

Minos, Dimitrios

Working Paper

"Eat, my child". Overweight and obesity among children in developing countries

Discussion Papers, No. 197

Provided in Cooperation with:

Courant Research Centre 'Poverty, Equity and Growth in Developing and Transition Countries',
University of Göttingen

Suggested Citation: Minos, Dimitrios (2016) : "Eat, my child". Overweight and obesity among children in developing countries, Discussion Papers, No. 197, Georg-August-Universität Göttingen, Courant Research Centre - Poverty, Equity and Growth (CRC-PEG), Göttingen

This Version is available at:

<https://hdl.handle.net/10419/127447>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

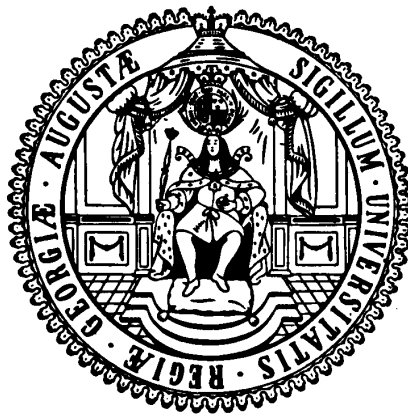
You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

Courant Research Centre

‘Poverty, Equity and Growth in Developing and Transition Countries: Statistical Methods and Empirical Analysis’

Georg-August-Universität Göttingen
(founded in 1737)



Discussion Papers

No. 197

**“Eat, my child”. Overweight and obesity among
children in developing countries**

Dimitrios Minos

Februar 2016

Wilhelm-Weber-Str. 2 · 37073 Goettingen · Germany
Phone: +49-(0)551-3914066 · Fax: +49-(0)551-3914059

Email: crc-peg@uni-goettingen.de Web: <http://www.uni-goettingen.de/crc-peg>

“Eat, my child”. Overweight and obesity among children in developing countries

Dimitrios Minos*

Research Associate

* Chair of Development Economics

Georg-August-University of Göttingen

JEL code: I12, I18, P46

Key words: obesity, nutrition transition, developing country, South Africa

Göttingen, September 2015

Abstract

Childhood obesity in developing countries is a topic that hasn't found its way in the economic literature yet. Despite the fact that obesity rates are rising worldwide and the phenomenon is very present even among the poorest of households in developing countries, most of the attention is still drawn towards industrialized ones. This paper utilizes the South African NIDS panel data set to highlight some of the aspects policy makers should bear in mind. In particular, drivers of the phenomenon and their resulting policy options that are widely used in industrialized countries may not be appropriate in a developing setting, especially in one where excess body weight is considered by many as a positive outcome.

1. Introduction

Since the Millennium Declaration in 2000 a large part of the literature on nutrition in developing countries has revolved around undernutrition. While this has drawn the attention of researchers and policy makers alike, another health issue seems to be on the rise. According to the World Health Organization, overweight and obesity rates are rising all over the world and especially in developing countries. Since 2002 obesity rates in Sub-Saharan Africa have increased by almost 30% and other regions are following the same trend¹. Particularly in South Africa childhood obesity had reached almost 8% in 2012. While this figure seems to stabilize, the share is still surprisingly high for a developing country and is close to overtaking the share of undernourished children².

Obesity is associated with several health risks (Mokdad et al., 2001), as well as direct and indirect costs that influence the economic performance of individuals and subsequently countries (Anderson, Butcher and Levine, 2003). Moreover, Krebs and Jacobson (2003) and Whitaker et al. (1997) claim that excess body weight can persist from early childhood, to adolescence and adulthood, thus creating a burden that is difficult to overcome. Besides that, Case and Menendez (2009) argue that early life conditions can predetermine a child's outcome in the future. Furthermore, Anderson, Butcher and Levine (2003) claim that childhood obesity can lead to problems in the children's social relations and school performance, thus affecting a country's human capital. Furthermore, Lockwood and Collier (1988) consider malnutrition in general as a violation of a child's human rights and a restriction in their freedom and capabilities³. It is therefore essential to monitor the phenomenon from early childhood in order to prevent potential consequences at an early stage.

So far very few studies have examined the economic aspects of the phenomenon in a developing setting, since most researchers focus on industrialized ones. Even fewer have used appropriate econometric techniques, since most use cross sectional data and descriptive statistics and do not account for omitted variables, time invariant characteristics or unobserved heterogeneity. Moreover, the discussion seems to revolve around income as the main factor that drives obesity rates (Abdulai, 2010; Qaim and Römling, 2012). However, the results are inconclusive and the role of income is still unclear, especially since obese children can also be found among the poorest of households.

¹ WHO data.

² NIDS data.

³ The capability approach developed by Amartya Sen (1985) is the authors' guideline.

The main argument presented in studies concerning industrialized countries, revolves around the mother of the child. Fertig, Glomm and Tchernis (2009), for instance, made a strong case that the number of hours a mother works is detrimental to the quality of care a child receives and its future outcome in relation to obesity. Mahler (2007) presents similar arguments for children in Germany, whereas Garcia et al. (2006) complement this line of argumentation by claiming that better educated mothers tend to provide better care. This paper makes the case that this type of argumentation may not be appropriate in a developing setting. If the mother is working, there is usually some other household member that takes care of the children. Moreover, arguments are presented that higher school education does not necessarily imply higher health awareness and that individuals in developing countries may have a strong preference towards higher body weights, which in turn can affect the health status and wellbeing of children.

This paper utilizes the National Income Dynamics Survey of South Africa to examine the drivers of overweight and obesity among children at school age. It is one of the very few studies that focus on childhood obesity in a developing setting and to our knowledge the first to use a panel data set to account for unobserved heterogeneity.

The rest of the paper contains a comprehensive literature review and conceptual framework in section 2, a detailed description of the data and descriptive statistics in section 3, while section 4 presents the results of the analysis. Finally, we conclude in section 5 proposing some policies, in order to prevent the expansion of childhood obesity as early as possible.

2. Conceptual Framework

Obesity is mainly a problem in the developed world. In recent years, however, the number of overweight children increases gradually in developing countries as well. In order to identify the causes of this phenomenon, most authors refer to the undernutrition literature, since both are forms of malnutrition and for most aspects the argumentation is similar.

The main assumption is that individual welfare is conditional on consumption C and a person's health status H (or high body weight O).

$$W_t = f(C, H(O^-))$$

In the case of increasing body weight calorie intake exceeds calorie expenditure for longer periods of time.

$$CI_t > CE_t$$

The question is, however, what drives daily intake expenditure. Following a similar framework to Römling and Qaim (2012) one can identify individual, household and community or environmental characteristics as underlying causes that influence children outcomes.

$$CI_t = f(I, H, E)$$

$$CE_t = f(I', H', E')$$

These factors can have direct or indirect effects on calorie intake and expenditure. This is illustrated in Figure 1.

Figure 1: Summary of direct and indirect individual, household and environmental factors

	Individual	Household	Environmental
Intake	Food Consumption*	Demographics, Economies of scale	Food prices, food availability
Intake/ Expenditure	Age*, Gender*, Genetic predisposition(?)*, Preferences/Habits	Income, Caregiver, Genetic predisposition(?)*, Behaviour/Habits	Urban location, Ethnicity(?)*, Culture/Traditions
Expenditure	Physical activity*	Means of transport	Public transport

Note: Own composition. * denotes direct factors

However, it is rather difficult to disentangle certain effects, since some factors may have an impact on both (intake and expenditure) and also in opposing directions. Moreover, it is safe to assume, that especially in the case of underlying factors, their effects can be observed after longer periods of time. Some may have short-term impacts, while others act in the longer run.

