"I'm just well nourished"

A study on Overweight and Obesity in Developing Countries

Dissertation

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AIDS	Acquired Immune Deficiency Syndrome
BMI	Body Mass Index
CA	Central Asia
CPI	Consumer Price Index
DALYs	Disability Adjusted Life Years
EUR	Europe
FAO	Food and Agriculture Organization
FE	Fixed Effects
GDP	Gross Domestic Product
HH	Household
HIV	Human Immunodeficiency Virus
IHD	Ischaemic Heart Disease
KOF	Konjukturforschungsstelle
LAC	Latin America and the Caribbean
LPM	Linear Probability Model
MENA	Middle-East and North Africa
NIDS	National Income Dynamics Study
NR-NCDs	Nutrition-related Non-communicable Diseases
NTC	National Technical Certificates
OLS	Ordinary Least Squares
PC	Personal Computer
PPP	Purchasing Power Parity
RE	Random Effects
SA	South Asia
SADHS	South African Demographic and Health Survey
SALDRU	Southern Africa Labor and Development Research Unit
SE	Standard Error
SSA	Sub-Saharan Africa
TV	Television
UPA	Urban and Peri-urban Agriculture
VAT	Value Added Tax
WHO	World Health Organization
z-BMI	BMI-z-score

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Foreword

I fondly remember my childhood years in Greece in the late ‘80s and early ‘90s. Especially, the summers were a carefree time and an opportunity to spend time with the grandparents in the village. They themselves had a rough life stricken by war, the Nazi occupation and poverty. Hunger and deprivation was very common, especially in rural areas. My parents’ generation had it only marginally better. Political unrest and a military junta meant that living conditions remained very low. Things started changing in 1974 with the return of democracy and an era of political stability. Improvements in living standards were noticeable after the early ‘80s, when Greece became a member of the European Economic Community and the newly elected socialdemocratic government increased public investment and consumption and pushed social reforms. This led to a substantial increase in disposable incomes for the poorer households and overall improvement in living standards. Hunger was forgotten and the generations that experienced it seemed determined to “protect” their children and grandchildren by providing in excess.

Memories of such behaviors became more prominent after I started researching obesity in the developing world. It was very common for parents and grandparents to offer snacks to children, often between frequent and generous meals. Refreshing drinks and soda became part of everyday diet. “Skinny” children were often referred to as “diseased”, whereas overweight children were regarded as “strong” and perfectly normal. Moreover, parents and grandparents insisted and often pushed children to consume these meals or snacks. These attitudes were often justified by the abundance of food and that “children in other countries are starving”. Naturally, this helped in obesity rates in Greece increasing rapidly over the past few decades, ranking the country among the Top 5 in Europe according to the World Health Organization.

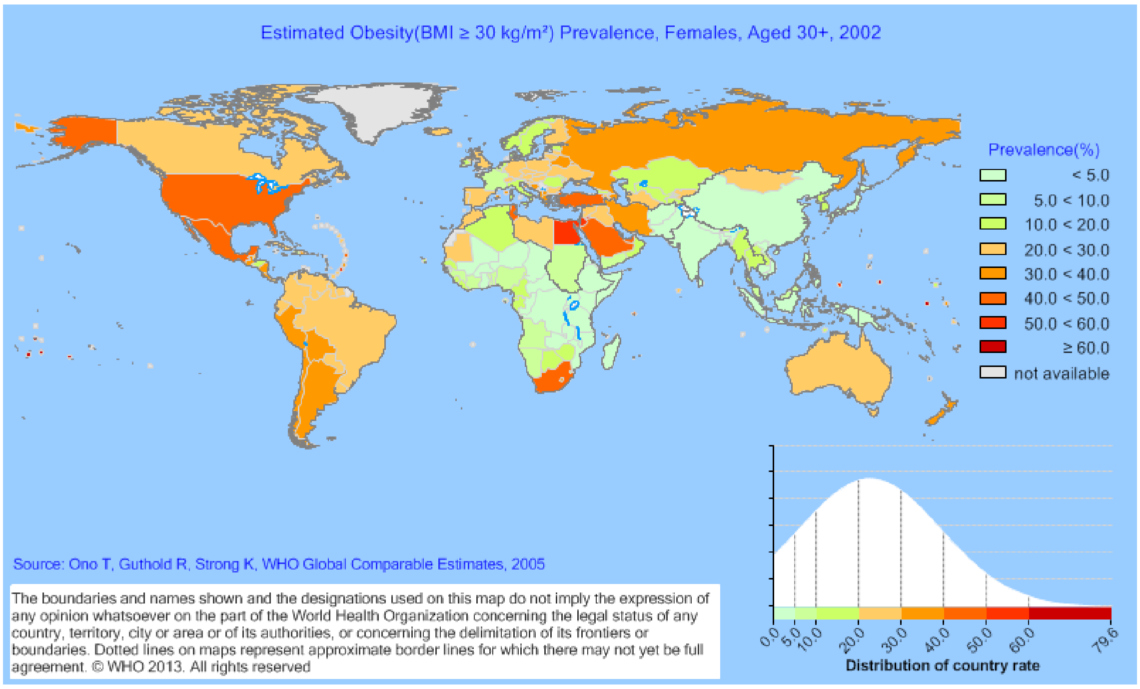
It is very likely that something similar is happening all around the globe and especially in transition and emerging economies. Poorer countries are not an exception either, although their rates remain somewhat lower. In this dissertation I will try to provide arguments supporting the idea that obesity is especially becoming a problem in societies where for different cultural reasons it is seen as a positive outcome and an escape from the problems of the past.

Background

Since overweight and obesity were estimated to account for 3.4 million deaths per year, 93.6 million DALYs in 2010 and are still increasing in all countries, there is good reason to lift this topic on the political agendas of countries. Worldwide the prevalence of obesity has nearly doubled between 1980 and 2014 to more than half a billion adults (WHO, 2014). The Region of the Americas shows the highest rates for overweight and obesity (with 61% overweight or obese in both sexes, 27% points of these are obese), the only exception are the Pacific Islands with very high prevalence rates of overweight obesity of more than 70% (WHO, 2014). The European and Eastern Mediterranean Region and the Region of the Americas exhibit a 50% share of overweight women and about 25% to 30% are obese. For all WHO regions it holds true that women are more likely to be obese than men (WHO, 2014, p. 79). As income levels of countries increase, the prevalence rates of overweight and obesity increase as well (WHO, 2014), however the transmission channels are not very clear. Moreover, prevalence rates of overweight pre-school aged children are increasing fast, and they are increasing fastest in low- and lower-middle-income countries. Studies show that around 60% of overweight children remain overweight later in adulthood, which gives reason to worry about the development of people's health status in future (Antipatis and Gill, 2001; Halford et al., 2004; Popkin et al., 2006; Stifel and Averett, 2009)

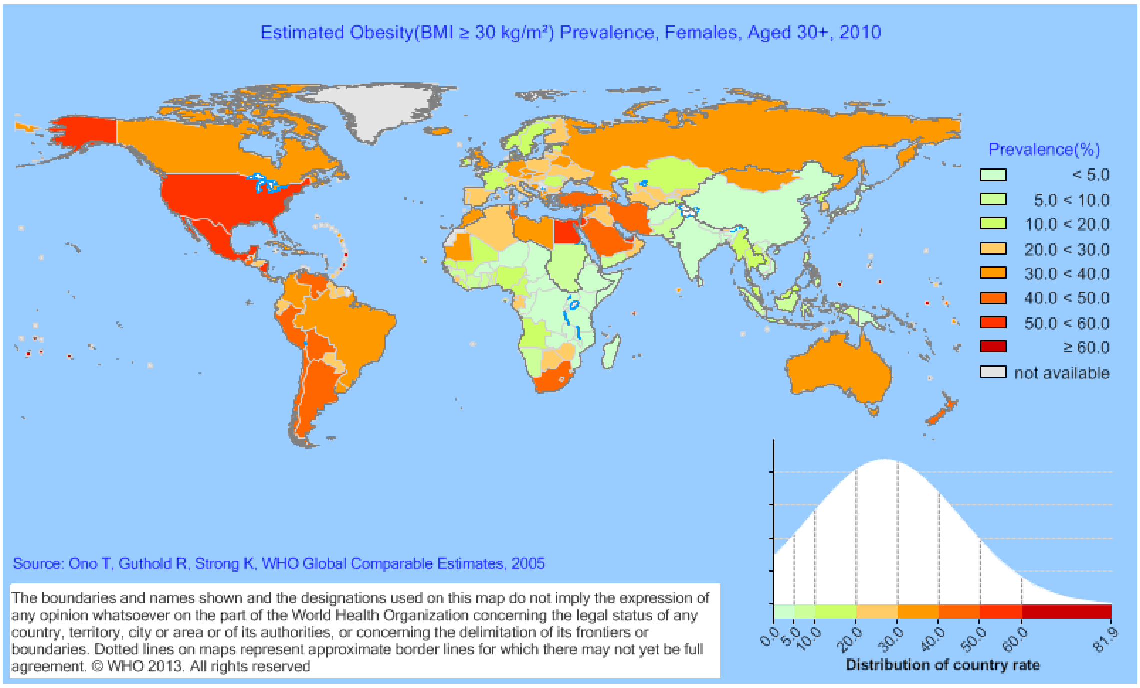
Looking at Tables A and B provides a clear picture of how obesity evolved across the globe in recent years. Even countries located in SSA appear to be affected and their shares are increasing as well.

