Ethnic inequalities in early overweight: determinants and consequences

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GENERAL DISCUSSION

This thesis focuses on determinants of early childhood overweight in different ethnic minority groups living in the Netherlands, i.e. those of African descent (Black-African and Black-Caribbean), Turkish, Moroccan and other western and non-western groups and, for one study conducted in the USA, non-Hispanic white, non-Hispanic black, and Hispanic. Three important determinants of childhood overweight are highlighted: 1) early life factors, more specifically prenatal, birth outcome and postnatal factors, 2) (infant) diet, and 3) maternal perception of offspring’s weight. In addition, the cardiometabolic consequences of ethnic inequalities in early overweight are investigated.

This final chapter reflects on the results of the studies, including some of the methodological limitations. The results are discussed in the light of their relevance for public health practice. Finally, some recommendations are made for further research.

Summary of main findings

Part one: Determinants of ethnic inequalities in early overweight

What is the role of early life factors on increased risk of overweight in ethnic minority populations at the age of 2 years?

In Chapter 2 we found that children from Turkish and Moroccan origin have 2 to 3-fold higher odds for overweight at age 2 years compared with ethnic Dutch children. Children from African descent and those in the ‘other western and non-western’ groups did not have higher rates of overweight. In this study we focused on identifying and quantifying prenatal, birth outcome and postnatal factors that play a role in the explanation of ethnic inequalities in overweight during infancy. Although several factors were found to be associated with overweight, they did not necessarily explain the ethnic inequalities in overweight. From this study we concluded that maternal pre-pregnancy BMI and weight gain during the first 6 months of life of the child made a large contribution to the observed ethnic inequalities in overweight at the age of 2 years.

What is the influence of infant feeding pattern on ethnic inequalities in early growth in the first 6 months of life?

In Chapter 3 we focused on the ethnic differences in early growth in the first 6 months in weight, length and weight-for-length. Ethnic differences are shown in growth rate, with a faster gain in weight and length among Turkish, Moroccan and African descent infants compared to the Dutch, and also in weight-for-length among the Moroccan infants. Furthermore, we examined whether differences in growth were explained by differences in feeding pattern during infancy. However, it was found that accelerated growth in the
Turkish and Moroccan infants was not explained by differences in feeding pattern, as no differences in feeding patterns emerged; in fact, these mothers have the highest prevalence of initiating breastfeeding. Only the weight increase in the African descent infants was partly explained by the shorter duration of breastfeeding and the early introduction of complementary foods.

**What is the role of maternal BMI, immigrant status and perception of offspring’s weight on racial/ethnic differences in diet quality in 3-year-olds?**

In this ethnically diverse cohort of 3-year-old children from the USA we found a higher intake of sugar sweetened beverages and fast food, and a lower intake of skim or low fat (1%) milk, among black and Hispanic children compared to white children (chapter 4). Snack intake, on the other hand, tended to be consumed less often among these groups. Some nutrient intakes (total energy intake, percentage energy from trans fat and saturated fat and dietary fibre) also differed between the ethnic groups. Most ethnic differences in diet were independent of sociodemographic-related factors. Controlling for maternal immigrant status revealed that being born in a foreign country was associated with a higher quality intake of some nutrients and lower intake of fast food.

**What is the role of socio-economic status, parental BMI and maternal immigrant status on ethnic differences in maternal perception of their 5-6 year old child's body weight?**

Chapter 5 provided insight into ethnic differences in the maternal ability to adequately estimate their child’s weight status at age 5-6 years, and the factors associated with underestimation by the mother. We found that the percentage of maternal underestimation is high, irrespective of the ethnic background. Maternal underestimation occurred mainly in mothers with an overweight/obese child, although mothers with a normal weight child also underestimated their child’s weight. Overall, mothers with an overweight/obese child underestimated their child’s weight in 79% of the cases. The highest percentage of underestimation occurred among the Turkish mothers with overweight/obese children (92.3%), and both Moroccan and Turkish mothers more often perceived the weight of their normal weight child to be ‘too low’ (approximately 15-16% vs. 6% for ethnic Dutch mothers). African descent mothers with an obese child tend to correctly estimate their children’s weight more frequently than the Dutch mothers.

