIN 2010

Table 5.3.2 Measurements and methods, ENSIN 2010

Component	Source/measurement characteristics	Age group
Anthropometry • Weight • Height • Waist circumference	A group of nutritionists were specifically trained to take anthropometric measures. Weight and height were measured with standardized equipment. Weight was measured to the nearest 0.1 kg using a digital floor scale (SECA model 872; Brooklyn, NY) with capacity of 200Kg and mother/ child function. It was properly adjusted for the Colombian geographical latitude. Participants were instructed to wear light clothing and remove shoes. • Height was measured to the nearest 1.0 cm using portable stadiometers (Shorr Productions®). • Waist circumference was measured by using a steel flexible tape with a filed notch and patch zero indicator (Rosscraft®) measuring midway between the uppermost border of the iliac crest and the lower border of the costal margin (rib cage). The tape was placed around the abdomen at the level of this midway point avoiding the compression of the skin.	Weight: All Length: <2y Waist circumference: 13 -17y
Frequency of consumption	24-hour Dietary Recall by applying a structured interview about all foods, beverages and dietary supplements consumed by the respondent in the past 24 hours.	5-64y
Household food insecurity	Food Security Scale-ELCSA: It was a previously validated and linguistically adapted for Colombian population. Adult-only households and households having adults (Cronbach=0.927), households having teens and children (Cronbach=0.953). During the validation process the scale's predictive ability was 75 % in the three components identified: quality and quantity of	All households (excluding Indigenous)

Component	Source/measurement characteristics	Age group
	food access or availability of food and non-socially acceptable means of acquisition and distribution.	
Physical activity	Physical Activity Questionnaires (IPAQ) linguistically adapted and validated for Colombian population. Reference not stated.	18-64y
Time watching television and playing video games	It was assessed by asking one question: "During the last seven days, did (child's name) watch television or play video games?". Informers who provided a positive answer were also asked about the frequency of the event: "How many days?", followed by "How much time did (child's name) usually spend during one of those days watching television or playing video games?" If the interviewed parent or guardian could not answer the last question due to the variability of the report from day to day, the interviewer would then ask: "What is the total amount of time that (child's name) spent over the last seven days watching television or playing video games?".(Gomez et al., 2007a)	5-17y
Body weight perception	It was used a validated questionnaire about body perception developed by the Centre for Disease, Control and Prevention: Behavioural Risk Factor Surveillance System-BRFSS,CDC (2002)	13-64y

Source: 2010 ENSIN

Biologically implausible values (BIVs)

Biologically implausible values (44 records) ALL ETHNIC GROUPS)

. list ethnicity age sex weightKg height_m bmi bmiwhoz_ch if bmiwhoz_ch<-5

	ethnicity	age	sex	weightKg	height_m	bmi	bmiwhoz~h
4637.	General Population	6	male	10.9	1.116	8.751815	-8.605311
10907.	General Population	3	male	7.9	1.02	7.593234	-10.1706
11802.	General Population	8	female	20	1.71	6.839711	-13.80396
13816.	General Population	9	female	21.2	1.555	8.767487	-8.291305
16169.	General Population	11	female	24.4	1.547	10.19552	-6.202393
16488.	General Population	8	female	20.2	1.782	6.361156	-15.94197
21465.	General Population	2	male	11.5	1.115	9.250135	-8.400002
21662.	General Population	14	male	23.2	1.637	8.657463	-13.0417
35341.	General Population	12	male	21.9	1.421	10.84566	-6.580401
40677.	General Population	13	male	35.5	1.745	11.65836	-5.654198
42974.	General Population	11	female	19.3	1.431	9.424926	-7.610098
44103.	General Population	3	male	5.9	1.001	5.888218	-14.34139
52561.	Indigenous	6	male	21.2	1.774	6.736413	-14.59903
53675.	Indigenous	7	female	13	1.129	10.19895	-5.02723
54464.	Indigenous	6	male	14.3	1.172	10.41072	-5.407431
57429.	Indigenous	16	female	25.8	1.454	12.20368	-5.001339