Figure A: The share of obesity among women aged over 30 in 2002



Note: WHO Global Comparable Estimates (2010)

Figure B: The share of obesity among women aged over 30 in 2010



Note: WHO Global Comparable Estimates (2010)

Many studies on overweight and obesity have focused on developed countries although the number of articles on developing countries is increasing. In general, drivers that were identified to have an influence on increasing body weight are: a negative relationship of socioeconomic status for richer countries (Jones-Smith et al., 2011; Deuchert et al., 2012; Tafreschi, 2014), a positive and in many cases non-linear relationship of income for developing countries (Subramanian and Smith, 2006; Abdulai, 2010; Römling and Qaim, 2012), education (negative, Huffman and Rizov, (2010)), technological change (Philipson and Posner, 1999, 2003; Lakdawalla and Philipson, 2002), food price subsidies (Asfaw, 2007), or the rise of supermarkets (Reardon et al., 2004; Kimenju et al., 2015; Rischke et al., 2015).

Some studies have tried to detect the impact of policy programs that address the growing obesity problem. Schmidhuber (2004) discusses several policy options in this regard. He finds that food price interventions, which have been also established in some European countries as part of a set of instruments to target the growing obesity epidemic, are more likely to be efficient when they are implemented as consumer price interventions rather than at the producer price level (on fat taxes in European countries see also Holt, 2011; Villanueva, 2011). Fat taxes are implemented to "increase the costs of energy-dense and "saturated fat rich foods by adding an extra tax on energy-rich food [...]" so that consumers will avoid these kind of foods (Schmidhuber, 2004). The effect of a tax highly depends on how responsive consumers are to price changes. If income elasticities are negative, then poor consumers are likely to react stronger to a fat tax than rich consumers. Often rich people have inelastic price elasticities for food items which means they react with only small reductions in demand (Schmidhuber, 2004).Guo et al. (1999) examined price policy options and point out that in China fat taxes would have low effects for rich persons but probably some consumption-contracting effects for poor people. So, it would be more helpful to be able to impose taxes on nutrients directly rather than on food items (Schmidhuber, 2004). Mytton et al. (2012) provide a short analysis of health related food taxes and conclude that taxes "would need to be at least 20% to have a significant effect on population health". Finally, Lu and Goldman (2010) predict that a 10% increase in the price of energy dense food items such as staple oil could lead to a 0.4% reduction in the BMI in China, which seems to be rather low.

Other countries have implemented more diverse policies to address the obesity problem in their societies. Reduced consumption of high-fat, energy-dense food and hence reduced number of deaths from coronary heart diseases in Finland (Puska et al., 1995) and Norway (Norum, 1997). In Singapore national intervention programs were successful in decreasing the levels of some cardiovascular risk factors and of childhood obesity (Cutter et al., 2001). Furthermore, Mauritius has implemented and evaluated successful a program that has reduced NCDs by means of using the mass media, pricing policy, educational activity in the community, workplaces and schools, and other legislative and fiscal measures (Dowse et al., 1995). The WHO (2014) argues that school is an important setting for promoting healthy diets. Regarding obesity reduction programs, a review of 28 studies by Hawley et al. (2013) concludes that a multiple traffic light systems is seen as a trustworthy source for the amount of calories in food items.

The purpose of this dissertation is to address policy makers to change the way they think about the phenomenon. So far the discussion revolves around increasing incomes and imposing taxes on high fat food, despite their disputed effectiveness. Most of these studies seem to neglect the cultural dimension of the phenomenon and the fact that obesity is seen as a positive outcome in many societies, so that individuals show a clear preference for higher body weight, while ignoring the adverse health effects associated with it.

The main body of the dissertation consists of three parts. The first one provides an analysis at the macro-level using country data for low- and middle- income countries. The two other parts focus on South Africa and use household data to examine the phenomenon for children and adults respectively.

Part 1

Overweight and obesity in low- and middle income countries: A panel-data analysis

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Abstract

The rather small literature on obesity in developing countries mainly uses descriptive statistics and cross section analysis to focus on rising income levels as the source of rapidly increasing obesity rates. This paper uses a new panel dataset comprised of WHO and World Bank data for 126 low- and middle income countries to focus on rapid and urbanization as the main driver of rising obesity levels. The results of the fixed effects estimation suggest that urbanization and lifestyle changes associated with the "Nutrition Transition" are responsible for the phenomenon. Moreover, time invariant effects such as tradition and culture account for the differences in overweight and obesity rates across countries. These findings raise new questions and open up paths for further research and can also lead to direct policy implications drawn from the "Urban Agriculture" literature.

1.1 Introduction

Rising obesity rates in recent years and the health risks associated with the phenomenon have been well documented in the literature. High body fat exposes individuals to health risks such as diabetes, hypertension and cardiovascular disease (Mokdad et al., 2001). While this phenomenon is mostly encountered in industrialized countries, developing countries are closing in and in many cases overtaking them in the prevalence of overweight and obesity. According to the World Health Organization (WHO) obesity is the epidemic of the 21st century. This seems to affect especially women in adulthood (Martorell et al., 1998; Marini and Gragnolati, 2006). As a result they and also their children are exposed to the aforementioned health risks[1] (Anderson, Butcher and Levine, 2003). Therefore, it is crucial to target women and especially mothers and caregivers, so as to prevent the spread to future generations.

Many researchers refer to the "nutrition transition" hypothesis as the main source of rising obesity rates. This hypothesis states that innovations in the food industry have made high-fat food cheaper in relation to traditional food and that societies in developing countries move towards more sedentary lifestyles (Lakdawalla and Philipson, 2002; Popkin, 1999; Popkin, 2003). However, empirical evidence that cover this hypothesis is scarce. So far the literature focuses on income levels (Martorell et al., 2000, Popkin, 2003; Monteiro et al., 2004), arguing that higher incomes drive obesity rates. However, these studies are conducted at the cross sectional level and mainly rely on descriptive statistics. The nutrition transition hypothesis itself is taken as granted and very little empirical evidence is provided. This paper aims at diverting attention from income levels and highlighting other factors such as urbanization, structural changes in the economy, health provision and cultural factors as potential sources of the phenomenon.

Although these rising trends are clearly based on individual choices and behaviors, country level data may offer valuable insight on the mechanisms behind it. Furthermore, the use of panel data (which are extremely rare on the micro-level) allows us to control for unobserved heterogeneity and time invariant characteristics, in order to focus on the real effect of changes in income and urbanization levels. This also allows us to take genetic and cultural differences into account. Several studies argue that the phenomenon is viewed differently in various regions and societies and may even be regarded as a positive outcome in some cultures (Brown, 1991; Ulijaszek and Lofink,

[1] Children are heavily dependent on their mother's care and also adapt to certain obesogenic behaviors. Thus, a link between obese mothers and obese children has been established in the literature (Anderson, Butcher and Levine, 2003; Fertig, Glomm and Tchernis, 2009; and others).

2006; Case and Menendez, 2009). The views of a society changes rather slowly and can therefore be captured by the fixed effects component. Moreover, one can safely assume that cultural factors can be correlated with GDP levels, through institutions for instance (Tabellini, 2010). This provides another argument for the use of panel data instead of cross sectional, in order to account for this as well and overcome some of the shortcomings of cross section analyses (Wooldridge, 2002a).

In 2010 the WHO completed a database on global obesity rates starting in 2002 (Ono, Guthold and Strong, 2010). To our knowledge, these data have not been used yet for examining the drivers of global obesity rates. Therefore, this study uses the Global Obesity Infobase to present the case, that rapid and uncontrolled urbanization and the underlying factors associated with it, should be considered among the main drivers of the sharply rising obesity shares and that cultural differences across regions and other time invariant characteristics account for a very large part of the differences observed across the globe.