The role of income is rather unclear. The literature focuses mainly on developed countries and finds a negative relationship between socioeconomic status and obesity⁴. The argument here is that healthy living has become very expensive in terms of money and time and is unaffordable for the lower classes.

The obesity epidemic in the developed world was already considered a problem back in the 80s, but since then it has not drawn much attention until recently. Some authors, however, tried to highlight its importance and the factors that lie behind it, like for example Coate (1983), who stresses that a young person's diet is strongly correlated to the family's income. In order to test this he applies a 2SLS using data from the US to measure obesity among children aged 0-3 and 10-16. In the first stage he tries to predict calorie intake as a function of family income. He finds that family income only has a moderate positive impact and is barely significant for the age group 10-16 at the 10% level only⁵. In the second stage he uses the calorie intake as an explanatory variable for obesity. Again he finds a weak positive relationship. These results indicate that income does not have the expected impact on obesity, at least through this channel, and other factors matter as will be discussed later.

Anderson, Butcher and Levine (2003), on the other hand, report that the percentage of overweight children is higher in the low income quartile in their sample. Chou, Rashad and Grossman (2008) also find a negative impact of family income on the BMI for children aged 3-11, when controlled for other characteristics, in a study also conducted in the US. Boumtje et al. (2005) find a small but significant negative effect on the probability that a child aged 5-11 is overweight. Fertig, Glomm and Tchernis (2009) also find no impact of family income on obesity. In contrast to that Marini and Gragnolati (2006) observe that obesity among adults and children is quite larger in non-poor families in Guatemala compared to the poorer ones, this could be due to the fact that richer people in developing countries have a higher propensity to consume and also offer to their children high calorie food. Monteiro et al. (2004), on the other hand, argue that obesity in middle-income countries is related to a lower socio-economic status and add another argument by addressing the lack of information among lower income individuals concerning the risks of obesity. Finally, Abdulai (2010) finds no significant relationship between household expenditure and childhood obesity in urban Ghana. It is clear that we obtain a mixed picture in the literature as to the role of household income in explaining childhood obesity.

⁴ See for instance Boumtje et al. (2005).

⁵ For children 0-3 years old the coefficient is negative and insignificant.

Another area of focus that can influence child outcomes is urbanization. Marini and Gragnolati (2003) note that most obesity incidence are observed in the Metropolitan area of Guatemala. This could be a reflection of the higher wages achieved there, while the authors note that most fast food restaurants are located in this region. Adair and Popkin (2005) find that in urban areas of the Philippines “junk” food consumption is extremely high. There are several other ways in which residing in an urban environment can have an effect on children’s body weight. On the one hand, residing in a city increases the chance for the household to achieve a higher income, while high fat food is available at a wide price range (Abdulai, 2010; and Römling and Qaim, 2012). Moreover, one can argue that due to safety reasons children spend much more time at home instead of playing outside. In this paper we also present some evidence that the use of motorized vehicles and public transport is more widely used in urban areas, whereas in rural areas children typically walk to school.

An essential part of the discussion in the literature is about the role of the mother or the caregiver of the child. These can be seen as household characteristics. Better educated mothers tend to be more aware of the health risks and thus provide healthier food for their children. On the other hand, they are also more likely to be gainfully employed and achieve higher incomes, a fact that complicates the net effects. Moreover, employed mothers have less time to look after their children. This is especially true in developed countries, where studies show that employed mothers spend less time preparing meals for the children and tend to resort to other solutions like food away from home, in order to provide nourishment⁶. This last argument, however, may not hold in a developing setting, because of different family structures and larger households. It is usually the case that if the mother works another household member (usually a relative) steps into the role of the caregiver and looks after the children. Finally, the physical development of the mother/caregiver seems to be a key factor in the outcome of the child. Although genetic transmission of obesity from mother to child is still debated in the medical literature, it cannot be denied that an obese mother has adopted a certain behavior or lifestyle or has certain views regarding the ideal body weight that lead to this condition (Caprio et al., 2008). It is this behavior a child is very likely to adapt. To put it in other words, if a mother tends to eat high fat food herself, it is likely she will provide her children with the same type of food. Furthermore, if she leads a life low on physical activity and considers a higher body weight to be desirable, the child is very likely to

⁶ See Fertig, Glomm and Tchernis (2009).

adapt to the same lifestyle. It is, therefore, one of the most important factors with regard to childhood obesity.

Whitaker et al. (1997) claim that genetic predisposition clearly plays a role, but according to Mahler (2007) it has not changed significantly over the last two decades, whereas obesity incidence dramatically have⁷. This has to be due to structural and especially behavioural and lifestyle changes that have occurred recently and have led to more energy intake than energy consumption (Boumtje et al. (2005) and Garcia, Labeaga and Ortega (2006)). Many of these changes can be attributed to certain cultural aspects and the view of obesity in a society (Brown, 1991). Moreover, Anderson, Butcher and Levine (2003) argue that genetic predisposition only determines whether a person is susceptible to obesity, but it is these views regarding obesity and the behavioural changes connected to them are really the trigger. Furthermore, Brown (1991) argues that in many African cultures obesity is regarded as “healthy” and “prestigious”, whereas Case and Menendez (2009) take this argument further arguing that this view is more widespread in societies that have experienced deprivation in the past. Finally, several authors have covered the misconception of “benign” obesity, especially among African populations (Phillips et al., 2013). Although recent advances in the medical literature hint that genetic predisposition may cause obesity in a small part of the population and certain gene mutations are directly linked to obesity (Asai et al., 2013), the largest body of the medical literature is inconclusive on the matter. In any case it is safe to assume that both, genes and culture can be seen as time invariant over relatively short periods of time and can therefore be modeled as fixed effects.

3. Data Description and Descriptive Statistics

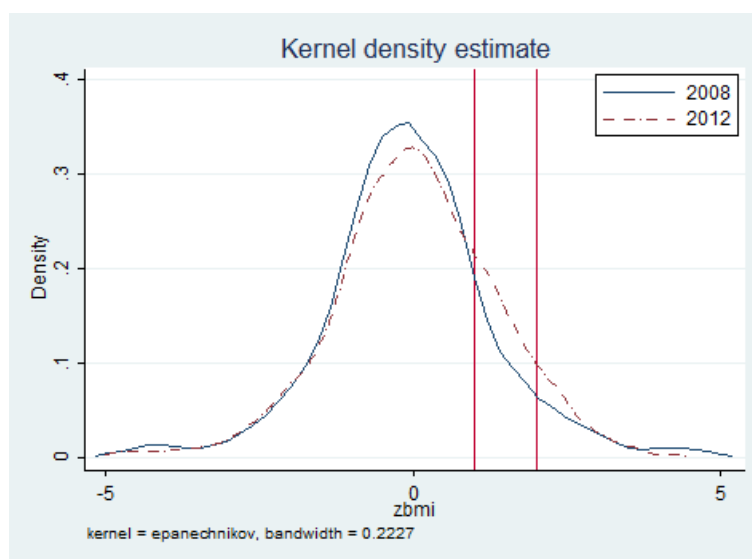
This paper utilizes the three waves (2008, 2010/11, 2012) of the South African National Income Dynamics Study (NIDS) provided by the South African Labor and Development Research Unit (SALDRU) of the University of Cape Town. The sample has been restricted to children who were between 6 and 12 years of age in the first wave, for which anthropometric data are available and follows them across all three waves. After some basic data cleaning we come up with a sample consisting of 2283 children. However, the final panel used in the analysis is an unbalanced one, due to missing values for certain variables.

