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Master thesis Population Studies

The effect of single motherhood on childhood obesity

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Abstract

Levels of childhood obesity are increasing globally since the start of the 21st century, as well as the number of single mother households. Since childhood obesity comes with serious health risks, this is an important topic for researchers and policy makers. Literature shows that children living in single mother households are more likely to obese. However, there is a lack of information on how these differences in obesity prevalence arise. Theory suggests that parent-child relations in food provision are influenced evolutionary, economically and sociologically. Therefore, this study aims to explore factors behind the association in order to fully understand how single motherhood affects childhood obesity. This study used the KiGGS dataset from the ''German Health Interview and Examination Survey for Children and Adolescents''. By doing binary logistic regression four models have been made, measuring the effect of living in a single mother household, time of the mother, knowledge of the mother and household income on childhood obesity. Results show that knowledge of the mother has a significant effect on childhood obesity. Furthermore, household income seems to have a significant effect as well, but only for the low income households compared to high income households. Time of the mother does not play a significant role. Moreover, the effect of living in a single mother household is becoming insignificant after adding the explanatory variables to the model. In conclusion, this study highlights the important role of education of the mother in the development of childhood obesity as well as single motherhood being a risk factor of low education. For future research and policy making it would be more interesting to look into the preventing role of the mother's education in childhood obesity in order to address the real cause of the problem.

Contents

1. Introduction

Globally, levels of childhood obesity are rising. From 1999 to 2014 the USA experienced an increase in obesity prevalence among youth from 13.9 to 17.2 percent (Ogden et al., 2015). Also in the Netherlands, the prevalence of childhood obesity has increased. Van den Hurk et al. (2007) compared levels of overweight and obesity among children in 2003 to 1980 and 1997 and found a rising trend. However, numbers of the Netherlands Statistics (Volksgezondheidenzorg, 2020) show that the percentage of overweight and obese children aged 4 to 17 has barely changed between 1990 and 2017. Still, the prevalence of overweight and obesity is rather high and not decreasing yet.

The risk for developing type 2 diabetes mellitus, certain types of cancer and cardiovascular diseases is positively correlated with the BMI (Wyatt et al., 2006), which shows the negative impact of overweight and obesity on health outcomes (e.g. Kopelman, 2000; Guh et al., 2009; Williams et al., 2015) and consequently morbidity and mortality (Whitaker et al., 1997; Reilly & Kelly, 2011). Preventing overweight and obesity could therefore play an important role in preventing a large disease burden in the future (Guh et al., 2009).

Wilkinson & Marmot (2005) have studied health inequalities between and within countries and found that health follows a social gradient. Statistics show that a higher social position comes with better health outcomes. To understand the influence of this social gradient, they argue it is important to look at the circumstances in which people work and live, also the social determinants of health (Wilkinson & Marmot, 2005). Examples of social determinants that could influence overweight and obesity are early life, food, work and social support (Wilkonson & Marmot, 2003). This stretches the importance of the social environment in health outcomes like overweight and obesity.

On the other hand, Kopelman (2000) found that there is an interaction between genetic, environmental and psycho-social factors that influences the development of obesity acting through energy intake and energy expenditure. Kopelman (2000) suggests that the interaction of genes and environment (defined by social determinants of health) might explain important differences in health outcomes.

Previous studies have determined the parental influence on childhood and adulthood obesity (Whitaker, 1997). The prevalence of single parent households is increasing, mainly due to an increased divorced rate. In the Netherlands, 75,000 people were divorced in 1950 compared to 1,302,000 people in 2017 (CBS, 2019). Furthermore, on EU-level the crude divorce rate (divorces per 1,000 inhabitants) more than doubled between 1965 and 2016 (Eurostat, 2019a). McLanahan & Sandefur (1994) showed that single parenthood, as a result of divorce, diminishes the child's chances for wellbeing. This suggests single mother household might also influence the development of childhood obesity. This assumption can be confirmed by a previous study conducted in the USA where was found that children who lived with single mothers were significantly more likely to develop obesity (Strauss & Knight, 1999) and a Canadian study suggesting that children from single parent families were more likely to obese than children from dual parent families (Tremblay & Willms, 2003). Also more recent studies

showed the influence of a single mother household on childhood obesity risks (Chen & Escarce, 2010; Schmeer, 2012).

Given the important role of parents on child health and the changes in household composition, this study therefore aims to look into the differences between a single mother households and a dual parent households in their influence on childhood obesity. Furthermore, this study will investigate the relationship between single motherhood and childhood obesity, and how this association is influenced by other factors. This is academically relevant since previous studies that have already shown this relationship seem to be quite outdated, as the datasets that were used are over 20 years old now. Eurostat (2019b) shows an increase of single adults with children from 4.0% in 2008 to 4.4% in 2018, suggesting that single parenthood is getting more common. Therefore, data on single motherhood would likely have changed over time. It would be interesting to study the influence of this type of household on childhood obesity, now that single parenthood has become more common. Furthermore, the relationship has not extensively been investigated in Germany, which gives this research a motivation to study the mentioned relationship using German data. Subsequently, although the relationship between living in a single mother household and childhood obesity has been investigated for other populations, in general there is a lack of information in literature on how single mother households influence childhood obesity. Therefore, this study is aiming to explore the associations behind this relationship in order to try to fill up the gap in literature on how differences in family structure influence childhood obesity.

Furthermore, studying the relationship between single mother households and childhood obesity will give more insights into the risk factors and causes of childhood obesity. This stretches the societal relevance of this study, since it could provide important information that policy makers could use for designing appropriate interventions on preventing and decreasing childhood obesity.

Firstly, the theoretical framework will be discussed, followed by a literature review on the most important literature of the topics from the conceptual model. Next the data and methodology of the research will be discussed. Consequently, after doing the analyses the next chapter will give the results. At last, these results will be discussed in the conclusion.

2. Theoretical framework

This research seeks to identify whether living in a single mother household affects child's obesity risk. Most likely, this relationship is influenced by different factors that could be tested with various operationalization. Therefore, the theoretical framework will first look into the theories and concepts of childhood obesity and lone motherhood. In order to fully understand the relationship and the mechanisms behind, different perspectives will be discussed. After studying the theory and existing literature on the topic, a conceptual model will be built.

2.1 Evolutionary perspective

Parental-offspring relationships are deeply rooted in human development. From an evolutionary perspective it may explain why parents provide nutrition for their children as well as a certain nutritional pattern.

Trivers' (1974) theory of parent-offspring conflict explains how parent and offspring disagree over the amount and period of parental investment in parent-offspring relations. From a classical evolutionary perspective is assumed that parents allocate their resources and investment in such a way that they maximize their reproductive success and therefore the number of surviving siblings (Trivers, 1974). However, Trivers (1974) predicts that also the offspring has an active role in the parent-offspring relation, always demanding more investment from the mother than she would be selected to give, while still maximizing her reproductive success. Both mother and offspring will weigh the costs and benefits of parental investment, which are not similar, and this is where the conflict occurs over provision and demand of parental investment (Trivers, 1974). This theory is important for this study, since it explains how levels parental investment come about in a parent-offspring relation, and therefore the amount of provided child nutrition.

