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Weight status and food intake in Brazilian children

The relation between socio-economic status, weight status and food intake

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Acknowledgements

In August 2010, at the start of this master, I received an email with the sentence ‘we recommend you to already think about a topic for your master thesis’. When I read that email, writing a master thesis seemed to be a long way ahead and it was a bit overwhelming to think about it that early in the college year. But now, at the end of the master I can honestly say that writing my master thesis was in no way as frightening and difficult as I thought it to be. However, I could not have done this without the help of a lot of people.

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So finally, a year after that first email, I owe to all of you a heartfelt thank you.

Abstract

Objectives: (1) Study food intake and weight status of both high and low SES and relate this to stages in the nutrition transition; (2) to get insight in determinants of differences in weight status and food intake between Brazilian children of high and low SES at the age of 4.5 years; (3) to determine the extent to which food intake tracks from 8 months old to 4.5 years; (4) to determine the extent to which food intake of this sample of children meets WHO/FAO recommendations.
Methods: Starting with description of the nutrition transition. In a cross sectional and longitudinal analysis this model will be compared to the data. The data is a secondary dataset collected in a community-based study in Pelotas, Brazil. Weight status and food intake were compared between 4.5 year old children from high (n=30) and low (n=34) SES. For comparison between the two groups t-tests and non-parametric Mann-Whitney tests were used. Analysis of the differences between SES groups was performed by analysis of covariance. Tracking of food intake was assessed by comparing the intake of the children at 8 months and 4.5 years of age. Total energy intake and macronutrient intake is compared to WHO/FAO recommendations by using a paired and one sample t-test. The complete research is embedded in and linked with the nutrition transition theory.
Results: Weight status and food intake differed significant (p< 5%) between high and low SES. Ethnicity proved to be most influential in explaining the differences between high and low SES. Total energy intake for high SES children met WHO/FAO recommendations; this was not the case for low SES children, this group had an intake below WHO recommendations. Macronutrient intake of both high and low SES children met WHO/FAO recommendations.
Conclusions: SES in combination with ethnicity are considered as the main explanatory determinants of weight status and food intake of children. The food intake and weight status of low SES children fits best in the receding famine stage of the nutrition transition. The food intake and weight status fits best in the NRNC-disease stage of the nutrition transition. Differences have also been observed. Macronutrient intake should not be assessed as a percentage of total energy intake but, in order to prevent a certain degree of bias, in grams per kilogram bodyweight.

Keywords: Nutrition transition, child nutrition, child weight status, food intake, weight status, BMI, FMI, FFMI, WHO/FAO recommendations.

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List of abbreviations

ANCOVA	Analysis of covariance
BMI	Body mass index (kg/m^2)
CI	Confidence interval
EST	Ecological systems theory
FAO	Food and Agricultural Organisation
FFMI	Fat free mass index (kg/m^2)
FMI	Fat mass index (kg/m^2)
Kcal	Kilo calorie
NRNC-disease	Nutrition related non communicable disease
PAHEF	Pan American Health and Education Foundation
SD	Standard deviation
SE	Standard error
SES	Socio-economic status
WHO	World Health Organisation

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1. Introduction

1.1 Background

Underweight and obesity are according to the WHO (2002) both among the top ten leading risk factors for the global burden of disease. Along with other middle-income countries in Latin America, Asia, and the Middle-East, Brazil is far advanced in the processes involving the demographic, economic, environmental, cultural and nutritional transitions (Monteiro et al, 2002). These authors also stress the fact that the impact of these changes on the nutritional profile of the population of these countries still needs to be assessed. For many reasons, Brazil has a privileged position in research of the nutrition transition in developing countries. Monteiro et al. (2002) mention the major demographic, socio-economic, environmental, and cultural changes in the last quarter of the 20^{th} century; the availability of repeated nationally representative cross-sectional surveys on nutrition; the continental dimensions of Brazil; and the strong uneven income distribution across the country. Monteiro et al. argue that these income disparities "permits the dynamics of the nutrition transition among the relatively poorer and richer social strata to be individualized and compared within each region (2002, p.223)". In the period of 1975 to 1997 declining trends in under nutrition were documented for all ages and among all regional and income strata. However, at the same time increasing trends in overweight or obesity could be observed for older children and adolescents, male adults and women in less-developed regions (Monteiro et al., 2002).

In the case of this thesis, a comparison will be made based on two socio-economic groups in the city of Pelotas. The data used for this thesis is secondary data, collected for a PhD study (Haisma, 2004). The data was collected in Pelotas, a city of about 340,000 habitants in 2007 (IBGE, 2011) located in the extreme south of Brazil. Pelotas is part of the state Rio Grande do Sul. The majority of the inhabitants of Pelotas work in services, followed by industry and only a small part works in agriculture. This pattern is the same in both Rio Grande do Sul and Brazil. Health expenditure in Brazil is mostly related to medicines and health plans (Barros et al., 2008).

Pelotas was chosen as study site for the initial study because of the fact that social inequity in Brazil is among the highest of the world, which makes it a suitable site to study the effect of SES. For the original study, another motivation for this study location was given, that was the fact that babies are breast-fed for a longer period of time, which allowed assessment of the effect of breast-feeding pattern (Haisma, 2004).

This background picture of Brazil should be considered when taking into account the worldwide trend towards increased obesity. Obesity is often associated with excessive food intake, a reason why study of this disease has not been number one priority in Third World countries, where protein-energy malnutrition is an important public health problem. However, according to the World Health organization, childhood obesity is increasing worldwide at an alarming rate with the countries of Latin America and the Caribbean among the most affect. This worldwide increase is a serious problem, because childhood obesity is an important predictor of adult obesity, which comes with all its negative health consequences. (PAHEF, 2010). In Latin America, prevalence of obesity among preschool children remains low, but among schoolchildren it has increased considerably (Kain et al, 2003). Overall levels of overweight and obesity in Latin America are relatively high. In 2003 38.1% of the Brazilian population over 18 years old (based on a study with a sample size over 50,000 cases) was classified as obese, with small difference between men and women (Doak and Popkin, 2008).

The topic of this study is the weight status and food intake of 4.5 year old Brazilian children in relation to socio-economic status. Because overweight, underweight and malnutrition are occurring together and interact, it is interesting to look at differences between socio-economic groups in weight status and food intake and look for potential explanatory factors. Following from this, it can be concluded that the scope of this thesis is wider than only a focus on obesity. This thesis aims to get insight in food intake patterns of both high and low SES children and to relate this intake to stages in the nutrition transition. In relation to this objective determinants of differences in weight status and food intake between children of high and low SES will be assessed. It is also interesting to determine whether food intake shows some kind of tracking pattern and whether the intake of this sample of children at 4.5 years meets WHO/FAO recommendations.

According to the WHO (2011a) the world nowadays faces a double burden of malnutrition that includes both under nutrition and overweight. This poses real threats to human health. Under nutrition contributes about one third of all child deaths. At the same time are worldwide growing rates of overweight and obesity associated with a rise in chronic diseases such as diabetes, cardiovascular diseases and cancer. As mentioned before, Brazil is a country with great differences between high and low income and socio-economic status. Different stages of the nutrition transition are occurring at the same time, where problems related to under nutrition overlap with threats posed by over nutrition. Many developing countries, including Brazil, deal with infectious diseases as HIV-AIDS and malaria together with increasing prevalence of nutrition-related non communicable diseases. All these factors should be taken into account in developing a comprehensive public health policy (Caballero and Popkin, 2002).

1.2 Objective

This research has multiple objectives:

1. Study food intake and weight status of both high and low SES and relate this to stages in the nutrition transition;
2. To get insight in determinants of differences in weight status and food intake between Brazilian children of high and low SES at the age of 4.5 years;
3. To determine the extent to which food intake tracks from 8 months old to 4.5 years;
4. To determine the extent to which food intake of this sample of children meets WHO/FAO recommendations.

This study will take place in a positivistic paradigm. This paradigm continues to form the paradigmatic basis for much health research nowadays (Broom and Willis, 2007). Food intake and weight of people can be measured and from this data, conclusions can be drawn about the relationship between socio-economic status, weight status and consumption.

1.3 Research questions

In relation to this objective a main research question is formulated with corresponding sub questions.

Main research question

What is the relation between socio-economic status, food intake, and weight status of Brazilian children aged 4.5 years and how can this be linked to the theoretical framework of the nutrition transition?

Sub questions

1.1 Is there a difference in weight status between children of high and low SES?

1.2 Is there a difference in food intake between children of high and low SES and can there be made a link with stages of the nutrition transition?

2.1 Which factors determine the difference in weight status between high and low SES children?

2.2 Which factors determine the difference in food intake between high and low SES children?

3. Does dietary behaviour track over time?

4. Does total energy and macronutrient intake of these children meet the dietary recommendations of the WHO/FAO?

1.4 Structure

This thesis consists of five chapters. The first chapter is the introduction of the thesis. In the second chapter a theoretical background will be provided together with a literature review, conceptual model and hypotheses. In the theoretical framework the nutrition transition theory will be outlined together with the ecological systems theory (EST) which will provide the theoretical background throughout this research. Chapter three will consist of a description of the data and methods used in this research. This will include a study design, conceptualisation and operationalization and a description of the statistical methods used in the analysis. The fourth chapter will include the results of the analysis. In the fifth and final chapter conclusions will be formulated, results will be discussed and recommendations for further research will be provided.

2. Theoretical framework and literature review

2.1 Theory: the nutrition transition

The theoretical background of this thesis is the nutrition transition theory as formulated by Popkin (2002). In this section the nutrition transition will first be outlined in global context, second it will be applied to the developing world and finally a micro level theory called the ecological systems theory will be discussed.

In figure 2.1 different stages of health, nutritional and demographic change are outlined (Popkin, 2002). The stages of the epidemiological transition are of main concern for this thesis, but complete understanding of the nutrition transition is not possible without insight in the demographic and epidemiological transition. In the next section these transitions will discussed, followed by a description of the nutrition transition

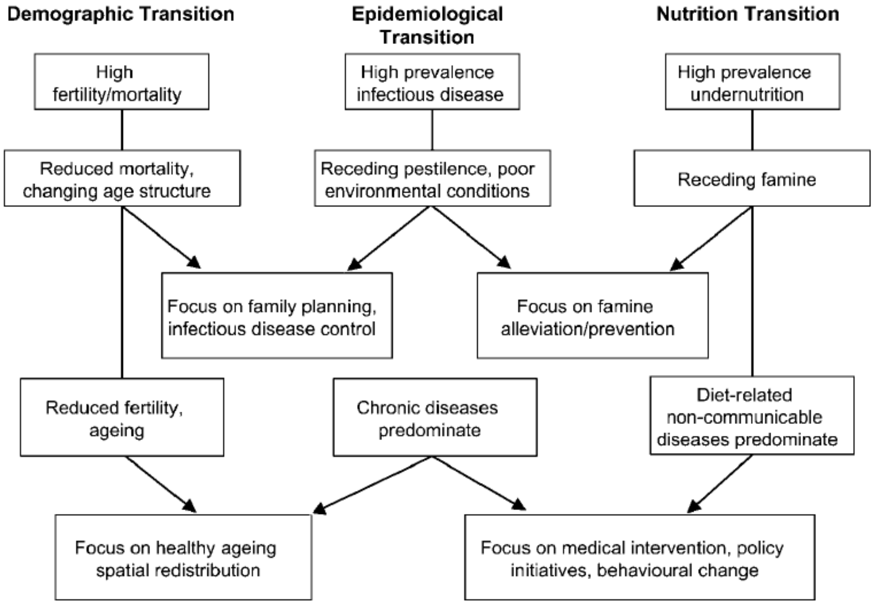


Figure 2.1 Stages of health, nutritional and demographic change
Source: Popkin (2002)

When one reviews agricultural history, a rise in agricultural efficiency can be observed. Fogel and Helmchen (2002) point out that a larger and better survival diet allowed adult members of the generation that first witnessed this rise in agricultural efficiency to increase weight, and, consequently, to improve health and extend life. Fogel and Helmchen (2002) also relate a nutritional deprivation in earlier years of life to an increased risk of mortality at the middle and late ages.

Food production has changed in the course of history. Having insight in this change is important in understanding the processes underlying the nutrition transition. It is possible to provide a generalized overview of ways people collected food throughout human history. However, it is important to keep in mind that transition from one to another method was not a sudden shift, but a more gradual process. Smil (2002) provides a clear overview of these steps in food production throughout history, which starts with foraging societies, followed by traditional agricultures and finally modern farming. Taking differences within the Western dietary patterns into account, Seckler and Rock (1995, in: Smil (2002)) suggested two different patterns of food consumption that should be considered when forecasting the future composition of food intakes in developing countries. First is a Western model. In this model includes a daily mean supply of more than 3200 kcal/capita with more than 30% of food energy coming from animal sources. Next to this pattern they mention that "a great deal of evidence confirms that another model – […] the Asian-Mediterranean pattern, with overall food energy availability below 3200 kcal/capita and with animal products supplying less than 25% of food energy, appears to be a more powerful attractor for many developing countries." (Seckler and Rock, 1995, in: Smil, 2002 p.44).

The changes in the way food is produced can be placed in a wider context of demographic change, which is marked as a demographic transition. The demographic transition states that societies, experiencing modernization, progress from a pre-modern pattern of high fertility and high mortality to a post-modern pattern of low fertility and low mortality (Kirk, 1996). Especially when these countries are in the third phase of the demographic transition, with declining mortality and high fertility an enormous population growth can be observed. All these people need to be fed, which reinforces developments in modern agricultural methods.

All these processes are needed in order to understand the nutrition transition. The nutrition transition is one of the main theories on nutrition patterns and how they have changed over time. According to Popkin (2002) two historic processes of change occur simultaneous to or precede the nutrition transition. One is mentioned before, the demographic transition. The other is de epidemiological transition. The epidemiologic transition as formulated by Omran (1998) is based on the "[…] systematic application of epidemiologic interference to changing health, mortality, survival and fertility over time and place, linked to their socio-economic, environmental, lifestyle, demographic, health care and technological determinants and/or correlates in different societal settings"(1998, p.99).

The nutrition transition provides a model for understanding changes in dietary patterns. In this thesis research focuses on relation between SES, weight status and food intake. By performing different kind of analysis we aim to get insight whether or not there is a link between food intake and SES which can be linked to the phases of the nutrition transition. Modern societies show a pattern of diet high in saturated fat, sugar and refined foods and low in fiber (Popkin, 2002). Popkin (2002) also formulates five main dietary patterns which give a broad overview of a sequence of shifts. Popkin stresses that it is important to keep in mind that the patterns vary over time and space.

- The first pattern is that of collecting food. A diet that characterizes hunter-gatherer populations, and which is high in carbohydrates and fibre and low in (saturated) fat.
- The second pattern can be described as one of famine. It includes a diet that becomes less varied and comes with periods of acute scarcity of food.
- The third pattern is that of receding famine. This does not mean that chronic hunger and famine vanished completely, but they were reduced significantly.
- The fourth pattern is that of nutrition-related non communicable disease (NRNC-disease). This pattern comes with a diet high in total fat, cholesterol, sugar and other refined carbohydrates and is low in polyunsaturated fatty acids and fibre. An increasingly sedentary life accompanies this pattern, which is characteristic of most high-income societies.
- The fifth and last pattern is that of behavioural change. It is a new dietary pattern that appears to be emerging as a result of changes in diet, evidently associated with the desire to prevent or delay degenerative diseases and prolong health.

The model of Popkin is in the first place applied on Europe, but the transition also fits many non-European countries including Brazil. Popkin (2001) stresses that it is important to keep in mind that these patterns vary over time and space.

In relation to research on increasing prevalence of obesity among children in Brazil, the fourth pattern is the most important. This pattern results in increased prevalence of obesity and becomes a characteristic of increasing proportions of the population in low-income societies (Popkin, 2002) such as Brazil. In later research, Popkin (2008) further explores the processes linked to the nutrition transition. One of the main processes is economic change. An important change in economic structure associated with the nutrition transition is the shift from a preindustrial agrarian economy to industrialization (Popkin, 2008). Next to economic change, socio-economic changes are important in the nutrition transition. For example the changes in the role of women (this is related to time allocation), changes in income patterns, household food preparation technology and family and household composition (Popkin, 2008). Popkin also mentions the 'distribution of chronic disease risk factors by income group' as a crucial dimension of the relationship between socio-economic status and nutrition. Related to these socio-economic changes is the demographic force of urbanization in developing countries. With increasing urbanization after World War II, there is a remarkable shift of poverty toward the urban areas, particularly toward squatter and slum areas. At lower-income levels urbanization can double the amount of sweeteners in the diet and increases considerably the total fat consumed. Observations are confirmed that people living in urban areas consume diets that are distinct from the diets consumed by their rural counterparts (Popkin, 2008).

The model of nutrition transition and in particular the fourth pattern of nutrition-related non communicable disease tells us about changing food patterns. However, it does not explicitly refer to the determinants of the weight status of a child. This can be contextualized using the Ecological Systems Theory (EST) as discussed by Davison and Birch (2001). The model these authors have constructed is displayed in figure 2.2.