**Part two: Consequences of ethnic inequalities in early overweight**

**What are the cardiometabolic consequences of early overweight in the different ethnic groups at the age of 5-6 years?**

Chapter 6 examined ethnic inequalities in cardiometabolic risk profile, and the explanatory role of body mass index (BMI) and waist circumference (WC) in a healthy population
of Dutch, African descent, Turkish and Moroccan 5-6 year olds. We found that ethnic inequalities in cardiometabolic risk profile do exist at a young age. All non-Dutch groups showed higher BMI and WC values compared to the Dutch children, except for WC in the African children. African descent children showed higher diastolic blood pressure (DBP) levels and more favourable high-density lipoprotein (HDL) levels, and Turkish children higher systolic blood pressure (SBP) and DBP, and glucose and triglyceride levels. On the other hand, the Moroccan children (except for the higher BMI and WC) did not differ from the ethnic Dutch in cardiometabolic risk profile. BMI and WC partly explained the ethnic difference in blood pressure (BP), glucose and triglyceride levels; however, ethnic differences remained for DBP (African descent and Turkish).

Are there ethnic-specific associations between different adiposity measures and blood pressure at the age of 5-6 years?
In Chapter 7 we explored ethnic-specific associations between three measures of body size, i.e. BMI, waist-to-height ratio (WHtR) and fat mass index (FMI), as well as BP (both SBP and DBP) in children aged 5-6 years. In addition, we compared BMI with WHtR and FMI as determinants of BP. The data revealed ethnic differences in the association between body size and BP: i) body size was relatively strongly associated with BP in Turkish children, indicating higher BP (mainly SBP) levels with increasing BMI and FMI, ii) Black-Caribbean and Moroccan children showed high BP at low BMI, whereas at low FMI this relation was seen only in Moroccan children. Moroccan children also showed higher SBP at high BMI and FMI, iii) in general, the strongest associations with BP were found for BMI in all ethnic groups.

Reflection on the results
Ethnic inequalities in overweight already seen in infancy
Ethnic minority children bear a disproportionate share of the burden of obesity and its related comorbidity. According to the Dutch growth study, the prevalence of young persons aged 2-21 years having overweight (including obesity) in 2010 was 32.5% among Turkish, 25.2% among Moroccan and 13.3% among ethnic Dutch children.1 Less information is available for children from African descent, but a recent review on ethnic inequalities in obesity among children in the UK suggests that black (subgroup) girls may have a higher risk, and boys a lower risk of obesity, compared to European origin girls and boys.2 In adults, obesity is more common among Turkish and Moroccan migrants.3 The same applies to the African descent population in Europe, especially among women.2,4 In this thesis we have shown that ethnic inequalities in overweight start at an early age. At age 2 years the prevalence of overweight among Turkish and Moroccan children was already 2-3 times higher compared to ethnic Dutch children (Chapter 1). A comparable
trend was seen when children turned 5-6 years old (Chapters 6 and 7). Overweight was most prevalent in Turkish and Moroccan 5-6 year olds, followed by children from African descent (Black-African and Black-Caribbean).

Socio-economic status (SES), usually measured by occupation, educational level, or household income, is a multidimensional construct that is known to exert a profound influence on health. Ethnic inequalities in health are often (in part) explained by differences in SES.\(^5,6\) In this thesis we found that the prevalence of early overweight, or related outcomes, remained higher in Turkish and Moroccan children, irrespective of SES. Residual confounding might play a role, since we only adjusted for educational level instead of the combination with occupation and household income; nevertheless, it is more likely that other factors also contribute to the ethnic inequalities that emerged.

According to de Kroon et al., the age interval from 2-6 years is a highly critical growth period for adult overweight.\(^7\) Moreover, in an additional analysis we found that only 6% of the children aged 2 to 5-6 years, with normal weight at age 2 years, had become overweight at age 5-6 years (Table 1). Most of the children with overweight at age 5-6 years were already overweight at age 2 years. Thus, the period between 0-2 years appears to be crucial for developing overweight among children. This is supported by the fact that approximately 40% of the children with overweight at age 2 years are also overweight at 5-6 years of age (Table 1). Taking into account the different ethnic minority groups, we found that for children of Turkish (71.4%), Moroccan (66.7%) and African descent (55.6%) this percentage is much higher than for their ethnic Dutch counterparts (31.9%). This indicates that overweight at age 2 years has a strong predictive value for staying overweight (tracking), specifically in non-Dutch children aged 5-6 years. The critical period for preventing ethnic inequalities in childhood overweight might thus be even before the age of 2 years.