The remainder of the paper introduces a conceptual framework and a literature review in Section 1.2. Section 1.3 provides an overview of the dataset and some descriptive statistics, whereas the results of the analysis are presented in Section 1.4. Finally, Section 1.5 summarizes and gives some policy implications.

1.2 Conceptual Framework and Literature Review

This paper follows a simple framework, where aggregate welfare is function of income and health. The health status is in turn determined and affected negatively by a high body weight.

$$\boldsymbol{W = f(Income, Health\ (Obesity^{-}))}$$

Obesity is caused by a chronic imbalance between daily caloric intake and expenditure. If the intake exceeds expenditure over longer periods of time, body weight increases:

$$\boldsymbol{CI_t > CE_t}$$

where CI denotes caloric intake and CE stands for caloric expenditure. It is also assumed that a high imbalance in period t_o will lead to increased body weight in the next period t_1. Increasing body weight leads in turn to overweight and eventually obesity.

Although the BMI ($Body\ Mass\ Index = \frac{Weight}{Height^2}$) is far from perfect as a measure of overweight and obesity among adults[2], it is widely used in the literature, because of its simplicity and ease of measurement. In general, a BMI>25 indicates overweight, while a BMI >30 indicates obesity (WHO/ FAO (2003)).

Most studies argue that obesity rates in developing countries are driven by rising income levels (Martorell et al., 2000). This holds especially for middle-income countries. The mechanism behind this fact is connected to generally lower prices of high-fat food and a clear preference towards it (Cutler et al., 2003). Moreover, higher income levels allow increased imports or production of such food types, since the demand is there. It is safe to assume that the availability of various food types has an impact on dietary habits. On the other hand, higher income is also linked to preferences towards a "healthier" lifestyle. In most developed countries the higher income groups tend to avoid sedentary lifestyles and are therefore less obese compared to the lower income groups (Lakdawalla and Philipson, 2002). Furthermore, the income level at which obesity among women occurs is getting lower, which is in line we the picture we obtain in industrialized countries (Monteiro et al., 2004).

In micro-level studies conducted for individual developing countries, the effects of household income levels differ across countries. Abdulai (2010), for instance, finds a positive non-linear relationship between household expenditures and obesity rates among women. This suggests that at the higher end of the income distribution, obesity may even decline. Moreover, Wittenberg (2013) reveals a mixed picture between household income and the mean BMI across population groups in South Africa, whereas Römling and Qaim (2012) find a clear positive relationship between household expenditures and the BMI. Fernald (2007) on the other hand presents the case that the socioeconomic status is only positive among the poorest households in Mexico.

A part of the literature also argues that obesity in developing countries can be mostly found in urban areas (Popkin, 1999; Subramanian et al., 2011). The reasons behind this, is that, first of all, high-fat food is available in higher quantities and lower prices in large cities. Besides that, higher urbanization is also a result of a development process and rising incomes. Moreover, lack of space in large cities prohibits -especially among the

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2 See Cawley and Burkhauser (2008) for more on the subject

poorer groups- the production and consumption of own-produced fruits and vegetables. Furthermore, living in urban areas raises the probability to be employed in the service sector, in an occupation, that requires less physical activity. Finally, overall changes to a more sedentary lifestyle are closely linked to residing in urban areas (shorter distances and means of transportation, availability of television or radio, or staying at home due to higher crime rates). Therefore, rapid and uncontrolled urbanization is linked with both, higher calorie intake and lower calorie expenditure.

The role of education is not that clear. Part of the literature argues that education has positive externalities[3] and raises awareness on the health risks connected with obesity. On the other hand, it might be the case that higher education leads to higher income levels and also higher employment in the service sector, which in turn requires less physical activity.

The situation is clearer, when we look at medical provision. One can safely assume that higher medical provision raises awareness on the health risks associated with obesity and also encourages recreational physical activity.

Finally, we expect that structural changes in the economy have an effect on nutritional outcomes through both, caloric intake and expenditure. An economy that moves from agricultural production towards services can arguably lead to lower physical activity levels, on the one hand, and to rising incomes on the other.

Many of the economic studies cited tend to neglect a very important factor in their empirical analyses. Cultural differences are essential in explaining the differences in obesity rates around the globe. Many authors from other fields have focused on this issue and have argued that obesity is regarded differently in various cultures (Brown, 1991; Ulijaszek and Lofink, 2006) and thus socioeconomic variables may also have varying impacts through different channels across regions and cultures. This is especially the case, if a higher body weight is seen as a positive outcome in some cultures and a negative one in others.

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[3] Gibson (2001) and Monteiro et al. (2004)

1.3 The Data

This study uses a dataset for 126 low- and middle-income countries, constructed by using WHO and World Bank data. The variables for overweight and obesity are provided by the World Health Organization for 2002, 2005 and 2010 (Ono, Guthold and Strong, WHO Global Comparable Estimates, 2010). All other variables are taken from the World Bank databases[4] for the years 1996-2009. They have been aggregated into period averages (1996-2001, 2002-2004 and 2005-2009), in order to deal with missing observations and to balance the panel.

The dependent variable is the prevalence of overweight or obesity for female adults aged over 30 in each country. The main explanatory variables are income, given by the natural logarithm of the Gross Domestic Product per capita, PPP, in constant 2005 US$, and urbanization, given by the share of the population living in urban areas. Controls for education levels and health care are also used. For education, the secondary school enrollment rates are included. Furthermore, health care provision is proxied by the number of hospital beds per thousand people and for robustness checks by the number of physicians per thousand people. Finally, the value added of services as a share of GDP[5] and the food imports as a share of GDP are used to account for structural changes in the economies.

Further robustness checks include the same specifications for females aged over 15, as well as regressions for men of both age groups. Additionally, we run Pooled OLS regressions with the inclusion of the lagged share of overweight and obesity. Moreover, this paper uses a few other control variables, which include the Gini Index of Inequality and the KOF Index of Globalization[6]. However, they are dropped from the final specifications, because the number of observations drops substantially due to missing values and the main results do not really change. A final robustness check is to drop Oceania as a region, because it exhibits extremely high shares of overweight and obesity and may bias the results. All of these can be seen in the Appendix A1.

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4 http://data.worldbank.org/indicator

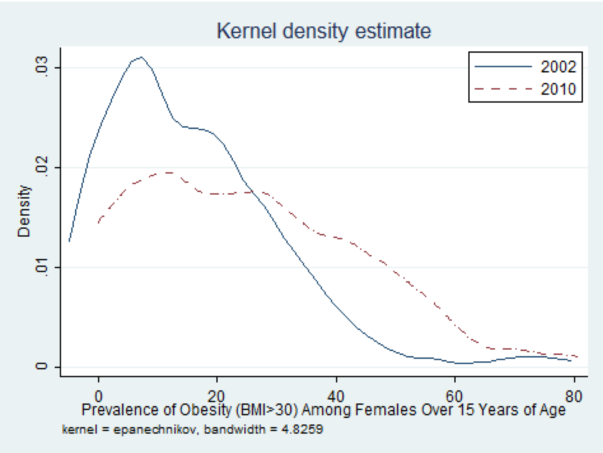
5 For robustness we also use the share of agriculture in GDP

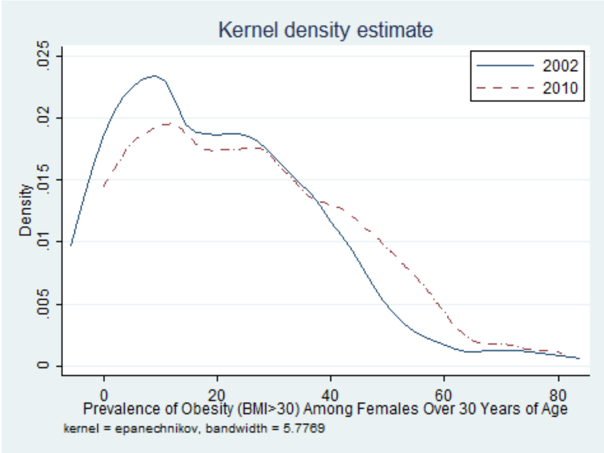
6 Dreher (2006). Available at: http://globalization.kof.ethz.ch/

1.3.1 Stylized Facts

In the period between 2002 and 2010 obesity among women aged over 30 rose by 21.4% to average almost 25% in the sample. The same trend occurs for both sexes. On average, overall prevalence of obesity in 2010 for men and women made its mark at 17.8%. The Kernel density estimations in Figure 1.1 show a very clear shift to the right. A similar pattern is observed, when the younger population is included (aged over 15). It is a clear indication that body weight increases rapidly all over the developing world.