⁷ See also Anderson, Butcher and Levine (2002).

Overweight and obesity are defined by the standardized BMI-z-score calculated by the SALDRU for the existing data. The BMI-z-score is the Body Mass Index of a child compared to a world median with respect to age and gender and it is the main tool the WHO uses to measure childhood obesity. It is calculated for children between 5-19 years of age and it's derived from the WHO child growth reference standard of 2007. In simpler words it is an estimation of how a child would be expected to grow given its age and gender. A child who's BMI-z-score is over 1 standard deviation from the median is considered overweight and 2 standard deviations classify it as obese.

Figure 2 shows the density estimation of the standardized BMI. A clear shift to the right can be seen, that indicates that body weight has increased substantially between 2008 and 2012. Moreover, overweight and obesity have clearly increased in the same period, as indicated by the cut off points of 1 and 2 standard deviations respectively. Furthermore, it is clear that childhood obesity is becoming a problem in South Africa, while undernutrition is still prevalent.

Figure 2: Density estimates of the BMI-z-score



Note: Own calculation using NIDS data. The red lines represent the cut-off points for overweight and obesity

Childhood overweight and obesity rates are on the rise in South Africa. Between 2008 and 2010/11 overweight rose by over 30% to 22.97%. However, the growth in the prevalence of obesity is even more alarming. Childhood obesity rates rose from 6.55% to 7.11% in 2010/11 and further increased in 2012 to 7.79%.

Table 1: The share of overweight and obesity

	Overweight	Obese
2008	16.82%	6.55%
2010/11	21.41%	7.11%
2012	22.97%	7.79%

Note: Own calculations using NIDS data

The share of overweight children seems to be slightly higher for girls than for boys, but the differences are rather small and the confidence intervals show a substantial overlap. Moreover, the differences are even smaller in the case of obesity, while in 2010 the share even seems to be higher for boys. A similar picture is obtained when comparing the average BMI-z-score. This suggests that increasing body weight is not predetermined by a child's gender.

Table 2: Overweight, Obesity and the BMI-z-score by gender

		Overweight	Obese	z-BMI
2008	Female	17.68%	7.09%	-0.0227
	Male	15.99%	6.02%	-0.0883
2010/11	Female	22.29%	6.78%	0.0766
	Male	20.49%	7.44%	0.0171
2012	Female	25.54%	7.91%	0.1543
	Male	20.55%	7.67%	-0.0513

Note: Own calculations using NIDS data. Overweight and Obesity as shares and the BMI-z-score as a mean.

As is expected, overweight and obesity can be mostly found in urban areas. However, rural areas exhibit a much sharper increase between 2008 and 2010 as can be seen below in Table 3. Especially when overweight is concerned it increased in urban areas by over 5 percentage points, while the observed increase in rural ones is roughly 6.5 percentage points. An explanation could be given by the means a child uses to go to school every day. Close to 90% of the children in rural areas walked or rode a bicycle to school in 2008, whereas the same share for urban areas was below 70%. In urban areas the use of motorized vehicles or public transport is substantially higher, leading to lower levels of physical activity. We see, however, that this share drops for rural areas and may have played a role in the sharper increase in children's body weight.

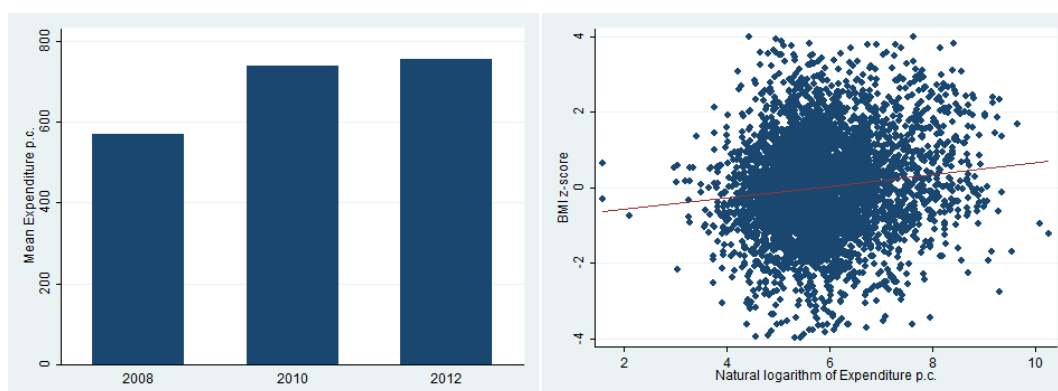
Table 3: The shares of overweight, obesity and children walking/riding to school by residential area

		Overweight	Obese	Child walks/rides bicycle to school
2008	Urban	20.44%	8.09%	69.87%
	Rural	14.37%	5.5%	89.25%
2010/11	Urban	23.33%	7.71%	71.93%
	Rural	19.84%	6.52%	88.23%
2012	Urban	25.72%	9.79%	72.36%
	Rural	20.84%	6.23%	85.1%

Note: Own calculation using NIDS data

In the same period expenditure per capita grew from roughly 570 Rand in 2008 to 760 in 2012⁸. This increase was much sharper between 2008 and 2010.

Figure 3: The evolution of per capita expenditure and its correlation with the BMI-z-score



Note: Own calculation using NIDS data. The mean total expenditure per capita adjusted by the CPI is used for the bar graph, whereas the scatter plot uses the natural logarithm of the same variable.

The scatter plots also show a loose positive relationship between higher household income and body weight. However, the most interesting finding is that obesity rates rose sharper in the poorest quintile of the income distribution, while incomes increased sharper for the richest 20%. However, obesity does not seem to be present only among the richest households. The share of obese children in the lowest expenditure quintile has doubled between 2008 and 2010 and decreased slightly in 2012 to 5.21%, while the average for that year is 7.78%. It is clear that obesity is present across the whole income distribution and even the poorest groups seem to be vulnerable.

⁸ The figures are per month and have been adjusted by the CPI.

Table 4: The share of obesity across the income distribution

2008	Poorest 20%	3.2%
	Sample Average	6.55%
	Richest 20%	9.28%
2010/11	Poorest 20%	6.67%
	Sample Average	7.11%
	Richest 20%	9.12%
2012	Poorest 20%	5.21%
	Sample Average	7.78%
	Richest 20%	13.3%

Note: Own calculation using NIDS data. The quintiles are based on total expenditure per capita.

Table 4 shows some descriptive statistics on the caregiver of the child. In 25.16% of the cases the mother does not live in the household in 2008 and overall in only about 2/3 of the cases is one of the parents the primary caregiver of the child. Naturally, it is the mother in most cases. This share remains roughly the same in the subsequent years. About 1 out of 5 children is watched after by its grandparents, whereas it is also not uncommon that older siblings or other relatives are responsible for each child. Furthermore, in roughly 15-20% of the cases some other household member is responsible for the children, even if the mother resides in the household. Another fact worth noting is that on average the education level of the caregiver is lower if the individual in question is the child's grandparent compared to parents themselves. On the other hand, it is slightly higher if the caregiver is an older sibling or an aunt or uncle.