In Chapter 2 we found that maternal pre-pregnancy BMI and rapid weight gain in the first 6 months largely explained the higher prevalence of overweight at age 2 years in Turkish and Moroccan infants. In an additional analysis we explored whether these early life factors might (partially) explain the higher prevalence of overweight in the Turkish and Moroccan children aged 5-6 years (Table 2). Table 2 shows that primarily rapid weight gain in the first 6 months was important and decreases the odds for overweight at the age of 5-6 years in mainly the Moroccan (decrease in OR Model 1 vs. Model 3: 28%) and Turkish (22%) children. The explanatory role of maternal pre-pregnancy BMI was smaller.

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**Table 1:** Overview of overweight status at age 2 years compared to overweight status at 5-6 years of age.

<table>
<thead>
<tr>
<th>Overweight status at 2 years vs 5-6 years</th>
<th>Overall n=1948</th>
<th>Dutch n=1225</th>
<th>African descent n=109</th>
<th>Turkish n=65</th>
<th>Moroccan n=95</th>
</tr>
</thead>
<tbody>
<tr>
<td>% (n)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overweight-overweight</td>
<td>40.8 (69)</td>
<td>31.9 (30)</td>
<td>55.6 (5)</td>
<td>71.4 (10)</td>
<td>66.7 (14)</td>
</tr>
<tr>
<td>Overweight-normal weight</td>
<td>59.2 (100)</td>
<td>68.1 (64)</td>
<td>44.4 (4)</td>
<td>28.6 (4)</td>
<td>33.3 (7)</td>
</tr>
<tr>
<td>Normal weight-overweight</td>
<td>6.0 (107)</td>
<td>3.4 (38)</td>
<td>15.0 (15)</td>
<td>17.6 (9)</td>
<td>20.6 (15)</td>
</tr>
<tr>
<td>Normal weight-normal weight</td>
<td>94.0 (1672)</td>
<td>96.6 (1093)</td>
<td>85.0 (85)</td>
<td>82.4 (42)</td>
<td>79.7 (59)</td>
</tr>
</tbody>
</table>
but still substantial for the Moroccan children (decrease in OR Model 1 vs. Model 2: 13%). Together with the knowledge that overweight beginning in childhood is associated with overweight in adulthood, and the finding that overweight at age 2 years is highly predictive for overweight at age 5-6 years (Table 1), the prevention of overweight should start early in life, i.e., at <2 years or even earlier during the first 6 months of life. A recent review by Stocks et al. (which, however, did not take into account ethnicity), also concluded that large body size as of 5-6 months, and fast weight gain before 2 years of age, are related to large body size at age 5-13 years.

Rapid growth in the first 6 months among Turkish and Moroccan infants not explained by infant feeding pattern

Previous studies suggest that the prenatal and early postnatal environments may play an important role in the occurrence of overweight or obesity later in life. Taveras et al., investigating a multi-ethnic cohort of US born children, concluded that many early life risk factors for overweight are more prevalent in ethnic minority groups. We highlighted that the higher prevalence of early rapid growth is an important risk factor for childhood overweight in Turkish and Moroccan children. Besides genetic factors (determinants which are beyond the scope of this thesis), infant feeding plays an important role in early growth. In Chapter 3, an inverse relationship is described between breastfeeding and growth from birth to 6 months. Although a causal relation between infant feeding and overweight is difficult to prove, having exclusive breastfeeding for at least 4 months was found to be protective against growth acceleration in weight and length in the first 6 months, when compared to formula feeding and/or introduction of solid food at 4 months of age. However, we were unable to prove that differences in infant feeding pattern explained the higher gain in weight and length in the Turkish and Moroccan infants. Mothers from Turkish and Moroccan origin breastfed their children longer compared to ethnic Dutch mothers, which should protect against rapid growth. The early introduction of additional formula feeding, which might increase the risk for early rapid growth, in the presence of breastfeeding in especially Moroccan infants might surpass any protective effects of breastfeeding.