Wells (2003) reviewed the model of begging behavior of children in order to evaluate the role of crying and suckling behavior within parent-offspring relations, and investigated how this model together with Trivers' general theory of parent-offspring conflict improves understanding of nutritional problems, like infant obesity. His conclusion was that environmental factors can alter tensions in parent-offspring conflict and therefore influence the supply of nutrition to the infant (Wells, 2003). This finding is important for this study, since this partly explains how changes in social and physical environments can lead to excessive supply of child nutrition in relation to the actual energy requirements and therefore cause excessive weight gain.

Subsequently, parental attitudes have changed over time. Parents have developed a greater sensitivity for offspring demand, resulting in higher levels of provision (Wells, 2003). A study by Carey (1985) found a relationship between difficultness and infant weight gain, suggesting that difficult children will be fed more often, possibly more than their energy expenditures requires, to keep them quiet. An increase in available resources and a decrease in costs, as mentioned before, might also stimulate this process of provisioning. Additionally, Wells et al. (1997) found a relationship between infant irritability and body fatness. Furthermore, Wells (1998) found that mothers often use foods and drinks to deal with distress, even when not related to hunger or thirst.

The parent-offspring conflict theory explains the importance of available resources when it comes to providing child nutrition in parent-offspring relations. Furthermore, the change in parental attitudes leading to excess provision and overinvestment of parental resources can explain the general trend of increasing obesity rates.

2.2 Economic perspective

Consequently, it is interesting to look at the relationship between lone motherhood and childhood obesity from an economic perspective as well. In order to purchase food and provide nutrition a family income is necessary. Therefore one can imagine the availability of resources has an important role in the relationship between lone motherhood and childhood obesity. In order to understand how single mother households and dual parent households have different resources, and consequently affect child health and weight in a different way, Becker's household production model will be explained.

According to the household production model (Becker, 1965), households maximize their utility by producing commodities. These commodities are produced by combining time and market goods, which are subject to prices and can be constraint by resources. However, time and budget constraints can reduce the production of commodities and consequently the household welfare (Gronau, 1977). When distinguishing between single mother and dual parent households, time and budget constraints seem to play a big role for single mother households in particular. Therefore, the maximum household production will likely be higher for dual parents compared to single mothers (Kalenkoski et al., 2005). In conclusion, single mother households will likely have less time and budget resources to maximize their production and could consequently have a reduced household welfare.

In relation to the change in parental attitudes explained by Wells (2003), the effect of (over)feeding children in order to keep them quiet or to dissolve stress could be extra strong for single mothers, assuming these households only have one parent and therefore less time resources in terms of parental support according to the household production model (Becker, 1965). Resources of food provision therefore might be less costly compared to resources of parental support, which could lead to a stronger increase in food provision compared to dual parent households, who have more time resources for parental support in order to deal with distress or to keep the child quiet. This explains how the fewer resources of single mothers, compared to dual parents, can stimulate excess food provision and therefore lead to a higher risk of obesity.

2.3 Sociological perspective

From the previous two perspectives, it seems food practices and eating habits within families are formed in a unidirectional way, assuming parental 'failure' has occurred when a child is obese. However, from a sociological perspective, it is important to acknowledge that the relationship between child and adult in food practices and eating habits are way more complicated than that. Curtis et al. (2011) have illustrated this in their study where they interviewed parents of obese children. They found that family life consists of patterns of dependence as well as interdependence and independence which imply a flattening traditional parent-child hierarchy, suggesting that food practices and eating habits do not simply embrace from parental control. Furthermore, social contexts and in particular the negative framing of

obesity can influence the food environment in families (Curtis et al., 2011). Looking at childhood obesity from the sociological perspective allows to look at the broader social context and also explains how child eating patterns are influenced by more than just parental control.

Assuming the existence of patterns dependence, interdependence and independence within households and a flattening parent-child hierarchy, it is interesting to have a look at single mother households more specifically. One could imagine that children in a single mother household are less dependent on the household for developing eating patterns and obtaining food. In the first place because the mother simply does not have the resources to apply parental control, but it is also possible that the mother is trying to compensate for being the only present parent to the child by being more tolerant to the child's wishes and demands. A single mother household could therefore have an even more flattening parent-child hierarchy.

The literature review will further discuss what is considered to be childhood obesity and a single mother household. Furthermore, the literature review will discuss how certain resources can be environmental factors in the relationship between living in a single mother household and childhood obesity.

2.4 Literature review

2.4.1 Defining childhood obesity

Obesity is defined as an excess of body fat to the extent that it could negatively affect health (WHO, 1998; Ogden et al., 2007). However, measuring body fatness is very complicated or impossible (Ogden et al., 2007), which makes it hard to measure obesity and more specifically child obesity is very complicated. Most commonly, Body Mass Index (BMI) is used as a parameter to determine overweight and obesity, calculated by dividing the person's weight by the square of the height in meters. These measures will be discussed first.

The World Health Organization (WHO) defines adult overweight as a BMI greater than or equal to 25, and obesity as a BMI greater than or equal to 30 (WHO, 2018). These cut off points for adults seem to be internationally recognized (Cole et al., 2000). However, the median BMI for children changes substantially with age (Power et al., 1997), which makes this cut off point not applicable for measuring childhood overweight and obesity. Therefore, the WHO defines overweight for children 0-5 of age as weight-for-height greater than 2 standard deviations and obesity as weight-for-height greater than 3 standard deviations above the WHO Growth Reference median (WHO, 2006). For children aged 5-19 overweight is defined as a BMI-for-age greater than 1 standard deviation and obesity as a BMI-for-age greater than 2 standard deviations above the WHO Growth Reference median (WHO, 2006).

Alternatively, Cole et al. (2000) developed an internationally acceptable definition of child overweight and obesity, commonly referred to as the IOTF cut offs. The study used data from Brazil, Great Britain, Hong Kong, the Netherlands, Singapore and the United States in order to obtain cut off points for body mass index at different ages in childhood that are linked to the cut off point of a body mass index of 25kg/m^2 and 30 kg/m^2, as defined by the WHO. Although this approach is less arbitrary than others and moreover internationally based, they do admit it is still a statistical definition, which always had disadvantages (Cole et al., 2000).

Other measures for childhood obesity that have been used are based on the 85th and 95th percentiles of BMI for age and sex (Barlow, 2007). The expert committee of this study recommends to use the 85th percentile till the 94th percentile of BMI-for-age to determine overweight and the 95th percentile or greater to determine obesity. A study by Krebs et al. (2007) adds to this recommendation that also a BMI-for-age greater than 30 should be considered as obesity next to the 95th percentile cut off point.