Table 5: The primary caregiver for children

	2008	2010/11	2012
Parent	66.04%	66.06%	67.40%
Grandparent	21.94%	19.10%	19.65%
Aunt or Uncle	5.30%	3.92%	7.30%
Sibling	1.42%	1.42%	2.60%
Other	5.30%	9.50%	3.05%

Note: Own calculation using NIDS data

4. Empirical Analysis and Results

This section of the paper presents the empirical results of our analysis. We distinguish between overweight and obesity and use a Pooled Probit estimation to get an overview of these aspects of child malnutrition in South Africa⁹.

$$P(y = 1)_{it} = \alpha + \beta X_{it} + \delta T_t + v_{it}$$

Next we use fixed effects models to account for time invariant characteristics like genetic predisposition or culture. The Linear Probability Model, allows us to accurately model fixed effect and explore the within variation, but it may be inappropriate for binary choice models.

$$Y_{it} = \alpha + \beta X_{it} + \delta T_t + c_i + v_{it}$$

Since probit fixed effects estimations can be problematic¹⁰, we turn to the Mundlak Approach, which allows us to obtain the fixed effects estimator by including the within group means of the explanatory variables and also allows distinctions between short- and long-term effects (Wooldridge (2002a)).

$$P(y = 1)_i = \alpha + \beta X_{it} + \delta T_t + \gamma \bar{X}_i + v_i$$

Income is measured by the natural logarithm of total household expenditures per capita, which is adjusted for inflation using the CPI of the Statistics Department of South Africa¹¹. Since in many households the children receive care from another person than their mother¹² and weight gain is probably closer associated to behavior rather than genes, a dummy on whether the caregiver is obese is used to account for this. Moreover, a categorical variable on the education level of the caregiver also accounts for the quality of care given, as well as their employment status. Furthermore, the number of children residing in the household is used to account for intra-household resource allocation, while the presence of a television set in the household and the means of transport to school are used as 'imperfect' proxies for the child's physical activity levels. Other child specific characteristics include age and gender. In order to account for environmental

⁹ All the results shown use heteroscedasticity robust standard errors clustered at the household level

¹⁰ See Greene (2003)

¹¹ Available at: http://www.statssa.gov.za/?page_id=1854&PPN=P0141&SCH=6039

¹² In Appendix A2 we show regressions where variables for both the mother and the caregiver are included. The caregiver seems to be more important, especially with the z-BMI as the dependent variable.

characteristics, we use a dummy for the area of residence (1 is urban), two other groups of dummies for ethnicity and province of residence, as well as a time dummies¹³.

The regression results on the probability of a child being overweight are presented in Table 6. The first column shows the results of the Pooled Probit regression. Although this method does not account for time invariant characteristics, it is useful to provide a general picture of the phenomenon and it provides a glimpse at the differences in the outcomes between children, as well as the long-term influence of the covariates. The first thing to notice is that the natural logarithm of household expenditure per capita exhibits a positive and highly significant coefficient. This indicates that there is a positive non-linear relationship between income and the probability of a child being overweight. Moreover, we find that residing in an urban area is also positively associated with the probability. However, we find that the largest effect comes from the dummy for an obese caregiver. This gives a clear indication that the behavior adapted by the caregiver that led to this condition is to some extent transferred to the child as well. On the other hand, we do not find any significant effect for the level of education or the employment status of the caregiver. This finding is in contradiction to what has been shown in studies concerning industrialized countries. It seems that this transmission channel does not apply in a developing country setting. The argument that better educated caregivers and that those with more free time tend to provide better care for the children does not seem to be valid for South Africa.

The number of the children in the household on the other hand has a negative and highly significant effect at the 1% level. An explanation for this comes from the discussion on economies of scale and resource allocation within the household. Given that the means for cooking in terms of utensils and time is limited, an extra child in the household would lead to smaller portions. This would in turn decrease the amount of food consumed per child and subsequently their calorie intake.

The gender of the child is insignificant, which suggests that there is no indication of gender bias or genetic predisposition at a very young age. On the other hand, the age of a child is negatively associated with the probability of the child being overweight. This suggests that compared to the WHO growth referenced standard younger children in South Africa either gain weight faster or are slower in gaining height.

¹³ See the Appendix for more details.

Turning to proxies for calorie expenditure, we see that the presence of a television set in the household does not affect a child's weight. This dummy, however, does not provide any information on the use of the television in terms of frequency and time. The dummy for physical activity shows a weak negative relationship, significant only at the 10% level. This provides some evidence that children who walk to school have a somewhat lower probability of being overweight.

The results of the Pooled Probit can be seen as the cumulative or long-run influence of factors. They may be however contaminated by unobserved heterogeneity, much of which is time invariant. Therefore, fixed effects models are estimated to account for this and to get a glimpse at changes in outcomes within observational units.

Even at the first glance it is evident, that not a single variable exhibits a significant coefficient in the Linear Probability Model. This may be in part due to the fact that many of the explanatory variables show very little, or no variation at all over the examined time period. Focusing at household income, however, we find that changes do not seem to affect the status of the child. Moreover, the rho gives us the fraction of the variance explained by the fixed effects component. It is quite high with over 60%. This practically means that c_i accounts for the largest part of the deviation from the predicted mean. An interpretation of this can be that any influence from the examined factors is visible very slowly, that their effect is cumulative and that the time invariant component clearly plays a major role in the outcomes of children.

The Mundlak approach allows us to examine both dimensions. In the case of the within variation the results are very similar to the LPM, while the between variation resembles closely the Pooled Probit. Another interpretation that can be given is that the betas indicate short-term effects, whereas the time means can be seen as long-term ones (Wooldridge, 2002a; 2002b). The first thing to notice is that just as in the case of the LPM we do not find any significant coefficients in the first column. This changes, however, when we look at the long term effects. The coefficient for total household expenditure is significant only at the 10% level, whereas the dummy for residing in an urban area turns insignificant. Similar to the Pooled Probit we find a strong positive relationship for the weight status of the caregiver on the probability of a child being overweight, whereas we find a negative relationship for the number of children in the household. These findings suggest that these factors and the mechanisms behind them take some time to develop and influence the weight status of a child. Moreover, the R-squared is only marginally higher compared to the Pooled Probit. This suggests that

adding a within observations component only marginally improves the explanatory power of the model.

Table 6: Regression on the probability of a child being overweight

	Pooled Probit	Linear Prob. FE	Mundlak	
				Means
Household Expenditure p.c.	0.1034*** (3.04)	-0.0085 (0.68)	0.0231 (0.54)	0.1273* (1.92)
Urban	0.2118*** (2.85)	0.1007 (1.45)	0.0543 (0.24)	0.1427 (0.62)
Caregiver obese (BMI>30)	0.2793*** (5.49)	0.0076 (0.32)	-0.0214 (0.27)	0.4333*** (4.23)
Caregiver education	-0.0148 (0.49)	-0.0199 (1.33)	-0.0852 (1.52)	0.0691 (1.02)
Caregiver Employment	-0.0903 (1.41)	0.0032 (0.14)	-0.0418 (0.52)	-0.0996 (0.90)
Number of children in HH	-0.0729*** (4.04)	0.0031 (0.39)	-0.0057 (0.19)	-0.0806** (2.22)
Gender	-0.0831 (1.58)			-0.0833 (1.57)
Age	-0.0032** (1.98)	0.0007 (0.18)	0.0066 (1.23)	-0.0104** (1.99)
TV	0.0477 (0.79)	0.0111 (0.50)	0.1041 (1.25)	-0.1112 (1.03)
Physical Activity	-0.1245* (1.75)	0.0124 (0.42)	0.0428 (0.41)	-0.1947 (1.36)
African	0.04 (0.20)			0.1862 (0.87)
Coloured	-0.3706* (1.64)			-0.2196 (0.94)
Asian	-0.3007 (0.80)			-0.2443 (0.64)
Year 2010	0.2221*** (2.96)	0.0461 (0.39)	0.0044 (0.03)	
Year 2012	0.3288*** (3.44)	0.0235 (0.11)	-0.0851 (0.32)	
Western Cape	0.2842* (1.80)	-0.4497*** (2.62)	-0.7195 (1.13)	1.0228 (1.56)
Eastern Cape	0.3749*** (3.04)	-0.3087* (1.66)	-0.8558 (1.43)	1.2527** (2.06)
Northern Cape	-0.1054 (0.67)	0.0883 (0.82)	0.1236 (0.28)	-0.2352 (0.49)
Free State	0.13 (0.90)	0.3317 (1.53)	-0.0467 (0.05)	0.1994 (0.23)
KwaZulu-Natal	0.3297*** (2.84)	-0.2381 (1.40)	-0.9387* (1.90)	1.3051*** (2.57)
North West	0.1263 (0.83)	0.0491 (0.43)	0.0446 (0.11)	0.1404 (0.32)
Mpumalanga	0.1132 (0.81)	0.1465 (0.13)	-0.2655 (0.65)	0.4284 (0.98)
Limpopo	0.0844 (0.63)	0.0835 (0.78)	-0.0389 (0.10)	0.1747 (0.42)
Observations	4199	4199 (2122)	4199 (2122)	
R-squared (pseudo)	0.0518	0.0192 (within)	0.0632	
Rho		0.6242		