Table 2: Differences in prevalence of overweight at age 5-6 years associated with ethnicity using native Dutch children as reference (crude and multivariable adjusted ORs, 95% CIs)

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>Crude Odds Ratio (95% confidence interval)</th>
<th>Model 1: Maternal education and child sex and age</th>
<th>Model 2: Model 1 including maternal pre-pregnancy BMI</th>
<th>Model 3: Model 1 including weight gain first 6 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dutch</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>African descent</td>
<td>3.80 (2.10, 6.59)</td>
<td>2.11 (1.08, 3.96)</td>
<td>2.15 (1.09, 4.06)</td>
<td>1.85 (0.93, 3.54)</td>
</tr>
<tr>
<td>Turkish</td>
<td>7.57 (4.11, 13.56)</td>
<td>3.99 (2.01, 7.73)</td>
<td>4.06 (2.03, 7.97)</td>
<td>3.13 (1.55, 6.21)</td>
</tr>
<tr>
<td>Moroccan</td>
<td>7.82 (4.68, 12.89)</td>
<td>4.30 (2.35, 7.78)</td>
<td>3.78 (2.04, 1.91)</td>
<td>3.55 (1.91, 6.52)</td>
</tr>
</tbody>
</table>
Unfortunately, in the ABCD study it was not possible to examine the infant feeding pattern in more detail. However, it is possible that the quantity of food or the type of formula feeding differs between groups, which could result in a higher energy intake among the Turkish and Moroccan infants. An earlier study found that approximately 20% of the parents use too much milk powder per bottle while preparing the infant formula, which might lead to higher caloric and protein intakes. High doses of protein in formula feeding may play a role in predisposing infants to an increased obesity risk in later life due to the introduction of higher insulin levels that, in turn, stimulate greater adipose tissue deposition and weight gain (the early protein hypothesis). Furthermore, due to differences in dietary intake, the composition of breastfeeding in Turkish and Moroccan mothers might be different compared to the ethnic Dutch mothers who breastfed.

Previous qualitative studies on feeding practices among Turkish mothers report high prevalence of breastfeeding, but also suggest early introduction of complementary foods and syrups, topping up breastfeeding with formula feeding. A study of the Public Health Service in Amsterdam conducted by Meijers et al. showed that the total energy intake was higher among Turkish infants. They received larger portion sizes and more energy-rich products than Dutch infants, as early as age 6 months. This suggests that the amount and type of feeding might explain the higher infant growth in Turkish children.

**Contribution of culture**

Increased attention has been paid to culture as an underlying factor that may contribute to ethnic inequalities in overweight and obesity. There is increasing evidence of a change in health status across generations, particularly when it concerns changes in healthy, traditional diet components. In Turkish and Moroccan cultures, food plays a central role in expressing hospitality, resulting in a social context where food is abundant and difficult to refuse. The central role of food in these populations, coupled with the economic and physical changes that arise as a result of migration, can lead to overeating, which in turn may impact the development of overweight. Whether Turkish and Moroccan children also take part in their parents’ social activities and the extent to which this affects their offspring’s weight status is unknown. However, there is evidence that parental feeding style is associated with offspring’s BMI dietary intake. Furthermore, the use of food for infant/child comforting is more prevalent among Turkish mothers. This is probably due to their parenting style which is, according to de Wilde et al., more permissive among Turkish mothers compared to ethnic Dutch mothers. In Chapter 4 we found that the diet quality of 3-year-old children reduces across generations, with children of foreign (non USA) born mothers having a higher quality nutrient intake and a lower intake of fast food than the offspring of second-generation mothers born in the USA. More research is needed to examine whether the same applies to Turkish and Moroccan groups living in Western Europe. A few European studies have shown that residence duration was associated with poorer eating habits in adults of Afro-Caribbean and Mediterranean (Tunisia) origin.
Culture may also play a role in shaping parental perceptions of their children’s health status. For example, in many cultures mothers may consider a ‘chubby’ infant as healthy.\textsuperscript{34} The first step in promoting a healthy lifestyle and a healthy body weight among children might be to create awareness amongst parents that obesity is a health problem. The Dutch \textit{Voedingscentrum} has developed a visual tool (pictures) to help professionals in their conversation with parents whose children are overweight or obese, to help recognise their offspring’s overweight.\textsuperscript{35} Nevertheless, Turkish or Moroccan parents may have different ideas and preferences for what they consider a ‘healthy’ child.

