Ethnic inequalities in early overweight: determinants and consequences

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Citation for published version (APA):

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Chapter 1

Introduction
INTRODUCTION

Overweight is a major public health issue. In the Netherlands, at least half of the general adult population is estimated to be either overweight (45%) or obese (11%)\(^1\). However, it is not only an adult problem, the prevalence of overweight and obesity is also high during childhood.\(^2\)-\(^4\) In the Netherlands, in 2009, the prevalence of childhood obesity ranged from 1.8% (boys) to 2.2% (girls) while prevalence rates for overweight in children were 12.8% for boys and 14.8% for girls.\(^4\) This may lead to important health consequences later in life such as type II diabetes, cardiovascular disease, osteoporosis and depression.\(^5\)-\(^7\)

Trends over time show that the prevalence of overweight and obesity has increased considerably during the last 20-30 years.\(^2\),\(^3\),\(^8\) Fortunately, the obesity epidemic in children, at this moment, seems to have levelled off.\(^8\),\(^9\) However, children from a lower socio-economic status (SES), and other disadvantaged groups, do not seem to benefit from this trend.\(^9\)-\(^11\)

Within the European Union, the number of non-western immigrants has increased significantly\(^12\),\(^13\), including the Netherlands where currently 11% of the population is comprised of non-western immigrants.\(^13\) Most of these people live in larger cities, such as Amsterdam, where 35% of the inhabitants are of non-western origin. Among this group a large proportion is of Turkish (5.3%), Moroccan (9.1%), and Surinamese (8.8%) origin. In general these populations have a poorer socio-economic position compared to the ethnic Dutch population.\(^14\)

Studies in Europe\(^15\)-\(^17\) and in the USA\(^18\)-\(^20\) have shown that immigrant status is a consistent correlate of childhood obesity, with also large variation within ethnic groups; some are more affected by overweight than others. In the Netherlands, children from Turkish and Moroccan origin have the highest prevalence (25-30%) of overweight and obesity.\(^1\),\(^15\) In 2010, the fifth Dutch growth study (TNO) concluded that the prevalence of overweight among these groups is still rising and requires urgent attention.\(^21\)

This thesis focuses on determinants and consequences of childhood overweight in different ethnic minority groups living in the Netherlands [i.e. African descent (Black-African and Black-Caribbean), Turkish, Moroccan and other western-and non-western] and (for one study conducted in the USA) for non-Hispanic white, non-Hispanic black, and Hispanic. A detailed description of the definition of ethnicity and of the African groups is presented in Box 1 and Box 2.
Box 1: Terminology of ethnicity
An ethnic group (or ethnicity) is a group of people whose members identify with each other, through a common heritage, often consisting of a common language, a common culture (often including a shared religion) and/or an ideology that stresses common ancestry or endogamy.

In this thesis we used two different ways to define ethnicity depending on the dataset used, i.e. the ABCD study (Amsterdam, Netherlands) or Project VIVA (Boston, USA).

For the investigations in which we used data from the ABCD study, ethnicity was based on the country of birth of the child’s mother and her mother (self-reported), in order to include both children from first-generation (born outside the Netherlands) and second-generation (born in the Netherlands, but with a mother born in another country) mothers. This is the way ethnicity is registered by the Central Office of Statistics in the Netherlands. Thus, in this thesis, third-generation infants/children have second-generation mothers and will still be classified as an 'ethnic minority group'. We chose to use this terminology because the influence of the parents’ (especially the mother) culture and origin influences the child at early age. In addition, to differentiate between ethnic subgroups (e.g. Surinamese-Creole and Surinamese-Hindustani groups) a question on self-identification was included in the questionnaire.

In one study we used USA data from Project VIVA. In that study, research assistants collected information on child’s ethnicity during the 3-year interview period. The mothers were asked the following question: Which of the following best describes your child’s race or ethnicity? Mothers had a choice of >1 of the following racial/ethnic groups: Hispanic or Latino, white or Caucasian, black or African American, Asian or Pacific Islander, American Indian or Alaskan Native, and other. Only the single-race children of Hispanic, white or black origins were included in that study.