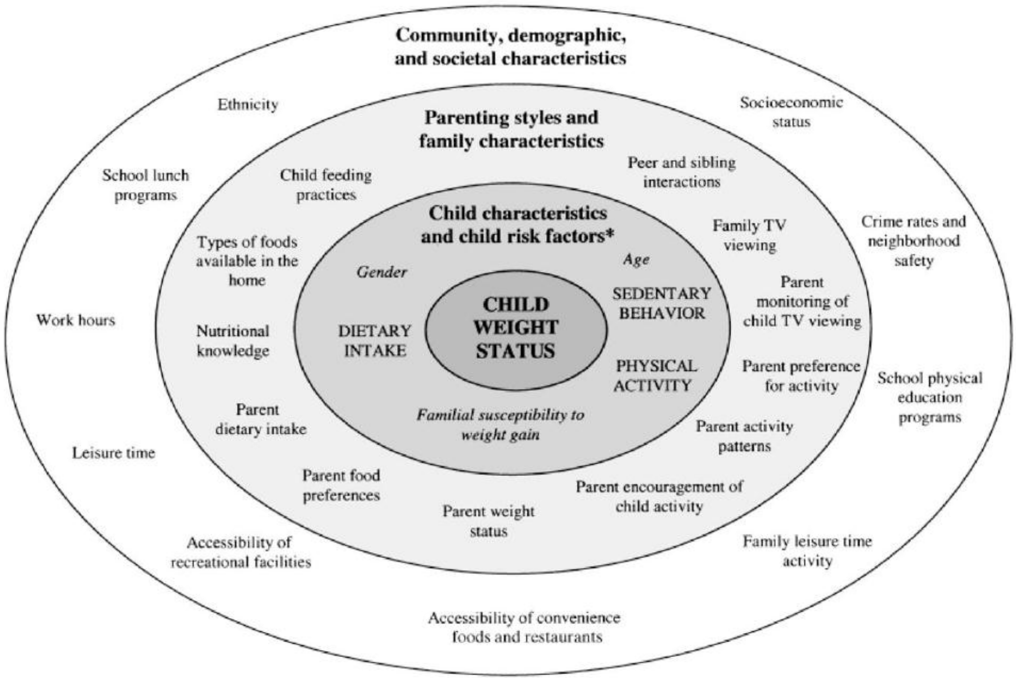


Figure 2.2 Ecological model of predictors of childhood overweight
Source: Davison and Birch (2001)

This theory conceptualizes human development from an interactive contextual perspective (Davison and Birch, 2001) and is useful in looking at predictors of childhood overweight in children. It may also be useful in the wider context of weight status of children, instead of only overweight.

According to Davison and Birch (2001), development or change in individual characteristics [such as bodyweight], cannot be effectively explained without consideration of the context in which the person is embedded. Davison and Birch (2001) relates the concept of context to the concept of ecological niche, which not only includes the immediate context in which a person is embedded, but also the context in which that context is situated. In the case of a child, the ecological niche includes the family and the school, which are in turn embedded in larger social contexts including the community and society in general. In addition to this larger context, characteristics particular to the child, such as gender and age, interact with familial and societal characteristics to influence development (Davison and Birch, 2001). Relating the context of the society in general to the concept of the fourth pattern in the nutrition transition, the theory of EST forms a bridge between the macro level of the nutrition transition to the micro level at which we find the child.

2.2 Literature review

In this paragraph earlier research on body composition, food intake and the relation of these two topics with socio economic position will be reviewed. This has been done in two sections, first the research on body composition, including body mass index (BMI) and fat mass index (FMI) will be reviewed. Second the research on food intake will be discussed. However, the distinction between these two topics is not always this clear and research has often been performed on both topics in one study. When this is the case, the research will be discussed in the section which was most appropriate.

2.2.1 Literature related to weight status

In this section of the literature review, earlier research with regard to body composition will be reviewed. A relative great proportion of recent research focuses on overweight and obesity among children, adolescents and adults. Research related to underweight is in most cases focusing on child malnutrition, but underweight is also having a low weight for height.

Kain et al. (2003) pointed on the fact that information on obesity trends in Latin America is in most cases limited to preschool children and women in childbearing-age. The research of this thesis is relevant because research on the possible explanatory factors of over- and underweight among school-aged is less common.

Comparison of four successive nationwide surveys undertaken in Brazil in 1975, 1989, 1996 and 1997 gives insight in the trends in anthropometry of the Brazilian population. Monteiro et al. (2002) used three age groups in the analysis: the young child group (one to four year old individuals); the old child/adolescent group (10 to 17 year old individuals); and an adult group (aged 20 or more years). For this research, where the study population is aged four and an half year, the young child group is relevant. Monteiro et al. (2002) found that the prevalence of young child overweight for the entire country is relatively low and does not change significantly throughout the surveys of 1975, 1989 and 1996. Higher rates of child overweight have been observed among the higher income children from the more-developed south eastern region, but these rates also do not change significantly during the three surveys. In both the southeast and northeast region child wasting[1] tends to be more common among lower income families and overweight tends to be more common among higher income families. However, the stunting[2] versus overweight ratio has changed when comparison is made between 1975 and 1996. In 1975 ten cases of child stunting could be observed to one case of overweight. To compare, in 1996 this ratio was three to one (Monteiro et al. 2002). This ratio is for the whole country. When looking at different regions, different ratios of stunting to overweight could be found.

Caballero (2005) points out that obesity traditionally has been linked with abundance. Following this way of reasoning it could be anticipated that as developing countries improved their economic status and gross national product (GNP), under nutrition would decrease and obesity would begin to appear among members of the higher socio-economic classes. But the current trends indicate otherwise. ‘[…] although being poor in the poorest countries […] indeed “protect against” obesity, being poor in a middle-income country is actually associated with a higher risk of obesity than being richer in the same country.’ According to Caballero (2005) reasons for this phenomenon is not completely clear, but reduction in energy expenditure is a possible explanation, where in the healthier parts of a population this influence may be balanced by access to better health and nutrition related education. Caballero also mentions the underweight-overweight paradox. This paradox is discussed in more detail by Doak et al. (2000). One of the direct environmental factors which influence the life of a child is the household in which he or she lives. Research performed by Doak et al. (2000) indicates that underweight and overweight often coexist in one household. They have used three large national surveys from Russia, Brazil and China in their research. The researchers indicated that the prevalence of households in which both an overweight and an underweight member is present is respectively 8,

[1] Wasting is defined by the WHO as a low weight-for-age (WHO, 2011b).
[2] Stunting is defined by the WHO as a low height-for-age (WHO, 2011b).

11 and 8% in these three countries. The most prevalent combination was the one in which an underweight child lived together with an overweight nonelderly adult. Living environment (e.g. urban or rural) can be considered as a potential explanatory factor of the prevalence of underweight or overweight. According to Caballero (2005) will the contribution of the urban environment to the underweight-overweight probably continue to increase. Caballero does also mention data from the World Bank, which shows that the rates of poverty and underweight have increased among children younger than five years in urban areas of countries in socio-economic transition. This statement is relevant for this thesis, because Brazil is one of the countries in socio-economic transition together with an increasing urbanization. Besides diet and lifestyle, other factors can be linked to overweight and especially overweight in adulthood. The Barker hypotheses or the hypothesis of fetal origins of disease states that early under nutrition (in utero) increase the risk of certain chronic diseases in adulthood (Barker, 1996). This theory is relevant in respect to the third research question which focuses on the tracking of food intake. In this question the consumption at 8 months and 4.5 years will be reviewed. Besides food intake data, at 8 months energy utilisation has also been measured. Birth weight data is also known for this sample, and birth weight can be used as an indicator for growth in utero. However, because children studied in this thesis are 4.5 years old and the Barker hypothesis focuses on the very early life of a person, this is not directly relevant for this research, but nonetheless important to mention.

Danielzik (2004) writes about a longitudinal study aiming to characterize the determinants and risks of childhood overweight. This study is called the Kiel Obesity Prevention Study (KOPS) which is started in 1996 and was planned to run until 2009. In KOPS determinants of overweight are divided into different groups: determinants related to family, environment and development of the children; social data; infancy; physical activity/inactivity and nutrition. These factors are also taken into account in this thesis, in which determinants related to the environment and child are used as main (possible) explanatory factors. Danielzik (2004) emphasizes the fact that obesity is a complex phenomenon. Despite a great amount of research, the contribution of dietary intake, patterns of activity, sedentary behaviour and family factors still present a confused picture.

Griffiths eat al. (2008) performed a study among children aged 9 and 10 years. They studied the relation between socio-economic status and body composition outcomes in urban South African children. They concluded that SES at birth did not have a significant association with FMI, BMI or LMI (lean mass index) before controlling for confounding factors. At ages 9 and 10 years this picture was different. SES was significantly associated with BMI and FMI before controlling for confounding factors and controlled for confounding factors SES was significantly associated with FMI. Interesting is the difference between the association between SES and the body composition outcomes at birth and at age 9 and 10. The study population of my research has an age almost exactly in between which makes studying the association between SES and body composition relevant to see whether this picture is confirmed.

The study described in this thesis looks at children at 4.5 years old, with the possibility to link this to the same cohort of children of 8 months old. In the KOPS study was concluded that the major determinants of overweight and obesity of 5-7 year old children are parental overweight; a low socio-economic status and high-birth weight (Danielzik, 2004). However, this study is conducted in Western-Europe, a region that has already gone through the demographic, epidemiologic and nutrition transition, which is not the case for Brazil. This thesis might add new insights to the explanatory factors of body composition (BMI/FMI) of children living in a country in transition.

2.2.2 Literature related to food intake

The data used for this research has been collected for a PhD thesis focusing on energy utilisation of infants in southern Brazil (Haisma, 2004). Romulus-Nieuwelink et al. (2011) have used this data to study breast milk and complementary food intake in Brazilian infants according to socio-economic position. The infants in this research are aged 8 months. My research is an extension of this thesis, focus will be placed on children at the age of 4.5 years with some linkages to the food intake at 8 months. Romulus-Nieuwelink et al. (2011) found that the feeding habits of these children at 8 months of age deviate from the PAHO and WHO recommendations.

Food intake is often related to behavioural characteristics of a child. Pearson and Biddle (2011) reviewed over fifty studies in which sedentary behaviour was linked with at least one aspect of dietary intake in children, adolescents and adults. From this review sedentary behaviour, which is usually assessed as screen time and predominantly TV viewing, is associated with unhealthy dietary behaviours in children, adolescents and adults. In order to be able to watch television or play videogames a television has to be available. In this research, socio-economic status is defined by the education of the mother, but higher education in many cases also leads to higher income. The study of Pearson and Biddle included children, adolescents and adults. However, many studies only take the dietary intake of adults in account, or focus on one specific food product such as soft drinks or fast food (Wang et al., 2009; Francis et al., 2009). Specific studies on the relation of socio-economic status of children in relation to their weight status and overall food intake are not common. In an Israelian study the dietary intake and eating habits among adults across socio-economic statuses have been assessed. Shahar et al. (2005) found in this research that lower SES group had a diet of poorer quality. In this study no explanation for causes of this divergence has been given. In addition to this study, a study of Hulshof et al. (2005) is relevant. They related dietary intake to socio-economic status from Dutch adults. The researchers found a higher prevalence of obesity and skipping of breakfast among people with a low SES. People in the low and very low SES group had a higher consumption of potatoes, meat and meat products, visible fats, coffee and soft drinks (men only). Higher SES was associated with a lower fat intake but these differences between social classes were small and not consistent when contribution of alcohol to energy intake was taken into account. These studies are relevant to mention, but it is important to keep in mind that they have an adult study population and that different countries have different food products and eating cultures so conclusions can not be drawn universally.

Related to macronutrient intake a study performed by Rodriguez and Moreno (2005) reviewed whether energy intake, macronutrient composition of diet, eating patterns or other dietary intake factors are able to explain differences in body composition when obesity has already been developed or even in subjects at risk to become obese. They did not find evidence of the exact effect of diet on the prevalence of overweight among children and adolescents.

Looking at macronutrients is interesting and might prove to be insightful, but one does not eat a single nutrient, nutrients are integrated within food products. A trend towards studying dietary patterns can be observed in the field of nutrition sciences. Next to the fact that we consume food items and instead of separate micro and macronutrients, the study of single macronutrients such as fat, carbohydrate, and protein comes with methodological limitations, since many nutrients occur together in foods and meals (Newby, 2007). The World Health Organization (WHO) has identified energy density and fiber as important dietary factors for determining overweight and obesity risk (WHO, 2003). Under the influence of the nutrition transition there have been many changes in the eating pattern and eating behaviour of children over the last several decades. These changes include changes in total energy intake and macronutrient composition, but also the types of foods and beverages that are consumed (Newby, 2007). Eating behaviour includes the increase in away-from-home dining and snacking. There has been conducted research on the relation between eating patterns and weight status but most of this research has been done on adults. Robust evidence from prospective studies for specific determinants of obesity in children is limited (Johnson et al., 2008).

Johnson et al. (2008) tried to identify a dietary pattern, for children aged 5 and 7 years old, characterized by three risk factors for obesity: dietary energy density (DED), fiber density (FD), and percent of energy from fat. They found that the effect of a dietary pattern associated with high DED, low-fiber intake and high fat intake is much greater than the effect of the factors DED, FD, or percentage of energy intake from fat alone. They also observed a weaker effect for diet at 5 years of age compared with diet at 7 years of age. This difference is explained by the fact that children 7 years of age experienced longer duration between measurement and follow-up.

Besides the methodological advantage, studies of food and feeding patterns are better equipped to provide a dietary advice, because people consume foods and not nutrients (Newby, 2007). In the study of dietary patterns, many dietary items are grouped together to provide a picture of a total diet. In his literature review Newby (2007) observes an increasing popularity of this approach in nutritional epidemiology in recent years. Newby and Tucker (2004) stress the fact that many studies show that eating patterns are associated with other characteristics, including sex, age, socio-economic status, and general health habits such as smoking and drinking. In my study, we were not able to use methods in order to define dietary patterns. However, it is possible to say something about food intake patterns of low and high SES children. Food intake and dietary patterns are related to local food culture. But in this research a generalisation towards the nutrition transition will be made. Sichieri (2002) conducted a study among adults living in the city of Rio de Janeiro. The aim of this study was to evaluate the dietary patterns of adults living in the city of Rio de Janeiro and their associations with body mass index (BMI). More than one-third of the adult population (20 to 60 years old) was overweight and 12% were obese. Using factor analysis, Sichieri identified three major dietary patterns: 'a mixed pattern when all food groups and items had about the same factor loading except for rice and beans; one pattern that relies mainly on rice and beans, which was called the traditional diet; and a third pattern, termed a Western diet, where fat (butter and margarine) and added sugar (sodas) showed the highest positive loading and rice and beans were strong negative components (Sichieri, 2002).' In this study the traditional diet was associated with lower risk of overweight/obesity in a logistic model adjusted for dieting, age, leisure physical activity and occupation.

2.3 Conceptual model

In this section the different factors influencing weight status and food intake will be combined into a conceptual model. In figure 2.3 the conceptual model used in this research is displayed in which the theory of the nutrition transition will be related to a number of determinants of both food intake and weight status. A distinction could be made into a macro and micro level in this model. The nutrition transition is a model useful for making generalisations at the macro level. The determinants of weight status/food intake are related to the micro level. The determinants in this conceptual model are also used in determining whether a factor is regarded as a confounding or mediating factor in the statistical analysis. A distinction has been made between demographic and the rest of the determinants because demographic determinants are considered as unchangeable in contrast to the other determinants which can change under influence of the different stages of the nutrition transition. This will be discussed in more detail in the data and methods chapter.

Briefly a factor is a considered as a confounding factor if: it is associated with the exposing variable, in this case SES, it is associated with the outcome variable, for example FMI, and if the factor is not part of the causal chain. (Rothman and Greenland, 1998 in: Haisma, 2004). This means that the demographic determinants sex and ethnicity are considered as confounders in the analysis. The conceptual model has been based on the conceptual model of Haisma (2004).

2.4 Hypotheses

Based on the theory of the nutrition transition in relation to the objectives and research questions the following hypotheses have been formulated:

1. Children in the low SES group are expected to have a food intake which could be related to the third phase of the nutrition transition. Children in the high SES group are expected to have food intake which could be related to the fourth phase of the nutrition transition.
2. Children from high SES are expected to have a higher weight compared to children from low SES.
3. Children are expected to stay in the same tertile with regard to consumption at eight months of age compared to 4.5 years.
4. The proportion of children of which the food intake meets WHO/FAO recommendations is expected to be higher in the high SES group compared to the low SES group.

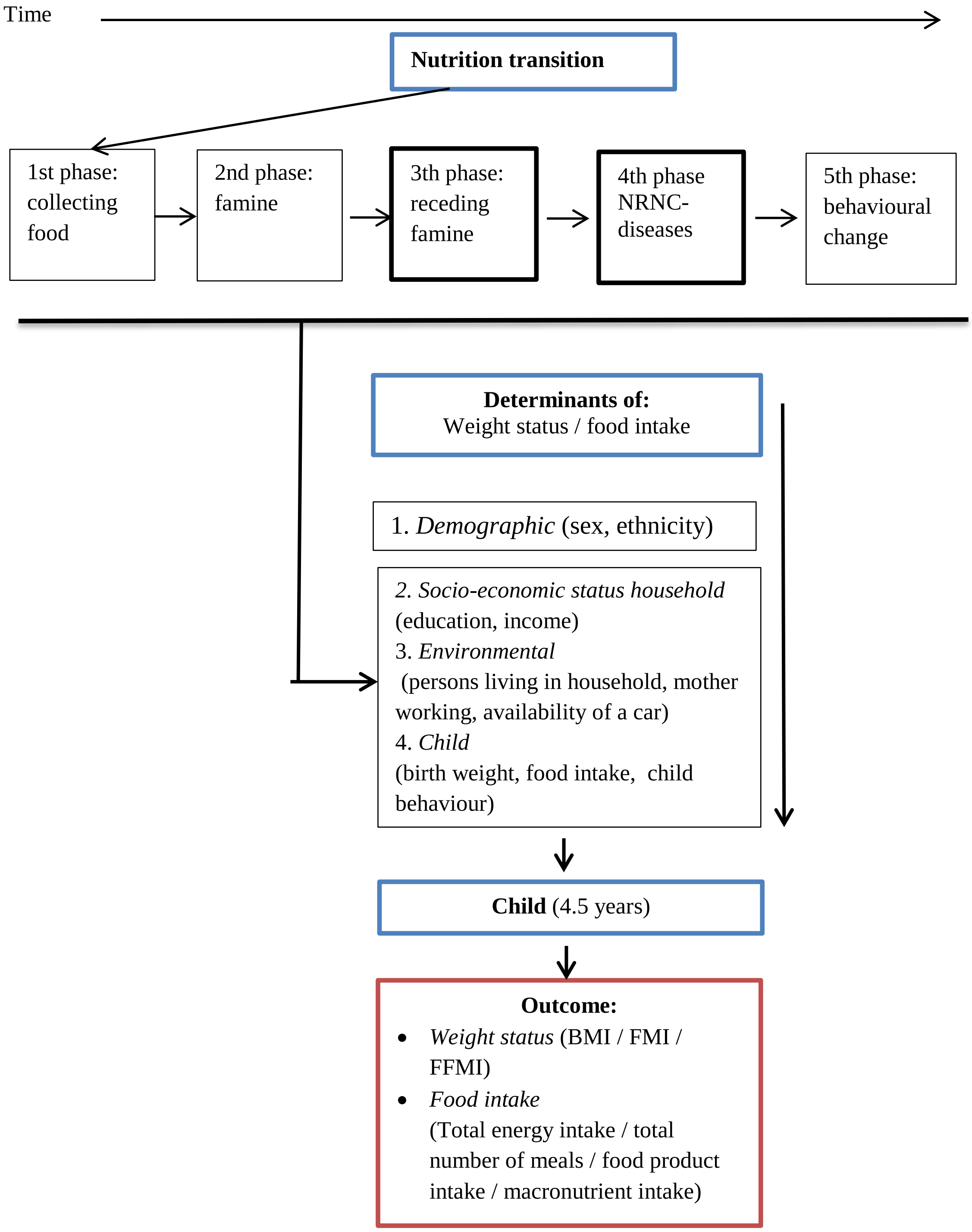


Figure 2.3 Conceptual model – determinants of weight status and food intake
Based on: Popkin (2002) and Haisma (2004)

3. Data and methods

In this chapter the data and (statistical) methods which are used in the analysis will be discussed. In the first paragraph the study design will be outlined, including the level of analysis and a description of the data, discussion of data quality and ethical considerations. In the next paragraph the concepts used in this research will be explained and operationalized in the next paragraph. This chapter will be concluded with a description of the methodology used in the analysis.