Robust absolute values of t-statistics in parentheses, using clustered standard errors at the household level

*significant at 10%; ** significant at 5%; *** significant at 1%

Left out province is Gauteng

In the case of obesity most of the arguments and the general picture we obtain by comparing all three models is very similar to the ones for overweight. Here, we once again confirm the positive link between household expenditure and the probability of a child being obese, as was the case for overweight, whereas the urban dummy turns insignificant in the Pooled regression. The coefficient for the caregiver being obese is once again large and highly significant, hinting that this may be the most important aspect in explaining the phenomenon. The number of children in the household remains negative and significant; suggesting that intra household allocation of resources also plays an important role. It also worth noting, that we find no evidence that gender differences exist at a young age. Moreover, the weak relationship between the physical activity dummy and the probability of overweight disappears in the case of obesity. However, we confirm the fact that coloured children have a lower probability of being obese compared to white ones.

The linear probability model with fixed effects returns similar results to the one for overweight. The majority of the explanatory variables fail to explain the variation within observations, but the Rho is again high, suggesting that the largest part of the variance is due to the fixed effects component. We find, however, that changes in the education level of the caregiver are negative and significant at the 5% level. Since, the level of education rarely changes among adults, this result may be driven by changing the caregiver.

This last result is also confirmed by the Mundlak specification. Surprisingly, we also find a positive association for the group mean of the caregiver's level of education. However, this may be a spurious correlation and a reflection of how obesity is seen in the society and that even better educated individuals show a preference towards a higher body weight. Moreover, we find that household expenditure is not correlated with the probability of a child being obese either in the short- or the long-term. However, we confirm that having an obese caregiver over longer periods of time is positively associated with the child's body weight. Furthermore, we confirm the absence of gender differences, while the coefficient for coloured also turns insignificant.

Table 7: Regression on the probability of a child being obese

	Pooled Probit	Linear Prob. FE	Mundlak	Means
Household Expenditure p.c.	0.0937** (2.14)	0.0082 (1.10)	0.0523 (0.95)	0.0509 (0.62)
Urban	0.1561 (1.58)	0.0811 (1.44)	0.2736 (0.82)	-0.1412 (0.42)
Caregiver obese (BMI>30)	0.2381*** (3.77)	0.062 (0.42)	0.0386 (0.40)	0.2896** (2.20)
Caregiver education	-0.0025 (0.60)	-0.019** (1.99)	-0.1833** (2.39)	0.1866** (2.09)
Caregiver Employment	-0.0294 (0.37)	-0.0102 (0.69)	-0.1085 (1.04)	0.1026 (0.72)
Number of children in HH	-0.0856*** (3.58)	-0.0054 (1.12)	-0.0267 (0.63)	-0.0768 (1.61)
Gender	-0.0142 (0.21)			-0.0212 (0.19)
Age	-0.0029 (1.33)	-0.0012 (0.42)	0.0089 (1.32)	-0.0121* (1.86)
TV	0.0424 (0.54)	0.0064 (0.55)	0.1045 (1.04)	-0.1058 (0.79)
Physical Activity	-0.0718 (0.82)	0.0144 (0.69)	-0.0212 (0.15)	-0.0304 (0.16)
African	-0.255 (1.25)			-0.1679 (0.77)
Coloured	-0.4746** (2.02)			-0.3578 (1.47)
Asian	-0.2405 (0.68)			-0.2098 (0.58)
Year 2010	0.0596 (0.57)	0.0434 (0.52)	-0.2318 (1.14)	
Year 2012	0.1644 (1.21)	0.0703 (0.47)	-0.3828 (1.12)	
Western Cape	-0.0051 (0.03)	-0.2666* (1.80)	-0.5426 (0.77)	-0.5426 (0.80)
Eastern Cape	0.2132 (1.43)	-0.1773 (1.14)	-0.901 (1.28)	1.1898* (1.65)
Northern Cape	-0.187 (0.91)	-0.0846 (0.97)	-0.4404 (0.79)	0.2801 (0.46)
Free State	0.0382 (0.22)	-0.1313 (1.26)	-1.2547** (2.41)	1.3961** (2.50)
KwaZulu-Natal	0.2282 (1.57)	-0.226 (1.28)	-1.4252** (2.26)	1.7567*** (2.72)
North West	-0.187 (0.13)	-0.1145 (1.25)	-0.7996* (1.74)	0.9022* (1.87)
Mpumalanga	0.1698 (0.94)	0.0026 (0.05)	-0.0628 (0.15)	0.32 (0.68)
Limpopo	0.0233 (0.14)	-0.004 (0.08)	-0.0246 (0.07)	0.1363 (0.34)
Observations	4199	4199 (2122)	4199 (2122)	
R-squared (pseudo)	0.0448	0.0114 (within)	0.0577	
Rho		0.5866		

Robust absolute values of t-statistics in parentheses, using clustered standard errors at the individual level

*significant at 10%; ** significant at 5%; *** significant at 1%

Left out province is Gauteng

These results suggest that the caregiver plays an important role in both, the within and the between variation of the weight status of a child¹⁴. In order to further explore the links and mechanisms at work we construct an interaction term by inverting the dummy of a caregiver being obese (1 for non-obese) and multiplying it by the education level of the caregiver. The idea behind this is that the education level does not necessarily reflect awareness as to the health problems associated with obesity, especially in a society where to some extent obesity is regarded as a positive outcome. This is the reason why obesity among adults in South Africa seems to be positively correlated with higher education, as it reflects social status (Case and Menendez, 2009). However, it is more likely that non-obese, well educated individuals are more health conscious, do not see obesity as benign or a confirmation of their status and are, therefore, more concerned about the body weight of the child for which they provide care.

¹⁴ This is also confirmed by Pooled OLS and Fixed Effects estimations on the BMI-z-score itself. The same exercise is repeated with lagged variables for the z-score on the right hand side. These can be seen in Appendix A2.