Box 2: African descent population
In this thesis, people from African origin were classified in different ways. Either as an ‘African descent’ group (Chapters 2, 3, 5, and 6) or subdivided into the ‘Black-African’ or ‘Black-Caribbean’ group (Chapter 7). In Chapter 4, the group from African descent living in the USA are classified as ‘blacks’.

In this thesis, the African descent group consisted of all children whose mothers originally came from Sub-Saharan Africa, whether or not they emigrated to the Dutch-speaking Caribbean countries during the 18th century (Surinam-Creole, Antilles). We decided to combine this group because they have a similar ethnic background. However, in one study (Chapter 7) we further divided this group into two groups: Black-African group: mothers originally from Ghana (largest population) or other Sub-Saharan African countries. Black-Caribbean group: mothers from (Dutch-speaking) Surinam (Surinam-Creole) and the Antilles.

The ‘black’ group defined in Chapter 4 (living in the USA) are all the children defined as ‘black’ or ‘African American’ by their mother. Although all children in Project Viva were born in the USA, the majority of the black mothers are originally from Sub-Saharan African countries and Caribbean islands (such as Dominican Republic, Haiti and Jamaica).
Part one: Determinants of ethnic inequalities in early overweight

The etiology of childhood overweight and obesity is complex, but is ultimately determined by the long-term balance between energy intake and energy expenditure. Genetic factors may have an effect on the variation in childhood body mass index (BMI) or body fat (25-70%). However, the remaining part considers environmental factors, possibly interacting with genetics, which makes overweight largely preventable. Therefore, recognition of these environmental factors is of critical importance in the success of interventions aimed at preventing childhood overweight.

In the following paragraphs we discuss some of the current insights into the underlying (environmental) determinants of childhood overweight and obesity that could play an explanatory role in the ethnic inequalities in overweight. These potential determinants will be further outlined in this thesis.

Early life factors

There is compelling evidence that a significant number of independent risk factors leading to obesity and its related disorders in adulthood originate in the earliest stages of life. Adverse environmental conditions in utero and during infancy can lead to negative health effects during the subsequent lifetime of the exposed individual: this is known as the Developmental Origin of Health and Disease (DOHaD) hypothesis. The DOHaD states that, as early as the intrauterine period, environmental effects on human health and disease may occur as a result of prenatal, or even pre-conceptional characteristics of the mother, for example maternal BMI, smoking, diabetes or hypertensive status. Results from the ABCD study showed that pre-pregnancy BMI is an independent determinant for BMI of the child at the age of 14 months. Furthermore, accumulating evidence suggests an independent role of low birth weight, rapid postnatal growth and infant feeding on BMI and other cardiometabolic outcomes later in life.

Many early life risk factors for child overweight are more prevalent in ethnic minority groups. For example, results from the ABCD study showed that some minority groups are more likely to start their pregnancy already overweight or obese, and lower birth weight among African (black) newborns is more common. Postnatal ethnic differences in early growth and infant feeding pattern have also been described.

In this thesis we have identified and quantified those prenatal factors, birth outcomes and postnatal factors that contribute most to the explanation of differences in early overweight. Insight into these contributions is essential to develop effective strategies for early prevention of overweight, and to eliminate ethnic inequalities in overweight.

Infant feeding pattern and diet quality
Diet and feeding patterns during infancy and childhood are considered important and modifiable exposures that have short and long-term implications for health and development.