Alternative measures of obesity that do not consider BMI are waist circumference (WC) and waist-hip ratio (WHR). In a report from 2008, the WHO has identified these measures to be superior to BMI, among other for practical reasons (WHO, 2008). Additionally, Yang et al. (2006) compared the usefulness of BMI, WC and WHR to predict obesity in Asian populations and found that both BMI and WC are strong predictors to diagnose obesity accurately. Alternatively, WHR is slightly less accurate compared to the last two (Yang et al., 2006). Likewise, Neovius et al. (2005) found BMI and WC to perform best at diagnosing body fat. However, despite the empirical evidence of the effectiveness and accuracy of WC and alternatively WHR, this measure of obesity still seems to be less commonly used (Ahmad et al., 2016).

This study will use the obesity definition of the WHO based on BMI while making use of the IOTF cut offs from Cole et al. (2000) in order to investigate the relationship between living in a single mother household and childhood obesity.

2.4.2 Living in a single mother household

There is quite some research about growing up with a single parent, and more specifically a single mother, and the adverse child health outcomes. A study of McLanahan & Sandefur (1994) found that single parenthood diminishes the child's chances for wellbeing. This is consistent with a more recent literature review from East et al. (2006) on father absence during childhood, which concluded that this has negative implications for child health and wellbeing. Furthermore, Scharte & Bolte (2012) found an increased health risk for children of single mothers. Consequently, Franz et al. (2003) found an increased distress for sons of single mothers in a large German sample.

Furthermore, recent literature confirms the negative influence of living in a single mother household on child development. The negative effect on education was studied by Park (2008) and the research found that students with divorced single parents were less likely to aspire university education. Also, Fergusson et al. (2007) found that exposure to single parenthood in childhood was significantly associated with poorer educational outcomes in later life. Furthermore, Fergusson et al. (2007) found that exposure to single parenthood in childhood was also negatively related to anxiety disorder and criminal behavior. This evidence in literature of the negative influence of living in a single mother household on child health and development suggests that it could also negatively influence child weight and therefore play a role in developing childhood obesity.

Previous research has studied the likelihood of childhood obesity for children living with a single mother. A study conducted in the USA found that children who lived with single mothers were significantly more likely to develop obesity than children living with two parents (Strauss

& Knight, 1999). More recent literature confirms this higher risk of obesity for children living with a single mother (Chen & Escarce, 2010; Schmeer, 2012). Moreover, a Canadian study found that children from single parent families were more likely to be obese than children from two-parent families (Tremblay & Willms, 2003). This is in confirmation with more recent a studies of Huffman et al. (2010) and Byrne et al. (2011) who also found that children living in a single parent household were more likely to be obese.

In summary, the extensive amount of literature shows evidence of an increasing risk of childhood obesity for children from single mother households. This underlines the important role of parenting in childhood obesity and implies a strong relationship between the status of single mother households and excess weight gain in childhood. Firstly, based on literature study, a few potential influential factors of the relationship between living in a single mother household and childhood obesity will be described. Using these influential factors as explanatory variables, this will result in a conceptual model that tries to explain how living in a single mother household influences childhood obesity.

This leads to the following research question: *How does living in a single mother household influence childhood obesity?*

2.4.3 Explanatory variables

In order to explain this research question, this study has constructed a conceptual model. According to the household production model (Becker, 1965) resources will be the influential factor in the relationship between living in a single mother households and childhood obesity. Next will be discussed which different resources could be used to explain the effect in this conceptual model, based on previous research and literature.

Income

The first potential influential factor is household income. Current statistics of the Netherlands show that single parent households with minor children are at significant risk of living in poverty (Hoff and van Hulst, 2018). Especially for single mother households the risk is high, as 16% of the single mother households are living in poverty, compared to 7.5% of the single father households. Hoff and van Hulst (2018) explain this by the dependence of single mothers on social security benefits. Additionally, literature shows that single mothers are at higher risk of poverty compared to couples with children (Van Lancker et al., 2012, Ananat & Michaels, 2008).

Dowda et al. (2001) confirmed that children from families with larger incomes have a lower risk to be overweight. This relation can firstly be explained by the influence of a low income on diet and secondly on physical activity.

Gable et al. (2000) suggests that the relative consumption of prepared food will increase as income decreases. Since single mother household likely have a lower household income (e.g. Van Lancker et al., 2012, Ananat & Michaels, 2008), consumption of prepared food is more attractive because it is more affordable than fresh food. However, prepared food is not in particular healthy, as it is usually high in fat and sodium (Gable et al., 2000). A recent study of Juul & Hemmingson (2015) found that the consumption of ultra-processed foods in Sweden over the period 1950-2010 dramatically increased, mirroring the increasing obesity rates. This

suggests a relation between the consumption of this type of food and obesity, and therefore could it be possible that the increased consumption of prepared food among single mother households leads to a larger prevalence of childhood obesity. However, the relation between processed or prepared food and risk of obesity seems to be quite controversial (Mendonca et al., 2016) and since not many studies have confirmed this suggested relationship, this study will be a useful addition to current literature on the topic.

Furthermore, due to a lower household income (Van Lancker et al., 2012, Ananat & Michaels, 2008), single mothers will have less money to spend on physical activities for their children. In line with the flattening traditional parent-child hierarchy (Curtis et al., 2011) as described in the theoretical framework, single mothers might try to compensate for the fact that they cannot afford to spend on physical activities by providing more and unhealthier (but more popular) foods that are cheaper. However, many studies have shown that increasing physical activity among children will lower the chances of getting obese (e.g. Sothern, 2004). Therefore, children from single mother households could be at higher risk of getting obese due to physical inactivity as well as specific dietary intakes as a result of a lower income as described above.

A literature review from McLanahan & Percheski (2008) on changes in family structure and income inequalities created a simple pathway explaining the relation between family structure and child outcomes (see Figure 1). Since single mothers are likely to be economically disadvantaged (e.g. Van Lancker et al., 2012, Anamat & Michaels, 2008) this typical family structure will reduce the available parental resources. In turn, this will reduce the quality of parenting and therefore will have negative consequences on child outcomes (McLanahan & Percheski, 2008), which could also be childhood obesity. This pathway clearly illustrates the potential role of income in the relation between single motherhood and child outcomes.

Figure 1: Simplified pathway between family structure and child outcomes (Source: McLanahan & Percheski, 2008).

Time mother

Another factor that could possibly influence childhood obesity among single mother households is the factor of time. A study of Kalil et al. (2014) found that children living in a single parent household receive less parental investment in terms of time than children living in a dual parent household. Likewise, Kendig & Bianchi (2008) found that single mothers spend less time with their children compared to married mothers. They argue this by the fact that single mothers need to spend more time in employment in order to be able to financially support their children than married mothers who can share this responsibility with their partner. Therefore, single mothers are ‘’time poor’’ (Kendig & Bianchi, 2008).

Since single mothers cannot share the responsibility for the household income and child care, it is likely this will affect their time resources. The question is whether this will result in increasing work hours for the single mother and therefore decreased time for child support.