3.1 Study design

The objective of this research is to describe and to get insight in difference in weight status and food intake between Brazilian children aged 4.5 years of high and low socio-economic status. To achieve this objective a quantitative analysis on secondary data will be conducted. This is a combination of descriptive and explanatory research. In performing this study, it is tried to explain how socio-economic status influences weight status and food intake and what explains possible differences. As theoretical background for the interpretation of the results, the third and fourth phase of the nutrition transition as formulated by Popkin (2002) will be used. One part of this analysis will be descriptive, another part will be explanatory. The first research question focuses on description of weight status and food intake of both high and low SES children at the age of 4.5 years and the relation to the phases of the nutrition transition. This research question has a descriptive character. The second research question focuses on the explanation of the differences found in research question one and has an explanatory character. Research question three and four focus on the description of tracking of food intake between age 8 months and 4.5 years and a comparison between food intake of this sample of children at 4.5 years of age and the WHO/FAO recommendations. The research questions one, two and four focus on one moment in time when the children are 4.5 years old. Research question three has a longitudinal character, because it focuses on two moments in time.

3.1.1 Level of analysis

Data is available at the individual level, which in this case is the level of the child. The analysis will also be performed on the individual level. Describing and exploring how different groups of this children, for example based on SES or sex, behave is also relevant for this study, but the level of analysis will still be de individual, because individual characteristics of the children will be taken into account (Babbie, 2010). As described by Babbie (2010) social research often describes social groups and interactions by aggregating and manipulating the descriptions of individuals.

3.1.2 Description of data

The data used for this thesis originates from a larger PhD study on the influence of socio-economic status on energy utilization of infants in Pelotas, Brazil (Haisma, 2004). The data collection started with the 1993 birth cohort of the city of Pelotas. Relevant for this thesis is the data collected at 8 months and 4.5 years of age. Selection criteria are described in more detail in the thesis of Haisma (2004). The sample has been selected based on SES. Sample size at 8 months is 77 and sample size at 4.5 years was 66. From the 66 children, two are excluded. One child is excluded because food intake measurements were very high and unrealistic and the other child was excluded because it was sick and ate very little. The initial PhD study for which the data was collected consisted of a number of smaller studies. The dataset of children aged 4.5 is based on a sample of 77 mother-infant pairs. This dataset included all babies who participated in the study from beginning to end [from birth up to eight months of age] (Haisma, 2004). This study was initially designed to study differences in socio-economic classes. These two classes are of approximately the same size as can be observed in table 3.1.

Table 3.1 Descriptive statistics dataset

Variable		%	Cases
Sex	Male	43.75	28
	Female	56.25	36
SES	High SES	46.88	30
	Low SES	53.12	34
Colour	White	65.6	42
	Non-white (mixed)	34.4	22

The first, second and fourth research question were answered using sample size n=64. An exception is the third research question, which takes two moments in time into consideration. For 57 cases food intake data was available at both ages. These cases will be used for answering the third research questions. The sample size is relatively small, because of expensive isotope measurements of total energy expenditure for the original study. For children at the age of 8 months all components of energy utilization were included. This is not the case for the sample at the age of 4.5 years. The study is unique because all components of energy utilization were included. The results on energy utilization breast-feeding pattern and socio-economic status in relation to obesity have been published previously (Haisma, 2004).

This thesis focuses on the relation between socio-economic status, weight status and food intake of children aged 4.5 years. It can be related to the study of Romulus-Nieuwelink and colleagues (2011) studied breast milk and complementary food intake of infants aged eight months using this dataset.

3.1.3 Data quality

The data is collected as a part of a PhD project. Pelotas was chosen as the research location because: "Social inequity in Brazil is among the highest in the world, making it a suitable site to study the effect of SES […] (Haisma, 2004, p.21)" The data set which is used is rich in detail. There are anthropometric variables such as weight and length of the child, but also more specific variables such as fat mass index and fat free mass index. The availability of these variables is one of the main advantages of this relatively small dataset. Next to that, food intake of a whole day, measured by qualified research assistants, is available. This includes all the food items actually consumed by a child. At the starting point of this research, the food items still had to be entered in SPSS in order to be able to perform an analysis. Data has been entered twice, to reduce data-entry errors.

The advantages are at the same time also the disadvantages. Due to the fact that collecting anthropometric data such as the fat free mass index and the fat mass index and food intake data is time consuming and leads to higher costs, not that many cases are included. Studies which specifically focus food intake often include more cases. However, these studies often work with data reported by the subjects self and, are more sensitive to a bias. Because the data of this study is collected by research assistants, the quality of the collected data is higher, but a certain degree of bias has to be taken into account. One might say this is in a way inherent to nutrition data. Data is collected on a working day, but the children can still be fed differently than normal, for example because their mothers want to present themselves more positively. This is something which has to be taken into account in the analysis and a reason why using a (linear) regression is not appropriate for individual food items.

The sample size of 64 children is reduced to a sample size of 57 children for research question three, because this research question required a longitudinal dataset. For 57 children data on food intake was available at both 8 months and 4.5 years of age. The sample size was not reduced for the other three research question, an alternative decision could have been to use the dataset of 57 cases for all research questions, but this would have further reduced the statistical power of the analysis and this is why the decision was made not to do this. In research question three, no statistical analysis has been performed, so power issues were not directly relevant. A dataset with more cases would have provided

more (statistical) opportunities. However, we had to work with this dataset, so certain caution is needed in performing and interpreting the results.
An other reason for caution in interpretation is the fact that the last data collection occurred in 2005. At the time of this analysis this data is 6 years old. Brazil is a country in transition and may have by now undergone major changes which also affect life in Pelotas.

3.1.4 Ethical considerations

The dataset used for this analysis consists of secondary data collected for an earlier research. The data is collected by informed consent. The analysis will be conducted in such way it is not possible to identify individuals from the results. Because this research was an analysis of secondary data, no ethical approval was needed from the university. However, ethical considerations are still relevant. In conducting the research we will try to display both positive and negative results as objective as possible. When encountering bias or unclear results, these will be discussed. It is still important to keep in mind the background of the researcher and the background of the data. In this case it is possible to speak of two different 'worlds' where I as the researcher have been living all my life in a developed country such as the Netherlands. The data, however, is collected in a country in transition, with great social and economic disparities. I cannot switch of my background, but I can be conscious of it and take this into account when interpreting results. Another consideration which has to be taken into in account that one cannot draw conclusions about the population as a whole, or about the present situation. The data is from the 1993 birth cohort, and given the fact that Brazil is a country undergoing many transitions, the situation might have changed since the moment of data collection. Brazil is also a country with regional differences, so the situation in the northern part of the country might be different from the situation in the southern part.

3.2 Conceptualization

In this paragraph the concepts mentioned in the conceptual model will be defined, starting with the nutrition transition, followed by the determinants of weight status and food intake. In the next paragraph, these concepts will be operationalized.

The conceptual model consists of two parts. The framework of the nutrition transition provides the context on the macro level. On the micro level the determinants of weight status and food intake can be found. These determinants are influenced by the context. Two phases in the nutrition transition are highlighted, the third phase of receding famine and the fourth phase of NRNC-disease. The food intake of the children will be related to one of these two phases.

The nutrition transition is in this research used as a theoretical background. First the way the nutrition transition is conceptualized in this research will be discussed. The nutrition transition is a shift from a pattern with a diet high in carbohydrates and fibre and low in fat, towards a pattern with a diet high in total fat, cholesterol, sugar and other refined carbohydrates, and low in polyunsaturated fatty acids and fibre, often accompanied by an increasingly sedentary life. This pattern is characteristic of most high-income societies and of increasing portions of the population in low-income societies. (Popkin et al., 2002) Popkin has defined five phases or patterns in this transition, which will be conceptualized below. Relevant for this research are the third and fourth phase.

1. The first pattern characterizes hunter-gatherer populations, collecting food and having a diet high in carbohydrates and fibre and low in (saturated) fat.
2. The second pattern defined as a phase of famine includes a diet that becomes less varied and comes with periods of acute scarcity of food.
3. The third pattern is characterized by receding famine, famine and chronic hunger will still be present, but are reduced significantly.
4. The fourth pattern is that of nutrition-related non communicable disease (NRCD). In this phase the diet is high in total fat, cholesterol, sugar and other refined carbohydrates and low in

polyunsaturated fatty acids and fibre. Together with this diet an increasing sedentary lifestyle can be observed.

5. The fifth pattern is that of behavioural change, which is a new pattern emerging as a result of changes in diet and associated with the desire to prevent or delay degenerative diseases and prolong health.

The two concepts indicating outcome variables are weight status and food intake. The determinants of weight status and food intake are concepts indicating independent variables. In using analysis of covariance a distinction will be made between confounders and mediators. This will be discussed in more detail in the last paragraph of this chapter. The unit of analysis is the child.

Outcome variables
The outcome variable *weight status* can be defined as concept defining whether an individual is underweight, has a normal weight or is overweight or obese. Being overweight or obese is defined by the WHO as abnormal or excessive fat accumulation that may impair health. Cole et al. (2007) conclude that underweight does not have the same meaning in adults and children. In adults, underweight or thinness indicates a low BMI. At the same time, in children underweight is low weight for age and wasting is low weight for height.

The second outcome variable is *food intake* which includes nutrition of an individual in a given time unit.

Independent variables
The independent variables are in the conceptual model indicated as determinants of respectively weight status and food intake.

Demographic determinants *sex* and *ethnicity* are unchangeable characteristics of an individual. These determinants can be used to classify an individual in a given group and he or she cannot change this classification. In this way this concept differs from that from for example socio-economic status. The demographic determinants are displayed in a separate box in the conceptual model, because they cannot change under influence of the context, which is in this case the nutrition transition.

Socio-economic status of a household is assessed by the concepts *education (of the mother)* and *household income*. Dutton and Levine (1989 in: Adler at al., 1994) describe socio-economic status as incorporating both economic status, measured by income, social status, measured by education and work status, measured by occupation (Dutton and Levine, 1989 in: Adler et al., 1994).

Environmental determinants are assessed by using the variables mother working out of the house, persons living in the household and availability of a car. Egger and Swinburn (1997) categorize environmental influences in relation to obesity into macro (of the wider population) and micro (closer proximity to the individual). They state that "In general, the macro-environment determines the prevalence of obesity in a population and the micro-environment, along with biological and behavioural influences, determines whether an individual is obese. (Egger and Swinburn, 1997, pp. 479)" In this research which focuses on weight status and food intake, environmental influences on micro-level are relevant.

The last determinant is the *child* itself. The child has a number of characteristics, which influence the weight status and food intake. Characteristics which have been included in this analysis are birth weight, food intake (analysed at the level of total energy intake and food items) and child behaviour (whether a child practice sports, goes to school, plays videogames at home and watches television). Birth weight is not taken into account in the analysis of food intake.

3.3 Operationalization

In this section the concepts defined in the previous chapter will be operationalized. All variables used in this thesis will be discussed in this paragraph. First the third and fourth stage of the nutrition transition will be operationalized, followed by the outcome variables and finishing with the independent variables.

Third and fourth stage of the nutrition transition

Because the third and fourth stage of the *nutrition transition* will be used in relation to food intake of the Brazilian children, these two stages will be operationalized in terms of food items fitting in one of these two patterns. This operationalization is based on Popkin (2003, 2006).

- Third stage – this stage of receding famine is characterized by a dietary pattern with plant based foods, low variety, low fat and high in starches. Food products considered as characteristic for this pattern are beans and rice.
- Fourth stage – this stage of NRNC-disease is characterized by a diet with more fat (especially from animal products), sugar, processed foods and consisting of less fiber. Food products considered as characteristic for this pattern are: animal-source food such as eggs, meat and milk products/dairy; processed foods; but also caloric sweeteners such as sugar, fruit juices and soft drinks.

Outcome variables
Weight status is assessed through the variables body mass index, fat mass index and fat free mass index:

- Body mass index (BMI) – an index of weight-for-height, this index is defined as the weight in kilograms divided by the square of the height in meters (kg/m^2).
- Fat mass index (FMI) – an index of fat mass-for-height, this index is defined as the fat mass in kilograms divided by the square of height in meters (kg/m^2).
- Fat free mass index (FFMI) – an index of lean body mass-for-height, this index is defined as the lean body mass in kilograms divided by the square of height in meters (kg/m^2).

These measurements of weight status/body composition will be used to determine the prevalence of underweight, normal weight, overweight and obesity in the study population based on the cut-points defined by Cole et al. (2000, 2007). Because the study population consists of children, the cut-points for weight status differ from that of adults. In table 3.2 the cut-points for thinness, overweight and obesity are displayed. The cut-points are based on the BMI values for respectively underweight, overweight and obesity at 18 years.

Table 3.2 Cut-points for underweight, overweight and obesity

BMI at 18 years	Boys	Girls
16 kg/m^2 (Thinness grade III)	12.76	12.61
17 kg/m^2 (Thinness grade II)	13.41	13.21
18 kg/m^2 (Thinness grade I)	14.31	14.06
25 kg/m^2 (Overweight)	17.47	17.19
30 kg/m^2 (Obese)	19.26	19.12

Source: Cole et al. (2000, 2007)

Food intake is the second concept used to define outcome variables. This concept is assessed at different levels: total energy intake, the numbers of meals consumed and the consumption of separate food items. A comparison with WHO recommendations will be made; this will be done for total energy intake and macronutrient intake.

- Total energy intake – the energy consumed by a child in a given time unit. In the case of this research, the time unit is a day. The energy intake will be expressed in kilo calories (kcal). This unit of energy has been chosen because of convenience, data was available at the kilocalorie level at both 8 months and 4.5 years of age. An alternative unit of energy intake, which is used more and more in Europa, is energy expressed in kilojoules.

- Number of meals – the total number of eating or drinking moments measured in one day. Consuming water is not considered as an eating moment, other drinks are. Eating and drinking moments are classified in seven periods per day, where every period can contain more than one eating or drinking moment. The following periods are identified: breakfast; during the morning; lunch; during the afternoon; diner; before going to sleep and during the night.
- Consumption of food items - food items are identified using the questionnaire filled in during the day the food intake of the children was measured. Some food items are combined into one group. In table 3.3 the food product(group)s as used in this research are displayed. Each food product or food product group is initially provided on three measurement levels: the intake in grams; the intake in kilocalories and the intake as percentage of total energy intake. This last measurement level will be used in the analysis. This has been done because this makes it possible to look at the relative importance of different food items and it prevents being biased by the differences in the total consumption between the children.
- Macronutrient intake – will be divided into three levels: intake of carbohydrate, fat and protein. This will be measured as the percentage of energy from carbohydrate/fat and protein. One exception will be made to this level of measurement, in the last research question, the protein consumption will be assessed in grams, because this matches most recent WHO recommendations. This will be discussed in more detail in the next paragraph.