. list ethnicity age sex weightKg height_m bmi bmiwhoz_ch if bmiwhoz_ch>5

	ethnicity	age	sex	weightKg	height_m	bmi	bmiwho~h
3990.	AfroColombian	8	male	27.7	.277	361.0108	7.102515
4110.	AfroColombian	7	female	115.3	1.153	86.73027	6.561761
4208.	General Population	3	female	14.4	.746	25.87527	5.267094
4840.	General Population	5	male	221.9	1.053	200.1246	13.85643
6311.	General Population	3	female	14.1	.398	89.01291	13.00964
6340.	General Population	13	female	42	.422	235.8437	5.436482
6980.	General Population	2	male	11.7	.684	25.00769	5.000781
7292.	General Population	10	male	135.4	1.354	73.85524	5.039202
7976.	Raizal	2	female	22.4	.92	26.46503	5.350933
9954.	General Population	3	male	15.6	.794	24.74478	5.420864
15220.	General Population	5	male	34.4	1.15	26.01134	5.16526
16459.	General Population	2	male	21	.823	31.00414	6.963302
21101.	General Population	4	female	29.5	1.062	26.1561	5.062563
25313.	General Population	6	male	51.7	1.171	37.70308	6.86292
27444.	General Population	5	male	31.7	1.1	26.19835	5.221958
29667.	General Population	6	female	118.5	1.185	84.38819	7.651622
29701.	General Population	8	male	69.8	1.39	36.1265	5.048223
31334.	General Population	17	male	109.1	1.064	96.36992	5.503644
32762.	General Population	5	male	36.6	1.161	27.15293	5.501061
32899.	General Population	4	male	32.4	1.156	24.2454	5.125469
40626.	General Population	7	male	44	1.107	35.90521	5.747347
40627.	General Population	6	female	46	1.09	38.71728	5.758522
43207.	General Population	2	female	17.7	.818	26.4525	5.34677
44405.	General Population	2	female	22.3	.934	25.56296	5.043169
48843.	General Population	7	female	126.2	1.262	79.2393	6.460276
49425.	Indigenous	2	male	23.8	.944	26.70748	5.629155
56368.	General Population	2	male	22.5	.945	25.19526	5.07348
59730.	General Population	3	male	20	.902	24.58199	5.34866
60133.	General Population	4	female	30.4	1.082	25.96684	5.004126

Self-Audit Checklist for Level 1 Ethical Review for secondary analysis

University of Edinburgh,
Centre for Population Health Sciences
RESEARCH ETHICS SUBGROUP
Self-Audit Checklist for Level 1 Ethical Review for PGR projects

See **Intra** website for further information: http://www.cphs.mvm.ed.ac.uk/intra/research/ethicalReview.php

NOTE to student: *Completion of this form should be under the **oversight** of your supervisor. A good strategy would be to complete a draft as best you can, then discuss with your supervisor before completing a final copy for your supervisor to sign.*

Proposed Project: The goal of the present thesis is to examine the evidence to understand the role of ethnicity for framing childhood obesity as a public health problem in Colombia, contrasting Brazil, Mexico, Canada and the United Kingdom. The proposal has been divided into five chapters. The first two chapters will give a review of the core ethnicity concepts and contextualization of childhood obesity in the countries of interest. The last chapters will show the variations in childhood obesity and risk factors by ethnic groups in Colombia and countries of interest by performing a systematic review and, following the systematic review, a secondary analysis of the Colombian National Nutrition Survey, 2010. The First chapter will be a preamble about the main issues addressed in this thesis and its theoretical orientation. The second chapter is a scoping review of the core concepts related to ethnicity and race, and childhood obesity. The third chapter is a systematic review about framing childhood obesity as a public health problem and ethnicity-based approaches in Colombia contrasting with the countries of interest. The Fourth Chapter* will be a secondary analysis of the 2010 Colombian nutrition survey to explore the variation in childhood overweight and obesity by ethnic groups in Colombia. The last chapter will summarize the findings in relation to the literature existent. This study will contribute to the further discussion about tackling childhood obesity in Colombia.

*The Fourth chapter will be co-supervised by Dr. Louise Marryat

1. Bringing the University into disrepute

Is there any aspect of the proposed research which might bring the University into disrepute? YES/ NO X

2. Data protection and consent

Are there any issues of DATA PROTECTION or CONSENT which are NOT adequately dealt with via established procedures? YES/ NO X

These include well-established sets of undertakings. For example, a 'No' answer is justified *only if*:

(a) There is compliance with the University of Edinburgh's Data Protection procedures (see www.recordsmanagement.ed.ac.uk);

(b) Respondents give consent regarding the collection, storage and, if appropriate, archiving and destruction of data;

(c) Identifying information (eg consent forms) is held separately from data;

(d) There is Caldicott Guardian approval for (or approval will be obtained prior to) obtaining/ analysing NHS patient-data.

(e) There are no other special issues arising about confidentiality/consent.