Current data from the Netherlands Statistics (CBS, 2018a) shows that single mothers have a lower net employment rate than mothers with partner (64.9 for single mothers and 78.7 for mothers with partner). However, this does not simply answer the question asked before. Since mothers with partner have a shared responsibility for household income and child care, it makes sense they will have more opportunities to work compared to single mothers while still having enough time for childcare. Furthermore, the data shows that 25% of the working single mothers are working fulltime, compared to 18.5% of the working mothers with partner (CBS, 2018a). Still this does not imply that single mothers work more compared to mothers with partner, but the higher percentage of fulltime jobs among working single mothers does show a higher dependency on their job. As a result of this, single mothers will likely have less time for child care.

As for the factor income discussed before, the limited time for child support could affect child weight through diet and physical exercise. Firstly, limited time resources could result in a lack of time for cooking – healthy – meals and will therefore encourage consumption of prepared food and consequently result in an unhealthier diet and higher risks of overweight or obesity for children as discussed earlier (Gable et al., 2000). Secondly, due to limited time resources the mother could be of limited support in encouraging the child to do physical activities. Springer et al. (2006) found that family encouragement is positively related to physical activity, and as mentioned earlier, increasing physical activity among children will lower the chances of getting obese (e.g. Sothern, 2004). Therefore, this could have a negative effect on the child's weight. Furthermore, Hawkins et al. (2008) found specifically that long hours of maternal employment was associated with a reduced access to healthy foods and physical activity for children. Consequently, the results of a study from Quarmby et al. (2010) show that children from single parent families receive less parental support for doing physical activities and therefore spend more time doing sedentary activities (e.g. watching TV, computer gaming and listening to music) than children from dual parent families.

Knowledge mother

The last factor explaining the relationship between living in a single mother household and childhood obesity in this conceptual model is parental knowledge. The Institute for Women's Policy Research (2018) found that only 24.1% of the single mothers in the United States have obtained an associate or bachelor's degree, compared to 37.3% of the married mothers. The Netherlands Statistics studied a generation of mothers, born in 1970, for 45 years and found that regardless the age of the mother, most single mothers were low educated (CBS, 2018b). Since this data quite clearly suggests that single mothers in general are low educated, it is interesting to look at the influence of a parent's education on a child's health and weight.

Kendig & Bianchi (2008) found that college-educated mothers spend more time with their children compared to low educated mothers. They explain this by the role of education in creating awareness of the importance of investment in child support. Therefore, higher educated mothers would prioritize investing time in their children and end up spending more time supporting them (Kendig & Bianchi, 2008). Langnäse & Müller (2002) studied the relation between social class differences and childhood obesity, where they used the highest school education from either the mother or father as an indicator for social class. They found that

children from low social class were significantly more overweight than children from high social class, suggesting that education of the parent does influence childhood obesity. Furthermore, Lamerz et al. (2005) found a significant relationship between parental years of education and childhood obesity.

2.4.4 Control variables

However, the three resources as described above can be influenced by other factors. In order to measure the real effect of these factors, this study will need to control for the effects of a few other elements.

Number of siblings

Datar (2017) found an association between the number of siblings and child BMI and obesity in the United States. According to their analysis, having an additional sibling will decrease the likelihood of obesity in early adolescence with 2.6 percentage point (Datar, 2017). Furthermore, in line with the household production model (Becker, 1965), resources of income, time and parental knowledge will have to be divided by all siblings. As this number increases, resources will become more costly and provision will likely decrease. Since the number of siblings could have this effect on resources, it is important to control for this factor in order to measure the real effect of resources in the relationship between living in a single mother household and childhood obesity.

Family nutrition environment

Next, it is important to control for the genetic effect. Childhood obesity is determined by genetic, environmental and psychosocial factors (Kopelman, 2000). This study is in particular interested in the influence of environmental and psychosocial factors of a single parent household on childhood obesity and consequently uses these factors as explanatory variables in the model. However, many studies have shown that children with obese parents are more likely to be overweight compared to children who do not have an overweight parent (Sothern, 2004; Strauss & Knight, 1999; Dowda et al., 2001; Davison & Birch, 2002). This genetic effect cannot simply be ignored, and therefore this model will control for mother's weight.

Age of child

Additionally, the model will control for the age of the child. This is necessary because the prevalence of obesity among different age groups differs a lot. The WHO Country Profile of Germany (2013) for example shows that between 2003 and 2006 that from all children aged 3-6 years 2.9 percent was obese. On the other hand, from all children aged 7-10 years 6.4 percent was obese. Furthermore, the WHO Country Profile of Germany (2013) illustrates that numbers of overweight between age 10 and 19 differ. Furthermore, Ogden et al. (2016) studied trends of obesity prevalence among children in de US and consistently found a higher prevalence of obesity among older children, compared to younger children. These consistent differences in prevalence of obesity among different age group could have implications for the analysis and therefore will be controlled for.

Gender of child

At last, the model will control for the variable gender. The WHO Country Profile of Germany (2013) found differences in obesity prevalence for different age groups as well as gender.

Overall, in the younger age group till age 7, girls show a higher prevalence of obesity. However, after age 7 boys show an increase in overweight and obesity prevalence that eventually transcends the numbers for girls. It is important to eliminate this gender effect in de analysis by controlling for it.

2.4.5 Hypotheses

This conceptual model results in the following hypothesizes:

H_1: Living in a single mother household does not affect child's obesity risk

H_2: Household income does not affect child's obesity risk

H_3: Knowledge of the mother does not affect child's obesity risk

H_4: Time of the mother do not affect child's obesity risk

2.4.6 Conceptual model

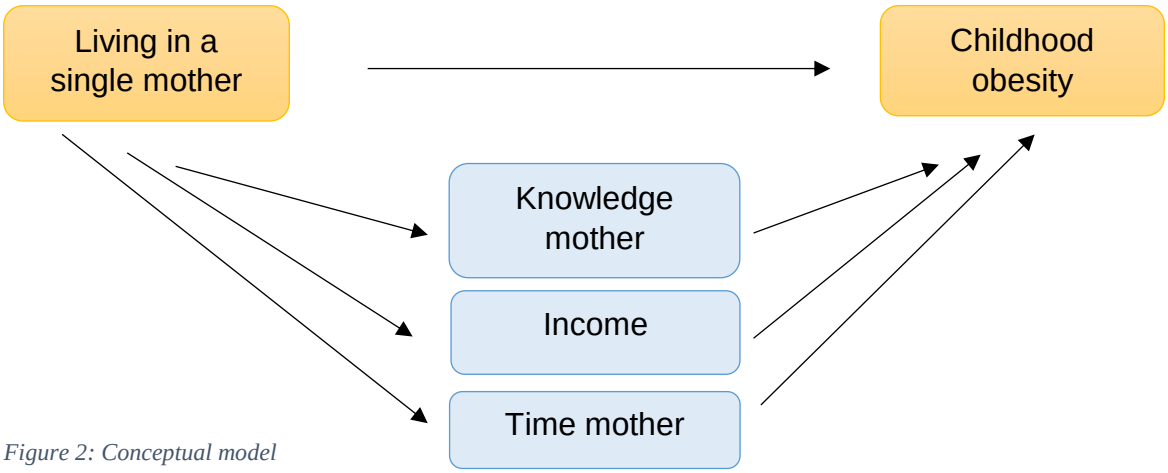

Figure 2: Conceptual model

4. Data and methodology

4.1 Dataset

The data that will be used for this study is secondary data from the ‘’German Health Interview and Examination Survey for Children and Adolescents’’ (KiGGS). This survey has been running since 2003 by the Robert Koch Institute (RKI), with a baseline study from 2003 to 2006. After 2009 the KiGGS continued collecting data in waves as a more long-term study in order to monitor the countrywide health of Germany. The RKI operates within the Federal Ministry of Health in Germany and aims to gain scientific insights for decision-making in the health sector. This study will make use of the baseline study data.