Table 3.3: Food product(group)s

Food product (group)	Products included	Food product (group)	Products included
Rice	White rice cooked; white rice uncooked	Soft drinks	Milk shake; coca cola; fanta; guarana (Brazilian soft drink)
Pasta	Home made pasta; pasta (egg based); cooked pasta; pasta (not egg based)	(Fruit) juice	Home made fruit drink; industrial fruit drink; fruit juice (industrial).
Bread	White bread; corn bread; corn bread homemade; wheat bread; bread pole	Beef	Fat beef; lean beef
Potato	Sweet potato; cooked sweet potato; English potato	Chicken	Fat chicken; lean chicken; chicken skin raw
Fried potato	Fried potato	Pork	Bacon; pork skin raw; pork skin fried; fat pork; lean pork; ham
Sugar	Moscovado (brown) sugar; refined (white) sugar	Other meat	Liver; sausage; intestines; pate; turkey lean; turkey fat
Cookies	Sweet cookies; savoury cookies	Meat	All meat combined
Other sweets	Diverse sweets; honey; homemade ice cream; industrial ice cream; sweets based on milk; sweets based on eggs	Eggs	Egg; egg-white; egg-yolk; fried egg
		Milk	Cows milk (not pasteurized); cows milk (pasteurized)
Beans	Black beans cooked; black beans uncooked	Yoghurt	Yoghurt
Beans juice	Juice of black beans	Cheese	Young white cheese (industrial); yellow cheese; cheese spread
Leaf vegetables	Lettuce; spring union; broccoli; cauliflower; spinach; cabbage; parsley	Dairy	Milk; yoghurt and cheese combined
Fruit vegetables	Pumpkin; cucumber; (split)peas; pickle; pepper; tomato; tomato paste;	Margarine/oil	Pork lard (industrial); unsalted butter; salted butter; margarine

	tomato juice; green beans		(vegetable); vegetable oil
Bulb vegetables	Garlic; beetroot; union; carrot; anise	Chocolate	Chocolate bar; chocolate powder; nescau.
Vegetables	All vegetables combined.	Prepared meals	Fried rice balls; pizza; pancake; savoury pastry; mashed potatoes; rice with beans; porridge made from milk; salted popcorn
Fruit	Avocado; pineapple; plum; banana; plantain; fig; orange; lemon; apple; papaya; mango; passion fruit; yellow passion fruit; honeydew melon; watermelon; strawberry; nectarine; pear; Brazilian cherry; grape	Sauces	Ketchup; mayonnaise

Independent variables
Demographic determinants are the first concepts in the hierarchical list of determinants influencing weight status and food intake. Two independent variables will be used to asses these demographic determinants:

- Sex is a dichotomous variable indicating a child is a boy or a girl.
- Ethnicity is a variable with two possible outcomes: being white and being non-white.

Socio-economic status of the household is the second concept. The children in the dataset were already classified in a high and a low socio-economic group.

- Socio-economic status (SES) is used as a classification variable. This variable has two groups based on maternal education. Other classification methods can be used, but maternal education proved to have a protective effect on the prevalence of obesity in Brazilian adults (Haisma, 2004). Children are classified as low SES when the mother has received up to three years education. High SES has been classified as having a mother which has received eight or more years education.
- Household income is related to socio-economic status and will be used in the analysis as an independent variable. The household income is assessed through asking who worked the last month and how much each person earned per month. The sum of these earnings plus other income is the household income, which is expressed in dollars.

Environmental determinants are defined as a number of variables.

- Mother working out of the house is a dichotomous variable indicating whether the mother works out of the house or does not work out of the house.
- Persons living in the household are the numbers of persons living in the house. This is assessed by asking the mother how many people live in the house. This has been coded into a continuous variable.
- Availability of a car is a dichotomous variable indicating whether the mother/family has a car or not.

The influence of *child* related characteristics will be done by using the following variables:

- Birth weight is a continuous variable which indicates the birth weight of a child as recorded on his or her birth certificate.
- Food intake is divided in a number of variables. Food intake is both outcome and independent variable. The definition of food intake as an independent variable is the same as the definition as an outcome variable. For the complete operationalization of this concept, see the outcome variable food intake.
- Availability of a television is a dichotomous variable indicating whether or not the child watches television.
- Availability of videogames is a dichotomous variable indication whether or not the child plays videogames at home.
- Child plays on the street / sports is a continuous variable indicating how many times a week a child plays on the street or sports.
- Child going to day care/school is a dichotomous variable indicating whether or not a child visits school or day care.

3.4 Methodology

In this paragraph the methodology applied in this thesis will be outlined. In each sub paragraph the methodology of a research question will be discussed. Two computer programs have been used in the analysis, Microsoft Excel and SPSS statistics 17.0 and intake of food products has been entered in Excel using the processed forms from the 24 hour observations. Data entry has been checked twice. Using food composition tables from the Brazilian Institute of Geography and Statistics (IBGE, 1981) the food products are decomposed into different components. For each food item the following characteristics are available: the number of kcal, amount (g), protein (g), fat (g), carbohydrates (g), fibres (g), dietary ash (g), calcium (mg), phosphorus (mg), iron (mg), retinol (mmg), vitamin B1 (mg), vitamin B2 (mg), niciana (mg), vitamin C (mg) and a part which is not digestible (%).

Macronutrient consumption is not only measured in grams, but the consumption of carbohydrate, protein and fat is also converted from grams to kcal. These macronutrients are converted using the Atwater general factor system. This system is based on the heats of combustion of protein, fat and carbohydrate, which are corrected for losses in digestion, absorption and urinary excretion of urea. In this section attention will also be paid to macronutrient level. The data file with consumption per child also provides the carbohydrate, protein and fat intake in grams. This intake was converted to grams by using Atwater conversion factor of respectively 4/4/9 kcal per gram for carbohydrate, protein and fat (FAO, 2003). The calculation of the total energy intake of the food items comes up with a slightly different outcome, due to a different conversion method. This does not cause great problems, because both methods are applied consistently and do not influence analysis of each other.

Low SES has been used as the reference category in the analysis of covariance procedures. This is a rather arbitrary choice, but the low SES group has been chosen based on the fact it is the largest group (n=34) compared to high SES (n=30).

Results of statistical analysis using SPSS are considered significant when the p-value is less than 5%. If other significance levels are used, this will be indicated. A last general comment on the used methods involves Levene's test for equality of variance. When SPSS comes up with a p-value of less than 5% for this test, equality of variance was not assumed and the outcome of the test not assuming equal variances will be used.

3.4.1 Research question one – Difference in weight status and food intake

First descriptive statistics of weight status expressed as being underweight, overweight or obese will be provided by using SPSS. Second step is determining the shape of the distribution of the outcome variables. When the distribution is (approximately) normally distributed a t-test will be used. When this is not the case, but the shapes of the distributions are the same in the two study groups, the Mann-Whitney test, a non-parametric alternative will be used.

Bar charts of macronutrient intake at 4.5 years by SES (n=64) and at 8 months and 4.5 years (n=57) will be made in Excel. Another bar chart will be made for the consumption of food products of high and low SES children. Consumption will be displayed as percentage of total energy intake.

Food intake measured as total energy intake, macronutrient intake and consumption of food products will be compared for the two SES groups. An independent sample t-test or Mann-Whitney test will be used depending on the shape of the distribution of the variable. Food products which will have a mean intake of more than 1% of total energy intake in at least one study group and a significant difference between high and low SES ($p<0.05$) will be analysed in research question two.

Research question discuss both weight status and food intake. First weight status will be discussed followed by food intake sections. Weight status of high and low SES children will be compared with BMI, FMI and FFMI as outcome variables. FMI is preferred as an outcome variable, because this index gives us more insight in the prevalence of health related dangers of overweight. However, because all three variables are present all will be tested. When outcome for both BMI and FMI proves to be significant, FMI will be used in the rest of the analysis.

Next food intake of high and low SES children will be compared. To assess food intake, the consumption of the following food products will be tested : rice; pasta; bread; potato; fried potato; sugar; cookies; other sweets; beans; beans juice; leaf vegetables; fruit vegetables; bulb vegetables; vegetables overall; fruit; (fruit)juice; beef; chicken; pork; other meat; meat overall; eggs; milk; yoghurt; cheese; dairy; margarine/oil; chocolate; prepared meals; sauces and soft drinks. In table 3.3 the food items included in each of these variables are described. The food intake of high and low SES children will, if possible, be related to the nutrition transition. Further interpretation will be reviewed in the discussion of chapter five.

3.4.2 Research question two – Factors explaining weight status and food intake

In the second research question the differences in weight status and consumption found in research question 1 will be examined. The analytical method used is explanatory. Different variables will be assessed in order to define variables related to the differences between high and low SES.

Analysis of covariance will used to analyse the differences. Analysis of covariance (ANCOVA) is a technique that sits between analysis of variance and regression analysis. ANCOVA is chosen as a method because this research focuses on the difference between high and low SES children. This method makes it possible to assess possible explanatory factors of this difference. A distinction can be made between variables marked as confounders and variables marked as mediators. To determine whether an independent variable is a confounder or a mediator, the conceptual model discussed in chapter 2 will be used. In this subparagraph the way ANCOVA will be used in this research will be outlined. (1) The conceptual model (figure 2.1 and 2.2) will be used to decide which variables are considered as potential confounders and mediators. Determinants that are placed higher than SES will be considered as potential confounders, determinants placed lower than SES are considered as potential mediators. This approach is based on the approach used by Haisma (2004). For this thesis, sex and ethnicity are considered as potential confounders. (2) Second a correlation procedure will be used to define whether the potential confounders can be considered as actual confounders. When a correlation with a p-value of less than 10% is found, the variable will be used in the analysis as a confounding factor. Correlations will be performed for the outcome variable with sex/ethnicity and for SES with sex/ethnicity. (3) When confounding factors are found, they will always be included as a covariate in the analysis. (4) To define which variables are potential mediators a correlation procedure will be used for the outcome variable with potential mediators and SES with the potential mediator. (Correlation of SES with food products has already been done in research question one). These two variables will be adjusted for ethnicity. The next step will be looking for potential mediators. Variables tested for correlations are: total energy intake (only for BMI and FMI); total number of meals, whether the child has breakfast or not; the number of minutes a child sleeps; whether a child goes to day care/school or not; the number of times a child plays outside the house or performs some kind of sport; whether the mother works out of the house or not, whether the family has a car or not; the birth weight of the child; number of people living in the house; playing videogames yes or no; having a television yes or no; the consumption of: sugar, meat, beans, rice, bread, cookies, fruit vegetables, yoghurt, cheese, dairy, margarine/oil and soft drinks. All these food products are measured as percentage of the total energy intake per day. The food products are selected based on the results of the Mann-Whitney test in the first research question. The variables used are all measured on a binary or ratio scale; otherwise it was not possible to include them in this type of analysis.
(5) The next step is to use the Generalized Linear Models (univariate) procedure in SPSS. SES will be used as a fixed factor and confounders, if found, will be included as covariate. Every potential mediator will be entered separate as a covariate. (6) A factor is considered as a definite mediator if its inclusion leads to a change of 10% or more in the crude difference of the outcome variable between high and low SES. (7) A table will be made displaying the results of the ANCOVA procedure. All mediators will be displayed.

This approach will be used for both weight status and food intake.

3.4.3 Research question three – Tracking of consumption

The third research question examines whether consumption of children tracks over time. The consumption of the children from which data is available is measured twice, at 8 months and 4.5 years of age. For 57 children data is available at these two moments. Total energy intake (kcal/day), sugar, carbohydrate, fat and protein intake will be reviewed. Sugar, carbohydrate, fat and protein were all measured as percentages of total energy intake. These variables are chosen because they are available at both ages and provide sensible outcomes. At eight months most children consume very little solids, a reason why food products are hard to assess. Sugar is one of the few products consumed both at 8 months and 4.5 years. Another reason for using sugar is the differences in sugar consumption between high and low SES. At 8 months and at 4.5 years the consumption at macronutrient level is available. We have to be careful with using this level, because measurements are only done once, but macronutrient level can still be insightful.

This research question has a descriptive character. For each variable a new variable with three values (1, 2 and 3) will be calculated. Each value will represent a group. These groups will have the same size and will reflect the tertile with the highest consumption (3), the tertile with mediate consumption (2) and the tertile with lowest consumption (1). This will be done for both ages. The next step will be calculating another variable, which will be named the tracking variable. This variable will be calculating by subtracting the group number of the child at eight months from the group number of the child at 4.5 years. The outcome will be labelled, where a child tracks when the outcome is 0, a child moves down when he or she has a value -2 or -1 for the tracking variable and a value of 1 or 2 will indicate moving up. The decision the use three groups have been made because the dataset is relatively small and when using four groups, these groups became very small, especially because we also looked at the two SES groups, sex and ethnicity. We asses tracking at the complete sample (n=57) for boys and girls separate, for ethnicity and for SES. Tracing, moving up and moving down is expressed in percentages of the group assessed and displayed in a table.

3.4.4 Research question four: Assessment of WHO recommendations

In the fourth and last research question the consumption of the children will be compared with recommendations concerning total energy and macronutrient intake of the WHO and FAO. Specific recommendations for Brazilian children are not available; this is why we use the WHO/FAO recommendations. The WHO/FAO recommendations for children were not all available at the same level. Recommendations formulated in recommended intake in grams per kilogram bodyweight should be ideal, but these kinds of recommendations are only available for total energy intake and protein intake.

For total energy intake the WHO (2001) recommendations for energy intake are used. The recommended intake in kcal per kg bodyweight per day is different for boys and girls. The recommended intake for each child is calculated and the null-hypothesis is formulated as: no differences between recommended and actual energy intake. This has been done for the complete sample en for high and low SES. A table will provide an overview of the mean intake and the p-value of the paired sample t-test.

Carbohydrate intake is compared to FAO/WHO (1998) recommendations for children. The carbohydrate intake is measured as a percentage of total energy intake. The actual carbohydrate intake is tested by using a one-sample t-test. The test value is 55, which is the minimal percentage of total energy intake which should be formed by carbohydrates. This approach is different from that of total energy intake, because these recommendations provide a percentage of total energy intake instead of a recommended consumption in grams per kg bodyweight.

Fat intake is compared to FAO/WHO (1994) recommendations. The fat intake is measured as a percentage of total energy intake. There are two different recommendations, for an active and sedentary lifestyle. The intake of the children is tested by both the maximum intake recommended for an active and a sedentary lifestyle. A one-sample t-test is used with a test-value of respectively 35 and 30.

The approach used for protein intake differs from that of carbohydrate and fat intake and is comparable to the approach used to assess total energy intake. Recommendations for average and safe level intake are available for this age group in the WHO (2007) recommendations for protein intake. This recommendation is formulated as grams per kilogram bodyweight. These requirements are for sexes combined for children up to 10 years of age. For each child the protein intake per kilogram bodyweight is calculated and using a one-sample t-test compared to the recommended intake. The results of the analysis will be displayed in tables.

4. Results

4.1 Weight status and food intake compared by SES

The first research question focuses on the differences in weight status and food intake between children from high and low SES. First the weight status of high and low SES children will be compared. Next the food intake of the children will be compared.

4.1.1 Body mass index and fat mass index in high and low SES

Based on the cut points formulated by Cole et al (2000, 2007) for overweight and thinness of children the prevalence of overweight, underweight and normal weight is defined for this sample of children. Results can be observed in table 4.1.

Table 4.1 Descriptive statistics weight status

Weight status	Complete sample (n=64) Frequency %	Boys (n=28) Frequency %	Girls (n=36) Frequency %	High SES (n=30) Frequency %	Low SES (n=34) Frequency %
Thinness grade 3	1.6	3.6	0	0	2.9
Thinness grade 2	1.6	3.6	0	3.3	0
Thinness grade 1	9.4	17.9	2.8	6.7	11.8
Normal weight	81.3	71.4	88.9	80.0	82.4
Overweight	4.7	3.6	5.6	6.7	2.9
Obese	1.6	0	2.8	3.3	0

Source: Cut-of points based on Cole et al. (2000, 2007)

The sample of 64 children can be divided in two subgroups based on SES. Weight status is measured by using body mass index (BMI), fat mass index (FMI) and fat free mass index (FFMI). The body composition of children of high and low SES has been compared by using these three anthropometric measurements. Independent sample t-tests have been used to determine whether an actual difference between the two SES groups can be assumed. The results of these tests can be observed in table 4.1

Table 4.2 Results independent sample t-test BMI, FMI and FFMI by SES group

Variable	High SES (N=30) (±SD)	Low SES (N=34) (±SD)	P-value
BMI (kg/m^2)	15.87 (1.43)	15.2 (1.10)	0.031
FMI (kg/m^2)	3.68 (1.20)	2.8 (1.05)	0.005
FFMI (kg/m^2)	12.24 (1.16)	12.3 (1.14)	0.774

In the next chapter attention will be paid to factors contributing to the difference in FMI and BMI between high and low SES children.

4.1.2 Food intake of high and low SES

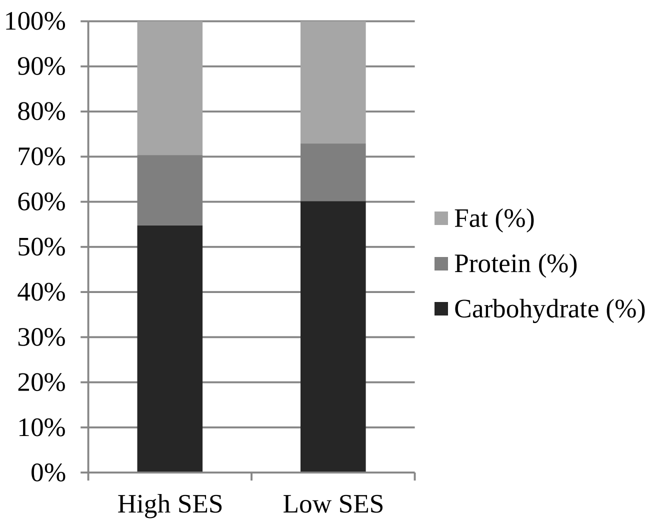
The intake of food products might provide more insight in consumption patterns and differences between high and low SES groups. In this section the food intake of high and low SES children will be compared. Later in this research attention will be paid to potential explanatory factors. Food products and food product groups included in the analysis are based on the available data and the nutrition transition of Popkin (2002a).

First the total number of meals which were consumed in a day is compared for high and low SES children. High SES children consumed a mean of 5.8 meals per day (±SD 2.0) and low SES children consumed a mean of 4.8 meals per day (±SD 1.0). The total number of meals consumed by the two SES groups was significantly different (p=0.011).

Second total energy intake in kilo calorie (kcal) and macronutrient intake (% of total energy intake) a day of the children has been compared between high and low SES. Results are displayed in table 4.3. In relation to the nutrition transition fat intake is relevant. The fourth stage of the nutrition transition indicates a higher fat intake than the third stage of the transition. Mean fat intake is higher in high SES compared to low, but this difference is not significant. Energy from macronutrient sources will also be displayed in figure 4.1, which provides an overview of the macronutrient consumption of high and low SES children, and figure 4.2.having a longitudinal scope, looking at the energy from macronutrient intake at 8 months and 4.5 years of age.