3. Study participants

a) Will a study researcher be in direct contact with participants to collect data, whether face-to-face, or by telephone, electronic means or post, or by observation? (eg interviews, focus groups, questionnaires, assessments) YES/ NO X

b) **Answer this only if qu. 3 above = 'YES':**

*In ethical terms, could any participants in the research be considered to be **'vulnerable'**?*

e.g. children & young people under age of 16, people who are in custody or care (incl. school), a marginalised/stigmatised group

Please tick one: 'vulnerable' ☐ not 'vulnerable' ☐

4. Moral issues and Researcher/Institutional Conflicts of Interest

Are there any SPECIAL MORAL ISSUES/CONFLICTS OF INTEREST? YES/ NO X

(a) An example of conflict of interest for a researcher would be a financial or non-financial benefit for him/herself or for a relative of friend.

(b) Particular moral issues or concerns could arise, for example where the purposes of research are concealed, where respondents are unable to provide informed consent, or where research findings could impinge negatively/ differentially upon the interests of participants.

(c) Where there is a dual relationship between researcher and participant (eg where research is undertaken by practitioners so that the participant might be unclear as to the distinction between 'care' and research)

5. Protection of research subject confidentiality

Are there any issues of CONFIDENTIALITY which are NOT adequately handled by normal tenets of confidentiality for academic research? YES/ NO

These include well-established sets of undertakings that should be agreed with collaborating and participating individuals/organisations. For example, a 'No' answer is justified *only if*:

(a) There will be no attribution of individual responses;

(b) Individuals (and, where appropriate, organisations) are anonymised in stored data, publications and presentation;

(c) There has been specific agreement with respondents regarding feedback to collaborators and publication.

6. Potential physical or psychological harm, discomfort or stress

(a) Is there a FORSEEABLE POTENTIAL for PSYCHOLOGICAL HARM or STRESS for participants? YES/ NO

(b) Is there a FORSEEABLE POTENTIAL for PHYSICAL HARM or DISCOMFORT for participants? YES/ NO

(c) Is there a FORSEEABLE RISK to the researcher? YES/ NO

Examples of issues/ topics that have the potential to cause psychological harm, discomfort or distress and should lead you to answer 'yes' to this question include, but are not limited to:

relationship breakdown; bullying; bereavement; mental health difficulties; trauma / PTSD; violence or sexual violence; physical, sexual or emotional abuse in either children or adults.

7. Duty to disseminate research findings

Are there issues which will prevent all relevant stakeholders having access to a clear, understandable and accurate summary of the research findings if they wish?* YES/ NO

** If, and only if, you answered 'yes' to 3 above, 'stakeholders' includes the participants in the research*

Overall assessment

- If every answer above is a definite NO, the self-audit has been conducted and confirms the ***ABSENCE OF REASONABLY FORESEEABLE ETHICAL RISKS*** – *please tick box* ✓

  *This means that regarding this study, as currently self-audited, no further ethical review actions are required within CPHS. However, if in the coming weeks/months there is any change to the research plan envisaged now (and outlined above), the study should be **re-audited** against a Level 1 form, because it may be that the change made negates the absence of ethical risks signed off here.*

- If one or more answers are YES, then risks have been identified and prior to commencing any data collection **formal ethical review** is required - either:
  - ~ by NHS REC (NB copy of ethics application and decision letter to be sent to CPHS Ethics); or
  - ~ if not to be formally reviewed by NHS REC, then CPHS level 2/3 ethical review required.

  [If either 4 is 'yes' or 3b is 'vulnerable' then it is possible level 3 review is required.]

Two copies of this form should be taken for inclusion in the final dissertation/thesis and the original should be returned to the CPHS Ethics administrator.