Table 8: Mundlak specifications with interaction terms on the caregiver

		Overweight	Obese	
		Means	Means	
Household Expenditure p.c.	0.0222 (0.52)	0.1231* (1.86)	0.0503 (0.92)	0.0441 (0.54)
Urban	0.055 (0.25)	0.148 (0.64)	0.2817 (0.86)	-0.1394 (0.42)
Caregiver not obese (BMI<30)	-0.0811 (0.57)	-0.1202 (0.65)	-0.1649 (0.82)	-0.1772 (0.82)
Caregiver education	-0.1153* (1.75)	0.1662** (2.01)	-0.2196** (2.44)	0.3252*** (2.98)
Caregiver not-obese* Education	0.0656 (0.89)	-0.198** (2.04)	0.0767 (0.76)	-0.284** (2.15)
Caregiver Employment	-0.0419 (0.52)	-0.0981 (0.88)	-0.1107 (1.05)	0.1107 (0.75)
Number of children in HH	-0.0059 (0.19)	-0.0811** (2.23)	-0.0287 (0.67)	-0.0763 (1.59)
Gender		-0.0877 (1.64)		-0.0195 (0.29)
Age	0.0069 (1.30)	-0.0106** (2.03)	0.0092 (1.38)	-0.0124* (1.90)
TV	0.105 (1.26)	-0.1126 (1.04)	0.1062 (1.06)	-0.1053 (0.79)
Physical Activity	0.0412 (0.40)	-0.1967 (1.37)	-0.0216 (0.16)	-0.0317 (0.17)
African		0.1633 (0.75)		-0.2071 (0.94)
Coloured		-0.2348 (1.00)		-0.3831 (1.58)
Asian		-0.2343 (0.61)		-0.1916 (0.52)
Year 2010	-0.0053 (0.03)		-0.2422 (1.20)	
Year 2012	-0.0988 (0.37)		-0.4001 (1.18)	
Western Cape	-0.6825 (1.06)	0.9797 (1.48)	-0.4921 (0.70)	0.5227 (0.71)
Eastern Cape	-0.8342 (1.39)	1.2395** (2.02)	-0.8608 (1.22)	1.1626 (1.61)
Northern Cape	0.1367 (0.30)	-0.2513 (0.52)	-0.4378 (0.80)	0.2667 (0.44)
Free State	0.0254 (0.03)	0.1367 (0.16)	-1.1766** (2.33)	1.3358** (2.44)
KwaZulu-Natal	-0.9477* (1.91)	1.3303*** (2.59)	-1.4322** (2.29)	1.789*** (2.78)
North West	0.0691 (0.17)	0.124 (0.29)	-0.7635* (1.67)	0.8781* (1.82)
Mpumalanga	-0.2638 (0.64)	0.437 (0.99)	-0.0506 (0.12)	0.3202 (0.69)
Limpopo	-0.0294 (0.07)	0.1774 (0.43)	-0.0055 (0.02)	0.1297 (0.33)
Observations	4199		4199	
R-squared (pseudo)	0.0646		0.0615	

Robust absolute values of t-statistics in parentheses, using clustered standard errors at the individual level

*significant at 10%; ** significant at 5%; *** significant at 1%

Left out province is Gauteng

The results confirm our suspicion for both dimensions; overweight and obesity. The group mean of the interaction term is negative and significant in both models. This implies that having a non-obese, well educated caregiver over longer periods of time seems to be beneficial for a child's health. Moreover, the dummy for the body weight of the caregiver is no longer significant. An interpretation of this fact could be that the body weight of caregivers is linked with their level of education. However, school education is not synonymous to health education. Caregivers with lower health awareness are more likely to be obese, especially if they are well educated, and adapt to certain lifestyles or behaviours that also affect the children. A non-obese and well educated caregiver seems to provide higher quality of care and reduces the probability of a child becoming obese.

5. Conclusions

This paper is one of the very few so far to discuss childhood obesity in a developing setting, since the largest body of the literature focuses on industrialized ones. Furthermore, most of the literature focuses on household income and maternal education and employment status as the main drivers of the phenomenon and mostly relies on cross sectional data for the analysis. This paper used the South African NIDS panel dataset to argue that some of the arguments presented in the literature may not be appropriate for a developing country. Moreover, the use of panel data allows controlling for unobserved heterogeneity and time invariant characteristics like genetics and culture. Taking the existing literature a small step further, we also apply the Mundlak Approach to distinguish and gain a better understanding of short- vs. long term effects.

The results of the empirical analysis suggest that the within variation or short-term effects seem to be less important compared to the long term ones. It becomes obvious that weight gain occurs and accumulates after adapting certain behaviours over longer periods of time. This also seems to apply for children. In their case, however, individual choices regarding those behaviours are rather limited. The analysis clearly shows that the beliefs and behaviours of the caregiver are important for the development of the child. An obese caregiver has certainly adapted to a certain lifestyle and in a sense passes this condition on to the children he or she provides care for. This fact becomes all the more important in a society where obesity is regarded by many as a positive outcome, even among the better educated caregivers, since school education does not

automatically imply higher health awareness. The analysis suggests that better educated, non-obese caregivers, who are more likely to be aware of the dangers associated with extreme weight, can be beneficial for the outcome of the child.

In terms of policy options, the way forward seems to be clear. The notion that obesity is a desirable outcome seems to be deep rooted in South African culture and it will take some time to overturn this belief. Raising health awareness through information campaigns, for instance, is detrimental. Several countries around the world impose so called fat-taxes to reduce consumption of high fat food. However, the results clearly show that obesity is not necessarily associated with changes in income (or prices for that matter) especially in the short run. Moreover, it seems unlikely that higher prices can have long lasting effects on consumption when there is a clear preference towards these types of food items and higher body weight. It is, therefore, why policy makers should turn their efforts into changing the perceptions of the society regarding obesity, in order to enable a future for children, unencumbered by the burden of obesity.

BIBLIOGRAPHY

- Abdulai A. (2010).** Socio-economic characteristics and obesity in underdeveloped economies: does income really matter? *Applied Economics* **42**, 157–169 (DOI: 10.1080/00036840701604313)
- Adair, L.S. and Popkin, B.M. (2005).** Are Child Eating Patterns Being Transformed Globally? *Obesity Research* **13**, 1281-1299
- Anderson, P.M., Butcher, K.F. and Levine, P.B. (2003).** Economic Perspectives on Childhood Obesity. *Economic Perspectives* **27**, 30-48
- Asai, M., Ramchandrapa, S., Joachim, M., Shen, Y. et al. (2013).** Loss of Function of the Melanocortin 2 Receptor Accessory Protein 2 Is Associated with Mammalian Obesity. *Science* **341**, 275-278 (DOI: 10.1126/science.1233000)
- Boumtje, P.I., Huang, C.L., Lee, J.-Y. and Lin, B.-H. (2005).** Dietary Habits, Demographics, and the Development of Overweight and Obesity among Children in the United States, *Food Policy* **30**, 115-128
- Brown P.J. (1991).** Culture and the evolution of obesity. *Human Nature* **2**, 31–57 (DOI: 10.1007/BF02692180)
- Caprio S., S.R. Daniels, A. Drewnowski, F.R. Kaufman, L.A. Palinkas, A.L. Rosenbloom, and J.B. Schwimmer (2008).** Influence of Race, Ethnicity, and Culture on Childhood Obesity: Implications for Prevention and Treatment A consensus statement of Shaping America's Health and the Obesity Society. *Diabetes Care* **31**, 2211–2221 (DOI: 10.2337/dc08-9024)
- Case A., and A. Menendez (2009).** Sex differences in obesity rates in poor countries: Evidence from South Africa. *Economics & Human Biology* **7**, 271–282 (DOI: 10.1016/j.ehb.2009.07.002)
- Chou, S.-Y., Rashad, I. and Grossman, M. (2008).** Fast-Food Restaurant Advertising on Television and its Influence on Childhood Obesity. *Journal of Law and Economics* **51**, 599-618 (DOI: 10.1086/590132)
- Coate, D. (1983).** The Relationship Between Diet, Parent's Fatness and Obesity in Children and Adolescents. *NBER Working Paper No.1072*
- Doak C.M., L.S. Adair, M. Bentley, C. Monteiro, and B.M. Popkin (2004).** The dual burden household and the nutrition transition paradox. *Int J Obes Relat Metab Disord* **29**, 129–136
- Fertig, A., Glomm, G. and Tchernis, R. (2009).** The Connection between Maternal Employment and Childhood Obesity: Inspecting the Mechanisms. *Rev Econ Household* **7**, 227-255 (DOI: 10.1007/s11150-009-9052-y)
- Garcia, E., Labeaga, J.M. and Ortega, C. (2006).** Maternal Employment and Childhood Obesity in Spain. *FEDEA Documento de Trabajo* **2006-17**
- Greene, W.H. (2003).** Econometric Analysis, *5th Edition*, Pearson Education Inc.