Table 4.3 Results independent sample t-test total energy and macronutrient intake by SES

Variable	High SES (±SD)	Low SES (±SD)	P-value
Total energy intake (kcal)	1385.4 (501.8)	1058.4 (474.2)	0.001
Carbohydrate (% of total energy intake)	53.7 (15.3)	60.1 (11.1)	0.107
Protein (% of total energy intake)	15.6 (5.8)	12.8 (3.9)	0.022
Fat (% of total energy intake)	29.6 (11.0)	27.1 (8.3)	0.299



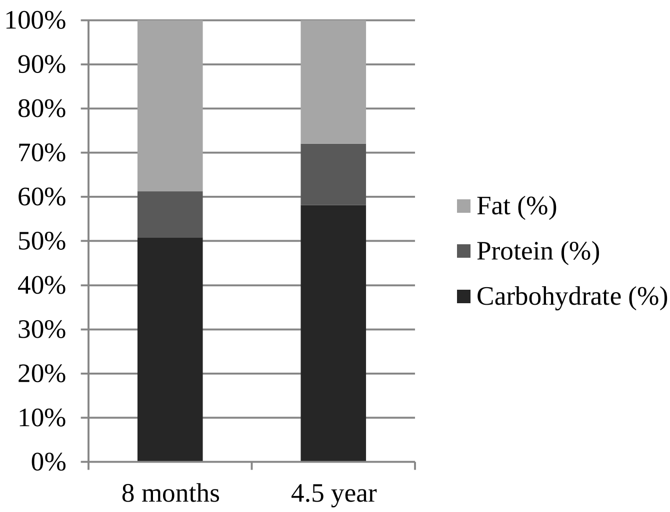


Figure 4.1 Energy from macronutrient intake at 4.5 years of age by high (N=30) and low SES (N=34)

Figure 4.2 Energy from macronutrient intake at 8 months (n=57) and 4.5 years (n=57)

The differences in energy from macronutrient intake at both ages were also tested by using a paired sample t-test (n=57). Results are displayed in table 4.4.

Table 4.4 Results paired sample t-test macronutrient intake at 8 mo and 4.5 years (n=57)

Variable	8 months (±SD)	4.5 years (±SD)	P-value
Carbohydrate (% of total energy intake)	51.72 (6.38)	58.16 (13.37)	0.002
Protein (% of total energy intake)	10.69 (3.35)	13.94 (5.02)	0.000
Fat (% of total energy intake)	39.53 (8.89)	27.90 (9.84)	0.000

The last level at which the consumption of the children has been evaluated is food product level. Products and product groups characteristic for the Brazilian eating culture and the third and fourth phase of the nutrition transition have been included in the analysis. The products of main concern for the nutrition transition are: rice, beans, eggs, meat, milk products/dairy, caloric sweeteners such as sugar, fruit juice and soft drinks. Figure 4.3 provides an overview of meant intake of these food products by SES group. Mean intake of the products is expressed as percentage of total energy intake.

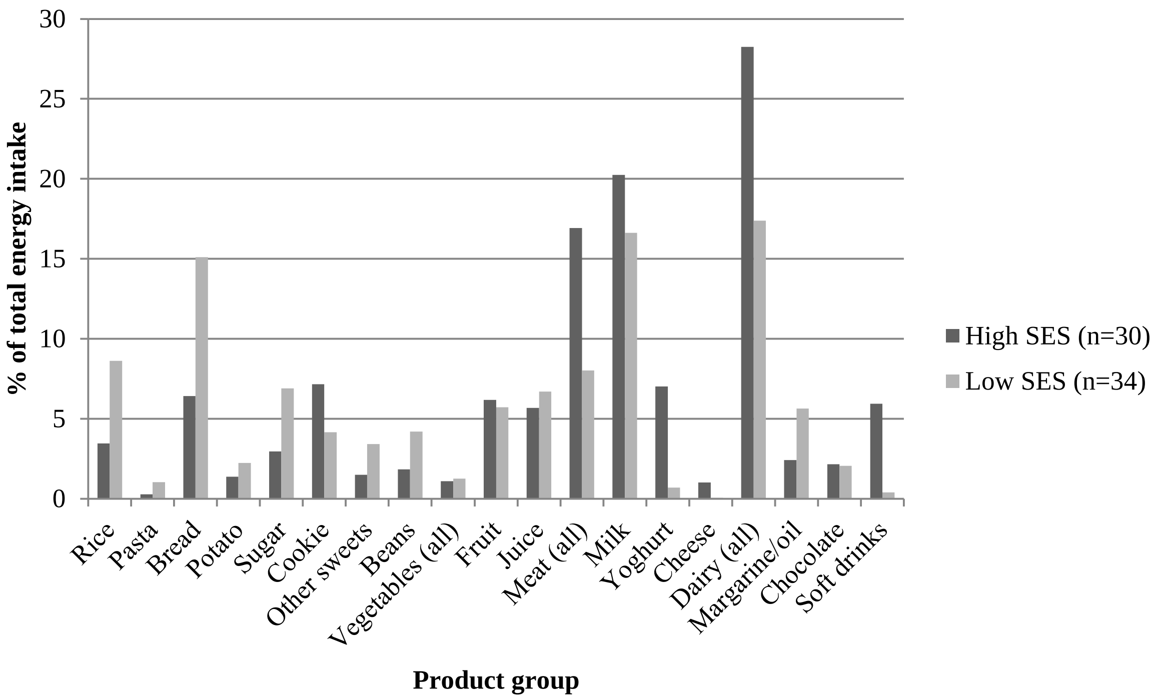


Figure 4.3 Consumption by SES group

None of the food products and food product groups where normally distributed but shape of the distribution was similar in high and low SES group. A Mann-Whitney test has been used to test whether differences in intake could be assumed. In table 4.5 the results of this analysis are displayed.

Table 4.5 Results Mann-Whitney test for food product(group)s (significant results are in *italic*)

Product(group)	% of total energy intake (mean)		p-value Mann-Whitney test (5% significance level)
	High SES (n=30) (SD)	Low SES (n=34)(SD)	
Rice	3.45 (4.70)	8.62 (11.21)	*0.01*
Pasta	0.28 (0.82)	1.03 (2.10)	*0.046*
Bread	6.41 (8.62)	15.10 (11.82)	*0.005*
Potato	1.37 (3.30)	2.24 (4.20)	0.229
Fried potato	0.64 (2.85)	1.20 (2.30)	0.926
Sugar	2.96 (4.54)	6.90 (6.32)	*0.007*
Cookie	7.16 (9.25)	4.15 (11.34)	*0.013*
Other sweets	1.50 (3.83)	3.42 (9.13)	1.000
Beans	1.83 (3.10)	4.21 (5.44)	*0.019*
Beans juice	0.21 (0.89)	0.00 (0.00)	0.061
Leaf vegetables	0.02 (0.04)	0.10 (0.45)	0.774
Fruit vegetables	0.82 (1.20)	0.21 (0.40)	*0.010*
Bulb vegetables	0.26 (0.33)	0.94 (2.42)	0.440
Vegetables (all)	1.10 (1.39)	1.25 (2.49)	0.647
Fruit	6.17 (8.49)	5.72 (8.66)	0.417
Juice	5.67 (7.35)	6.70 (9.50)	0.989
Beef	7.96 (14.59)	2.94 (4.38)	0.230
Chicken	3.01 (6.33)	2.38 (4.93)	0.908
Pork	2.34 (6.78)	1.30 (5.65)	0.360
Other meat	3.60 (8.68)	1.41 (2.77)	0.707
Meat (all)	16.92 (15.41)	8.02 (8.16)	*0.009*
Egg	0.81 (1.86)	1.16 (3.18)	0.534
Milk	20.24 (18.02)	16.63 (19.23)	0.289
Yoghurt	7.01 (8.34)	0.69 (2.26)	*0.000*
Cheese	1.01 (2.38)	0.06 (0.34)	*0.014*
Dairy (all)	28.26 (17.89)	17.38 (19.60)	*0.011*
Margarine/oil	2.41 (2.68)	5.64 (5.33)	*0.011*
Chocolate	2.15 (3.27)	2.05 (4.42)	0.197
Prepared meals	2.67 (4.43)	3.96 (10.64)	0.280
Sauce	0.18 (0.70)	0.02 (0.12)	0.847
Soft drinks	5.94 (15.62)	0.40 (1.84)	*0.001*

Rice and beans are food products related to the third stage of the nutrition transition. These two food products are consumed significantly more in the low SES group. Food products related to the fourth stage of the nutrition but which are consumed more in the low SES group are sugar, egg and fruit juice, but only sugar intake is significantly different from high SES children. Meat, dairy and soft drinks are the other food products related to the fourth stage of the nutrition transition. These products are all consumed significantly more by the high SES group.

Factors determining the weight and food intake of children will be discussed in the next research question.

4.2 Explanatory factors for differences in FMI and food intake between high and low SES

In this section analysis of covariance will be used to asses the difference in FMI of children from high and low SES background. The same method will be applied to look at factors that possibly explain the differences in consumption between children of these two groups.

4.2.1 Factors influencing FMI

In the previous section a difference in FMI between children from high and low SES was found. Children with high SES had a higher FMI compared to children with low SES. In this section, possible explanatory factors for this difference will be assessed. The results of the analysis for FMI are displayed in table 1. The same analysis has been performed for BMI but this resulted in fewer variables which were correlated with BMI, and the variables that were correlated were the same as for FMI. Therefore FMI has been used as the outcome variable for weight status. Ethnicity and sex were tested as confounders. Only ethnicity proved to be a confounder for ethnicity.

Variables with a correlation for FMI and SES with a p-value of less than 0.1 were included as potential mediating factors the analysis of covariance. In the chapter data and methods the variables used are listed. Variables with a p-value for correlation with SES of less than 0.1 were also used in the analysis of covariance for different food products.

Variables correlated with SES with a p-value of less than 0.1 were: total number of meals; going to day care or school; having a car; whether the mother works out of the house or not; family income; number of persons living in the household; total energy intake in kcal for one day; the consumption of: sugar; sugar, meat, beans, rice, bread, cookies, fruit vegetables, yoghurt, cheese, dairy, margarine/oil and soft drinks. All food products are measured as percentage of total energy intake. These variables were also used in testing for correlations with variables representing food intake as dependent variables. Not all variables correlated with SES were also correlated with FMI. Going to day care or school; having a car; persons living in the house; total energy intake; consumption of rice and yoghurt showed a correlation for FMI with a p-value < 0.10.

Analysis of covariance has been performed using the variables listed above. The analysis was adjusted for ethnicity, which was marked as a confounder for FMI. Variables causing a change of at least 10% in the difference between high and low SES are listed in table 4.6. After adjusting for ethnicity the difference between high and low SES is not longer significant at the 5% level. The column high SES – low SES represents the difference in FMI between the two SES groups. Low SES has been used as the reference category. All covariates cause a decline in the difference of FMI between high and low SES.

Table 4.6 Analysis of covariance for the association between FMI (adjusted for ethnicity) and SES

FMI				
Independent variable	High SES-Low SES (SE)	95% CI	P-value	R^2
SES	0.532 (0.315)	-0.098 – 1.162	0.096	0.172
SES	0.469 (0.000)	-0.177 – 1.115	0.152	0.184
Total energy intake	0.000 (0.323)	0.000 – 0.001	0.370	
SES	0.300 (0.339)	-0.378 – 0.978	0.379	0.211
Yoghurt	0.040 (0.023)	-0.007 – 0.086	0.094	
SES	0.414 (0.314)	-0.214 – 1.042	0.192	0.222
Persons living in household	-0.176 (0.090)	-0.355 – 0.003	0.054	
SES	0.336 (0.314)	-0.293 – 0.965	0.289	0.245
Has car	0.778 (0.325)	0.128 – 1.427	0.020	

4.2.2 Factors influencing food intake

The Mann-Whitney tests in the first research question resulted in various significant differences in food product intake between high and low SES. These results have been used the start for further research. Factors influencing food intake are assessed by using analysis of covariance. The same approach as for FMI has been used. First correlations with the outcome variable with the various outcome variables have been checked. Correlations with SES were already available from the analysis in section 4.2.1. For total energy intake potential mediating factors used are the same as for FMI and for the other variables the variables are the same except total energy intake. Covariates correlated with a p-value of less than 0.1 were included in the analysis of covariance. Table 4.7 provides an overview of variables included in the analysis of covariance as potential mediators. All the food products are measured in per cent of total energy intake of the child.

Table 4.7 Variables included in the analysis of covariance food intake

Dependent variable (outcome variable)	Potential mediators (covariates)	Adjusted for ethnicity? Yes/no
Total energy intake (kcal/day)	Total number of meals; mother working out of the house; child plays videogames (yes/no); consumption of: sugar, meat, rice, bread, cookies, margarine/oil.	Yes
Total number of meals (one day)	Mother working outside of the house; consumption of: bread, margarine/oil and soft drinks.	Yes
Rice	Having a car; consumption of: beans and dairy.	Yes
Pasta	Mother working outside of the house; consumption of: sugar and dairy	No
Bread	Total number of meals; going to day care/school; mother working outside of the house; family income; persons living in the house; consumption of: sugar, cookies; dairy and fat.	Yes
Sugar	Going to day care/school; consumption of: beans; bread; yoghurt and margarine/oil.	No
Cookies	Consumption of: bread and cheese	No
Beans	Consumption of: sugar, rice, dairy and margarine/oil.	Yes
Fruit vegetables	Consumption of: yoghurt	No
Yoghurt	Family income; consumption of sugar: fruit vegetables and fat	Yes
Cheese	Family income; consumption of cookies	No
Dairy	Having a car; family income; crowding; consumption of meat, beans, rice, bread and margarine/oil.	Yes
Margarine/oil	Total number of meals, going to day care/school, mother working out of the house; consumption of: beans, bread, yoghurt, dairy and sugar.	Yes
Soft drinks	Total number of meals	No
Meat	Going to day care/school; mother working out of the house; family income and consumption of dairy.	No.

In table 4.8 the results of the analysis of covariance for the association between food intake and SES are displayed. In this table yoghurt and cheese are not included. No different mediating factors came up from the analysis of these two variables compared to the category dairy.

Table 4.8 Analysis of covariance for the association between food intake (% of total energy intake) and SES

Dependent variable	Independent variable	High SES – Low SES (SE)	95% Confidence interval	P-value	R^2
Total energy intake (kcal/day) (adjusted for ethnicity)					
	SES	239.229 (138.521)	-37.761 – 516.219	0.089	0.129
	SES	206.411 (143.310)	-80.251 – 493.073	0.155	0.140
	Bread	-5.544 (6.082)	-17.709 – 6.622	0.366	
	SES	201.713 (140.182)	-78.693 – 482.119	0.155	0.155
	Total nr. of meals	55.785 (40.488)	-25.203 – 136.774	0.173	
	SES	197.530 (155.780)	-114.077 – 509.136	0.210	0.134
	Mother works out of house	84.474 (141.442)	-198.451 – 367.400	0.553	
	SES	195.332 (138.530)	-81.770 – 472.434	0.164	0.171
	Rice	-12.216 (6.983)	-26.183 – 1.752	0.085	
	SES	152.702 (143.518)	-134.376 – 439.781	0.292	0.176
	Sugar	-20.250 (10.868)	41.990 – 1.490	0.067	
	SES	146.710 (146.899)	-147.132 – 440.552	0.322	0.169
	Meat	8.593 (5.059)	-1.526 – 18.713	0.095	
Total nr. of meals (adjusted for ethnicity)					
	SES	0.673 (0.435)	-0.197 – 1.542	0.127	0.136
	SES	0.540 (0.48)	-0.356 – 1.436	0.233	0.156
	Bread	-0.022 (0.019)	-0.060 – 0.016	0.243	
	SES	0.451 (0.431)	-0.411 – 1.312	0.300	0.208
	Margarine/oil	-0.104 (0.045)	-0.193 – -0.015	0.023	
	SES	0.351 (0.482)	-0.613 – 1.314	0.469	0.167
	Mother working out of house	0.652 (0.437)	-0.223 – 1.526	0.142	
	SES	0.285 (0.358)	-0.432 – 1.001	0.430	0.443
	Soft drinks	0.084	0.055 – 0.113	0.000	
Rice (adjusted for ethnicity)					
	SES	-3.593 (2.498)	-8.589 – 1.402	0.155	0.107
	SES	-3.075 (2.513)	-8.101 – 1.952	0.226	0.133
	Dairy	-0.080 (0.060)	-0.200 – 0.040	0.188	
	SES	-3.029 (2.594)	-8.218 – 2.160	0.248	0.117
	Has Car	-2.239 (2.680)	-7.599 – 3.122	0.407	
	SES	-2.512 (2.407)	-7.325 – 2.302	0.301	0.207
	Beans	0.650 (0.237)	0.177 – 1.124	0.008	