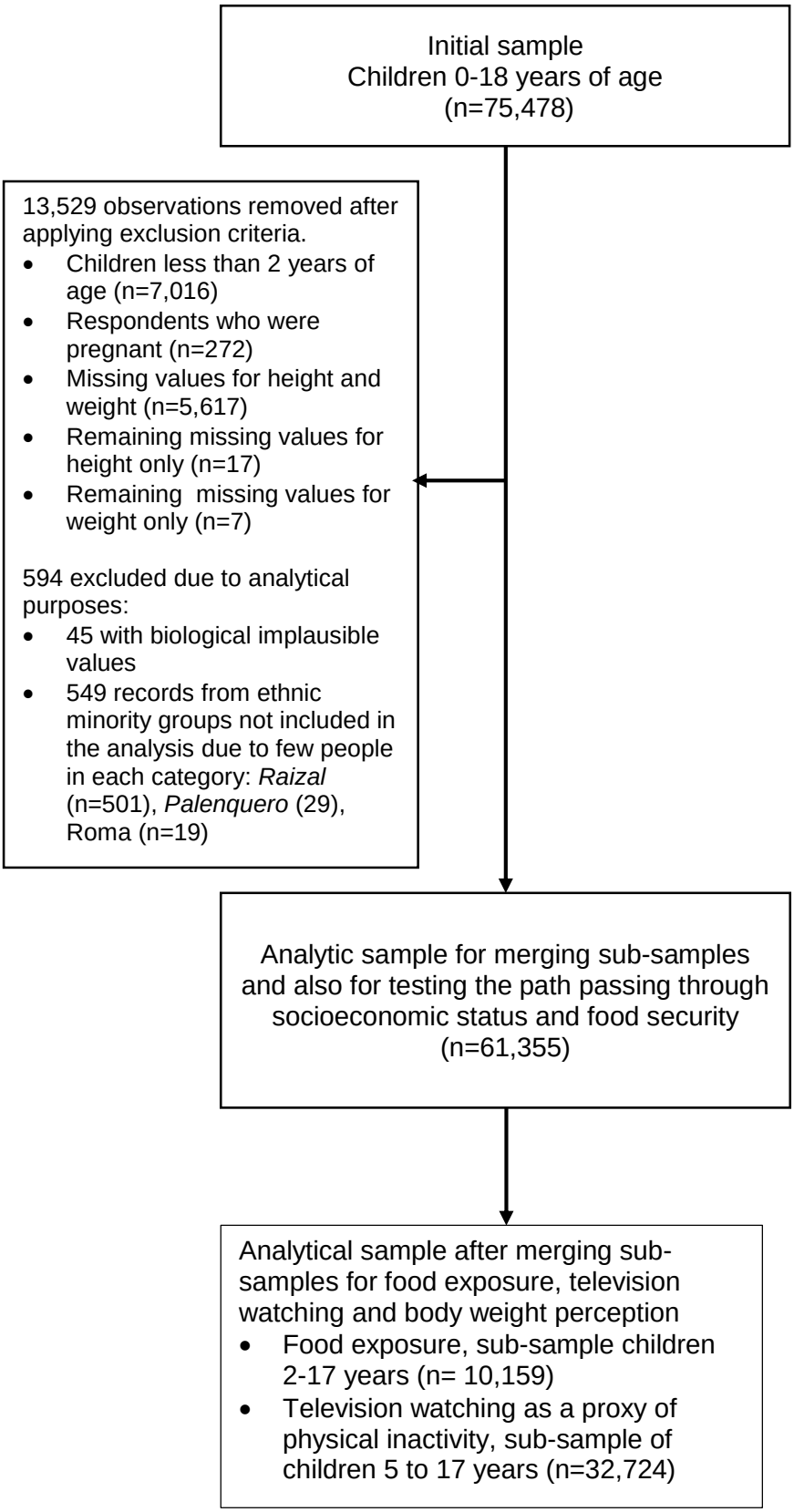
Jenny E. Ordonez Betancourth	Raj Bhopal	Ruth Jepson	Louise Marryat
Student Name	Supervisor Name	Supervisor Name	Supervisor Name
Student Signature	Supervisor Signature *	Supervisor Signature*	Supervisor Signature*

*** NOTE to supervisor:** *The CPHS Ethics Subgroup will not check this form (the light touch Level 1 form means we have insufficient detail to do so). By counter-signing this check-list as truly warranting all 'No' answers, **you** are taking responsibility, on behalf of CPHS and UoE, that the research proposed truly poses no potential ethical risks. Therefore, if there is any doubt on any issue, it would be a wise precaution to mark it as 'uncertain' and contact the Ethics Subgroup as to whether a level 2 form might be required as well. (See Intra Ethics website – URL at top of form)*

25 March 2014

Appendix F: Supplementary tables and figures of secondary analysis

Flow diagram of the final analytical sample



Baseline characteristics

Table 5.4.2 Baseline characteristics of the whole population included

Variable	All (61,355) μ *
	n μ (%)
Children's sociodemographic variables	
Sex	
Boys	31,286(50.7)
Girls	30,663(49.3)
Age group	
2-5	15,073(23.7)
6-10	19,935(31.5)
11-13	11,902(19.7)
14-18	15,039(25.1)
Health Care Scheme	
Contributory or Special Scheme	17,475(36.5)
No health scheme	7,342(11.9)
Subsidised	36,849(51.5)
Education Level	
Preschool	3,614(7.9)
Primary School	23,036(46.9)
Secondary School	19,290(43.6)
Technical /vocational	257(0.7)
Higher education	308(0.9)
Household variables as a proxy of children's socioeconomic status	
Family type	
Nuclear	33,388(55)
Lone parent	186(0.3)
Extended	28,116(44.7)
Family size	
Less than 3 people	8,127(14)
4 to 6 people	36,211(61.2)
More than 6 people	17,611(24.8)
Wealth Index	
Lowest quintile (or poorest)	22,618(25.2)
Second quintile	15,236(22.3)
Middle quintile	11,107(20.4)
Fourth Quintile	7,721(17.9)
Highest quintile (or richest)	5,267(14.2)