Nutritional studies into the growth pattern of breastfed and formula-fed children report that a long duration of breastfeeding can modulate growth in weight and length in infancy\textsuperscript{37-39}, and may reduce the risk of overweight in childhood.\textsuperscript{38} Late introduction of complementary food is related to beneficial effects on body fat percentage, blood pressure and adult weight\textsuperscript{40,41}, although not all studies showed consistent associations.\textsuperscript{42,43}

In the Netherlands, the duration of breastfeeding is known to differ between various ethnic groups.\textsuperscript{35,36} A Dutch study by Bulk-Bunschoten et al. showed that more mothers from non-Dutch origin start breastfeeding compared to ethnic Dutch mothers and do so for a longer period of time.\textsuperscript{35} However, the duration of exclusive breastfeeding tends to be shorter among Moroccan mothers since they are more likely to give additional formula feeding in the presence of breastfeeding. In contrast, results from the Generation R study agreed with the initial start but concluded that they face more difficulties to maintain breastfeeding (mainly the second-generation mothers).\textsuperscript{36} A study from the USA reported that early introduction of solid food is common among African-Americans.\textsuperscript{44} Less is known about the timing of the introduction of solid foods in ethnic minority groups in Europe and how this can affect ethnic inequalities in early growth and overweight.

After the period of infant feeding, poor diet in childhood becomes an important risk factor for the development of (later) overweight and health in general.\textsuperscript{11,45} Unhealthy dietary practices not only have immediate effects on health, but can determine trajectories of eating habits that persist into adulthood.\textsuperscript{46,47} In other words, poor dietary habits established in childhood may be carried into adulthood.\textsuperscript{46,48}

Ethnic minority groups in the USA have different dietary cultures\textsuperscript{49,50} and social background compared to the whites, which may lead to both higher and lower quality diets and habits among these groups.\textsuperscript{51-55} Demographic (e.g. socio-economic and immigrant status) and socio-cultural factors (e.g. general beliefs about weight) can positively or negatively influence diet quality.\textsuperscript{55-59} For example, better diet quality is more common in higher educated families\textsuperscript{55} and, for some ethnic minority groups, traditional dietary habits might be protective against poor diet quality.\textsuperscript{56-58}

In this thesis, both infant feeding and childhood diet are addressed. We describe the role of infant feeding in explaining ethnic inequalities in early growth among Dutch ethnic minority groups, and define diet in a multi-racial/ethnic sample of American 3-year-olds and examine the role of maternal BMI, immigration status and perception of child’s weight on diet quality in this population.

**Maternal perception of childhood overweight**

Recognition of overweight by parents is of critical importance in the early identification of childhood overweight. If overweight is recognized early in life, prevention and treatment strategies are more likely to be successful.\textsuperscript{60,61} On the other hand, maternal underestimation
of their child’s weight may promote an unfavourable weight gain in both normal weight children who are perceived as being too slim, as well as in overweight children who are perceived as having a healthy weight. Studies on the perception of the child’s weight show that identification of overweight in offspring is often underestimated by mothers. It seems that as long as their children are physically active and have a healthy diet or good appetite, mothers tend to be unaware of their child’s overweight. Studies from the USA generally found a higher degree of underestimation among black mothers, compared to white mothers. This might be due to the higher prevalence of overweight in this ethnic minority group and the greater acceptance of larger body size. Because it is unknown whether these findings are applicable to ethnic minority mothers living in the Netherlands, together with the role of demographic and socio-cultural factors, these issues are investigated in this thesis.

Part two: Consequences of ethnic inequalities in early overweight

The health-related consequences of early overweight/obesity are pervasive. Psychosocial outcomes include a decrease in the quality of life of the child concerned due to an increase in, for example, peer relation problems. Overweight/obese children are at increased risk of developing obesity at adult age that, in turn, is associated with various co-morbidities, such as type II diabetes, cardiovascular disease, osteoporosis and depression. Moreover, there is growing evidence that the unfavourable cardiometabolic risk profiles that were traditionally thought of as applying exclusively to adults are now increasingly observed among children. In the last decade, the prevalence of type II diabetes has increased among adolescents. Researchers of the Bogalusa Heart Study reported found that 58% of the overweight/obese children (aged 5-17 years) had at least one cardiovascular risk factor. This emphasizes the importance of adequate prevention of overweight among children.