4.1.1 Sampling

Data has been collected from May 2003 till May 2006. Participants were selected in two steps. Firstly, 167 places of investigation were selected randomly and secondly the subjects were selected randomly from local population registries (Kurth et al., 2008). During the pilot study, several random selecting methods were tested on their potential efficacy. After comparing the advantages and disadvantages of all methods, a general random sample from the population registries for all age groups was used for the eventual baseline study (Robert Koch Institute, 2005). Eventually, study has a total of 17,642 participants, children and adolescents aged from 0 to 17, of which 8985 boys and 8656 girls (Kurth et al., 2008).

4.1.2 Study design

The KiGGS is a cross-sectional study, meaning that the representative random sample of children and adolescents aged 0-17 years in Germany have been examined at one specific point in time (Babbie, 2007). The advantage of this type of approach is that results will be found relatively quick, making it more reliable for direct implementation (Robert Koch Institute, 2005). However, the disadvantage of cross-sectional studies is that it does not analyze behavior over a period of time and therefore cannot help determine the cause and effect (Babbie, 2007). This disadvantage will be offset by a re-examination of the same group in later waves of the KiGGS study (Robert Koch Institute, 2005). However, this study will only use data of the baseline study. It is therefore important to keep in mind that incidences could limit the precision of the study.

4.1.3 Data collection

Data of the KiGGS is obtained through interviews as well as physical examination. Until the age of 11, questionnaires have been filled out by the parents. Physical has been conducted by medial staff (Robert Koch Institute, 2005). Themes that play a big role in the survey are health status, health behavior, living conditions, protection and risk factors, and utilization of health services. The core survey focusses on environmental impact on health, mental health and motor development (Robert Koch Institute, 2005). This study will mainly use data of the environmental survey as well as socio-demographic data.

4.2 Operationalization of concepts

Childhood obesity

The dataset has several measurements of childhood obesity. Firstly the dataset offers two measurements in BMI based on either the IOTF cut offs (Cole et al., 2000) or the Kromeyer-Hauschild (Kromeyer-Hauschild et al., 2001). Furthermore, the dataset offers numbers on waist-hip ratio and waist- and hip circumference.

For the analysis the dependent variable, *childhood obesity,* is generated based on the data of the internationally acceptable definition of child overweight and obesity, using the IOTF cut offs (Cole et al., 2000). This indicator is categorical and provides the answer categories 'yes', 'no' and 'not applicable for age'. A new dummy variable is created, where 'no' is coded as 0 and 'yes' coded as 1. 'Not applicable for age' is treated as a missing value.

In order to check whether the results of this study are not dependent on the measurement of *childhood obesity*, a second analysis of the same model has been conducted, using waist-hip ratio as dependent variable.

Living in a single mother household

The main independent variable, *living in a single mother household,* is measured in the dataset by the main residence of the child. This study considers single mother households to be households existing of only one mother plus children, without the presence of either a father or a partner. Answer categories on the main residence of the child question are 'parents', 'mother and partner', 'father and partner', 'mother', 'father' and 'other'. This variable is recoded, where 'parents', 'mother and partner', 'father and partner' are merged into one category. The new variable is coded as followed: 0= 'two parents/parent and partner', 1= 'mother' and 'father' and 'other' are treated as missing variables.

Income

The three independent, explanatory variables are *income, time mother* and *knowledge mother*. *Income* is measured in the dataset by the monthly household income. This is a categorical variable with 13 answer categories starting with '< 500 €' and ending with '≥ 5000 €'. A new variable is created with three categories. All answer categories between '< 500 €' and '1500 €' are considered to be low income. All answer categories between '1500 €' and '3000 €' are considered to be middle income, and all answer categories above '3000 €' are considered to be high income. For interpretation reasons, the new variable is coded as followed: 1= 'high income', 2= 'middle income' and 3= 'low income'.

Time mother

Time mother is measured in the dataset by the occupation of the mother. This variable is categorical and has six categories. 'Not working', 'unemployed', 'temporary exemption', 'part-time working', 'fulltime working' and 'trainee'. A new variable is created with three categories, coded as 1= 'not working', 2= part-time working' and 3= 'fulltime working'. 'Not working', 'unemployed', 'temporary exemption' are merged into the category of 'not working' and 'trainee' is merged into the category of 'fulltime working'.

Knowledge mother

Knowledge mother is measured in the dataset by the level of graduation of the mother. This a categorical variable with eight different categories. Since the dataset is German it is quite hard to translate the different school types. Therefore, translated into years of education, a new variable is generated coded as 1= '<10 years of education', 2= '10 years of education' and 3= '>10 years of education'. In this case, 'Haupt-/Volksschulabschluss' , 'Ohne Schulabschluss' and 'Noch keinen Schulabschluss' are considered to be less than ten years. 'Realschulabschluss (Mittl. Reife)' and 'Abschluss Polytechn. Oberschule' are considered to be ten years and 'Fachhochschulreife' and 'Abitur (Gymnasium bzw. EOS)' are considered to be more than ten years. The category 'Anderer Schulabschluss' stands for 'other' and will be treated as missing.

Control variables

The control variable *number of siblings* is measured in the dataset by whether the child has siblings in the household. The variable is categorical with answer categories 'no', 'yes' and 'not applicable for age'. This variable is transformed into a dummy variable where 0= 'no' and 1= 'yes'. 'Not applicable for age' is treated as missing.

The control variable *family nutrition environment* is measured in the dataset by the BMI of the mother. The variable is categorical with answer categories 'underweight (BMI<18.5)', 'normal weight (BMI 18.5-25)', 'overweight (BMI 25-30)' and 'obesity (BMI>30)'. This variable is transformed into a dummy variable where 0 is coded as 'no overweight' and 1 is coded 'overweight or obese'.

The control variable *age of child* is measured in the dataset by different age groups of three years starting with '0-2 years old' and ending with '14-17 years old'. Since obesity in children below age three is hard to measure and even harder to compare with older groups, this study will limit its analyses on children aged from three till eighteen. Therefore, a new variable will be created containing four age groups where 1 is coded as '3-6 years old', 2 is coded as '7-10 years old', 3 is coded as '11-13 years cold' and 4 is coded as '14-17 years old'. This grouping is comparable to the study of Kurth & Rosario (2007) on obesity in childhood in Germany that used the same dataset of KiGGS.

The last control variable *gender of child* is measured in the dataset by the two answer categories 'boy' or 'girl'. For analysis purposes this variable has been recoded where 0 is 'boy' and 1 is 'girl'.