Beans (adjusted for ethnicity)					
	SES	-1.663 (1.283)	-4.229 – 0.903	0.200	0.087
	SES	-1.438 (1.296)	-4.031 – 1.155	0.272	0.106
	Dairy	-0.035 (0.031)	-0.097 – 0.027	0.266	
	SES	-1.175 (1.354)	-3.883 – 1.532	0.389	0.106
	Sugar	0.114 (0.103)	-0.091 – 0.319	0.270	
	SES	-1.046 (1.240)	-3.527 – 1.434	0.402	0.189
	Rice	0.172 (0.063)	0.047 – 0.297	0.008	
	SES	-1.002 (1.270)	-3.541 – 1.538	0.433	0.165
	Margarine/oil	0.309 (0.132)	0.046 – 0.573	0.022	
Bread (adjusted for ethnicity)					
	SES	-5.920 (2.920)	-11.759 – -0.080	0.047	0.201
	SES	-5.318 (2.973)	-11.264 – 0.628	0.079	0.216
	Persons living in household	0.897 (0.850)	-0.802 – 2.597	0.295	
	SES	-5.207 (2.921)	-11.049 – 0.635	0.080	0.233
	Dairy	-0.110 (0.070)	-0.249 – 0.030	0.120	
	SES	-4.813 (2.950)	-10.713 – 1.087	0.108	0.238
	Margarine/oil	0.518 (0.306)	-0.093 – 1.129	0.095	
	SES	-4.202 (3.257)	-10.717 – 2.312	0.202	0.219
	Mother works out of the house	-3.479 (2.957)	-9.394 – 2.435	0.244	
	SES	-2.874 (3.324)	-9.523 – 3.774	0.391	0.243
	daycare/school	-6.053 (3.342)	-12.737 – 0.632	0.075	
Sugar					
	SES	-3.943 (1.392)	-6.726 – -1.160	0.006	0.115
	SES	-3.272 (1.721)	-6.713 – 0.169	0.062	0.121
	day care/school	-1.241 (1.853)	-4.945 – 2.464	0.506	
	SES	-2.940 (1.572)	-6.083 -0.204	0.066	0.140
	Yoghurt	-0.159 (0.118)	-0.395 – 0.077	0.184	
	SES	-2.640 (1.461)	-5.563 – 0.282	0.076	0.185
	Bread	0.150 (0.065)	0.019 – 0.281	0.025	
Cookies					
	SES	3.009 (2.608)	-2.205 – 8.223	0.253	0.021
	SES	3.449 (2.656)	-1.862 – 8.760	0.199	0.034
	Plays videogames	-1.186 (1.302)	-3.789 – 1.416	0.366	
	SES	1.262 (2.625)	-3.986 – 6.510	0.632	0.103
	Cheese	1.830 (0.777)	0.276 -3.383	0.022	
	SES	0.999 (2.775)	-4.551 – 6.549	0.720	0.074
	Bread	-0.232 (0.124)	-0.480 – 0.017	0.067	
Dairy (adjusted for ethnicity)					
	SES	6.488 (5.297)	-4.104 – 17.079	0.225	0.122

	SES	11.983 (5.423)	1.135 – 22.831	0.031	0.219
	Meat	-0.510 (0.187)	-0.884 – -0.137	0.008	
	SES	5.503 (5.358)	-5.214 – 16.221	0.309	0.140
	Beans	-0.592 (0.527)	-1.647 – 0.463	0.266	
	SES	5.195 (5.352)	-5.510 – 15.901	0.336	0.147
	Rice	-0.360 (0.270)	-0.899 – 0.180	0.188	
	SES	5.089 (5.488)	-5.889 – 16.068	0.357	0.136
	Has car	5.545 (5.670)	-5.797 – 16.888	0.332	
	SES	4.347 (5.307)	-6.469 – 15.163	0.425	0.157
	Bread	-0.362 (0.229)	-0.821 – 0.097	0.120	
	SES	3.973 (5.277)	-6.583 – 14.528	0.454	0.185
	Margarine/oil	-1.176 (0.547)	-2.270 – -0.083	0.035	
	SES	3.957 (5.823)	-7.691 – 15.605	0.499	0.137
	Family income	0.003 (0.003)	-0.003 – 0.010	0.301	
Margarine/oil (adjusted for ethnicity)					
	SES	-2.138 (1.205)	-4.548 – 0.273	0.081	0.174
	SES	-1.828 (1.334)	-4.496 – 0.840	0.176	0.179
	Family income	0.000 (0.001)	-0.002 – 0.001	0.580	
	SES	-1.742 (1.185)	-4.113 – 0.629	0.147	0.233
	Dairy	-0.061 (0.028)	-0.118 – -0.004	0.035	
	SES	-1.717 (1.273)	-4.264 - 0.831	0.183	0.188
	Sugar	0.098 (0.096)	-0.094 - 0.291	0.311	
	SES	-1.711 (1.405)	-4.521 – 1.099	0.228	0.179
	day care/school	-0.848 (1.412)	-4.673 – 1.977	0.551	
	SES	-1.695 (1.354)	-4.402 – 1.013	0.215	0.182
	Mother works out of house	-0.897 (1.229)	-3.356 – 1.561	0.468	
	SES	-1.684 (1.179)	-4.041 – 0.674	0.158	0.244
	Beans	0.273 (0.116)	0.041 – 0.505	0.022	
	SES	-1.615 (1.227)	-4.069 – 0.838	0.193	0.212
	Bread	0.088 (0.052)	-0.016 – 0.192	0.095	
	SES	-1.601 (1.187)	-3.975 – 0.772	0.182	0.243
	Total nr. of meals	-0.798 (0.343)	-1.483 – -0.112	0.023	
Meat					
	SES	8.900 (3.031)	2.840 – 14.960	0.005	0.122
	SES	11.365 (2.981)	5.404 – 17.325	0.000	0.231
	Dairy	-0.227 (0.077)	-0.381 – -0.072	0.005	
	SES	6.932 (3.485)	-0.037 – 13.902	0.051	0.140
	Mother works out of the house	3.983 (3.506)	-3.028 – 10.994	0.260	

	SES	6.472 (3.490)	-0.507 – 13.452	0.069	0.148
	Family income	0.003 (0.002)	-0.001 – 0.007	0.175	
	SES	5.590 (3.689)	-1.788 – 12.967	0.135	0.155
	day care/school	6.117 (3.972)	-1.826 – 14.059	0.129	
Soft drinks					
	SES	5.540 (2.697)	0.149 – 10.931	0.044	0.064
	SES	1.318 (2.296)	-3.273 – 5.910	0.568	0.399
	Total nr. of meals	4.181 (0.717)	2.747 – 5.615	0.000	

As can be observed from the results from table 4.8, none of the food products adjusted for ethnicity had a significant difference in intake between high and low SES. The consumption of bread is the only exception to this. The food products which were not corrected for ethnicity kept a significant difference, which could be expected, because only food products were used with a significant difference from the first research question. However in interpreting results of analysis of covariance, relative changes in the difference between high and low SES for the outcome variable are meaningful. In table 4.8 changes in the difference of more than 10% are displayed.

A negative coefficient for a mediator indicates that this mediator causes a decrease in the outcome variable. A positive coefficient indicates an increase in the outcome variable. This is not directly related to increase or decrease of the difference between high and low SES. For example: in total energy intake all mediators resulted in a smaller difference. The three food products with the largest change, meat, rice and sugar, are all products with very clear differences between the two SES groups. The other results can be read in the same way.

Almost all mediators caused a decrease in the difference. The only exception is the effect of the variables meat and dairy on each other. For the consumption of dairy, meat increases the difference between high and low SES with almost 85%. First the consumption of dairy (adjusted for ethnicity) did not differ between high and low SES. After meat was included in the analysis this difference becomes significant at the 5% level.

In the next section tracking patterns for food intake of children at 8 months and 4.5 years will be compared.

4.3 Does dietary behaviour track over time?

This section discusses the tracking of dietary behaviour over time. Dietary intake data is available at 8 months and 4.5 years of age. Total energy intake, sugar consumption and energy from macronutrient intake are compared at these two ages. These variables are split up into three groups based on position in the lowest third of the sample, the middle group or the highest group of the sample when looking to intake. The three groups are of the same size.

Tracking was defined as being in the same group at 4.5 years as at 8 months. A child moves up when it is in a higher consumption group at 4.5 years than at 8 months and a child moves down when it is in a lower consumption group at 4.5 years than it was at 8 months. In table 4.9 the total energy intake tracking patterns can be observed. Tracking patterns are assessed for the complete sample, boys and girls separate, white and non white children and high and low SES children. For the total sample, the group that tracked was a little smaller than the groups moving up or moving down. However, no great difference can be observed. This is not the case for sex. The percentage of boys tracking or moving down was larger than that of girls, who had the tendency to move up. The tracking pattern of white children can be compared with the tracking of high SES children, in both groups moving up is the most common action compared to tracking or moving down. In low SES and mixed or non-white children most children moved down or tracked.

Table 4.9 Total energy intake tracking patterns: percentage of children who remained in the same group, moved to a lower group, or moved to a higher group during 2000-2005.

	Tracked %	Moved down %	Moved up %
All (n=57)	31.6	33.3	35.1
Boys (n=26)	34.6	42.3	23.1
Girls (n=31)	29.0	25.8	45.2
White (n=38)	36.8	23.7	39.5
Mixed (n=19)	52.7	21.1	26.3
High SES (n=28)	25.0	28.6	46.5
Low SES (n=29)	37.9	37.9	24.1

Food intake of children at 8 months did include few solids. Sugar consumption is one of the few variables that could be meaningfully compared. In table 4.10 the total sugar intake tracking patterns are displayed. The three groups are based on the sugar intake in grams of the children at 8 months and 4.5 years of age. Tracking was the most common action for all of the categories except the non-white/mixed group. These children moved up when looking at the sugar consumption. Between high and low SES there is no clear difference in percentage of the children tracking. More high SES children moved down and more low SES children moved up. This corresponds with the higher sugar intake of low SES children compared to high SES children.

Table 4.10 Total sugar intake tracking patterns: percentage of children who remained in the same group, moved to a lower group, or moved to a higher group during 2000-2005.

	Tracked %	Moved down %	Moved up %
All (n=57)	38.6	29.8	31.6
Boys (n=26)	42.3	26.9	30.7
Girls (n=31)	35.5	32.3	32.3
White (n=38)	42.1	31.6	26.4
Mixed (n=19)	31.6	26.4	42.1
High SES (n=28)	39.3	32.1	28.5
Low SES (n=29)	37.9	27.5	34.4

The last research question of this thesis focuses on the question whether the total energy and macronutrient intake of the children at 4.5 years meat the WHO recommendations. In relation to this question, the tracking patterns of carbohydrate, fat and protein are provided in table 4.11, 4.12 and 4.13. The three groups are based on the percentage of the total energy intake per macronutrient.

With regard to the carbohydrate intake in the complete sample, moving down was the most common action. For the various subgroups, this is not always the case. Boys had a different pattern in which moving up and tracking was the most prevalent action. Children of mixed showed strong tendency in moving up, more than half of this subgroup moved to a higher group. The same pattern can be observed in low SES children. For fat intake, the complete sample shows a pattern of moving up in group. This pattern is not consistent, again a similar pattern can be observed for children of mixed colour and low SES. These children move to a lower tertile for fat intake when they grow older. High SES and white children act the other way around, here moving into a higher tertile for fat intake is the most common. Protein is the most consistent macronutrient when looking to tracking patterns. The complete sample just as all subgroups (except low SES) come up with tracking as the most prevalent outcome. The protein intake of low SES children moves down.

Table 4.11 Carbohydrate intake (percentage of total energy intake) tracking patterns: percentage of children who remained in the same group, moved to a lower group, or moved to a higher group during 2000-2005.

	Tracked %	Moved down %	Moved up %
All (n=57)	29.8	36.8	33.3
Boys (n=26)	34.6	30.7	34.6
Girls (n=31)	25.8	41.9	32.3
White (n=38)	34.2	42.1	23.7
Mixed (n=19)	21.1	26.3	52.7
High SES (n=28)	32.1	42.8	25.0
Low SES (n=29)	27.6	31.0	41.3

Table 4.12 Fat intake (percentage of total energy intake) tracking patterns: percentage of children who remained in the same group, moved to a lower group, or moved to a higher group during 2000-2005.

	Tracked %	Moved down %	Moved up %
All (n=57)	24.6	35.1	40.3
Boys (n=26)	34.6	38.5	26.9
Girls (n=31)	16.1	33.3	51.7
White (n=38)	23.7	26.3	50.0
Mixed (n=19)	26.3	52.6	21.0
High SES (n=28)	25.0	28.6	46.4
Low SES (n=29)	24.1	41.4	34.5

Table 4.13 Protein intake (percentage of total energy intake) tracking patterns: percentage of children who remained in the same group, moved to a lower group, or moved to a higher group during 2000-2005.

	Tracked %	Moved down %	Moved up %
All (n=57)	40.4	31.6	28.1
Boys (n=26)	38.5	30.8	30.7
Girls (n=31)	41.9	32.3	25.8
White (n=38)	39.5	28.9	31.6
Mixed (n=19)	42.1	36.9	21.1
High SES (n=28)	42.9	21.4	35.7
Low SES (n=29)	37.9	41.4	20.6

These results are descriptive and can provide a starting point for more explanatory research. More research is needed to explore the tracking patterns of total energy intake, different food products and macronutrients. The intake of micronutrients should be assessed as well. Further research should also focus on possible explanations for tracking patterns.

4.4 Comparison with WHO/FAO recommendations for macronutrient intake

In this research question the food intake of the Brazilian children at 4.5 years of age will be compared with WHO/FAO recommendations. Total energy intake and the intake of the macronutrients carbohydrate, fat and protein are included in the analysis.

The total energy intake recommendations (FAO, 2004) for children aged 4 years are different for boys and girls. The recommended intake for boys is 76.8 kcal kg/day and for girls 73.9 kcal kg/day. Recommended intake per child has been calculated and compared to actual intake using the paired sample t-test procedure. Results are displayed in table 4.14. This outcome confirms the first impression of research question one, where the total energy intake of low SES children differs significantly from high SES children.

Table 4.14: Results comparison total energy intake of children with recommended intake (kcal/day)

	Mean (±SD)	P-value
Complete sample (n=64) Energy intake	1211.64 (510.70)	0.067
Recommended intake	1329.76 (221.72)	
High SES (n=30) Energy intake	1385.42 (501.88)	0.963
Recommended intake	1389.98 (212.16)	
Low SES (n=34) Energy intake	1058.31 (474.23)	0.011
Recommended intake	1276.62 (219.29)	
Boys (n=28)	1152.93 (537.60)	0.058
Recommended intake	1343.18 (207.51)	
Girls (n=36)	1257.31 (491.54)	0.466
Recommended intake	1319.32 (234.55)	

Carbohydrate intake is compared to FAO/WHO (1998) recommendation for children to consume at least 55 % of total energy from carbohydrates. One sample t-test procedure has been used to test the hypotheses that the total energy intake from macronutrients was at least 55 % for this sample. Results of this analysis can be observed in table 4.15. The mean intake of the complete sample meets the FAO/WHO recommendations. This is also the case for both high and low SES.

Table 4.15 Comparison energy from carbohydrate with FAO/WHO recommendations

	Mean (±SD)	P-value
Total (n=64)	57.61 (13.37)	0.123
High SES (n=30)	54.74 (15.25)	0.927
Low SES (n=34)	60.14 (11.07)	0.011

Table 4.16 and 4.17 show the outcomes of a comparison of the fat intake of the children with the FAO/WHO (1994) recommendations. Recommendations for a sedentary and an active lifestyle are available. It was not possible to say whether the children had to be placed in the active or the sedentary category, so analysis has been performed for both lifestyles. Recommended is a fat intake of 15 to 30% for sedentary individuals and 15 to 35% for active individuals. This has been tested by using a one-sample t-test with test values of respectively 30 and 35. The test value represents maximum recommended intake, a higher fat intake is not recommended. The group of children under study meet do meet the recommendations; mean energy intake from fat is below 30%.

Table 4.16 Comparison energy from fat with FAO/WHO recommendations for a sedentary lifestyle

	Mean (±SD)	P-value
Total (n=64)	28.28 (9.68)	0.160
High SES (n=30)	29.63 (11.04)	0.854
Low SES (n=34)	27.09 (8.28)	0.049

Table 4.17 Comparison energy from fat intake with FAO/WHO recommendations for an active lifestyle

	Mean (±SD)	P-value
Total (n=64)	28.28 (9.68)	0.000
High SES (n=30)	29.63 (11.04)	0.012
Low SES (n=34)	27.09 (8.28)	0.000

Table 4.18 shows the results of the tests performed for protein intake. These tests are based on the protein requirements in human nutrition of the WHO (2007). The recommendations are made at two levels, the average requirement of 0.69 grams of protein per kilogram bodyweight per day and the safe level requirement (+1.96 SD) which is 0.86 g/kg bodyweight per day. These requirements are for both sexes combined for weaned children up to 10 years of age. The protein intake is significantly higher than the recommended intake for this age group. The protein intake of high SES children is higher than that of low SES children, a significant difference as can be observed from table 4.3.

Table 4.18 Comparison protein intake (g/kg bodyweight) with WHO recommendations at the average and safe level.

	Mean (±SD)	P-value (average level 0.69g/kg)	P-value (safe level 0.86 g/kg)
Total sample intake (n=64)	2.58 (1.58)	0.000	0.000
High SES intake (n=30)	3.09 (1.81)	0.000	0.000
Low SES intake (n=34)	2.12 (1.21)	0.000	0.000
Boys (n= 28)	2.45 (1.87)	0.000	0.000
Girls (n=36)	2.67 (1.34)	0.000	0.000

5. Conclusion

In this chapter, the thesis will be concluded by presenting and discussing the main findings. First the sub questions formulated in the introduction will be answered. Next the final conclusion will be made based on the main question: *What relation exists between socio-economic status, food intake and weight status of children aged 4.5 years?* The last part of this chapter will constitute of a discussion of the results in relation to the hypotheses formulated at the start of the research and recommendations for the future.

5.1 Synthesis of results

This thesis focused on the question what relation existed between socio-economic status, food intake and weight status of children aged 4.5 years and whether this can be linked to the theoretical framework of the nutrition transition. The main research question is divided into four research questions. Research question one and two each constitute of two parts, the first part focusing on weight status and the second part focusing on food intake.

Is there a difference in weight status between children of high and low SES?

Weight status of the children is assessed as the body mass index (BMI), fat mass index (FMI) and fat free mass index (FFMI). Of these three indices BMI is the most common. The mean BMI and FMI of children in the high SES group was significantly higher compared to the mean BMI and FMI of the children in the low SES group. FFMI had no significant difference between those two groups. The presence of a significantly lower FMI and BMI of low SES children correspond with the hypothesis that the low SES group fits in the third stage of the nutrition transition, that of receding famine.