Figure 1.1: Prevalence of female obesity 2002-2010





Note: Own calculation using the WHO Global Infobase. The prevalence of obesity among females aged 15+ and 30+ in the sample

In Table 1.1 we present the obesity rates for each age group across regions. It can be seen that the regions with the highest obesity rates are Latin America and the Caribbean, Oceania and the MENA region. However, the prevalence of obesity increased across all regions at an alarming rate. In SSA for instance, the rates increased by over 33% among females aged over 30. In LAC on the other hand, obesity rose by 25-30% in both age groups.

During the same period, the urban population also increased. In 2001 about 45% of the total population in these 126 countries lived in urban areas. This figure rose by 3 percentage points in 2009. In very few countries did the share of urban population stagnate or retreat and in most cases a sharp rise could be observed. Especially in some South and Southeast Asian countries the share increased by more than 8 percentage points[7].

[7] World Bank Data

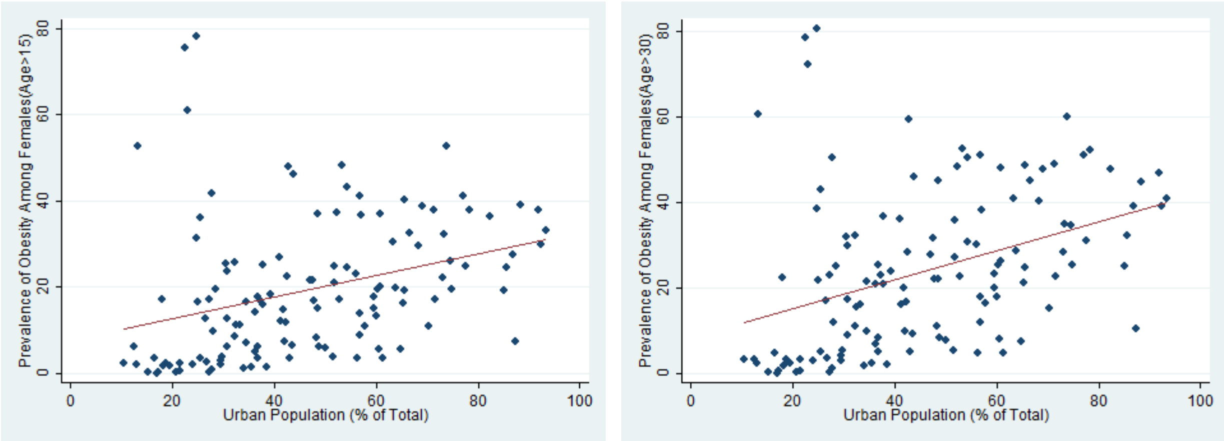
Table 1.1: Prevalence of overweight and obesity across regions

Region	Year	Overweight 30+ Years	Overweight 15+ Years	Obese 30+ Years	Obese 15+ Years
Sub- Saharan Africa	2002	36.91%	30.94%	9.72%	7.32%
	2005	38.98%	32.90%	10.91%	8.28%
	2010	42.24%	36.02%	12.94%	9.91%
Latin America and Caribbean	2002	66.41%	58.79%	30.35%	23.56%
	2005	68.63%	61.30%	33.34%	26.26%
	2010	72.20%	65.54%	38.70%	31.23%
East- and Southeast Asia	2002	32.42%	25.98%	5.92%	4.18%
	2005	35.07%	28.36%	7.01%	4.97%
	2010	40.18%	33.00%	9.29%	6.68%
South Asia	2002	25.18%	20.03%	6.89%	4.85%
	2005	26.81%	21.44%	7.63%	5.40%
	2010	29.83%	24.16%	9.01%	6.41%
Central Asia	2002	58.20%	47.20%	20.22%	14.93%
	2005	59.48%	48.57%	21.65%	16.20%
	2010	60.87%	50.00%	23.35%	17.83%
Middle East and North Africa	2002	64.01%	54.02%	31.51%	23.39%
	2005	65.28%	55.41%	32.95%	24.68%
	2010	67.55%	57.91%	35.69%	26.98%
Oceania	2002	67.87%	64.11%	40.86%	35.89%
	2005	69.44%	65.90%	42.79%	37.82%
	2010	71.92%	68.79%	45.92%	41.02%

Note: Own calculations using the WHO Global Infobase. Overweight is defined as BMI>25 and Obesity as BMI>30

Figure 1.2 shows the correlation in the cross section between the share of the population living in urban areas in 2009 and the overweight and obesity rates in 2010.

Figure 1.2: Correlation between obesity and urbanization



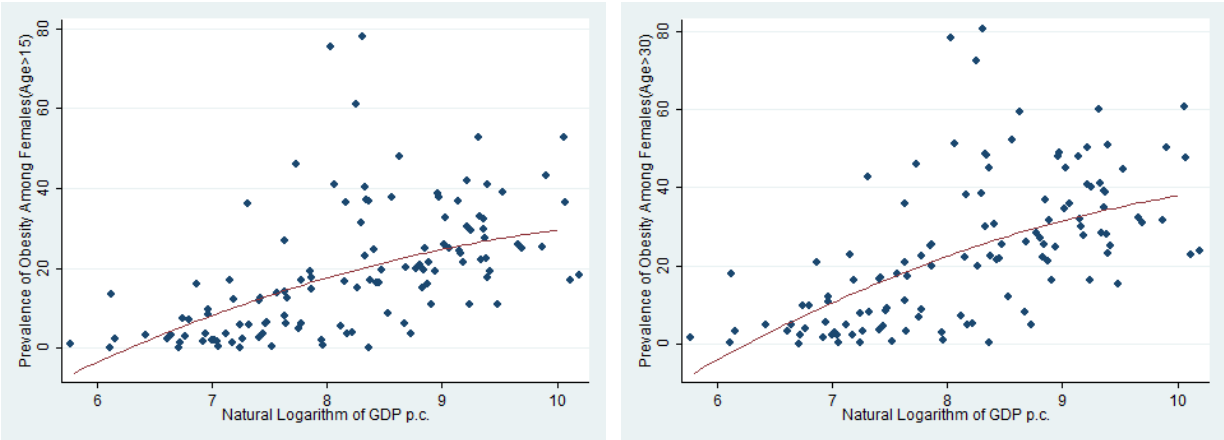
Note: Own calculation using the WHO Global Infobase and World Bank data. The prevalence of obesity among females aged 15+ and 30+ and the share of people living in urban areas.

A clear positive correlation can be identified. The outliers correspond to Pacific-Island countries that have high obesity rates and low levels of urbanization[8]. Heteroscedasticity may also be of some concern, but we use robust standard errors in the regressions. Furthermore, the same pattern emerges, when the data for 2001-2002 and 2004-2005 are used. The same picture, if not even clearer, is obtained, when overweight is used on the Y-Axis.

Figure 1.3 shows the correlation between obesity rates and the natural logarithm of per capita income, expressed by the GDP per capita, PPP, 2005 US$ (2010). In the cross section, a clear positive relationship can be confirmed. This is in line with the findings of Popkin (2003). The outliers are again countries located in Oceania. Removing them provides a better fit, but does not change the overall picture.

[8] Removing them will provide a better fit for the line, but the main point remains unchanged.

Figure 1.3: Correlation between obesity and income (2010)



Note: Own calculation using the WHO Global Infobase and World Bank data. The prevalence of obesity among females aged 15+ and 30+ and the natural logarithm of GDP per capita adjusted for PPP, in constant 2005 US dollars

However, a cross section analysis neglects unobserved heterogeneity between countries and time invariant factors that may have driven obesity rates for years. The real question is what the net effects of rising incomes look like. In order to provide an answer, a simple regression with fixed effects is considered, in order to also take a look at the within variation. Therefore, the following equation is estimated[9]:

$$\boldsymbol{Y_{it} = \alpha + \beta X_{it} + \gamma Z_{it} + T_t + u_i + v_{it}}$$

where u_i is the fixed effect component, X_{it} are the main variables of interest (GDP and Urbanization), Z_{it} are control variables, T_t are time dummies and v_{it} is the error term.

Since obesity can take some time to develop, it is assumed that any influence each parameter has, occurs in the next period. This effectively means that the period average of income between 2001 and 2004 is associated with the obesity rate of 2005. With this technique the model gains a dynamic component and some missing observations are filled in. All equations are estimated for females aged over 30 and report t-statistics derived from heteroscedasticity robust standard errors, clustered at the country level.

[9] The analysis follows the guidelines provided by Wooldridge (2002a; 2002b) and McCaffrey et al. (2012).