Ethnic inequalities in risk of cardiovascular disease and type II diabetes are consistently described in adults. In western countries (e.g. the USA and the UK), overall cardiovascular mortality is higher among ethnic minority groups compared to the general population. The Netherlands is no exception to this, although cardiovascular mortality among the Moroccan population tends to be lower. The higher prevalence of overweight among ethnic minority groups might play a role in explaining the ethnic inequalities in cardiovascular risk.

The distribution of body fat in the abdominal area (also called central obesity) is an important risk factor for hyperinsulinemia, high-density lipoprotein cholesterol, high triglycerides and hypertension. The relationship between measures of general and central adiposity, BMI and waist circumference (WC), and individual cardiovascular
endpoints like blood pressure, are often studied in both adults and children. There are indications that ethnicity may modify the relationship between measures of body size and blood pressure, although the results remain inconsistent. Ethnic differences in these associations might be due to differences in body composition, a parameter frequently compared between ethnic groups.

This thesis investigates whether ethnic inequalities in cardiometabolic risk profile already exist at a young age, and focuses on the (ethnic-specific) associations between body size and cardiometabolic risk factors.

**AIM OF THE THESIS AND RESEARCH QUESTIONS**

The work in this thesis aims to gain insight into the role of the underlying determinants (early life factors, infant feeding pattern, diet quality and maternal perception of childhood overweight) that may explain ethnic inequalities in childhood overweight and the consequences at early age in different ethnic groups living in the Netherlands and (for one study only) living in the USA. For a conceptual framework of these studies see Figure 1.

To address these aims the following questions were formulated:

1. Regarding the determinants of ethnic inequalities in early overweight (part one):
   a) What is the role of early life factors, more specifically prenatal, birth outcome and postnatal factors, on increased risk of overweight in ethnic minority populations at the age of 2 years?
   b) (Infant) diet:
      • What is the influence of infant feeding patterns on ethnic differences in early growth in the first 6 months in weight, length and weight-for-length?
      • What is the role of parental BMI, immigration status (US or foreign born) and maternal perception of child's weight on ethnic differences in diet in 3-year-olds?
   c) What is the role of socio-economic status, parental BMI and maternal immigrant status (Netherlands or foreign born) on ethnic differences in maternal perception of their 5-6 year old child’s body weight?

2. Regarding the consequences of ethnic inequalities in early overweight (part two):
   a) What are the cardiometabolic consequences of early overweight in the different ethnic groups at the age of 5-6 years? This question focuses on differences in blood pressure, lipid profile and glucose level, and the explanatory role of BMI and WC.
   b) Are there ethnic-specific associations between different adiposity measures [fat mass index (FMI), BMI and waist-to-height ratio (WHtR)] and blood pressure at the age of 5-6 years?
The studies described in this thesis have been conducted within two large population-based birth cohort studies: mainly the ABCD study (Amsterdam, the Netherlands)\(^9\) and (for one study only) Project Viva (Boston, MA, USA)\(^9\).

**Amsterdam Born Children and their Development study**
The *Amsterdam Born Children and their Development* (ABCD) study is a large prospective population-based cohort study, which examines the association between maternal lifestyle, medical, psychosocial and environmental conditions during pregnancy, and children's health at birth as well as in later life, with specific attention paid to ethnic inequalities. For that purpose, the study has detailed measurements of the ethnic background, including the country of birth of the pregnant woman herself, the country of birth of her parents, and ethnic identity.