4.3 Analytical methods

The first section of the results will give the descriptive statistics of all variables. Since all the variables are categorical, this section only gives information about the frequencies in terms of proportions. Furthermore, the bivariate statistics investigate the relation between different variables in terms of correlation and chi square. In this section multicollinearity between the independent variables will be tested in order to find the best combination of variables for the model that will be built to eventually test the hypotheses. A methodological problem of the conceptual model is the use of both *income* and *time mother* as explanatory variables. In the dataset, *income* is measured as household income and *time mother* is measured in terms of working, part-time working and fulltime working. Since fulltime working most likely comes

with a higher household income, these two variables would cause multicollinearity. To avoid this from happening, the influence of both variables will be tested in separate models.

In order to test the hypotheses of this study, a binary logistic regression will be conducted. The dependent variable of this study has only two outcome possibilities (*obese* or *not obese*) which makes it suitable for this type of regression. Furthermore, this study aims to find the relationship between independent variables and the probability of *childhood obesity*. The outcomes of a binary logistic regression will be in odds, and therefore perfectly suit the aim of this study.

The hypotheses will be tested in different models. Firstly, a model will be built using *childhood obesity* as dependent variable and using only *living in a single mother household* as independent variable, testing the relationship between living in a single mother household and childhood obesity. Next, in a second model *time* and *knowledge mother* will be added, whereas in the third model only *income* and *knowledge mother* will be added. These models will try to identify the influence of the household income, the time of the mother and the knowledge of the mother in the relationship between living in a single mother household and childhood obesity. At last, as fourth model will be created from the most influential explanatory variables and the control variables.

5. Results

This section will give the results of the analyses. Firstly, the descriptive and bivariate results will be discussed followed by the binary logistic regression.

5.1 Descriptive results

Table 1 gives a first impression on the frequencies of all variables used in the analysis. From all children in the dataset, a minor percentage of 4.77 (N=707) is obese. Furthermore, 10.59% (N=1,814) of all the children is living in a single mother household. The bar chart in figure 3 illustrates a difference in percentage of obese children for children living in a single mother household and a dual parent household. Of all children living in a single mother household, 6.33% is obese, whereas only 4.47% of the children living in a dual parent household is obese. These results give a first impression of the relationship between living in a single mother household and childhood obesity.

Table 1 shows that 21,68% (N=3,589) of the participants have a low household income. 53.95% (N=8,929) have a middle household income and 24.37% (N=4,034) have a high income. Furthermore, 40.02% (N=6,890) of all the children in the dataset have a mother that is not working. 39.21% (6,752) of the mothers are working part-time and only 20.77% (3,576) are working fulltime. Next to that, 24.13% (N=4,083) of all the children have a mother who has less than ten years of education. Almost half of the mothers have had about ten years of education (46.96%; N=7,945) and 28.9% (N=4,890) of the mothers has had more than ten years of education.

Additionally, 75.79% (12,604) of the children in the dataset have at least one sibling in the household. 35.64% (N=6,047) of the children in the dataset have a mother that is overweight or obese. Slightly more children are male (50.94%; N=8,985). Most children in the dataset are aged between 7 and 10 years (27.96%; N=4,148).

Table 1: Descriptives of all variables used in analyses

Variable	*Proportion of participants (N=17,640)*
Childhood obesity	
Childhood obesity: Yes	707 (4.77%)
Childhood obesity: No	14,128 (95,23%)
Living in a single mother household	
Living in a single mother household: Yes	1,814 (10,59%)
Living in a single mother household: No	15,310 (89,41%)
Income	
Income: Low	3,589 (21,68%)
Income: Middle	8,929 (53,95%)
Income: High	4,034 (24,37%)
Time	
Time: Not working	6,890 (40,02%)
Time: Working part-time	6,752 (39,21%)
Time: Working fulltime	3,576 (20,77%)
Knowlegde	

Knowlegde: <10 years of education	4,083 (24,13%)
Knowlegde: 10 years of education	7,945 (46,96%)
Knowlegde: >10 years of education	4,890 (28,9%)
Siblings	
Siblings: Yes	12,604 (75,79%)
Siblings: No	4,027 (24,21%)
Family nutrition environment	
Family nutrition environment: Mother not overweight	10,920 (64,36%)
Family nutrition environment: Mother overweight	6,047 (35,64%)
Gender of child	
Gender: Male	8,985 (50,94%)
Gender: Female	8,655 (49,06%)
Age of child	
Age: 3-6 years old	3,875 (26.12%)
Age: 7-10 years old	4,148 (27.96%)
Age: 11-13 years old	3,076 (20.73%)
Age: 14-17 years old	3,736 (25.18%)

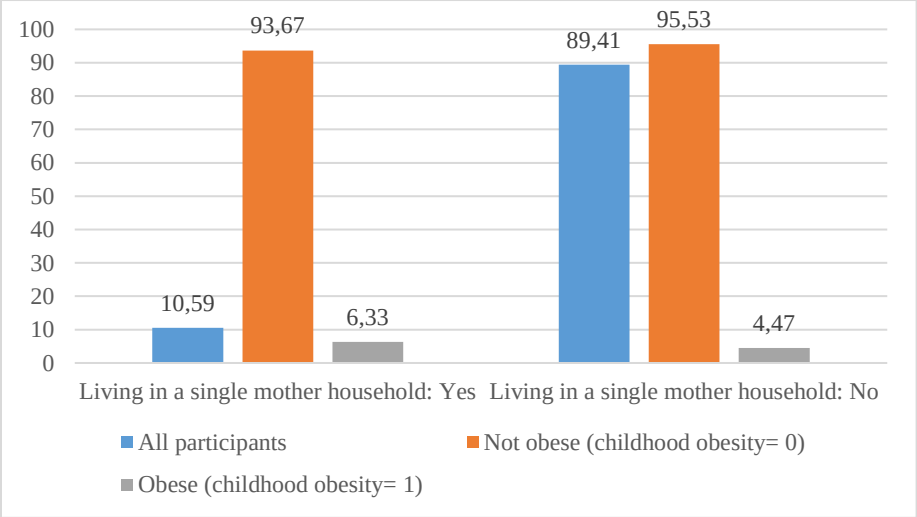

Figure 3: Percentage of obese children living in a single mother household

Table 2 illustrates the correlations between childhood obesity and the independent variables of the analysis. Furthermore, the table shows correlations between all the independent variables as well. First of all, the table shows that there is a significant positive correlation between childhood obesity and living in a single mother household ($r=0.03$; $p<0.05$). When looking at the other explanatory variables the table shows that childhood obesity and household income are significantly positively correlated ($r=0.08$; $p<0.05$). Subsequently, childhood obesity and time mother have a significant negative correlation ($r=-0.06$; $p<0.05$) as well as childhood obesity and knowledge mother ($r=-0.09$; $p<0.05$). Although all correlations are significant, the associations are rather weak. These correlations suggest, confirm literature, that as mother has a higher education level and is working longer hours, childhood obesity will likely decrease. When looking at income, the correlation shows that as the household income increases childhood obesity will also increase. However, correlations only measure some type of

relationship between two variables and not a causal relationship. Therefore it is important to further investigate the relationship by doing other analyses in order to be more sure about how to interpret the relationship between the variables.