1.4 Empirical Results

The analysis is based on the results of the fixed effects panel regression with robust standard errors, in order to correct for heteroscedasticity. The fixed effects account for time-invariant characteristics across countries, such as culture, tradition, genetic differences or the acceptance of obesity in each society.

A first glance at the results in Table 1.1 reveals that there is a positive and significant relationship between per capita income and overweight rates. Since a non-linear relationship is not confirmed in the first specification we drop the squared term for all other specifications. Changes in the level of a country's per capita income seem to positively affect female overweight in Column 2. However, adding further controls in Column 3 renders the coefficient insignificant. Furthermore, the inclusion of year dummies in the final specification turns the coefficient of the natural logarithm of GDP per capita to be negative and significant. This suggests that despite common belief, increasing income levels result in lower overweight rates among females for both age groups, after controlling for country- and time fixed effects. Urbanization on the other hand is positive and significant for all specifications. The size of the coefficient is also relative high. However, adding the year dummies causes the coefficient to drop sharply. This finding suggests that there are unobserved factors that vary over time, are common for all countries and are associated with the share of the population residing in urban areas. Further research that focuses on urban areas is required to identify these factors, in order to draw policy implications.

Better health provision is negatively correlated with overweight in Column 3. However, the coefficient is not significant. What female education is concerned, the coefficient is positive and significant, but this may be a spurious correlation, since the coefficient turns insignificant in Column 4 when the year dummies are added. On the other hand, the share of services in GDP and food imports are insignificant for all specifications. Finally, the year dummies are highly significant at the 1% level. This fact might provide evidence that a worldwide transition, such as the “Nutrition Transition”, takes place and leads to increasing body weights. Further research is required to determine what factors drive obesity rates and turn the sign of income levels negative.

Table 1.2: Fixed effects estimation for the share of overweight women aged over 30

	(1)	(2)	(3)	(4)
ln(GDP p.c.)	3.3114	4.0459***	1.3331	-3.9185**
	(0.482)	(3.650)	(0.798)	(-2.103)
ln(GDP p.c.) squared	0.0441			
	(0.109)			
Urban	0.8814***	0.8801***	0.7602***	0.3946***
	(11.025)	(11.146)	(5.374)	(3.123)
Female Schooling			0.1014***	0.0317
			(2.773)	(0.962)
Hospital Beds			-0.3219	-0.1361
			(-1.418)	(-0.524)
Services			0.0719	-0.0096
			(1.328)	(-0.212)
Food Imports			-0.0813	-0.0096
			(-1.113)	(-0.158)
Year 2005				1.4120***
				(3.317)
Year 2010				4.2880***
				(5.569)
Observations	369	369	200	200
Countries	124	124	103	103
R-squared (within)	0.588	0.588	0.643	0.782
Rho	0.9911	0.9911	0.9902	0.9953

*significant at 10%; ** significant at 5%; *** significant at 1%
Fixed Effects estimation. Robust values of t-statistics in parentheses, using clustered standard errors at the country level. Constant is not reported.

These results hold, when alternate samples, specifications or variable definitions are estimated[10]. Therefore, the results are considered robust. It is also worth noting, that adding the control variables reduces the number of observations, since they are not available for all countries and time periods. Still, there is no reason to believe that any systematic bias occurs.

The situation changes when considering obesity (BMI>30) in Table 1.2. In these regressions income shows a clear non-linear negative relationship with obesity rates among females. The turning point is well outside of the sample and lies at over 20,000$ per capita. Urbanization, on the other hand, is positive and highly significant in the first two specifications. However, the coefficient becomes negative and also turns insignificant, when the time dummies are added. This leads to the conclusion that factors associated with large populations in urban areas that are common for all countries and vary over time lead to increasing obesity rates. However, there are

[10] See Appendix A1.

significant regional differences what the effects of urbanization on obesity rates is concerned, as shown in Column 4. The interaction terms show that the impact of higher share in urban population varies across regions (or cultures), with East- and Southeast Asia being the left out category.

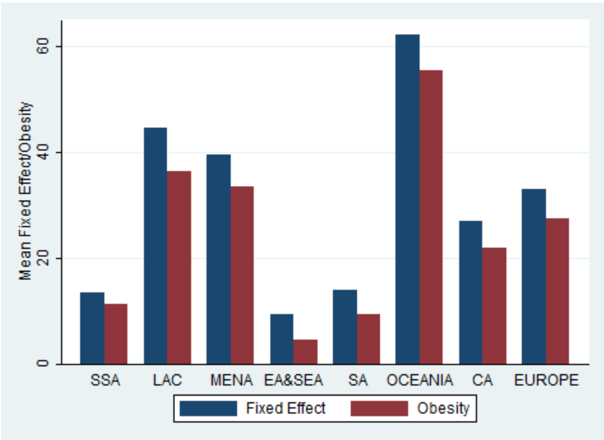
Table 1.3: Fixed effects estimation for the share of obese women aged over 30

	(1)	(2)	(3)	(4)
ln(GDP p.c.)	-24.8980***	-50.3940***	-49.3305***	-48.3553***
	(-2.763)	(-3.276)	(-4.082)	(-5.133)
ln(GDP p.c.) squared	1.7421***	3.0668***	2.5018***	2.5499***
	(3.099)	(3.173)	(3.282)	(4.690)
Urban	0.7147***	0.5842***	0.0058	-0.0105
	(7.187)	(3.147)	(0.042)	(-0.106)
Female Schooling		0.1442***	0.0305	0.0281
		(2.716)	(0.670)	(0.872)
Hospital Beds		-0.5767**	-0.2969	-0.0930
		(-1.991)	(-0.962)	(-0.330)
Services		0.0435	-0.0991	-0.1071**
		(0.540)	(-1.660)	(-2.255)
Food Imports		-0.1480	-0.0322	-0.1175
		(-1.344)	(-0.441)	(-1.287)
Year 2005			2.2798***	2.1641***
			(4.562)	(4.623)
Year 2010			6.8788***	6.2605***
			(7.614)	(6.779)
Urban*SSA				-0.2378
				(-0.806)
Urban*LAC				0.6712**
				(2.293)
Urban*MENA				-0.6800**
				(-2.380)
Urban*EUR				-1.4426***
				(-8.305)
Urban*SA				-0.0180
				(-0.148)
Urban*CA				-4.3676***
				(-3.384)
Urban*OCEANIA				0.6877***
				(2.722)
Observations	369	200	200	200
Countries	124	103	103	103
R-squared	0.421	0.503	0.763	0.850
Rho	0.9857	0.9789	0.9954	0.9993

*significant at 10%; ** significant at 5%; *** significant at 1%
Fixed Effects estimation. Robust values of t-statistics in parentheses, using clustered standard errors at the country level. Constant is not reported.

Furthermore, it is noticeable that most of the variance comes from the fixed effects[11]. The α_i accounts for more than 97% of the variance as indicated by rho. This practically means that the largest part of the deviation from the estimated mean is due to country specific characteristics that do not vary over time. An interpretation of this could be that time invariant factors such as culture or the standing of obesity in a society explain the largest part of the differences in overweight and obesity rates around the globe. In that regard, Figure 1.4 shows the mean of the fixed effects component across regions.

Figure 1.4: The average fixed effect per region



Note: Own calculation. The mean of the predicted $\alpha_i = const + u_i$ estimated from a modified version of the 3rd specification of Table 1.2. The GDP p.c. was used instead of its natural logarithm.

We clearly observe large differences in the fixed effects component across regions. An implication of this finding may be that policy should target each country individually. There does not seem to be a recipe that can be applied to all countries or regions. This suggests that the phenomenon should be further investigated using micro-level household data for individual countries. However, it is undeniable, that higher urbanization rates and other related factors are to some extent responsible for the rapidly spreading global obesity epidemic and also that economic development and increasing income levels seem to reduce the share of obesity.

[11] The fixed effects model performs better, than a random effects model (as expected), as the Hausman test suggests for all specifications.

1.5 Concluding Remarks

This paper used a new panel dataset on overweight and obesity in low- and middle-income countries to identify some of the drivers behind the rising global obesity trends. The results suggest that, contrary to common belief, the net effect of rising per capita income seems to be negative, when we account for fixed effects. These time invariant factors (tradition, culture) etc. explain the largest part of the differences in obesity rates across countries. This component varies largely across regions, indicating that either genetic or cultural differences clearly play a much larger role compared to the level of economic development. Regardless, economic development and increasing income levels do not seem to further increase obesity rates in the developing world as previously suggested by cross sectional studies.