From January 2003 until March 2004 all pregnant women living in Amsterdam (12,373) were invited to participate in the study at their first antenatal visit to their general practitioner, midwife or gynecologist (Figure 2). This approach allowed for the inclusion of pregnant women from all the main ethnic groups in Amsterdam: Dutch, Surinamese, Antillean (including Aruba), Turkish, Moroccan, and Ghanaian. All woman approached received an extensive questionnaire, covering socio-demographic characteristics, obstetric history, lifestyles, and psychosocial conditions. To enhance participation among foreign-born women, two supportive measures were taken: 1) a Turkish, Arabic, or English translation was provided to women born in Turkey, Morocco, or other non-Dutch speaking countries,
and 2) the possibility to complete the questionnaire orally was offered to women who were illiterate or had reading difficulties. 8,266 pregnant women returned the questionnaire. The offspring of these pregnant women formed the prenatally recruited birth cohort (Phase I). Three months after giving birth (median 13 weeks postpartum, interquartile range 1 week), the mothers who gave permission for follow-up (6,735 mothers of singletons, 119 mothers of multiples) received a questionnaire concerning the course of their pregnancy and delivery, the newborn’s health, development and growth, and the mother’s lifestyle during and after pregnancy (Phase II). A total of 5,218 mothers (5,131 mothers of singleton, 87 mothers of multiples) filled in the questionnaire. Again, the questionnaire was available in multiple languages to increase the response in specific ethnic groups. After the 3-month questionnaire, follow-up measurements were planned for singleton
infants only. Until the children are 4 years old, specially trained YHC nurses conduct an average of 14 standardized routine measurements to monitor their growth and feeding patterns. Of the 6,735 women who gave birth to liveborn singleton infants, 6,575 women gave permission to collect growth data.

Phase III of the study started in the summer of 2008 and finished in the winter of 2010. Around two weeks after their child's fifth birthday, 6,161 of the 6,735 mothers who gave permission for follow-up were approached for the 5-year follow-up and received a questionnaire (translated into English or Turkish). Reasons for lack of follow-up included withdrawal from the study, infant or maternal death, and loss to follow-up due to unknown address or emigration. A total of 4,488 mothers returned the questionnaire containing items about their child's health, development, and behaviour. In addition, this general questionnaire contained items about family socio-demographics, maternal lifestyle and psychosocial conditions, and family history of medical conditions. Furthermore, children were invited to participate in a health examination.

For children living in Amsterdam, the health check was held at the child’s primary school. Children and parents who had moved outside of Amsterdam, and children enrolled in small schools with no space available for the health check, were invited to a central location during the weekend and holidays. The physical examination consisted of a fasting capillary blood sample to assess glucose, total cholesterol, HDL, LDL, triglycerides, and c-peptide, as well as physical measurements and a cognitive test battery. The physical measurements included anthropometric measurements (height, weight, waist and hip circumference), body composition measures (fat mass and fat-free mass) by bioelectrical impedance analysis, blood pressure in supine and sitting positions, and cardiac function (heart rate, heart rate variability, and pre-ejection period) also in supine and sitting positions using the VU Ambulatory Monitoring System. Cognitive function was examined using four tasks from the Amsterdam Neuropsychological Tasks (ANT) program. A total of 3,321 children completed the physical examination and 2,108 blood samples were collected.

**Project Viva**

In the USA, *Project Viva* was designed to find ways to improve the health of mothers and their children by looking at the effects of the mother’s diet and other factors during pregnancy on her health and the health of her child. From April 1999 to July 2002 all pregnant women (2,670) who visited one of the eight offices of Harvard Vanguard Medical Associates (a large multi-specialty urban/suburban group practice in eastern Massachusetts, USA) were invited to participate in the study. Mothers attended regular interviews and completed questionnaires. Mothers and children visited the research centres where anthropometric measurements were taken. When these children turned 3 years, 1,286 mothers from different racial/ethnic origins filled out a questionnaire containing a validated food frequency questionnaire; data from this questionnaire are used in this thesis.
OUTLINE OF THE THESIS

Table 1 summarises the topics covered in each chapter. The first part (which includes Chapters 2-5) focuses on the determinants of ethnic inequalities in early overweight. **Chapter 2** assesses possible ethnic inequalities in overweight at age 2 years and the explanatory role of prenatal factors; in addition, birth outcomes and post-natal factors are studied (question 1a). **Chapter 3** describes the ethnic inequalities in early growth (weight, Table 1: Overview of the topics covered in each chapter of the thesis.