Furthermore, living in a single mother household is significantly positively correlated with household income (r=0.33; P<0.05) as well as time mother (r=0.05; p<0.05) and knowledge mother (r=0.03; p<0.05). Apart from household income, the associations again are rather weak. These results suggest that, for example, as household income increases, the number of children living in a single parent household also increases as they have a positive correlation. However, as mentioned earlier, these correlations do no tell anything about the direction of the relationship so one cannot be sure about how to interpret these results.

Between the explanatory variables the associations look stronger. Firstly, household income and time mother have a significant negative correlation (r=-0.15;p<0.05), suggesting that the household income increases as the mother is working longer hours. Next to that, household income and knowledge mother have a significant positive correlation (r=0.30; p>0.05), so this is suggesting that when the mother has a higher education level the household income increases. At last knowledge mother and time mother are significantly negatively correlated (r=-0.13; p<0.05), suggesting that as the mother has a higher education level she is working less hours. Again, also these results about the correlations do not tell anything about the direction of the relationship, meaning that the relationship could also be influenced the other way around. Binary logistic regression will investigate this further.

Table 2: Correlations between dependent and independent variables

Variables	Childhood obesity	Living in a single mother household	Household income	Time mother	Knowledge mother
Childhood obesity	-				
Living in a single mother household	0.03*	-			
Income	0.08*	0.32*	-		
Time mother	-0.02*	0.05*	-0.17*	-	
Knowledge mother	-0.09*	-0.04*	-0.30*	0.12*	-

** Statistically significant at the 0.05 level (2-tailed)*

5.2 Binary logistic regression results

Table 3 gives the results of the binary logistic regression with childhood obesity as dependent variable, living in a single mother household, household income, time mother and knowledge mother as independent variable and finally, siblings, family nutrition environment, gender and age as control variables.

Table 3: Results binary logistic regressions for each model

	Model 1	Model 2	Model 3	Model 4
Constant	-3.06	-2.48	-2.92	-3.88
Living in a single mother household (ref: not living in a single mother household)	0.37**	0.32**	0.03	0.13
Household income (ref: high)				
Middle			0.27*	0.16
Low			0.77**	0.57**
Time mother (ref: not working)				
Working part-time		-0.17		
Working fulltime		-0.12		
Knowledge mother (ref: <10 years of education)				
10 years of education		-0.56**	-0.52**	-0.43**
>10 years of education		-1.05**	-0.88**	-0.71**
Siblings (ref: no siblings in household)				-0.08
Family nutrition environment (ref: mother is not overweight)				1.21**
Gender (ref: boy)				-0.11
Age (ref: 3-6 years old)				
7-10 years old				0.57**
11-13 years old				0.55**
14-17 years old				0.68**
Log likelihood	-2704.79	-2527.56	-2425.70	-2194.36
Likelihood ratio chi-square	10.16**	104.74**	135.47**	352.14**

** Statistically significant at the 0.05 level (2-tailed)*

*** Statistically significant at the 0.01 level (2-tailed)*

Model 1 is a binary logistic regression childhood obesity and living in a single mother household as dependent variable only. In this model, the coefficient of living in a single mother household appears to have a significant effect on childhood obesity. As living in a single mother household increases from 0 to 1, the log-odds of being obese as a child increases with 0.37. In other words, when a child is living in a single mother household, compared to a dual parent household, chances of being obese increase with 0.37 log-odds.

The second model includes time mother and knowledge mother as well as the other variables of model 1. When looking at the coefficient of living in a single mother household, one can see that the coefficient decreased from 0.37 to 0.12, suggesting that by adding time mother and knowledge mother the explanatory value of living in a single mother household decreases, given all the other independent variables are constant. Time mother does not have a significant effect on childhood obesity. However, knowledge mother does have a significant effect. For children with a medium educated mother, compared to children with a low educated mother, chances of being obese decrease with 0.56 log-odds, given all the other independent variables are constant. Moreover, for children with a highly educated mother, compared to children with a low educated mother, chances of being obese decrease with 1.05 log-odds, given all the other

independent variables are constant. This suggests that the chances of being obese as a child decrease as the mother is higher educated.

The third model includes next to childhood obesity as dependent variable, and living in a single mother household as independent variable, household income and knowledge mother. When looking at the effect of living in a single mother household on childhood obesity in this model, this effect is no longer significant. On the other hand, household income and knowledge mother seem to have an significant effect, suggesting that these variables take away some of the explanatory value of living in a single mother household. For children living in a middle income household, compared to children living in a high income household, the chances of being obese increase with 0.27 log-odds, given all the other independent variables are constant. For children living in a low income household, compared to children living in a high income household, the chances of being obese even increase with 0.77 log-odds, given all the other independent variables are constant. For all children with a medium educated mother, compared to children with a low educated mother, chances of being obese decrease with 0.52 log-odds, given all the other independent variables are constant. Moreover, for children with a highly educated mother, compared to children with a low educated mother, chances of being obese decrease with 0.88 log-odds, given all the other independent variables are constant. Compared to model 2, the effect of knowledge mother decreased slightly.

The last model includes, next to the variables mentioned in model 3, the control variables siblings, family nutrition environment, gender and age. In this model, the effect of living in a single mother household remains insignificant. Furthermore, when it comes to household income, only children living in a low income household, compared to children living in a high income household, have significant higher chances of being obese (0.57 log-odds). The effect of children living in a middle income household compared to children living in a high income household is no longer significant, meaning that the log-odds of being obese do not significantly differ for these two groups. For children with a medium educated mother, compared to children with a low educated mother, chances of being obese decrease with 0.43 log-odds. Moreover, for children with a highly educated mother, compared to children with a low educated mother, chances of being obese increase with 0.71 log-odds. From the control variables, only family nutrition environment and age have a significant effect on childhood obesity. When the child have a mother with overweight or obesity, compared to children not having an overweight or obese mother, chances of being obese as a child increase with 1.21 log-odds, meaning that children with overweight or obese mothers are much more likely to be obese themselves, compared to children with a mother with a healthy weight. When the child is 7-10 years old, compared to children aged 3 to 6, the chances of being obese increase with 0.57 log-odds. When the child is ages 11 to 13, compared to children aged 3 to 6, chances of being obese increase with 0.55 log-odds. Subsequently, then the child is aged 14 to 17, compared to children aged 3 to 6, chances of being obese increase with 0.68 log-odds. These results require all other independent variables to remain constant. This suggests that as the child gets older, chances of being obese increase. Overall the model tells that the effect of knowledge and income on childhood obesity is quite strong, whereas living in a single mother household does not seem to play a big role.

As mentioned earlier, in order to test whether the results of model 4 are not dependent on the measurement of childhood obesity another model has been created using waist-hip ratio as dependent variable. The results of this analysis show the same significant influence of knowledge and high income. Results can be found in the appendix.