Chapter 5 provides insight into the maternal ability to correctly estimate their child’s weight status at age 5-6 years. We found that the percentage of maternal underestimation is high irrespective of the ethnic background, but highest among Turkish and Moroccan mothers, and occurred mainly among mothers with an overweight child. We speculated that mothers are likely to evaluate their child’s weight based on their comparison with other children in their social environment, which are mostly members of their own ethnic group. In other words: when the parents live in an obesogenic environment with a high prevalence of overweight/obesity it could be that ‘overweight is the benchmark for normal weight’. This is supported by the fact that the prevalence of overweight/obesity at age 5-6 years was found to be lowest in Dutch children (7%) and considerably higher among Turkish children (27%) and Moroccan children (26%; Chapters 6 and 7). An important implication of the idea that mothers compare their children to their immediate social group is that increased social contact with ethnic Dutch mothers may result in differential body weight perception among Turkish and Moroccan mothers. Qualitative research, including Turkish and Moroccan mothers, might provide more insight into the causes of differences in the perception of their offspring’s weight.

Consequences of early overweight later in life for Turkish and Moroccans: a downward spiral?

Overweight at young age is an important risk factor for obesity and cardiovascular risk factors in adult age. The difference in life expectancy between a person with and without obesity at this moment is 4.5 years.\textsuperscript{36} Forecasts suggests that the ‘obesity epidemic’ may reverse the current trend of the declining rate of death from cardiovascular causes, leading to a shorter lifespan for today’s children.\textsuperscript{37}

In the Netherlands, the risk for cardiovascular diseases differs substantially between ethnic groups. Although information on cardiovascular disease (CVD) among adult populations of Turkish, Moroccan and African descent is limited, previous studies generally found lower rates of CVD and cardiovascular mortality in Moroccan adults and less favourable cardiometabolic risk profile with slightly higher cardiovascular mortality for adults of Turkish origin in the Netherlands.\textsuperscript{3,38-40} Information on cardiovascular risk in African descent men and woman are conflicting, varying between a lower (especially men) to a slightly higher risk for CVD.\textsuperscript{4,38,41} In this thesis we found that ethnic differences in cardiometabolic profile already exist at age 5-6 years and show comparable patterns with adults. We found higher
BP, glucose and triglyceride levels in Turkish children compared to ethnic Dutch children of similar age, while Moroccan children at this age only showed higher adiposity levels (Chapter 6). In addition, particularly Turkish children are at increased risk for elevated BP with increasing BMI (Chapter 7).

Obesity and the cardiovascular consequences are highly preventable. If we fail to help these children escape from the downward spiral of obesity, we can only imagine what their world will be like when they become adults; or what will happen in the next generation when these girls become overweight pregnant women. It is likely that the cardiovascular mortality of Turkish adults will increase and the rates of CVD in Moroccan adults will converge towards the prevalence rates of ethnic Dutch adults, or beyond. In a Dutch study, Hosper et al. found that prevalence rates of overweight in Turkish and Moroccan men increase by generation. The hospital admission rates for Moroccans are currently low; however, this will probably change which may exert more pressure on the economy. In the Netherlands, the government spends more than 1.2 billion euro per year on health care as a consequence of (severe) overweight. The economic burden of overweight and obesity due to sick leave and disability is estimated by the Council for Public Health and Health Care (Raad voor de Volksgezondheid en Zorg) at 2 billion euro. There is some evidence that obese children that become non-obese adults may have a reduction in cardiovascular risk in adulthood similar to those individuals who were never obese. This implies that prevention of overweight at a young age in general, but especially among Turkish and Moroccan children, might offer health benefits and reduction of costs. Health care professionals need to counteract the current trends in childhood BMI. Reversal of this trend is necessary, and intervention is required.

Methodological considerations

All the studies described in this thesis are based on a population-based closed cohort study. With the exception of one study, all the research questions of this thesis were examined within the context of the Amsterdam Born Children and their Development (ABCD) study. The methodological considerations directly relevant to the specific studies are addressed in the Discussion sections of the previous chapters. In this section, we discuss some methodological issues of general importance.

Selective nonresponse

The response rate in Phase I (initial participation) of the study was 67% 44, which is lower than, for example, large population-based pregnancy cohorts in the UK, such as the Southampton Women’s Survey (75%) 45 and the ALSPAC (85%) 46, but higher than, for example, the Generation R study in Rotterdam, the Netherlands (61%). 47 Particularly in an era where response rates to large epidemiological studies are decreasing 48 our response rate may be considered adequate. Supportive measures were taken to enhance enrolment
of ethnic minority women in particular (e.g. translated questionnaires, or completing them orally with trained female interviewers).