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
<th>Determinants</th>
<th>Main outcomes</th>
<th>Study population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part one: Determinants of ethnic inequalities in early overweight</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Early life factors</td>
<td>Overweight at age two years in a multi-ethnic cohort (ABCD study): the role of prenatal factors, birth outcomes and postnatal factors</td>
<td>Ethnicity, prenatal factors, birth outcomes and postnatal factors</td>
<td>Overweight yes/no at the age of 2 years</td>
<td>Dutch, African descent, Turkish, Moroccan, others</td>
</tr>
<tr>
<td>3 Infant feeding pattern</td>
<td>The role of infant feeding practices in the explanation for ethnic differences in infant growth: the ABCD study</td>
<td>Ethnicity, duration of breastfeeding, introduction of formula feeding and solid foods</td>
<td>Δ standard deviation scores of weight, height and weight-for-height between age 1-6 months</td>
<td>Dutch, African descent, Turkish, Moroccan and others</td>
</tr>
<tr>
<td>4 Diet quality</td>
<td>Racial/ethnic and immigrant differences in childhood diet quality</td>
<td>Ethnicity, child factors, socio-demographic factors, immigrant status, maternal perception of child’s weight</td>
<td>Food groups and nutrients at the age of 3 years</td>
<td>Non-Hispanic White, Black-African, Hispanic</td>
</tr>
<tr>
<td>5 Perception of weight</td>
<td>Ethnic differences in maternal underestimation of offspring’s weight: the ABCD study</td>
<td>Ethnicity, socio-demographic factors, immigrant status</td>
<td>Maternal underestimation of child’s weight at the age of 5-6 years</td>
<td>Dutch, African descent, Turkish, Moroccan and others</td>
</tr>
<tr>
<td>Part two: Consequences of ethnic inequalities in early overweight</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Ethnic differences in cardiometabolic risk profile at age 5-6 years: the ABCD study</td>
<td>Ethnicity, BMI, WC</td>
<td>Systolic blood pressure, Diastolic blood pressure, glucose, HDL, LDL, triglyceride at the age of 5-6 years</td>
<td>Dutch, African descent, Turkish, Moroccan</td>
</tr>
<tr>
<td>7</td>
<td>Association between body size and blood pressure in children from different ethnic origins</td>
<td>Ethnicity, z-score BMI, z-score FMI, z-score WHtR</td>
<td>SBP, DBP at the age of 5-6 years</td>
<td>Dutch, Black-African, Black-Caribbean, Turkish, Moroccan</td>
</tr>
</tbody>
</table>

Abbreviations: BMI: body mass index; WC: waist circumference; FMI: fat mass index; WHtR: waist-to-height ratio; HDL: high-density lipoprotein; LDL: low-density lipoprotein; SBP: systolic blood pressure; DBP: diastolic blood pressure
length and weight-for-length) in the first 6 months with the aim to gain insight into the mechanisms underlying these differences by exploring the role of ethnic differences in infant feeding patterns: i.e. duration of (exclusive) breastfeeding and introduction of formula feeding and solid foods (question 1b). Chapter 4 investigates ethnic differences in diet quality in early childhood and examines the role of maternal BMI, immigrant status and mother’s perception of child’s weight (question 1b). Chapter 5 determines ethnic variation in maternal underestimation of their child’s weight status and the explanatory role of socio-economic status, parental BMI and immigrant status (question 1c).

The second part of this thesis focuses on the early consequences of ethnic inequalities in early overweight. In Chapter 6 we explore ethnic inequalities in cardiometabolic risk profile and determine to what extent BMI and WC affect any observed differences (question 2). Chapter 7 examines ethnic-specific associations between adiposity measurements (FMI, BMI and WHtR) and systolic/diastolic blood pressure, and investigates which of these adiposity measures is the strongest determinant of blood pressure (question 2). Chapter 8 summarises the main findings of these studies, discusses some of the methodological considerations, reflects on the main findings and discusses their relevance for public health practice, and also presents suggestions for future research.
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