Lockwood, M, and Collier, P. (1988). Maternal Education and the Vicious Cycle of High Fertility and Malnutrition: An Analytical Survey. *World Bank Policy Research Working Paper No.130*

Mahler, P. (2007). I'm Not Fat, Just too Short for my Weight: Family Child Care and Obesity in Germany. *Socioeconomic Institute University of Zürich Working Paper No.0707*

Marini, A. and Gragnolati, M. (2003). Malnutrition and Poverty in Guatemala. *World Bank Policy Research No.2967* (DOI: 10.1596/1813-9450-2967)

Mokdad A.H., Ford, E.S. and Bowman, B.A. (2001). Prevalence of Obesity, diabetes and obesity-related health risks. *Journal of the American Medical Association* **289:1**, 76-79 (DOI: 10.1001/jama.289.1.76)

Monteiro, C.A., Moura, E.C., Conde, W.L. and Popkin B.M. (2004). Socioeconomic status and obesity in adult populations of developing countries: a review. *Bulletin of the World Health Organization* **82:12**, 940-946

Mundlak Y. (1978). On the pooling of time series and cross section data. *Econometrica* **46**, 69–85 (DOI: 10.2307/1913646)

Römling C., and M. Qaim (2012). Obesity trends and determinants in Indonesia. *Appetite* **58**, 1005–1013 (DOI: 10.1016/j.appet.2012.02.053)

Sen A. (1985). Commodities and Capabilities. *Oxford University Press*. (ISBN: 0195650387)

Ulijaszek S.J., and H. Lofink (2006). Obesity in Biocultural Perspective. *Annual Review of Anthropology* **35**, 337–360 (DOI: 10.1146/annurev.anthro.35.081705.123301)

Whitaker, R.C., Wright, J.A., Pepe, M.S., Seidel, K.D., and Dietz, W.H. (1997). Predicting Obesity in Young Adulthood from Childhood and Parental Obesity. *The New England Journal of Medicine* **337**, 869-873 (DOI: 10.1056/NEJM199709253371301)

WHO (1995). *WHO / Physical status: the use and interpretation of anthropometry*. Geneva

Available at: http://www.who.int/childgrowth/publications/physical_status/en/index.html

WHO/FAO joint expert consultation (2003). *Diet, nutrition and the prevention of chronic diseases*. 160 pp

Available at: <http://www.who.int/dietphysicalactivity/publications/trs916/en/>

Wooldridge J.M. (2002a). *Econometric Analysis of Cross Section and Panel Data*. MIT Press, Cambridge, MA; London, England, 752 pp.

Available at: <https://mitpress.mit.edu/books/econometric-analysis-cross-section-and-panel-data>

Wooldridge J.M. (2002b). *Introductory Econometrics - A Modern Approach*. Thomson South-Western, (ISBN: 0-324-32348-4)

APPENDIX

Table A1: Variable definitions

Variable	Description
Household Expenditure	The natural logarithm of total household expenditure, as calculated by the SALDRU, adjusted by the CPI and divided per household resident.
Urban	Dummy variable, which takes the value, if the household resides in urban or peri-urban areas (incl. unofficial urban areas), as defined by the NIDS.
Age	The age of the child at the time of the interview in months.
Gender	Dummy variable, which takes the value 1 for males.
Caregiver	The person primarily responsible for the child.
Education (for caregiver or mother)	Categorical variable, which takes values 0-4 0: No education 1: Primary education (until 7 th grade) 2: Some secondary education (until 11 th grade, NTC1 (National Technical Certificates), NTC2, certificates and diplomas below 12 th grade) 3: Completed secondary education (12 th grade, NTC3) 4: Tertiary education
Employment (for caregiver or mother)	Dummy variable, which takes the value 1, if the individual in question is currently employed.
Obese (for caregiver or mother)	Dummy variable, which takes the value 1, if the individual in question has a BMI over 30
Smoking	Dummy variable, which takes the value 1, if an individual reported smoking regularly.
Physical Activity	Dummy variable, which takes the value 1, if a child walks or rides a bicycle to school.
Number of children in HH	The number of children below 17 years of age that reside in the household
TV	Dummy variable, which takes the value 1, if the household owns a television set

Table A2: Descriptive Statistics

	2008		2010/11		2012	
	Mean	S.E.	Mean	S.E.	Mean	S.E.
Obesity	0.0659	0.0051	0.0904	0.0052	0.0848	0.0048
Overweight	0.1727	0.0078	0.239	0.0077	0.242	0.0073
Underweight	0.112	0.0074	0.0891	0.007	0.0909	0.008
BMI z-score	-0.065	0.0287	0.1286	0.0261	0.1128	0.0232
Household Expenditure p.c.	490.58	17.96	684.38	27.96	667.61	20.13
Urban	0.4012	0.0091	0.3849	0.0072	0.3988	0.008
Number of children in HH	3.1737	0.0337	3.2185	0.0289	3.1764	0.0332
Mother's Employment	0.2096	0.0077	0.2396	0.0065	0.2534	0.0088
Caregiver obese	0.4211	0.0123	0.4629	0.0093	0.4339	0.0087
Caregiver BMI	29.506	0.2517	33.38	2.247	29.537	0.1191
Caregiver education	1.4137	0.0241	1.4825	0.0187	1.609	0.0171
TV ownership	0.6467	0.0089	0.6193	0.0097	0.787	0.0067
Gender	0.5116	0.0093	0.5043	0.0074	0.504	0.0082
Age in months	105.92	0.0363	119.16	0.4056	131.56	0.3584
Attending school	0.9907	0.0024	0.987	0.0036	0.9951	0.0012
Physical Activity	0.8339	0.0072	0.8183	0.0063	0.8072	0.0066
White	0.0184	0.0025	0.0126	0.0016	0.0121	0.0018
African	0.8358	0.0069	0.8569	0.0052	0.8526	0.0058
Coloured	0.1374	0.0064	0.1246	0.0049	0.13	0.0055
Asian	0.0083	0.0017	0.0059	0.0011	0.0054	0.0012
Western Cape	0.0948	0.0055	0.0912	0.0042	0.0998	0.0049
Eastern Cape	0.1407	0.0065	0.1339	0.124	0.1307	0.0055
Northern Cape	0.0656	0.0046	0.0568	0.005	0.0667	0.0041
Free State	0.0511	0.0041	0.0498	0.0436	0.0516	0.0036
KwaZulu-Natal	0.3244	0.0087	0.3339	0.007	0.3253	0.0564
North West	0.0775	0.005	0.0818	0.004	0.0643	0.004
Gauteng	0.0643	0.0046	0.0646	0.0036	0.0073	0.0043
Mpumalanga	0.067	0.0047	0.0694	0.0038	0.0839	0.0045
Limpopo	0.1146	0.0059	0.1184	0.0048	0.1043	0.005