μ Unweighted number of people

*All population column on the basis of

Food consumption

Table 5.4.4 Food consumption risk factors for childhood obesity by ethnic group, Colombian 2010 ENSIN

Variable	Indigenous (n= 1,237) μ	Afro-descendants (n= 1,121) μ	Reference Population (n=7,801) μ
	n μ (%)	n μ (%)	n μ (%)
Meals a day			
One meal a day	22(2.4)	137(11.6)	87(0.85)
Two meals a day	172(12.8)	12(0.75)	861(10.6)
Three meals a day	1,039(84.7)	955(87.6)	6,752(88.5)
Skip breakfast (Yes)	68(7.0)	62(4.7)	536(6.3)
Skip lunch (Yes)	29(2.3)	39(3.1)	165(2.1)
Skip dinner (Yes)	122(8.7)	60(5.4)	346(3.9)
Diet quality			
Healthy food score			
Lowest quantile (lower quality)	531(29.7)	270(22.6)	1,787(20.9)
Second quantile	208(21.7)	290(27.7)	1,823(23.6)
Middle quantile	144(23.5)	273(24.2)	1,893(26.6)
Fourth quantile(better quality)	129(25.2)	229(22.5)	1,927(29.0)
Unhealthy food score			
Lowest quantile (better quality)	31(25.6)	70(35.6)	517(29.0)
Second quantile	27(33.2)	37(22.8)	380(20.2)
Middle quantile	17(15.8)	41(20.0)	439(24.4)
Fourth quantile(lower quality)	33(25.4)	41(21.7)	452(26.5)
Sweetened soft drinks			
Daily	267(20.9)	247(25.7)	1834(27.2)
Weekly	621(65.7)	602(64.7)	3994(62.1)
Monthly	137(13.2)	80(9.53)	660(10.6)
Crisps and savoury snacks			
Daily	133(19.6)	241(28.7)	1461(24.1)
Weekly	589(70.6)	607(65.9)	4170(66.7)
Monthly	145(9.8)	58(5.3)	593(9.2)
Biscuit cakes and others			

Variable	Indigenous (n= 1,237) μ	Afro-descendants (n= 1,121) μ	Reference Population (n=7,801) μ
	n μ (%)	n μ (%)	n μ (%)
Daily	301(32.4)	506(53.9)	3412(52.2)
Weekly	563(63.5)	445(42.2))	3089(44.6)
Monthly	115(4)	34(3.7)	225(3.2)
Street food			
Daily	23(4.2)	42(10.5)	222(6.7)
Weekly	316(56.9)	287(68.5)	2002(66.7)
Monthly	187(36.9)	94(21)	789(26.6)
Fried food			
Daily	292(32.2)	383(37.3)	2736(35.7)
Weekly	759(64.7)	648(60.6)	4540(61.2)
Monthly	79(3.1)	18(2.1)	193(3.1)
Daily	8(3.4)	11(2.6)	85(2.3)
Weekly	91(55.7)	211(54.1)	1,928(50.4)
Monthly	101(41.0)	165(43.3)	1,834(47.3)
Roasted vegetables			
Daily	43(13.4)	106(12.6)	590(13.5)
Weekly	290(72)	442(74.8)	3,311(74.9)
Monthly	1,12(14.6)	71(12.6)	603(11.6)
Raw vegetables			
Daily	65(10)	117(17.3)	1,038(19.2)
Weekly	395(80)	569(76.3)	4,114(73)
Monthly	74(10)	65(6.4)	475(7.8)
Fresh fruit			
Daily	172(33.7)	263(29.7)	2,158(33.9)
Weekly	574(57.2)	628(61.5)	4,093(59)
Monthly	164(9.1)	80(8.8)	629(7.0)

μunweighted number of people

Univariate analysis

Table 5.3.5 Univariate analysis of risk factors for childhood obesity by ethnic group, children 2 to 17 years of age, Colombian 2010 ENSIN