In the current phase (Phase III) the response rate was 73%. In this phase, efforts to enhance participation among all women and children, regardless of ethnicity and education, included the use of translated questionnaires, an information leaflet, and a specially developed cartoon that explained the health check measurements to the children. Also, women from ethnic minority groups who did not respond within one month were approached by telephone by trained students who explained the study in the women’s own language. In non-response analyses in the separate studies of this thesis we compared loss to follow-up to those included in the analyses. This consistently showed a similar pattern, i.e. those included were more often higher educated, native Dutch, and healthier. Due to this selection and the small size of some ethnic groups, we might have underestimated the health effects in our study population. Nevertheless, we were still able to demonstrate inequalities between the ethnic groups. The selective non-response affects the validity of the study when the association between the determinant and outcome differs between those in the study and those (no longer) participating in the study. Unfortunately, this is difficult to ascertain in this phase, because we do not have complete information on the non-responders. However, a non-response analysis by anonymous linkage within the PRN conducted in Phase I showed a selective ethnic non-response with lower participation rates among women from non-Western ethnic origin, but indicated that selection bias was minimal: the association between ethnicity and low birth weight was similar in both the response and non-response group. This suggests that selection bias, at least in Phase I, may not be a major threat to the validity of our results.

**Note on ethnicity**

The term ‘ethnic minority group’ refers to minority non-European (or non-USA), non-white populations. Ethnicity refers to the group the individuals belong to as a result of their roots, which include language, religion, diet, and ancestry. In this thesis different terms are used to refer to populations of African descent. In Chapters 2, 3, 5 and 6 we combined children from the Dutch-speaking Caribbean area with African ancestral (Surinam-Creole and Antilles) and Sub-Saharan Africa into the ‘African descent’ group, whereas in Chapter 7 we divided this group into a ‘black-Caribbean’ and ‘black-African’ group. In Chapter 4 we used data from the USA and referred to the African descent group as ‘blacks’. These people are mainly from sub-Saharan Africa and people with African ancestral origin who migrated to the USA via e.g. the Caribbean islands (such as Jamaica and Haiti). Although in our thesis we compare outcomes of our African descent group with, for example, the blacks in the USA, we have to bear in mind that the composition of those groups do differ.

In Chapters 1, 2 and 5 we included an ethnic group called ‘others’, which refers to western and non-western migrant group as a whole, based on the implication that this group share some common characteristics (at least being non-Dutch). Some of the underlying concepts discussed in this thesis may overarch individual ethnicities. In these studies, although this
group was highly comparable to the Dutch group, it might be necessary to explore the perspectives of these separate ethnicities.

**Body size measurements**

In this thesis we used several measures to define body size in our study population, including the most common measure BMI. BMI by itself is useful as an approximate classification of obesity status; nevertheless, it cannot accurately predict a specific individual’s percentage body fat. Other techniques, such as underwater weighing and dual energy X-ray absorptiometry (DXA), offer more accurate measurement of obesity. However, because these techniques are costly, invasive and not feasible for children, they are not practical for epidemiological studies. In Chapter 7 we used arm-to-leg bioelectrical impedance analysis (BIA), which is a less expensive and non-invasive method to estimate body fatness such as the fat mass index (FMI). Unfortunately, ethnic-specific equations for children aged 5-6 years to estimate body fat with BIA are lacking. Nevertheless, we used an equation validated for children aged 4-7 years in order to minimise measurement errors.51

Other indicators for body fatness used in this thesis were weight, weight-for-height, waist circumference (WC) and weight-to-height ratio (WHtR). WC and WHtR, as measures of abdominal fat, are known to be associated with insulin resistance and BP.52 However, in Chapter 6 the explanatory role of BMI for ethnic inequalities in cardiometabolic profile at 5-6 year of age was higher compared to WC. In Chapter 7 the strongest associations with BP were found for BMI compared to FMI and WHtR. Still, we have to consider that the overall associations found between body size and cardiometabolic risk factors were weak and the percentage variances explained were small. This might become stronger with increasing age, as it known that at adult age abdominal obesity is a better predictor for adverse metabolic profile compared to general obesity. In addition, it is difficult to measure WC in young children. Although we trained students to measure WC correctly, especially in overweight children, variability in measurement may have increased.53