Nevertheless, some economic factors seem to be associated with the increasing prevalence rates. Higher urbanization is a possible source of increasing weight and its effects also vary substantially across regions. The implications of these findings are twofold. First, it gives researchers the incentive to further investigate the phenomenon on the micro-level in individual countries focusing mainly in urban areas. Secondly, direct policy implications can be drawn. There exists a large literature supporting and promoting urban and peri-urban agriculture (UPA). Policymakers could look into this concept, in order to deal with problems in the nutritional status of urban populations and the provision of low price, low calorie food items. Moreover, the fact that cultural aspects and a positive view of obesity in several societies clearly play an important role renders health education programs essential in changing these perceptions and effectively reducing obesity rates. Finally, new paths for research are opened, due to the fact that the year dummies have a positive and significant impact on obesity rates. This finding suggests that factors common to all countries that changed over time have driven the weight gain of the world population.

APPENDIX A1

Table A1.1: Descriptive statistics

	2002			2005			2010		
	Mean	S.E	Obs.	Mean	S.E.	Obs.	Mean	S.E.	Obs.
Overweight 15+	42.78	19.65	126	44.67	19.83	126	47.88	20.03	126
Overweight 30+	49.74	21.18	126	51.64	21.13	126	54.75	20.92	126
Obesity 15+	15.25	13.98	126	16.65	14.69	126	19.15	16.02	126
Obesity 30+	19.66	16.64	126	21.28	17.32	126	24.14	18.56	126
GDP p.c., PPP, 2005 US$	4275.1	4173.8	122	4656.2	4512.6	123	5503.9	5349.1	124
Urbanization	42.73	20.49	126	44.00	20.67	126	45.74	20.86	126
Female Schooling	52.11	31.02	105	56.98	31.67	111	62.85	30.35	117
Schooling	51.01	27.01	100	56.04	28.12	106	61.67	26.99	111
Hospital Beds per 1000	2.884	2.454	59	2.483	2.111	79	2.129	1.795	117
Physicians per 1000	1.071	1.101	95	1.143	1.257	64	0.906	1.128	107
Services in GDP	50.41	13.63	120	50.73	13.93	123	51.39	14.59	119
Agriculture in GDP	21.52	14.28	120	19.74	13.86	123	17.12	12.24	119
Food Imports	17.13	7.82	111	16.77	8.34	108	15.40	7.58	109
KOF Index	43.07	11.54	123	45.38	11.43	124	48.38	11.33	124
GINI	45.07	9.13	70	44.47	8.80	64	42.44	8.62	80

Note: Own calculations using WHO, World Bank and KOF Data.

Table A1.2: List of countries

Afghanistan
Algeria
Angola
Antigua and Barbuda
Argentina
Armenia
Azerbaijan
Bangladesh
Belarus
Belize
Benin
Bhutan
Bolivia
Bosnia and Herzegovina
Botswana
Brazil
Burkina Faso
Burundi
Cambodia
Cameroon
Cape Verde
Central African Republic
Chad
Chile
China
Colombia
Comoros
Dem. Rep. of Congo
Rep. of Congo
Costa Rica
Cote d'Ivoire
Djibouti
Dominica
Dominican Rep.
Ecuador
Egypt
El Salvador
Eq. Guinea
Eritrea
Ethiopia
Fiji
Gabon
Gambia
Georgia
Ghana
Grenada
Guatemala
Guinea
Guinea-Bissau
Guyana
Honduras
India
Indonesia
Iran
Jamaica
Jordan
Kazakhstan
Kenya
Kiribati
Kyrgyz Rep.
Lao PDR
Lebanon
Lesotho
Liberia
Libya
Madagascar
Malawi
Malaysia
Maldives
Mali
Mauritania
Mauritius
Mexico
Micronesia Fed. St.
Moldova
Mongolia
Morocco
Mozambique
Myanmar
Namibia
Nepal
Nicaragua
Niger
Nigeria
Oman
Pakistan
Panama
Papua New Guinea
Paraguay
Peru
Philippines
Rwanda
Samoa
Sao Tome and Principe
Saudi Arabia
Senegal
Seychelles
Sierra Leone
Solomon Islands
South Africa
Sri Lanka
St. Kitts and Nevis
St. Lucia
St. Vincent and Grenadines
Sudan
Suriname
Swaziland
Syria
Tajikistan
Tanzania
Thailand
Timor Leste
Togo
Tonga
Trinidad and Tobago
Tunisia
Turkmenistan
Uganda
Uruguay
Uzbekistan
Vanuatu
Venezuela
Vietnam
Yemen
Zambia
Zimbabwe

Table A1.3: Fixed effects estimation for the share of overweight females over 15 years of age

	(1)	(2)	(3)	(4)
ln(GDP p.c.)	-3.3882	4.3356***	1.6601	-4.7037**
	(-0.488)	(3.794)	(0.893)	(-2.446)
ln(GDP p.c.) squared	0.4639			
	(1.120)			
Urban	0.8817***	0.8685***	0.7587***	0.3152**
	(10.352)	(10.476)	(4.949)	(2.465)
Female Schooling			0.1117***	0.0269
			(2.727)	(0.751)
Hospital Beds			-0.4090*	-0.1812
			(-1.677)	(-0.683)
Services			0.0542	-0.0449
			(0.855)	(-0.880)
Food Imports			-0.0909	-0.0040
			(-1.089)	(-0.060)
Year 2005				1.7351***
				(3.838)
Year 2010				5.2092***
				(6.208)
Observations	369	369	200	200
Countries	124	124	103	103
R-squared	0.567	0.565	0.613	0.791
Rho	0.9905	0.9903	0.9881	0.9951

*significant at 10%; ** significant at 5%; *** significant at 1%
Fixed Effects estimation. Robust values of t-statistics in parentheses, using clustered standard errors at the country level. Constant is not reported.

Table A1.4: Fixed effects estimation for the share of obese females over 15 years of age

	(1)	(2)	(3)	(4)
ln(GDP p.c.)	-24.1831***	-49.4325***	-48.3343***	-45.7794***
	(-2.760)	(-3.185)	(-3.995)	(-4.851)
ln(GDP p.c.) squared	1.6785***	3.0324***	2.4793***	2.4292***
	(3.032)	(3.135)	(3.279)	(4.464)
Urban	0.5916***	0.4952***	-0.0689	-0.1083
	(6.508)	(2.727)	(-0.522)	(-1.041)
Female Schooling		0.1177**	0.0054	0.0067
		(2.381)	(0.130)	(0.222)
Hospital Beds		-0.5626*	-0.2795	-0.0865
		(-1.972)	(-0.999)	(-0.348)
Services		0.0242	-0.1161**	-0.1206**
		(0.316)	(-2.090)	(-2.550)
Food Imports		-0.1131	-0.0006	-0.0790
		(-1.081)	(-0.009)	(-0.936)
Year 2005			2.3169***	2.1646***
			(4.821)	(4.722)
Year 2010			6.7413***	6.0542***
			(7.675)	(6.607)
Urban*SSA				-0.2077
				(-0.777)
Urban*LAC				0.6967**
				(2.361)
Urban*MENA				-0.6080**
				(-2.267)
Urban*EUR				-1.2219***
				(-6.987)
Urban*SA				0.0068
				(0.054)
Urban*CA				-3.6548***
				(-2.786)
Urban*OCEANIA				0.7821***
				(3.321)
Observations	369	200	200	200
Countries	124	103	103	103
R-squared	0.384	0.459	0.747	0.837
Rho	0.9844	0.9754	0.9951	0.9992

*significant at 10%; ** significant at 5%; *** significant at 1%
Fixed Effects estimation. Robust values of t-statistics in parentheses, using clustered standard errors at the country level. Constant is not reported.

Table A1.5: Fixed effects estimation for the share of overweight males over 30 years of age

	(1)	(2)	(3)	(4)
ln(GDP p.c.)	-2.1300	5.0283***	3.8074	0.4637
	(-0.240)	(3.648)	(1.403)	(0.134)
ln(GDP p.c.) squared	0.4299			
	(0.827)			
Urban	0.7128***	0.7005***	0.4084**	0.1677
	(6.504)	(6.591)	(2.018)	(0.695)
Schooling			0.1611***	0.1036*
			(3.181)	(1.940)
Hospital Beds			-0.0682	0.0330
			(-0.270)	(0.129)
Services			0.0288	-0.0176
			(0.401)	(-0.260)
Food Imports			0.0124	0.0962
			(0.101)	(0.840)
Year 2005				0.5982
				(0.799)
Year 2010				2.8907**
				(1.992)
Observations	369	369	189	189
Countries	124	124	98	98
R-squared	0.467	0.465	0.541	0.606
Rho	0.9864	0.9861	0.9783	0.9877

*significant at 10%; ** significant at 5%; *** significant at 1%
Fixed Effects estimation. Robust values of t-statistics in parentheses, using clustered standard errors at the country level. Constant is not reported.