Is there a difference in food intake between high and low SES?

The research of food intake was done at different levels. The total energy intake and macronutrient intake were assessed, just as the consumption pattern in total number of meals, food products and food product groups. The mean energy intake in kcal was higher for high SES children (p=0.0009). Food products used in the analysis were both products characteristic for the third and fourth phase of the nutrition transition and products characteristic for the Brazilian eating culture. Rice and beans are products related to the third stage of the nutrition transition. These products are consumed significantly more by low SES children. Sugar, eggs and fruit juice are products related to the fourth stage of the nutrition transition and are consumed more by low SES children. However, only for sugar the difference is significant. Meat, dairy and soft drinks are food products related to the fourth stage of the nutrition transition and are consumed significantly more by high SES children.

What factors determine the weight of a child?

FMI is used as a dependent variable to assess differences between high and low SES. Ethnicity is a confounder and adjusted for ethnicity the differences in FMI between high and low SES children is borderline significant. Activity of the child did not cause an effect in this analysis. Having a car and people living in the household are environmental factors which have an effect on the difference in FMI between high and low SES. Total energy intake and the consumption of yoghurt are child related factors having an effect on the difference in FMI between high and low SES.

What factors determine the food intake of a child?

The food products for which analysis of covariance is performed are based on the results of the first research question. Food products with different intake for high and low SES children used in the analysis. For total energy intake, total number of meals, consumption of: rice, beans, bread, dairy, and margarine/oil ethnicity is a confounder. Adjusted for ethnicity only the consumption of bread is still significant and total energy intake is only borderline significant. The rest of food intake variables were not significant after adjusting for ethnicity. Ethnicity was no confounder for the consumption of sugar, cookies, meat and soft drinks. Meat and dairy increase the consumption of each other.

Does food consumption of children track over time?

The food intake of children at 8 months and 4.5 years of age has been compared in this section.
For total energy intake, boys appeared to track or move down and girls appeared to move up. Tracking pattern of SES groups shows similarities with that of the ethnic groups. Children of low SES or mixed colour moved down or tracked more than children of high SES or white colour, for which moving up was more common. For all groups except the non-white/mixed children group tracking was the most common category for sugar intake. In the non-white/mixed group moving up was the most prevalent category. Protein intake did track over time for the complete sample and the different sub groups except low SES children. The most common action for children of low SES was moving down in tertile for protein intake. For carbohydrate and fat intake no consistent tracking pattern can be observed.

Does the food consumption of children meet the dietary requirements as formulated by WHO/FAO?

WHO and FAO provide recommendations for total energy intake, macronutrient intake and micronutrient intake. In this research we have tested the total energy and macronutrient intake of the children. The total energy intake of the complete sample is below the recommended intake of the WHO with a value that is borderline significant. However, when looking to the separate intake of high and low SES children a different picture is provided. The intake of high SES children meets the recommended intake. Low SES children had a total energy intake that was below the recommended intake (p=0.011). A remarkable finding is the difference in intake for boys and girls. The intake of boys had a value below the recommended intake that was borderline significant (p=0.058). The total energy intake of girls was below the recommended value, but this difference was not significant (p=0.466).

Carbohydrate intake was compared to the recommendation of carbohydrate consumption being at least 55% of total energy intake. The complete sample did meet this requirement. The mean intake of carbohydrates was a little higher for low SES children but both groups did meat the recommended percentage of carbohydrates. Fat intake was assessed based on requirements for a sedentary lifestyle and an active lifestyle. Recommendations provided a maximum percentage of total energy intake being fat. For a sedentary lifestyle this was 30% and for an active lifestyle an intake of a maximum 35% was recommended. The mean intake of the complete sample was below the recommendations for a sedentary lifestyle and this was also the case for both high and low SES children. Protein intake was both the complete sample as when differentiated for SES and sex higher than significantly higher than the minimal recommended intake.

5.2 Overall conclusion

Following from the results from the four sub questions the research question can be answered. The weight status expressed as the fat mass index differs between high and low SES children where ethnicity is the main explanatory factor for this difference. Socio-economic status does affect the food intake of children; total energy intake is higher for high SES children compared to low SES children. Ethnicity again proved to be a confounder for total energy intake and the consumption of most of the other food products included in the research. Food product consumption can be linked to the nutrition transition where high SES children consumed more food products related to the fourth phase of this transition and low SES children consumed more food products related to the third phase of the transition; however the patterns do not fit completely. Behaviour of the children related to activity in this research was not an explanatory factor for both weight status and food intake. Total energy intake of low SES children was below WHO/FAO recommendations, the intake of macronutrients fat and carbohydrate meets the recommendations, and the intake of protein is significantly higher than recommended.

5.3 Discussion

In this section the results of this thesis will be interpreted and discussed. In order to do so, first the general approach and methods used for this research will be discussed. Next the resulting outcomes from the four research questions will be discussed and linked to the objectives, theory and earlier research.

This study took place a positivistic paradigm. Positivism assumes an objective reality; however this does not fit completely in the researcher's worldview. In my view the behaviour of people can be measured, but the perceptions of people and their relation to things, such as food, are not things that can be measured. But, when looking at the objective of this research, the positivistic paradigm fits the best. However, increasing attention is paid towards the fact that people's experiences are complex, subjective and embedded in specific social and historical contexts (Broom and Willis, 2007). An example is the differences in 'food culture' across the world.

Initially the aim of this study was to focus on the determinants of overweight and food intake in 4.5 years old Brazilian children. However, when analysing the data, the proportion of children which could be classified as being overweight or obese was only 6.3%. This percentage was even lower than the percentage of children in this sample being underweight. Because a small sample size has been used in this research, analysis only focusing on the overweight group was not considered appropriate. After rejecting the first idea, the focus has been placed on indices of body composition in the analysis of weight status and food intake in relation to the nutrition transition (Popkin, 2001, 2002, 2003, 2006, 2008).

Popkin states that '[…] global energy imbalances and related obesity levels are rapidly increasing. The world is rapidly shifting from a dietary period in which the higher-income countries are dominated by patterns of degenerative diseases and lower- and middle-income countries are dominated by receding famine, to one in which the world is increasingly being dominated by degenerative disease (2006, p.289).' The shift in food intake and weight status related to the patterns of receding famine and NRNC-disease is has been the focus of this research. To be able to do this food intake of 4.5 year old Brazilian children has been analysed and related to a number of factors. Analysing food intake data does always mean dealing with a certain degree of bias caused by a number of factors. In including and excluding cases we were very critical, on the one hand a case with very strange intake measurements was excluded, just as a child which was sick. At the other hand the choice has been made to include cases which had a very low total energy intake.

5.3.1 Differences in weight status and food intake

Research question 1.1 and hypothesis two are related to the objective to get insight in the differences in weight status between high and low SES children. Based on the theory of the nutrition transition low SES children were expected to fit predominantly in the third phase of this transition, the stage of receding famine. Receding famine was linked to having a lower BMI and FMI than high SES children who were expected to be in the stage of NRNC-disease.

The results did confirm this hypothesis. BMI and FMI of low SES children were significantly lower compared to that of high SES children. No significant difference was found in the FFMI. Both FMI and BMI were used as outcome variables for weight status, but because FMI is a more reliable indicator of fatness than is BMI or percentage body fat (Haisma, 2004) the use of this outcome variable is preferred in the analysis of the second research question.

Research question 1.2 and hypothesis one are related to the objective to study food intake of both high and low SES children in order to relate this to stages in the nutrition transition. In interpreting the results of the analysis of food intake data results one has to keep in mind that not all food products were consumed by all children at the day of measurement. Another important factor is the fact that the data are collected on one day and the relatively small sample size. Using food intake data also means dealing with the behaviour of people and in this case especially the behaviour of the mother. It is possible that some mothers fed their children according to what they perceived as socially desirable behaviour. This is some kind of bias which cannot be avoided totally, but should be taken into account in the interpretation of the results.

In comparing the food product intake at 4.5 years between high and low SES almost all food products that were recorded in the initial data collection were taken into account, except for salt and water intake. These food items have potential value in the analysis of food intake but because the food product intake was assessed as a percentage of total energy intake and because water and salt did not contribute to total energy intake these products could not be included in the analysis. Food intake has also been assessed at the macronutrient level, but one should not use the results of this analysis to build an explanatory model for food intake. The decision to take the macronutrient intake of the children into account was made because the WHO and FAO recommendations were not available at product level but were on the macronutrient level. Another advantage of this level was that a comparison between energy intake divided into macronutrients could be made in a longitudinal way. The percentage of energy consumed as carbohydrate, protein and fat proved to be significantly different at 4.5 years compared to 8 months of age. This comparison has been performed on a sample of 57 cases, because for these children data was available at both ages. The higher consumption of fat at eight months could be expected because almost all children were at least partially breastfed at this age and consumed very few solids. Breast milk contains a higher amount of fat, which explains the greater percentage of energy from this source.

At the start of this research in relation to the hypotheses, the third stage of the nutrition transition has been related to a dietary pattern with plant based foods, low variety, low fat and high in starches. In the analysis of the food intake of the children related to this pattern not all these characteristics were taken into account. In this research no specific analysis was conducted in relation to dietary variety of the children and the starches consumed. Dietary variety could have been assessed by using the dietary diversity index (DDI) but to be able to do so, the structure of the dataset should also include a great number of micronutrients and the dataset used in this analysis these data was not available. It was not possible to analyse starch intake from the initial dataset and this was not taken into further account in this research. Based on these considerations the decision has been made to use two food products of which consumption was expected to be related to the nutrition transition and SES. These two food products are rice and beans. On the macronutrient level, a lower fat intake and a higher carbohydrate intake were expected to be prevalent among low SES children compared to high SES children. This was the smallest level of analysis. It could be preferred to look at even smaller detail to the types of fat and carbohydrates consumed, but this detailed level of analysis was out of scope of this thesis.

The fourth stage of the nutrition transition was related to a diet with more fat, sugar, processed foods and consisting of less fiber. Food products considered as characteristic for this pattern were eggs, meat, dairy, processed foods, sugar, fruit juices and soft drinks. High SES children were expected to consume these products in higher amount than low SES children.

The results of the analysis did only confirm parts of hypothesis one. Although low SES children did appear to consume significantly more rice and beans, they did also consumed significantly more sugar compared to high SES. When looking to other research, this result is not that surprising because earlier research indicated an increasing sugar intake with decreasing SES (Galobardes et al., 2000; Drewnowski and Specter, 2004). Meat, dairy and soft drinks are so-called ‘fourth stage food products’ which did appear to be consumed more by high SES. This might possibly be explained by the fact that these products are more expensive than rice and beans. Although educational level of the mother has been used to determine SES of the child, it might be justified to make a link between educational level and the amount of many available to be spent on food.

Next to the food items directly linked to the nutrition transition a number of other food items showed a clear significant difference such as bread, sugar, and margarine/oil consumption. Because the food products were not normally distributed a non-parametric alternative of the independent samples t-test has been used to determine whether differences were significant. This method has a lower statistical power, but still came up with a number of significant differences. One significant result was not included in the analysis of covariance of the second research question. This is the consumption of fruit vegetables which had a significant difference (p=0.010) but the consumption in both groups was less than 1% of total energy intake, this is why the consumption of this food product was not considered in further analysis.

Total energy intake of low SES children was significantly lower than the energy intake of high SES children. This did confirm the hypothesis that the food intake of high SES children was higher. A low total energy intake does also fit the receding famine pattern. With regard to macronutrient intake, no striking differences between the two SES groups have been found. Only protein intake was significantly different, but this is explained by the fact that high SES children consume more meat and dairy.

5.3.2 Factors determining differences in weight status and food intake

The second research question was related to the objective to get insight in the potential factors determining differences in weight status and food intake. Analysis of covariance has been used to get insight in which factors are related to this difference. Both sex and ethnicity were considered as potential confounders but only ethnicity was included as a confounder. In this way the analysis was corrected for potential colinearity, because low SES is more prevalent among non-white Brazilians. The inclusion of ethnicity as a confounder proved to be of crucial influence on the difference in FMI between high and low SES children. The difference of FMI between high and low SES was before inclusion of the confounding factor significant, but after inclusion the different was not significant anymore at the 5% level. In the results of the analysis of covariance all covariates that were used in the analysis and caused a change of 10% or more in the difference were listed. However, because the p-value of the difference was not significant anymore after inclusion of ethnicity, the p-values of the difference after inclusion of the mediators was also not significant. The analysis of covariance resulted in a list of mediators which at first sight did not provide a clear pattern or correlation with the nutrition transition or dietary patterns. Because there was no valid argument on which the decision could be made to include or exclude some variables, all variables selected on beforehand to be considered as potential mediators and which had enough influence on the difference in FMI were included in the results. However, one should be careful in assuming causality between the mediating factors and FMI. In this case, the negative results are maybe more insightful than the positive results. The effect of ethnicity on the difference proved to be of great explanatory importance. On the other hand, the time a child sleeps and variables related to activity such as playing on the street or watching television did not prove to be of influence in this analysis, although this may be expected otherwise.
For food intake related to SES the same approach as for weight status have been used. In the first research question food products with a significant difference in intake between high and low SES were distinguished. The analysis in the second research question focused on these products. In interpreting the results one has to keep in mind that not all food products were consumed by all children. An other important factor is the fact that the data are collected on one day and the relatively small sample size.

As said before, dealing with food intake data also means dealing with the behaviour of people. This is some kind of bias which cannot be avoided totally, but should be taken into account in the analysis. This is one of the reasons why a (linear) regression at the individual level was not considered as an appropriate method.

Sex was no confounder for FMI and neither for the consumption of the food products. Ethnicity again played an important role in the consumption of a number of these food products. When ethnicity was included the differences between high and low SES in almost all cases was not significant anymore. A possible explanation of ethnicity could be related to the role of culture in eating. Different cultures use different products in their cooking. However, based on this research no valid conclusions can be drawn related to this hypothesis. The same inclusion criteria for mediators have been used in the analysis of FMI and food intake. This resulted in an on first sight incoherent picture of somehow random mediators influencing the food consumption. Just as for FMI the decision has been made to include all mediators, because no good exclusion criteria were found. Because this decision has been made, it is important to take the risk of circular argumentation into account. It is not possible to talk about clear causal relationships between the consumption of different food items. We tried to perform some cluster analysis to identify a number of dietary patterns, but no clear patterns could be observed from this analysis, partly due to the small sample size. However, it can be observed that a number of food products continue return in the analysis, which are consumption of dairy, sugar, meat, beans and rice, all food items which were marked in relatively many cases as a mediating factor. These are food products with a clear link to the nutrition transition, where beans and rice can be placed in the third phase and the other food products in the fourth phase of this transition. The most striking relation between two food groups is the relation of meat and dairy. When consumed together, this causes a significant increase in the difference between high and low SES. A possible explanation can be the fact that both meat and dairy are income related food items. An argument for this statement is the fact that for both the consumption of dairy and meat family income did prove to be a mediating factor.

Just as for the difference in FMI between the two study groups, the negative results for food intake might be just as or even more meaningful than the positive results. We already concluded that ethnicity plays in many cases an important role in food intake. But on beforehand we did expect activity related variables to be mediating factors. However, in the analysis of covariance activity did not prove to be a mediating factor for all variables taken into account as outcome variables in the analysis of covariance. Meat and dairy are both products consumed more by high SES children and included in the analysis together they increase the difference between high and low SES. This effect can also be observed when meat is the dependent variable and dairy is a mediator, which is logical, because it is the same type of analysis. Meat and dairy are the only variables where this effect can be observed.

Variables that were expected to be mediating factors but did not proved to be so were minutes sleep for FMI, and variables related to activity, such as playing on the street/performing sports but also having a television and playing videogames for both FMI and the food related variables. These results may be more meaningful than the results provided in table 4.6 and 4.8. In this case, the difference in FMI and consumption between high and low SES can not be explained by activity.

5.4.3 Tracking

One of the main advantages of this dataset is the longitudinal component. Research question three and hypothesis three are related to the objective to get insight in the tracking patterns of food intake. Data on consumption of the children is available at 8 months and 4.5 years of age. In addition to the rather random and possibly disappointing outcomes of the analysis of covariance, a descriptive analysis of the tracking of dietary behaviour was performed. Only percentages of children tracking, moving up in tertile or moving down in tertile were displayed. This method has been chosen because of the small sample size. After splitting the dataset into three same sized groups these groups were relatively small, together with splitting the complete sample (n=57) into two groups based on sex, SES and ethnicity statistical analysis was not considered as appropriate. The same motivation applies to the choice to divide the sample into tertiles instead of more common quartiles. Reviewing tracking of food intake over the life span could provide additional information on dietary behaviour of people and when linked to other factors give us more insight in what determines changes in dietary behaviour. Although the third research question of this thesis had a descriptive character, it resulted in some interesting outcomes especially related to SES and ethnicity.

In relation to the assessment of macronutrient intake as percentage of total intake in research question one the macronutrient intake in the third research question will also be assessed as percentage of total energy intake. Looking at protein intake raises some interesting questions, especially related to SES. When looking at the group that moved down, for high SES this is about half the percentage as it is for low SES. Moving up is more common in high SES compared to low SES. This might be related to the fact that children at 8 months do consume almost no solids, in contrast to children at 4.5 years of age. In the first two research questions a greater consumption of food items which are rich in protein (such as dairy and meat) was observed among high SES children at 4.5 years of age compared to low SES children. This observation is reflected in the tracking of protein. Compared to the tracking patterns of protein, fat intake shows the same pattern. Carbohydrate intake shows a different picture.

The percentage of low SES children moving up in carbohydrate consumption is a remarkably higher than that of high SES children. Compared to low SES, high SES children moved down relatively more. This can also be related to the first two research questions, where high SES children showed a significantly lower intake of food products containing a great amount of carbohydrates.