BMI can easily be calculated from weight and height, measures that are used worldwide in standard youth health care to follow a child’s growth and development. The use of BMI, instead of all other body size measurements, has the advantage that cut-off scores are established to define overweight and obesity in children from age 2 years. In this thesis we used age and sex-specific cut-off points based on the recommendations of the International Obesity Task Force.54 These cut-off points are derived from the cut-off points for adult overweight and obesity, and are based on their association with disease risk. An advantage of this method is that overweight prevalence is comparable among populations. A disadvantage is that the specificity is low, resulting in an underestimation of the number of children with overweight/obesity. However, since we compare ethnic minority children with ethnic Dutch children from the same cohort, we do not expect to experience any difficulties.
Generalisation of the results

We assume that the results of this study can be generalised to Turkish, Moroccan and African descent children (<7 years) within urban regions in the Netherlands. Furthermore, we expect that the higher prevalence of overweight in Turkish and Moroccan children and the risk factors and consequences might be similar to Turkish and Moroccan infants and children in other Western-European countries, such as Germany and Sweden. However, this will depend on whether the underlying determinants (such as SES and culture) have similar effects within different national contexts. This needs further investigation.

Implications for policy and practice

Decreasing ethnic inequalities in overweight prevalence during infancy and childhood might reduce ethnic inequalities in cardiometabolic health later in life. That makes sense, but is it easy? Successful interventions to prevent overweight at pre-school age are scarce, and additional budgets for youth health care are necessary to achieve this goal. Additionally, according to the Developmental Origin of Health and Disease hypothesis, a number of substantial physiological changes can already be defined in early childhood or even prenatally, by metabolic imprinting. That implies that some children already start with a disadvantage and prevention of childhood overweight should therefore start before conception. Pre-pregnancy counselling, as currently widely available in the Dutch health care system, could address overweight/obesity of the mother.

Early childhood seems particularly promising and ideally suited to interventions because there are multiple settings to access parents (e.g. youth health care centres, child care and primary care), and parents are highly sensitised to their child’s needs. In recognition of the importance of assessing overweight and obesity and instituting preventive measures in early years, the BeeBOFT (Breastfeeding, Breakfast daily, Outside playing, Few sugar sweetened drinks, less TV viewing) study has started (www.beeboft.nl). This national Dutch study aims to evaluate the effects on the prevention of overweight among 0-4 year olds, with a focus on nutrition, physical activity, and sedentary behaviour. The Dutch guideline ‘overweight’, for use within youth health care centres, has adapted these BOFT elements.

Unfortunately, until now, the Dutch health care system has not succeeded in decreasing ethnic inequalities in overweight. Moreover, there is evidence that inequalities increase each year. It is possible that public health campaigns and interventions during the past decade have been more directed to and adopted by ethnic Dutch parents and their children, than by ethnic minority groups. A low parental educational level, a known risk factor for childhood overweight and obesity, may be an important influential factor. Nevertheless, irrespective of the SES, we found ethnic inequalities in overweight in mainly the Turkish and Moroccan children. This thesis shows that ethnic groups faced with similar risk factors for overweight, but with differences in cultural beliefs, habits and needs, might require more ethnic-specific targeted interventions. In particular, when targeting parents who are
less integrated in Dutch society, the culture-specific beliefs and needs should be addressed in order to approach these parents and children to prevent early overweight. Important distinctions include perceptions of ideal body weight and decision-making influences. Youth health care physicians need to be aware that Turkish and Moroccan parents are most in need of advice/education regarding their child’s weight. Also, Turkish and Moroccan mothers need to be stimulated to continue exclusive breastfeeding but without formula or complementary foods, whereas ethnic Dutch and African descent mothers need to be stimulated to initiate breastfeeding. Furthermore, in the USA, health professionals should stimulate minority mothers to retain their traditional eating style; however, more research is needed on other ethnic groups to establish whether the latter recommendations also apply to parents in the Netherlands.