Variables	Indigenous (n= 7,676)[µ]	Afro-descendants (n= 6,760) [µ]	Reference Population (n= 46,919) [µ]	All (61,355)[µ]
	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)
Sociodemographic variables				
Sex (Male as reference)				
Female	1.49(1.14-1.95)**	1.57(1.29-1.89)**	1.33(1.24-1.43)**	1.36(1.28-1.45)**
Age group (children between 2 to 5 years as reference)				
6 - 10	0.78(0.56-1.07)*	1.90(1.43-2.52)**	1.54(1.39-1.70)**	1.52(1.39-1.66)**
11 -13	0.81(0.53-1.24)	1.92(1.42-2.58)**	1.50(1.34-1.67)**	1.49(1.35-1.65)**
14 - 18	1.21(0.84-1.75)	2.49(1.89-3.27)**	1.43(1.29-1.59)**	1.50(1.37-1.65)**
Wealth Index (highest quintile or richest as reference)				
Lowest quintile	0.42(0.15-1.10)*	0.24(0.17-0.33)**	0.29(0.26-0.34)**	0.30(0.27-0.34)**
Second quintile	0.63(0.23-1.69)	0.37(0.26-0.52)**	0.50(0.45-0.56)**	0.50(0.45-0.55)**
Middle quintile	0.82(0.29-2.29)	0.48(0.33-0.68)**	0.59(0.53-0.66)**	0.58(0.53-0.65)**
Fourth quintile	0.76(0.25-2.32)	0.59(0.41-0.84)**	0.72(0.64-0.80)**	0.71(0.63-0.79)**
Family type (nuclear family as reference)				
Lone parent family	0.30(0.04-214)	1.55(0.35-6.78)	0.73(0.42-1.25)	0.78(0.47-1.29)
Extended family	0.91(0.70-1.17)	1.04(0.85-1.28)	0.97(0.90-1.04)	0.97(0.91-1.04)
Family size (less than 3 people in the family as reference)				
4 to 6 people	0.81(0.52-1.24)	0.69(0.53-0.90)**	0.75(0.68-0.83)**	0.75(0.68-0.82)**
More than six people	0.55(0.34-0.86)**	0.53(0.39-0.72)**	0.51(0.45-0.58)**	0.51(0.46-0.57)**
Health care scheme (contributory and special scheme as reference)				
No health scheme	0.53(0.30-0.93)**	0.43(0.32-0.58)**	0.60(0.53-0.68)**	0.57(0.51-0.64)**
Subsidised	0.57(0.39-0.84)**	0.56(0.45-0.70)**	0.57(0.53-0.62)**	0.57(0.53-0.62)**
Maternal SES				
Maternal age (continuous)	1.00(0.9-1.02)	1.04(1.02-1.05)**	1.01(1.01-1.02)**	1.01(1.01-1.02)
Mother's Educational level (Higher education as reference)				
No education	0.25(0.11-0.56)**	0.28(0.13-0.59)**	0.28(0.20-0.40)**	0.27(0.20-0.35)**
Primary School	0.58(0.33-1.04)*	0.34(0.24-0.48)**	0.48(0.43-0.55)**	0.47(0.42-0.53)**
Secondary School	0.81(0.45-1.45)	0.76(0.57-1.02)*	0.69(0.62-0.76)**	0.69(0.63-0.77)**
Mother's Occupation (Employed as reference)				
Unemployed	1.98(0.42-9.16)	0.96(0.36-2.55)	0.98(0.67-1.42)	1.00(0.70-1.43)
Studying	1.27(0.33-4.81)	0.36(0.10-1.35)*	1.09(0.76-1.56)	1.02(0.73-1.43)

Looking after the house	0.89(0.63-1.23)	0.69(0.55-0.86)**	0.73(0.67-0.79)**	0.73(0.68-0.79)**

µ Unweighted number of people
* $0.05 < p \leq 0.150$; ** $p \leq 0.05$

(Continued). Univariate analysis of the pathway linking ethnicity and childhood obesity through food security, children 2 to 17 years of age, Colombian 2010 ENSIN

Path variables	**Indigenous (n= 7,676)µ**	**Afro-descendants (n= 6,760) µ**	**Reference Population (n= 46,919) µ**	**All (61,355)µ**
	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)
Maternal obesity status				
Maternal Obesity (No, BMI<30, as reference)				
Yes (BMI≥30)	2.10(1.51-2.91)**	2.21(1.76-2.78)**	2.49(2.28-2.72)**	2.43(2.24-2.63)**
Increased waist circumference (WC) (No, WC<80, as reference)				
Yes (WC≥80)	2.28(1.50-3.45)**	3.00(2.23-4.02)**	2.15(1.95-2.38)**	2.23(2.03-2.45)**
Food Security (secure as reference)				
Mild food insecurity	0.99(0.69-1.42)	0.72(0.56-.92)**	0.73(0.68-0.79)**	0.74(0.86-0.79)**
Moderate food insecurity	0.63(0.42-0.95)**	0.69(0.52-0.91)**	0.55(0.49-0.62)**	0.57(0.51-0.63)**
Severe food insecurity	0.44(0.27-0.72)**	0.45(0.34-0.61)**	0.44(0.37-0.53)**	0.43(0.38-0.50)**