Table A1.6: Fixed effects estimation for the share of obese males over 30 years of age

	(1)	(2)	(3)	(4)
ln(GDP p.c.)	-20.6801***	-32.3151***	-36.2450***	-27.2026***
	(-2.897)	(-2.728)	(-3.512)	(-2.946)
ln(GDP p.c.) squared	1.4038***	2.0008***	1.9425***	1.4599***
	(3.099)	(2.793)	(3.148)	(2.751)
Urban	0.3700***	0.2512*	-0.1128	-0.2260
	(4.754)	(1.710)	(-0.797)	(-1.225)
Schooling		0.1364**	0.0427	0.0304
		(2.610)	(0.786)	(0.755)
Hospital Beds		-0.3667	-0.1596	-0.0283
		(-1.282)	(-0.697)	(-0.125)
Services		-0.0572	-0.1327**	-0.1255**
		(-0.805)	(-2.081)	(-2.307)
Food Imports		0.0582	0.1717**	0.0385
		(0.593)	(2.013)	(0.462)
Year 2005			1.3884**	1.4262***
			(2.457)	(2.759)
Year 2010			4.5142***	3.9053***
			(4.210)	(3.889)
Urban*SSA				-0.1240
				(-0.556)
Urban*LAC				0.9855***
				(3.115)
Urban*MENA				-0.6228**
				(-2.159)
Urban*EUR				-0.6693***
				(-2.875)
Urban*SA				0.1698
				(0.848)
Urban*CA				-1.3341
				(-1.041)
Urban*OCEANIA				0.8113***
				(2.999)
Observations	369	189	189	189
Countries	124	98	98	98
R-squared	0.287	0.405	0.594	0.736
Rho	0.9809	0.9615	0.9905	0.9986

*significant at 10%; ** significant at 5%; *** significant at 1%
Fixed Effects estimation. Robust values of t-statistics in parentheses, using clustered standard errors at the country level. Constant is not reported.

Table A1.7: Fixed effects estimations for females over 30 years of age

	Overweight	Obesity	Overweight	Obesity	Overweight	Obesity
ln(GDP p.c.)	-4.1107**	-43.7109***	-5.5836***	-49.2110*	-4.3594**	-52.7836***
	(-2.039)	(-2.955)	(-2.711)	(-1.857)	(-2.341)	(-5.210)
ln(GDP p.c.) squared		2.2069**		2.3154		2.8107***
		(2.493)		(1.416)		(4.341)
Urban	0.3851***	-0.0195	0.4217*	-0.1902	0.3394***	-0.1460
	(3.093)	(-0.141)	(1.931)	(-0.791)	(2.694)	(-1.002)
Female Schooling	0.0268	0.0247	0.1299*	0.1619**	0.0562	0.0623
	(0.824)	(0.565)	(1.881)	(2.087)	(1.188)	(1.060)
Hospital Beds	-0.1523	-0.3565	-0.1324	-0.7473*		
	(-0.553)	(-1.093)	(-0.375)	(-1.843)		
Physicians					-0.8019	-0.6060
					(-1.407)	(-0.749)
Services	-0.0084	-0.0870	0.0184	-0.1146**		
	(-0.183)	(-1.462)	(0.363)	(-2.088)		
Agriculture					-0.0148	0.0108
					(-0.171)	(0.115)
Food Imports	0.0190	-0.0168	0.0134	-0.0375	-0.0644	0.0478
	(0.346)	(-0.233)	(0.082)	(-0.174)	(-1.041)	(0.673)
Globalization	-0.0098	-0.1106				
	(-0.102)	(-0.805)				
GINI			0.0600	-0.0095		
			(0.993)	(-0.107)		
Year 2005	1.5430***	2.4616***	1.2177	1.7510*	1.3991***	2.5050***
	(3.749)	(5.046)	(1.515)	(1.946)	(3.442)	(4.864)
Year 2010	4.5962***	7.3954***	4.7133***	7.4583***	4.3886***	6.5228***
	(6.168)	(8.058)	(3.319)	(4.765)	(5.743)	(7.134)
Observations	197	197	123	123	201	201
Countries	102	102	75	75	100	100
R-squared	0.791	0.771	0.799	0.796	0.783	0.705
Rho	0.9953	0.9952	0.9914	0.9956	0.9944	0.9943

*significant at 10%; ** significant at 5%; *** significant at 1%
Fixed Effects estimation. Robust values of t-statistics in parentheses, using clustered standard errors at the country level. Constant is not reported.

Table A1.8: Fixed effects estimations for females over 30 years of age, excluding Oceania

	Overweight	Obesity	Obesity
ln(GDP p.c.)	-4.3314**	-49.7382***	-48.4067***
	(-2.246)	(-4.114)	(-5.123)
ln(GDP p.c.) squared		2.5464***	2.5402***
		(3.343)	(4.644)
Urban	0.3873***	-0.0312	-0.0146
	(3.203)	(-0.230)	(-0.142)
Female Schooling	0.0220	0.0451	0.0237
	(0.583)	(0.881)	(0.686)
Hospital Beds	-0.2105	-0.2906	-0.1173
	(-0.821)	(-0.921)	(-0.398)
Services	-0.0114	-0.0999	-0.1047**
	(-0.261)	(-1.660)	(-2.152)
Food Imports	0.0377	0.0059	-0.1295
	(0.526)	(0.067)	(-1.156)
Year 2005	1.5895***	2.0998***	2.2280***
	(3.218)	(3.587)	(4.520)
Year 2010	4.7499***	6.7114***	6.4240***
	(5.441)	(6.265)	(6.698)
Urban*SSA			-0.2683
			(-0.865)
Urban*LAC			0.6532**
			(2.205)
Urban*MENA			-0.7088**
			(-2.310)
Urban*EUR			-1.4268***
			(-7.964)
Urban*SA			-0.0159
			(-0.123)
Urban*CA			-4.4114***
			(-3.457)
Observations	186	186	186
Countries	98	98	98
R-squared	0.783	0.750	0.839
Rho	0.9949	0.9947	0.9993

*significant at 10%; ** significant at 5%; *** significant at 1%
Fixed Effects estimation. Robust values of t-statistics in parentheses, using clustered standard errors at the country level. Constant is not reported.

Table A1.9: Pooled OLS estimations for females over 30 years of age

	Overweight	Obesity
Obesity (lagged)		1.0497***
		(54.728)
Overweight (lagged)	0.9909***	
	(94.237)	
ln(GDP p.c.)	0.2507	2.0015
	(0.749)	(0.733)
ln(GDP p.c.) squared		-0.0917
		(-0.576)
Urban	0.0170**	0.0195*
	(2.311)	(1.745)
Female Schooling	0.0003	0.0037
	(0.038)	(0.369)
Hospital Beds	-0.3041***	-0.3663***
	(-3.429)	(-3.434)
Services	-0.0022	0.0062
	(-0.179)	(0.382)
Food Imports	0.0067	-0.0137
	(0.305)	(-0.539)
Globalization	-0.0055	-0.0212
	(-0.280)	(-0.787)
Year 2010	1.3602***	1.4124***
	(6.419)	(4.722)
Constant	0.3052	-8.9918
	(0.150)	(-0.852)
Observations	153	153
Countries	100	100
R-squared	0.996	0.991

*significant at 10%; ** significant at 5%; *** significant at 1%
Pooled OLS estimation. Robust values of t-statistics in parentheses, using clustered standard errors at the country level. Year 2002 removed.

Part 2

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

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

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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.

2.1 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 trend[12]. 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 children[13].

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 capabilities[14]. 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.

[12] WHO data.
[13] NIDS data.
[14] 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 2.2, a detailed description of the data and descriptive statistics in section 2.3, while section 2.4 presents the results of the analysis. Finally, we conclude in section 2.5 proposing some policies, in order to prevent the expansion of childhood obesity as early as possible.

2.2 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 2.1.

Figure 2.1: 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 prediposition(?)*, Preferences/Habits	Income, Caregiver, Genetic prediposition(?)*, 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 obesity[15]. 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 only[16]. 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.

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

16 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 nourishment[17]. 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

[17] 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 have[18]. 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.