During childhood, whole-of-community programs such as the French EPODE program might be effective. This latter program aims to prevent a child from becoming overweight and obese by acting on the behaviour of the whole family, changing its environment and social norms. Evidence from EPODE and similar programs showing that multi-level interventions can be effective in prevention of overweight among children has led to the introduction of JOGG (Jongeren Op Gezond Gewicht) in the Netherlands. Another example of a whole-of-community program is JUMP-in. JUMP-in is a primary school-based (age 6-12 years) intervention program that started in 2002 in Amsterdam. This intervention aims to promote physical activity, involving municipal authorities, local sport services, primary schools and local sports clubs, with special attention paid to low SES and ethnic minority children. Recent results from this study showed an increase in structural sports participation among children, but no change in daily physical activity rates and body composition.

**Directions for further research**

Some studies within this thesis have a cross-sectional design, which makes it difficult to draw causal relationships. More insight is needed into the causal relation between the studied determinants and the risk of overweight. Ethnic differences might exist in the contribution of these determinants to the risk of developing overweight. Continuing the ABCD study and following the children into adulthood might allow to unravel the pathways from parental overweight to offspring overweight during childhood and adulthood. For example, the finding that rapid growth in the first 6 months (a critical period for childhood overweight) is more prevalent among Turkish and Moroccan infants emphasises the need for additional research on this topic.

International and European comparison studies between different countries might help to reveal protective determinants for overweight and cardiovascular risk. For example, to elucidate the mechanism whereby Moroccan children and adults show less cardiovascular risk, whilst the prevalence of overweight is high.

We were unable to clarify the explanatory role of infant feeding pattern on ethnic differences in rapid growth. However, as mentioned before, the composition and amount of feeding or
feeding habits might differ between groups, resulting in more energy intake. More studies are needed among Turkish and Moroccan infants to help define targets for prevention against early rapid growth in these groups.

Physical activity and sedentary lifestyle are not measured in depth in the ABCD study, but might become important determinants when the children grow older. For example, it is well established that screen-viewing behaviour is an important risk factor for overweight. The average daily television viewing in the Netherlands is higher among adolescents from non-western origin (Turkish and Moroccan origin).

Finally, in this thesis we suggest that ethnic-specific interventions might be helpful to help reduce overweight among ethnic minority children. More research is needed to confirm the effectiveness of these types of interventions.

In addition:
Although sex differences have also been described between ethnic groups related to determinants for overweight, we were unable to explore this topic due to the small ethnic groups. Because we only adjusted for sex, it is worthwhile to investigate determinants of early overweight stratified by ethnicity and sex. Furthermore, in this thesis we analysed children from African descent as a whole, which turned out to be a group with minor health problems compared to Moroccan and (especially) Turkish children. However, compared to Dutch children, this group also suffers from a high prevalence of overweight at age 5-6 years. Therefore, it is meaningful to explore the separate ethnicities within this African descent group, because data on feeding habits and feeding patterns in these children are scarce.

**Final conclusion**
Overall, ethnic inequalities in overweight and cardiometabolic risk factors are seen already during infancy, irrespective of socio-economic status. We found the highest prevalence of overweight among Turkish (2 years: 19.8% and 5-6 years: 27.0%) and Moroccan (2 years: 16.7% and 5-6 years: 26.2%) children, and the most adverse cardiometabolic profile among Turkish children aged 5-6 years. Because previous studies concluded that childhood overweight might track into adulthood, and overweight at age 2 years was found to be highly predictive for overweight at age 5-6 years (especially among Turkish and Moroccan children), we conclude that early preventive measures to elaborate ethnic health inequalities should start at an early age, i.e. < 2 years.

In this thesis, the key determinant is: rapid growth in the first 6 months of life. Youth health care professionals should be aware of this critical time period in relation to intervention. All children, but especially children from Turkish and Moroccan origin, should be carefully monitored concerning their weight change during this period.

Stimulation of breastfeeding alone might not be sufficient since breastfeeding was the most prevalent among the ethnic minority groups with the highest prevalence of overweight. Other factors (e.g. amount and composition of food) related to the relationship between
early rapid growth and infant feeding in Turkish and Moroccan children should also be taken into consideration.

Parental involvement is of critical importance for effective treatment and prevention of early overweight. Accordingly, health care professionals should take into account parental cultural background, which includes eating habits and parental perceptions of their children’s health status.

More research is needed to unravel pathways from parental to offspring overweight, and to develop and evaluate effectiveness of (ethnic-targeted and culturally appropriate) interventions to tackle ethnic inequalities in overweight and early rapid growth. Ultimately, we might be able to reduce the risk of chronic diseases later in life in general, as well as in specific ethnic groups.
References

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