µ Unweighted number of people
* $0.05< p \leq 0.150$; ** $p \leq 0.05$

Multivariate analysis to identify the effect of food security

Table 5.4.6 Multiple regression analysis for ethnicity and childhood obesity including food security, children 2 to 17 years of age, Colombian 2010 ENSIN

Path variables	Indigenous (n= 7,676)[µ]	Afro-descendants (n= 6,760) [µ]	Reference Population (n= 46,919) [µ]
	OR (95%CI)	OR (95%CI)	OR (95%CI)
Sociodemographic variables			
Sex (Male as reference)			
Female	Not included[§]	1.63 (1.29-2.06)**	1.32(1.21-1.43)**
Age group (children between 2 to 5 years as reference)			
6 - 10	Not included[§]	1.60 (1.14-2.23)*	1.54 (1.37-1.74)**
11 -13	Not included[§]	1.48 (1.03-2.14)*	1.33 (1.17-1.51)**
14 - 18	Not included[§]	1.57 (1.08-2.19)*	1.12 (0.99-1.28)*
Wealth Index (highest quintile or richest as reference)			
Lowest quintile	Not included[§]	0.39 (0.25-0.61)**	0.41 (0.34-0.49)**
Second quintile	Not included[§]	0.55 (0.36-0.85)*	0.64 (0.55-0.75)**
Middle quintile	Not included[§]	0.52 (0.34-0.79)*	0.65 (0.57-0.75)**
Fourth quintile	Not included[§]	0.77 (0.50-1.16)	0.76(0.66- 0.87)**
Family type (nuclear family as reference)			
Lone parent family	Not included[§]	Not included[§]	Not included[§]
Extended family	Not included[§]	Not included[§]	Not included[§]
Family size (less than 3 people in the family as reference)			
4 to 6 people	Not included[§]	0.68 (0.48-0.97)*	0.79 (0.70-0.89)**
More than six people	Not included[§]	0.70 (0.45-1.08)	0.60 (0.52-0.70)**
Health care scheme (contributory and special scheme as reference)			
No health scheme	Not included[§]	Not included[§]	0.90 (0.77-1.06)
Subsidised	Not included[§]	Not included[§]	0.86 (0.78-0.95)*
Maternal variables			
Maternal age (continuous)	Not included[§]	1.02 (1.01-1.04)*	Not included[§]
Mother's Educational level (Higher education as reference)			
No education	0.34 (0.14-0.80)*	0.47 (0.21-1.04)	0.65 (0.45-0.93)*
Primary School	0.67 (0.36-1.24)	0.49 (0.32-0.75)*	0.80 (0.69-0.93)*
Secondary School	0.92 (0.49-1.75)	0.84 (0.60-1.19)	0.89 (0.79-1.01)
Mother's Occupation (Employed as reference)			
Unemployed	Not included[§]	Not included[§]	1.28 (0.85-1.92)
Studying	Not included[§]	Not included[§]	1.09 (0.72-1.65)
Looking after the house	Not included[§]	Not included[§]	0.91 (0.83-0.99)*

Maternal obesity status			
Maternal Obesity (No, BMI<30, as reference)			
Yes (BMI≥30)	1.54 (1.08-2.20)*	1.60 (1.24-2.06)**	2.25 (2.04-2.49)**
Increased waist circumference (WC) (No, WC<80, as reference)			
Yes (WC≥80)	2.02 (1.30-3.14)*	2.23 (1.63-3.06)**	1.70 (1.52-1.90)**
Food assistance (No as reference)			
Yes	Not included§	Not included§	0.86 (0.78-0.94)**
Food Security (secure as reference)			
Mild food insecurity	1.13 (0.72-1.79) β	0.84 (0.62-1.13)	0.93 (0.85-1.03)
Moderate food insecurity	0.75 (0.46-1.22) β	1.00 (0.72-1.38)	0.85 (0.74-0.97)*
Severe food insecurity	0.75 (0.42-1.32) β	0.60 (0.40 -0.91)*	0.70 (0.56-0.87)**

μ Unweighted number of people

* $p \leq 0.05$; ** $p \leq 0.001$

§ Not associated; it means that the variable did not reach statistical significance to be part of the final model.