Table A3: Regressions on the BMI-z-score

	Pooled OLS	Fixed Effects
Household Expenditure p.c.	0.0999*** (3.48)	0.0463 (1.49)
Urban	0.1592*** (2.44)	0.4183** (2.05)
Caregiver obese (BMI>30)	0.3286*** (8.04)	0.1563*** (2.61)
Caregiver education	-0.0308 (1.22)	-0.0984** (2.11)
Caregiver Employment	-0.0331 (0.66)	0.0283 (0.47)
Number of children in HH	-0.0573*** (4.67)	-0.0045 (0.21)
Gender	-0.08* (1.86)	
Age	-0.0027** (2.03)	0.0015 (0.14)
TV	0.0622 (1.39)	0.025 (0.40)
Physical Activity	-0.0932 (1.54)	-0.043 (0.56)
African	-0.0912 (0.43)	
Coloured	-0.4659** (2.05)	
Asian	-0.727* (1.86)	
Year 2010	0.0876 (1.46)	0.0445 (0.14)
Year 2012	0.1562** (1.95)	-0.0167 (0.03)
Western Cape	0.1718 (1.21)	-0.8677* (1.72)
Eastern Cape	0.3592*** (3.23)	-0.0419 (0.08)
Northern Cape	-0.1955 (1.50)	0.2486 (0.76)
Free State	0.0875 (0.72)	0.2628 (0.51)
KwaZulu-Natal	0.2539*** (3.48)	0.06 (0.11)
North West	-0.0533 (0.44)	0.0717 (0.26)
Mpumalanga	0.1521 (1.23)	0.4704* (1.66)
Limpopo	0.0837 (0.76)	0.6144** (2.25)
Observations	3890	3890 (2041)
R-squared (pseudo)	0.0830	0.0207 (within)
Rho		0.6416

Robust absolute values of t-statistics in parentheses, using clustered standard errors at the individual level

*significant at 10%; ** significant at 5%; *** significant at 1%

Left out province is Gauteng. Excluding children with a z-BMI below -1.8

Table A4: Regression on BMI-z-score including lags

	Pooled OLS	Pooled OLS
z-BMI (lagged)	0.3063*** (10.00)	0.3059*** (9.94)
Household Expenditure p.c.	0.0643* (1.88)	
Household Expenditure p.c. (lagged)		0.0255 (0.74)
Urban	0.1018 (1.34)	0.1059 (1.40)
Caregiver obese (BMI>30)	0.2755*** (5.43)	0.2748*** (5.43)
Caregiver education	-0.0114 (0.41)	-0.0047 (0.17)
Caregiver Employment	-0.0139 (0.23)	-0.0001 (0.00)
Number of children in HH	-0.0271** (1.99)	-0.0335** (2.55)
Gender	-0.0022 (0.05)	-0.022 (0.05)
Age	-0.0024* (1.68)	-0.0025* (1.74)
TV	0.0726 (1.20)	0.0893 (1.49)
Physical Activity	0.0815 (1.13)	0.0657 (0.91)
African	-0.2785 (0.93)	-0.3363 (1.09)
Coloured	-0.5863* (1.89)	-0.6407** (2.03)
Asian	-0.8418** (2.17)	-0.8728** (2.24)
Year 2010	0.1722** (2.17)	0.2076*** (2.66)
Year 2012	0.2231** (2.31)	0.261*** (2.68)
Western Cape	0.0761 (0.48)	0.0759 (0.48)
Eastern Cape	0.229* (1.85)	0.2237* (1.80)
Northern Cape	-0.1867 (1.27)	-0.1911 (1.30)
Free State	-0.0283 (0.21)	-0.0379 (0.29)
KwaZulu-Natal	0.2317** (1.98)	0.2272* (1.93)
North West	-0.0673 (0.49)	-0.0741 (0.53)
Mpumalanga	0.0697 (0.49)	0.0653 (0.45)
Limpopo	0.0178 (0.15)	0.0058 (0.05)
Observations	1865	1865
R-squared (pseudo)	0.1988	0.1977

Robust absolute values of t-statistics in parentheses, using clustered standard errors at the individual level

*significant at 10%; ** significant at 5%; *** significant at 1%

Left out province is Gauteng. Excluding children with a z-BMI below -1.8

Table A5: Regressions including variables for the child's biological mother

	Overweight	Obese	z-BMI
Household Expenditure p.c.	0.0705* (1.68)	0.0549 (1.02)	0.0884** (2.50)
Urban	0.4112*** (4.76)	0.2332** (2.02)	0.2951*** (3.89)
Caregiver obese (BMI>30)	0.2384 (1.48)	0.2729 (1.36)	0.2308* (1.93)
Mother obese (BMI>30)	0.1565 (0.96)	0.0464 (0.23)	0.157 (1.27)
Caregiver education	-0.0033 (0.09)	0.0131 (0.25)	-0.0349 (1.09)
Caregiver Employment	-0.0882 (1.22)	0.0375 (0.42)	-0.0425 (0.73)
Number of children in HH	-0.0581*** (2.74)	-0.081*** (2.82)	-0.054*** (3.64)
Gender	-0.0455 (0.69)	0.0326 (0.40)	-0.0624 (1.18)
Age	-0.0054*** (2.72)	-0.0057** (2.23)	-0.0037** (2.39)
TV	0.0697 (0.92)	0.1415 (1.34)	0.0833 (1.51)
Physical Activity	-0.1394 (1.59)	-0.0272 (0.25)	-0.0753 (0.97)
African	0.0207 (0.09)	-0.3438 (1.53)	-0.1265 (0.57)
Coloured	-0.4101* (1.68)	-0.5445** (2.18)	-0.5289** (2.17)
Asian	-0.4418 (1.11)	-0.3875 (0.97)	-0.8287** (2.11)
Year 2010	0.3373*** (3.73)	0.1436 (1.15)	0.1748** (2.44)
Year 2012	0.4783*** (4.07)	0.3717** (2.28)	0.2758*** (2.84)
Western Cape	0.2774 (1.55)	-0.0122 (0.05)	0.2155 (1.30)
Eastern Cape	0.3346** (2.37)	0.3227* (1.83)	0.4211*** (3.15)
Northern Cape	-0.2001 (1.12)	-0.1991 (0.83)	-0.201 (1.35)
Free State	0.0597 (0.34)	-0.0542 (0.27)	0.0504 (0.34)
KwaZulu-Natal	0.3553*** (2.70)	0.3027* (1.80)	0.3969*** (3.31)
North West	0.2428 (1.48)	0.1015 (0.45)	0.0323 (0.23)
Mpumalanga	0.1122 (0.72)	0.1109 (0.55)	0.1716 (1.23)
Limpopo	0.2081 (1.31)	0.1644 (0.79)	0.2195* (1.67)
Observations	2771	2771	2564 (1457)
R-squared (pseudo)	0.0700	0.0611	0.1019
Rho			

Robust absolute values of t-statistics in parentheses, using clustered standard errors at the individual level

*significant at 10%; ** significant at 5%; *** significant at 1%

Left out province is Gauteng. Excluding children with a z-BMI below -1.8 in Column 3