As expected from the outcomes in the second research question, the tracking patterns of high SES show some resemblance to the tracking patterns of white children. The same applies to low SES and children of mixed ethnical background. Because the food intake of children at 8 months included few solids, the inclusion of actual food products causes problems. That is the main reason why only sugar intake was reviewed. Another argument for the inclusion of sugar is the significant difference in intake between high and low SES at 4.5 years and the fact that ethnicity was not included as a confounder in the analysis of covariance for sugar intake. When looking at tracking patterns of sugar intake there is no clear pattern in tracking or moving up or down.

Although some patterns can be observed, no clear conclusions can be drawn in relation to this research question. This might be related to the small dataset, which included only 57 children. No clear conclusions can be drawn from this analysis, and further research is needed, but SES, in relation to ethnicity, again appears to be a potential explanatory factor in tracking of dietary behaviour.

5.4.4 WHO/FAO recommendations

The last research question is in a way less theoretical and more practical. It is related to hypothesis four and research question 4 which both are formulated in relation to the objective to compare the dietary intake of this sample of children with WHO and FAO recommendations. In the research performed by Romulus-Nieuwelink and colleagues (2011) the dietary intake of this sample of children has been compared to WHO recommendations at eight months of age. The research in this thesis is in a way an extension of this earlier research.

By comparing the WHO/FAO recommendations for macronutrient intake, the nutritional status of this sample of children can be assessed and used as a basis to do further recommendations. The total energy the complete sample is borderline significant for the complete sample. But when looking in more detail a totally different picture occurs, where high SES children did almost exactly meet the WHO recommendations, but this was not the case for low SES children. The total energy intake of this last group was significantly lower than the recommendations of the WHO. These recommendations are based on the energy requirements per kilogram bodyweight in order to provide a detailed picture as possible. The total energy intake was also assessed by sex. This provided a somewhat strange picture where the consumption of boys was borderline significant. But when a chi-square test was performed to check for any correlation between high and low SES, no significant result was observed. In this research no answer was found to the question what causes this difference.

The macronutrient intake recommendations for fat and carbohydrate were met by both high and low SES children. Protein intake was for both groups significantly higher than recommended and high SES consumed significantly more protein than low SES children. The analysis of fat intake came up with p-values of less than 5% but because this referred to an intake below the recommended maximum intake, this significant result is not meaningful.

A disadvantage of using recommendations of macronutrient intake as percentage of total energy intake is the fact that in relation to the fact that a person can have a very high or a very low total energy intake and correspondingly high or low macronutrient intake when one uses absolute measurements, and that this is related to unhealthy intake levels (either high or low). Still the intake could still meet the WHO recommendations which are expressed as a percentage of total energy intake. For protein intake recommendations were available for grams per kilogram bodyweight. These recommendations did not have the disadvantage mentioned and are preferred to the recommendations in percentage of total energy intake. It should be noted that the recommendations for protein intake are of a more recent date. At the moment the WHO and FAO are working on new recommendations for fat and carbohydrate intake. An alternative decision could have been to use recommendations of an organisation other than the WHO. In order to prevent the bias of different sources the decision has been made to use recommendations from one consistent source, in this case the WHO/FAO. An other advantage of these recommendations is the fact that they are for global application, which is not directly the case for American or British recommendations.We considered it as not appropriate to use recommendations for countries which already have (almost) completely through the nutrition, epidemiologic and demographic transition for Brazil, a country which is at this moment undergoing these transitions. Further research with regard to the nutritional status of Brazilian children should focus on the question whether the consumption of these children meets dietary recommendations on the macronutrient and micronutrient level. A useful instrument for this analysis could be the dietary diversity index, which has been mentioned before in the discussion of research question 1.

Although macronutrient intake of this sample of children meets WHO/FAO recommendations, the total energy intake does not. Especially the energy intake of low SES children may be of concern. From this small dataset no general conclusions can be made, but a low total energy intake may also be an indicator of other nutritional deficits.

5.4 Recommendations

In this section recommendations for further research and policy recommendations resulting from this research will be discussed.

5.4.1 Recommendations for further research

The results of this thesis can be used as a starting point for on-going research. Future research could possibly focus on the relation between different food products and aim to create a number of dietary patterns of (Brazilian) children. Research on dietary patterns in Brazil has up to now predominantly focused on adults but in relation to the increasing prevalence of obesity, dietary patterns may provide new insights in the consumption related determinants of overweight.

Another topic for future research might possibly be the influence of culture and ethnicity on dietary behaviour. Ethnicity proved often to be a confounding factor in the analysis of this thesis. Further research may give more insight in the role of culture in dietary behaviour and may be linked to both the nutrition transition and ecological systems theory.

Also of interest is research focusing on tracking of consumption. In this research the tracking of dietary behaviour at 8 months and 4.5 years is discussed. Research reviewing dietary behaviour over a longer period of time can provide insight in determinants of (changing) dietary behaviour.

A last recommendation for future research is related to the comparison of dietary intake with recommended intake. The WHO and FAO are providing more and more recommendations for dietary intake. Comparing the dietary intake at different levels, such as the total energy intake, macronutrient and micronutrient intake (by using de dietary diversity index) may provide more insight in which part of the nutrition of a population meets the requirements and which part needs improvement.

5.4.1 Policy recommendations

In a country which suffers the burden of underweight and overweight as a result of malnutrition, the potential policy implications of research on weight and nutrition cannot be ignored. Brazil is already working on a national food and nutrition policy (Coitinho et al., 2002). A new national food and nutrition policy has been developed at the national and local level, following a wide-ranging set of discussions, meetings and negotiations, between the Ministry of Health, relevant parts of Brazilian civil society and other relevant governmental bodies (Coitinho et al., 2002). The main goal of this new policy is to promote, protect and support eating practices and lifestyles which should ideally lead to optimal nutritional and health status for all. This new policy attempts to continue to combat nutritional deficiencies with focused and targeted integrated interventions. It also attempts to shift increasing attention towards the prevention of nutritional disorders associated with over- or wrong feeding and sedentary lifestyles. These actions and programmes focus on large scale activities aimed at behavioural change to create healthier eating and increased physical activity pattern (Coitinho et al. 2002). But the fact that the low SES children from this sample consumed significantly less calories per day than recommended by the WHO and FAO may be considered as an indicator of the presence of malnutrition among low SES children. The significantly lower BMI and FMI among low SES children in this research do also reflect this picture. Brazil is a country undergoing a major transition with increasing urbanization and should thus pay attention to the shift towards western dietary patterns.

References

Adler, N.E., Boyce, T., Chesney, M.A., Cohen, S., Folkman, S., Kahn, R.L., Syme, S.L. (1994) 'Socio-economic status and health, the challenge of the gradient' *American Psychologist*, 49 (1) pp. 15-24.

Babbie, E. (2010), *The practice of social research.* Wadsworth, Cengage Learning: Belmont.

Barker, D.J.P. (1996): 'The fetal origins of adult disease' *Nutrition today* 31 (3) pp. 108-114.

Barros, A.J.D., Santos, I.S., Bertoldi, A.D. (2008) 'Can mothers rely on the Brazilian health system for their deliveries? An assessment of use of the public system and out-of-pocket expenditure in the 2004 Pelotas Birth Cohort Study, Brazil' *BMC Health Services Research* 8 (57)

Broom, A. and Willis, E. (2007): 'Competing Paradigms and Health Research' in: Saks, M. and Allsop, J. *Researching Health, qualitative, quantitative and mixed methods*, Sage publications London.

Caballero, B. and Popkin, B.M. (2002) 'Policy implications' pp. 241-250. in: B. Caballero and. B.M. Popkin (eds.) *The nutrition transition diet and disease in the developing world*. Academic press: London.

Caballero, B. (2005) 'A nutrition paradox – Underweight and obesity in developing countries' *New England journal of medicine,* 352 (15) pp. 1514 – 1516.

Coitinho, D., Monteiro, C.A., Popkin, B.M. (2002): 'What Brazil is doing to promote healthy diets and active lifestyles. *'Public Health Nutrition* 5 (1a) pp. 263-367.

Cole, T.J., Bellizzi, M.C., Flegal, K.M., Dietz, W.H. (2000) 'Establishing a standard definition for child overweight and obesity worldwide: International survey.' *BMJ*. 320 (7244) pp. 1240–1243.

Cole, T.J., Flegal, K.M., Nicholls, D., Jackson, A.A. (2007) 'Body mass index cut offs to define thinness in children and adolescents: international survey.' *British medical journal,* 335 (7612) pp. 194-201.

Danielzik, S., Czerwinski-Mast, M., Langnäse, K., Dilba, B., Müller, M.J. (2004) 'Parental overweight, socio-economic status and high birth weight are the major determinants of overweight and obesity in 5-7 y-old children: baseline data of the Kiel Obesity Prevention Study (KOPS)' *International Journal of Obesity.* 28, pp. 1494-1502.

Davison, K.K., Birch, L.L. (2001) 'Childhood overweight: a contextual model and recommendations for future research'. *Obesity Reviews*. 2 (3), pp159-171

Doak, C.M., Adair, L.S., Monteiro, C., Popkin, B.M. (2000): 'Overweight and underweight coexist within households in Brazil, China and Russia. Journal of Nutrition, 130 (12), pp. 2965-2971.

Doak, C.M. and Popkin, B.M. (2008): 'The rapid emergence of obesity in developing countries' pp.617-638, in: Semba, R.D. and Bloem, M.W. (ed.) *Nutrition and Health in Developing countries,* Humana press, Totowa (US).

Drewnowski, A. and Specter, S.E. (2004) 'Poverty and obesity: the role of energy density and energy costs' *American journal of clinical nutrition*, 79 (1) pp.6-16.

Egger, G. and Swinburn, B. (1997) ‘An “ecological”approach to the obesity pandemic’ *British Medical Journal* 315 (7106) pp. 477- 480.

FAO/WHO (1994). ‘Fats and Oils in Human Nutrition. Report of a Joint Expert Consultation’. Rome: World Health organization; FAO food and nutrition paper.

FAO/WHO (1998). ‘Carbohydrates in Human Nutrition. Report of a Joint Expert Consultation.’ Rome: Food and Agriculture Organization; FAO food and nutrition paper.

FAO (2003) ‘Food and nutrition paper 77; food energy – methods of analysis and conversion factors’ Rome: food and agricultural organization of the united nations.

FAO/WHO/UNU (2004) ‘Human energy requirements: report of a Joint FAO/WHO/UNU Expert Consultation.’ Rome: Food and Agricultural Organization of the United nations; FAO food and nutrition technical report series.

Fogel, R.W., Helmchen, L.A. (2002) ‘Economic and technological development and their relationships to body size and productivity’ pp.9-24 in: B. Caballero and. B.M. Popkin (eds.) *The nutrition transition diet and disease in the developing world*. Academic press: London.

Francis, D.K., Broeck, J. van den, Younger, N., McFarlane, S., Rudder, K., Gordon-Strachan, G., Grant, A., Johnson, A., Tulloch-Reid, M., Wilks, R. (2009) ‘Fast-food and sweetened beverage consumption: association with overweight and high waist circumference in adolescents’ *Public health nutrition*, 12 (8) pp. 1106-1114.

Galobardes, B., Morabia, A., Bernstein, M.S. (2000) ‘Diet and socioeconomic position: does the use of different indicators matter?’ *International journal of epidemiology,* 30 (2) pp.334-340.

Griffiths, P.L., Rousham, E.K., Norris, S.A., Pettifor, J.M., Cameron, N. (2008) ‘Socio-economic status and body composition outcomes in urban South African children’ *Archives of disease in childhood,* 93 (10) pp. 862-867.

Haisma, H.H. (2004) *Energy utilisation of infants in southern Brazil. Breast-feeding pattern and socio-economic status in relation to obesity.* Drukkerij van Denderen B.V. Groningen.

Hulshof, K.F.A.M., Brussaard, J.H., Kruizinga, A.G., Telman, J., Löwik, M.R.H. (2003) ‘Socio-economic status, dietary intake and 10 y trends: the Dutch national food consumption survey’ *European journal of clinical nutrition,* 57 (1) pp.128 – 137.

IBGE (1981) ‘Fonte-Estudo Nacional da Despesa Familiar – Tabelas de composição de alimentos. 2a edição – Secretaria de Planejamento da Presiděncia da República – Fundação Instituto Brasileiro de Geografia e Estatística. 216 p. – CDU 641.1 (81).

IBGE (2011) ‘Pelotas’
http://www.ibge.gov.br/cidadesat/painel/painel.php?codmun=431440 Last visited: August 21, 2011.

Johnson, L., Mander, A.P., Jones, L.R., Emmett, P.M., Jebb, S.A. (2008). ‘Energy-dense, low-fiber, high-fat dietary pattern is associated with increased fatness in childhood.’ *American Journal of Clinical Nutrition* 87 (4) pp. 846-854.

Kain, J., Vio, F., Albada, C. (2003) Obesity trends and determinant factors in Latin America. *Cad. Saúde Pública* [online]. 2003, vol.19, suppl.1 pp. S77-S86 Internet: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0102-311X2003000700009&lng=en&nrm=iso>. ISSN 0102-311X. doi: 10.1590/S0102-311X2003000700009. Last visited on September 27, 2010.

Kirk, D. (1996): ‘Demographic transition theory’ *Population Studies*, 50 (3) pp. 361-387.

Monteiro, C.A., Conde, W.L. and Popkin, B.M. (2002) ‘Trends in under- and overnutrition in Brazil’ pp.223-240. in: B. Caballero and. B.M. Popkin (eds.) *The nutrition transition diet and disease in the developing world*. Academic press: London.

Newby, P.K. and Tucker, K.L. (2004): ‘Empirically derived eating patterns using factor or cluster analysis: A review’ *Nutrition reviews* 62 (5) pp. 177-203.

Newby, P.K. (2007): ‘Are dietary intakes and eating behaviours related to childhood obesity? A comprehensive review of the evidence’. *Journal of Law, Medicine and Ethics* 35 (1) pp. 35– 60.

Omran, A.R. (1998): ‘The epidemiologic transition theory revisited thirty years later’ *World Health statistics* Quarterly 51: 99-119.

PAHEF (2010), ‘Child obesity’, Pan American Health & Education Foundation: Washington. Internet: http://www.pahef.org/priorities/childhood_obesity/ Last visited on September 21, 2010.

Pearson, N. and Biddle, S.J.H. (2011) ‘Sedentary behaviour and dietary intake in children, adolescents, and adults a systematic review’ *American journal of preventive medicine* 41 (2) pp. 178-189.

Popkin, B.M. (2001) ‘The Nutrition Transition and Obesity in the Developing World’ *Journal of Nutrition*. 131 (3), pp. 871S-873S.

Popkin, B.M. (2002) ‘An overview of the nutrition transition and its health implications, the Bellagio Meeting.’ *Public Health Nutrition* 5(1A): 93-103.

Popkin, B.M. (2003) ‘The nutrition transition in the developing world.’ *Development policy review* 21 (5-6) 581-597.

Popkin, B.M. (2006) ‘Global nutrition dynamics: the world is shifting rapidly toward a diet linked with noncommunicable diseases’ *The American journal of clinical nutrition*, 84 (2) pp. 289-298.

Popkin, B.M. (2008): ‘The Nutrition Transition and Its Relationship to Demographic Change’ pp.601-616, in: Semba, R.D. and Bloem, M.W. (ed.) *Nutrition and Health in Developing countries,* Humana press, Totowa (US).

Rodríguez, G., and Moreno, L.A. (2005) ‘Is dietary intake able to explain differences in body fatness in children and adolescents?’ *Nutrition, Metabolism and cardiovascular diseases*, 16 (4) pp. 294-301.

Romulus-Nieuwelink, J.J.C., Doak, C., Albernaz, E., Victoria, C.G., Haisma, H. (2011) ‘Breast milk and complementary food intake in Brazilian infants according to socio-economic position’ *International journal of pediatric obesity*, 6 (2-2) e508-e514.

Shahar, D., Shai, I., Vardi, H., Shahar, A., Fraser, D. (2005) ‘Diet and eating habits in high and low socio-economic groups’ *Nutrition* 21 (5) pp. 559-566.

Sichieri, R. (2002): ‘Dietary patterns and their associations with obesity in the Brazilian city of Rio de Janeiro’*Obesity research: official journal of the North American Association for the Study of Obesity* 10 (1) pp. 42-48.

Smil, V. (2002) ‘Food production’ pp.25-50 in: B. Caballero and. B.M. Popkin (eds.) *The nutrition transition diet and disease in the developing world*. Academic press: London.

Wang, Y. C., Ludwig, D.S., Sonneville, K., Gortmaker, S.L. (2009) 'Impact of change in caloric beverage consumption on energy intake among children and adolescents' *Archives of paediatrics and adolescent medicine,* 163 (4) pp. 336-343.

WHO (2002) 'World Health Report 2002. Reducing risks, promoting healthy life.' Geneva.

WHO (2003) 'Diet, nutrition and the prevention of chronic diseases. Report of a Joint WHO/FAO Expert Consultation.' *World Health Organisation Technical Report Series* 916:i–viii, 1–149.

WHO (2007) 'Protein and amino acid requirements in human nutrition: report of a joint WHO/FAO/UNU Expert consultation.' Joint WHO/FAO/UNU Expert consultation on protein and amino acid requirements in human nutrition. Geneva: World Health organization; WHO technical report series.

WHO (2009) 'Country cooperation strategy at a glance, Brazil'
http://www.who.int/countryfocus/cooperation_strategy/ccsbrief_bra_en.pdf
Last visited: August 13, 2011.

WHO (2011a) 'Moderate Malnutrition' http://www.who.int/nutrition/topics/moderate_malnutrition/en/
Last visited: August 13, 2011.

WHO (2011b) 'Health topics: nutrition' http://www.who.int/topics/nutrition/en/
Last visited: August 13, 2011