β Food security was forced into the final model for Indigenous children

Multivariate analysis to identify the effect of food security and place

Table 5.4.7 Multivariate analysis of the pathway linking ethnicity and childhood obesity through food security and place (region), children 2 to 17 years of age, Colombian 2010 ENSIN

Path variables	Indigenous (n= 7,676)[µ]	Afro-descendants (n= 6,760) [µ]	Reference Population (n= 46,919) [µ]
	OR (95%CI)	OR (95%CI)	OR (95%CI)
Sociodemographic variables			
Sex (Male as reference)			
Female	1.37(1.00-1.86)*	1.63(1.29-2.06)**	1.31(1.20-1.42)**
Age group (children between 2 to 5 years as reference)			
6 - 10	0.70(0.48-1.01)	1.58(1.12-2.21)*	1.53(1.36-1.73)**
11 -13	0.58(0.34-0.97)*	1.46(1.01-2.12)*	1.32(1.16-1.50)**
14 - 18	0.85(0.54-1.32)	1.55(1.06-2.26)*	1.11(0.97-1.26)
Wealth Index (highest quintile or richest as reference)			
Lowest quintile	Not included [§]	0.37(0.24-0.58)**	0.37(0.30-0.46)**
Second quintile	Not included [§]	0.54(0.35-0.85)*	0.58(0.49-0.69)**
Middle quintile	Not included [§]	0.51(0.33-0.79)*	0.62(0.54-0.72)**
Fourth quintile	Not included [§]	0.76(0.50-1.16)	0.75(0.65-0.86)**
Family type (nuclear family as reference)			
Lone parent family	Not included [§]	Not included [§]	Not included [§]
Extended family	Not included [§]	Not included [§]	Not included [§]
Family size (less than 3 people in the family as reference)			
4 to 6 people	Not included [§]	0.70(0.49-0.99)*	0.79(0.71-0.89)**
More than six people	Not included [§]	0.72(0.46-1.12)	0.60(0.52-0.70)**
Health care scheme (contributory and special scheme as reference)			
No health scheme	Not included [§]	Not included [§]	0.90(0.77-1.06)
Subsidised	Not included [§]	Not included [§]	0.84(0.76-0.94)*
Maternal SES as proxy for children SES			
Maternal age (continuous)	Not included [§]	1.02 (1.01-1.04)*	Not included [§]

Mother's Educational level (Higher education as reference)				
No education	Not included §	0.46(0.20-1.02)	0.62(0.43-0.90)*	
Primary School	Not included §	0.48(0.31-0.76)*	0.78(0.67-0.91)*	
Secondary School	Not included §	0.83(0.58-1.18)	0.88(0.78-1.00)	
Mother's Occupation	(Employed as reference)			
Unemployed	Not included §	Not included §	1.26(0.84-1.89)	
Studying	Not included §	Not included §	1.06(0.70-1.62)	
Looking after the house	Not included §	Not included §	0.89(0.82-0.98)*	

Maternal obesity status

Maternal Obesity (No, BMI<30, as reference)				
Yes (BMI≥30)	1.56(1.08-2.27)*	1.55(1.20-2.00)*	2.23(2.02-2.46)**	2.10(1.92-2.29)**
Increased waist circumference (WC) (No, WC<80, as reference)				
Yes (WC≥80)	1.86(1.18-2.92)*	2.19(1.59-3.02)**	1.71(1.53-1.91)**	1.78(1.61-1.97)**
Food assistance (No as reference)				
Yes	0.69(0.49-0.99)*	Not included §	0.84(0.76-0.92)**	0.84(0.77-0.91)**
Food Security (secure as reference)				
Mild food insecurity	1.10(068-1.76)	0.84(0.62-1.14)	0.93(0.84-1.02)	0.92(0.84-1.01)
Moderate food insecurity	0.77(0.47-1.25)	0.98(0.70-1.37)	0.86(0.76-0.99)*	0.88(0.78-0.99)*
Severe food insecurity	0.71(0.39-1.29)	0.60(0.40-0.91)*	0.72(0.58-0.89)*	0.71(0.59-0.85)**
Area (rural as reference)				
Urban	1.37(1.00-1.89)*	1.07(0.76-1.52)	0.92(0.80-1.06)	0.91(0.80-1.03)
Region				
Atlantic region	0.56(0.14-2.21)	0.82(0.28-2.38)	1.02(0.86-1.20)	1.03(0.88-1.20)
Eastern region	0.50(0.09-2.85)	0.68(0.21-2.19)	1.24(1.06-1.44)*	1.21(1.04-1.40)*
Central region	0.86(0.21-3.53)	0.79(0.26-2.34)	1.21(1.04-1.40)*	1.18(1.02-1.36)*
Pacific region	1.581(0.41-6.09)	1.08(0.37-3.10)	1.46(1.25-1.71)**	1.50(1.29-1.74)**
Amazonia/ Orinoquia	0.73(0.19-2.79)	1.80(0.52-6.18)	1.33(1.11-1.59)*	1.34(1.13-1.59)*

µ Unweighted number of people

*p<0.05, ** p<0.001

§ It means that the variable did not reach statistical significance to be part of them model.