5.3 Model fit

In order to decide on whether the previous models are statistically correctly specified, a few tests have been conducted. Firstly, a link test was performed. This test tries to detect a type of specification error which is called the link error, by checking if the wrong forms of variables have been used or whether some additional independent variables are missing (Mehmetoglu & Jakobsen, 2016). For any of the models this test does not seem to be significant, so misspecification will not be likely.

Furthermore, the log likelihood measures the fit of different models, using the same dataset. This measure is useful for comparing the four models (Mehmetoglu & Jakobsen, 2016). The smaller the negative value of the log likelihood, the better the model predicts the dependent variable. As table 3 shows, model 4 has the smallest negative value, compared to the other models, so this model would be best at predicting the dependent variable, hence childhood obesity.

Additionally, table 3 shows the results of the likelihood ratio chi-square of all models. This measure compares the goodness of fit of the model with independent variables with a model without independent variables. When the value is significant, the model as a whole (including independent variables) fits significantly better than an empty model (Mehmetoglu &Jakobsen, 2016). As shown in table 3, all models have an significant likelihood ratio chi-square value, meaning that all model have a better goodness of fit compared to an empty model. However, the likelihood ratio chi-square value of the last model is much higher than the value of the previous models. Despite the significance of all models, this result shows that the significance of the last model is strongest.

6. Conclusion and discussion

This study has analyzed the relationship between living in a single mother household and childhood obesity in German youth. Furthermore, the study also analyzed the influence of respectively household income, knowledge of the mother and time of the mother on childhood obesity. This section will conclude about the results that were found in the analyses.

As was expected in the conceptual model, this research found a significant relationship between living in a single mother household and childhood obesity. However, based on the theories of evolutionary, economic and sociological influence, the conceptual model expected this relationship to be caused by the factors knowledge of the mother, household income and time. The influence of these factors will be discussed firstly.

This study found that knowledge of the mother, measured as years of education, has a significant influence on childhood obesity. This is in line with the findings of Lamerz et al. (2005) that there is a relationship between parental years of education and childhood obesity and the expectations of the conceptual model. This effect is especially strong of children with a highly educated mother (more than ten years of education) compared to children with low educated mothers (less than ten years of education). However, in the conceptual model this factor was described as parental knowledge. While education level could be a good predictor of this factor, one cannot assume it perfectly reflects the parental knowledge. As the analyses have emphasized the important role of education of the mother, it might be interesting to look deeper into the relationship between parental knowledge and education level.

Furthermore, this study has found that the obesity risk for children is not the same for different income levels. In fact, children from low income households are at higher risk of being obese than children from high income households. This is in line with the study of Dowda et al. (2011) who found that children from households with larger income have a lower risk to be overweight. However, children from middle income households do not have a significant higher risk of being obese than children from high income households. To conclude, only children living in a low income household are at significant higher risk of being obese, which is not completely in line with the expectations of the conceptual model. Literature suggested that lower income could lead to an increase in consumption of prepared food (Gable et al., 2000), which could cause obesity (Juul & Hemmingson, 2015). One could argue that possibly only the low income households consume a larger amount of these type of food. As soon as the household has reached a middle income, the provision of the cheaper processed food is no longer necessary, so it no longer plays a significant role in the development of obesity. Thus, this could explain why household income only has a significant effect on childhood obesity for the low income group.

Consequently, this study found that time of the mother does not have a significant effect on childhood obesity. This is in contrary with the expectations from the conceptual model. This is an interesting finding, since literature suggested long hours of maternal employment reduce the access to healthy food and physical activity (Hawkins et al., 2008). One could expect that this would lead to higher risks of childhood obesity, but maybe the reduced access to healthy food and physical activity does not automatically lead to consumption of unhealthy food and physical

inactivity and therefore does not influence the weight of the child. It would be interesting to look deeper into the responsibility role of children living in single mother households. An older study of Weiss (1979) found that single parents who work fulltime need to share the household responsibilities with their children. One could argue this would lead to a larger sense of responsibility in general, which could prevent the children from overeating unhealthy food and being physically inactive. Another implication to this result could be the measurement of time of the mother as working hours of the mother. The use of this measurement could have an effect on the results, as it does not perfectly reflect one another and could explain why the results of the analysis where not significant. In future research it would be interesting to look into a better measurement of parental time in order to create better and more reliable results

Furthermore, this study found a very strong genetic effect on childhood obesity. Children of overweight parents are at significant higher risk to be obese than children of parents with an healthy weight, which is completely in line with the expectations that children from obese parents are more likely to be obese themselves (Sothern, 2004; Strauss & Knight, 1999; Dowda et al., 2001; Davison & Birch, 2002). This outstanding result does emphasize the important role of genes. This is interesting for policy makers who try to prevent childhood obesity, as this is a meaningful factor that they cannot control. Subsequently, this could show how genetics actually are in interaction with environmental and psycho-social factors, before influencing childhood obesity as Kopelman (2000) argues, since this study found significant effects of genes as well as education and income (environmental factors) on childhood obesity.

At last, this study wants to reflect on the first statement of influence of single motherhood on childhood obesity which was found in many studies obesity (Strauss & Knight, 1999; Chen & Escarce, 2010; Schmeer, 2012; Tremblay & Willms, 2003; Huffman et al., 2010; Byrne et al., 2011). As drawn in the conceptual model and found in an extensive amount of literature, the different levels of childhood obesity for children living in single mother households and dual parent household is caused by the factors education of the mother and household income. After adding these factors to the model, the effect of living in a single mother household became insignificant, suggesting that this is not an influential factor in itself. To conclude, the main finding of this study is that single motherhood is a risk factor of low education as well as low household income. These factors in return have an significant influence on childhood obesity.

The findings can easily be underlined when answering the research question of this study. *How does living in a single mother household influence childhood obesity?* The answer is that living in a single mother household does have a negative influence on the development or existence of childhood obesity, as previous studies have found, only this influence is mainly caused by the lower income level of single mothers as well as the lower education level and the higher overweight rates of single mothers.

These findings are interesting for future policy makers, as childhood obesity is still an important topic in public health. This study has exposed that the higher rates of childhood obesity in single mother households are more likely caused by income and education level. Furthermore, the influential role of genes should not be ignored, which something the policy makers cannot control. In order to make policy on decreasing childhood obesity and prevention, it would be interesting to look deeper into the protective role of the mother's education.

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Appendix

Table 4: Results linear regression for model 4 using wait-hip ratio as dependent variable

	Model 4
Constant	0.923
Living in a single mother household (ref: not living in a single mother household)	-0.002
Household income (ref: high)	0.002*
Knowledge mother (ref: <10 years of education)	-0.004**
Siblings (ref: no siblings in household)	-0.002
Family nutrition environment (ref: mother is not overweight)	0.006**
Gender (ref: boy)	-0.064**
Age (ref: 3-6 years old)	-0.028**
F-score	534.18**
Adjusted R-squared	0.3981

** Statistically significant at the 0.05 level (2-tailed)*
*** Statistically significant at the 0.01 level (2-tailed)*