2.3 Data Description and Descriptive Statistics

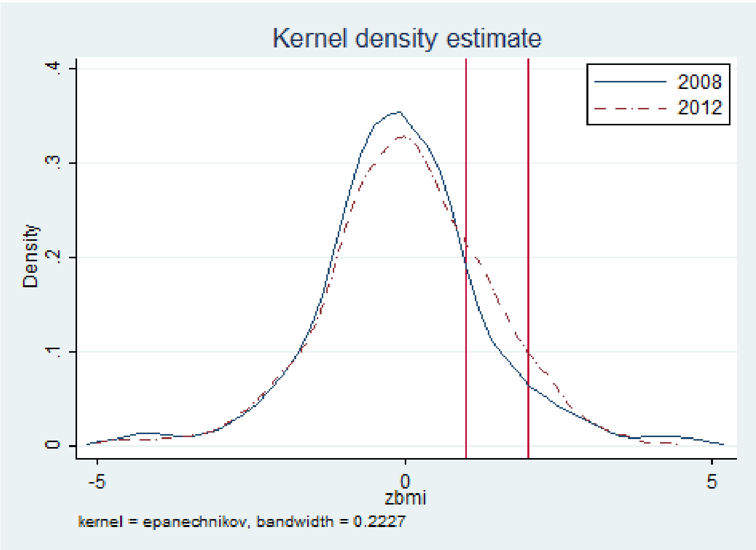
This paper utilizes the three waves (2008, 2010/11, 2012) of the South African National Income Dynamics Study (NIDS) provided by the South African Labor and Development Research Unit (SALDRU) of the University of Cape Town. The sample has been restricted to children who were between 6 and 12 years of 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.

[18] 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 2.2 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 2.2: 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 2.1: 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 2.2: 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 2.3. 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.

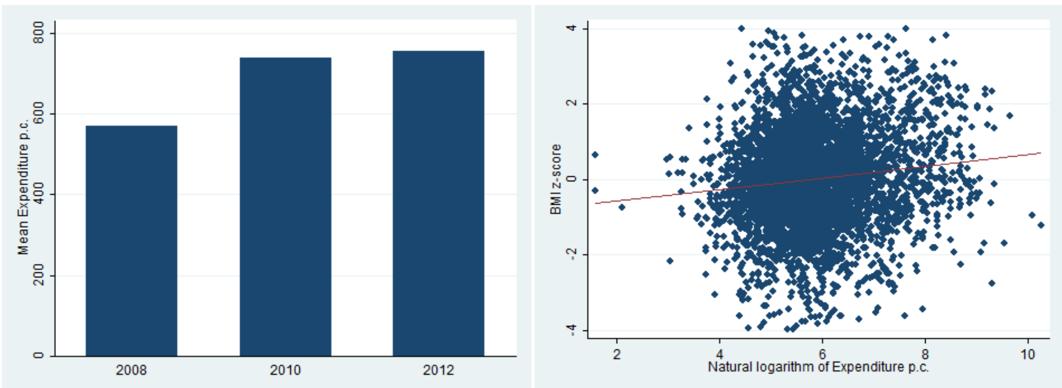
Table 2.3: The shares of overweight, obesity and children walking/riding to school by residential area

		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 2012[19]. This increase was much sharper between 2008 and 2010.

Figure 2.3: 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.

[19] The figures are per month and have been adjusted by the CPI.

Table 2.4: 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 2.4 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 2.5: 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

2.4 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 Africa[20].

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

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 problematic[21], 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)).

$$P(y=1)_{i} = \alpha + \beta X_{it} + \delta T_t + \gamma \bar{X}_{\iota} + v_{\iota}$$

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 Africa[22]. Since in many households the children receive care from another person than their mother[23] 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

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[20] All the results shown use heteroscedasticity robust standard errors clustered at the household level

[21] See Greene (2003)

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

[23] 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 dummies[24].

The regression results on the probability of a child being overweight are presented in Table 2.6. 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.

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[24] 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 week 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 2.6: Regression on the probability of a child being overweight

	Pooled Probit	Linear Prob. FE	Mundlak	
				Means
Household Expenditure p.c.	0.1034***	-0.0085	0.0231	0.1273*
	(3.04)	(0.68)	(0.54)	(1.92)
Urban	0.2118***	0.1007	0.0543	0.1427
	(2.85)	(1.45)	(0.24)	(0.62)
Caregiver obese (BMI>30)	0.2793***	0.0076	-0.0214	0.4333***
	(5.49)	(0.32)	(0.27)	(4.23)
Caregiver education	-0.0148	-0.0199	-0.0852	0.0691
	(0.49)	(1.33)	(1.52)	(1.02)
Caregiver Employment	-0.0903	0.0032	-0.0418	-0.0996
	(1.41)	(0.14)	(0.52)	(0.90)
Number of children in HH	-0.0729***	0.0031	-0.0057	-0.0806**
	(4.04)	(0.39)	(0.19)	(2.22)
Gender	-0.0831			-0.0833
	(1.58)			(1.57)
Age	-0.0032**	0.0007	0.0066	-0.0104**
	(1.98)	(0.18)	(1.23)	(1.99)
TV	0.0477	0.0111	0.1041	-0.1112
	(0.79)	(0.50)	(1.25)	(1.03)
Physical Activity	-0.1245*	0.0124	0.0428	-0.1947
	(1.75)	(0.42)	(0.41)	(1.36)
African	0.04			0.1862
	(0.20)			(0.87)
Coloured	-0.3706*			-0.2196
	(1.64)			(0.94)
Asian	-0.3007			-0.2443
	(0.80)			(0.64)
Year 2010	0.2221***	0.0461	0.0044	
	(2.96)	(0.39)	(0.03)	
Year 2012	0.3288***	0.0235	-0.0851	
	(3.44)	(0.11)	(0.32)	
Western Cape	0.2842*	-0.4497***	-0.7195	1.0228
	(1.80)	(2.62)	(1.13)	(1.56)
Eastern Cape	0.3749***	-0.3087*	-0.8558	1.2527**
	(3.04)	(1.66)	(1.43)	(2.06)
Northern Cape	-0.1054	0.0883	0.1236	-0.2352
	(0.67)	(0.82)	(0.28)	(0.49)
Free State	0.13	0.3317	-0.0467	0.1994
	(0.90)	(1.53)	(0.05)	(0.23)
KwaZulu-Natal	0.3297***	-0.2381	-0.9387*	1.3051***
	(2.84)	(1.40)	(1.90)	(2.57)
North West	0.1263	0.0491	0.0446	0.1404
	(0.83)	(0.43)	(0.11)	(0.32)
Mpumalanga	0.1132	0.1465	-0.2655	0.4284
	(0.81)	(0.13)	(0.65)	(0.98)
Limpopo	0.0844	0.0835	-0.0389	0.1747
	(0.63)	(0.78)	(0.10)	(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 2.7: Regression on the probability of a child being obese

	Pooled Probit	Linear Prob. FE	Mundlak	
				Means
Household Expenditure p.c.	0.0937**	0.0082	0.0523	0.0509
	(2.14)	(1.10)	(0.95)	(0.62)
Urban	0.1561	0.0811	0.2736	-0.1412
	(1.58)	(1.44)	(0.82)	(0.42)
Caregiver obese (BMI>30)	0.2381***	0.062	0.0386	0.2896**
	(3.77)	(0.42)	(0.40)	(2.20)
Caregiver education	-0.0025	-0.019**	-0.1833**	0.1866**
	(0.60)	(1.99)	(2.39)	(2.09)
Caregiver Employment	-0.0294	-0.0102	-0.1085	0.1026
	(0.37)	(0.69)	(1.04)	(0.72)
Number of children in HH	-0.0856***	-0.0054	-0.0267	-0.0768
	(3.58)	(1.12)	(0.63)	(1.61)
Gender	-0.0142			-0.0212
	(0.21)			(0.19)
Age	-0.0029	-0.0012	0.0089	-0.0121*
	(1.33)	(0.42)	(1.32)	(1.86)
TV	0.0424	0.0064	0.1045	-0.1058
	(0.54)	(0.55)	(1.04)	(0.79)
Physical Activity	-0.0718	0.0144	-0.0212	-0.0304
	(0.82)	(0.69)	(0.15)	(0.16)
African	-0.255			-0.1679
	(1.25)			(0.77)
Coloured	-0.4746**			-0.3578
	(2.02)			(1.47)
Asian	-0.2405			-0.2098
	(0.68)			(0.58)
Year 2010	0.0596	0.0434	-0.2318	
	(0.57)	(0.52)	(1.14)	
Year 2012	0.1644	0.0703	-0.3828	
	(1.21)	(0.47)	(1.12)	
Western Cape	-0.0051	-0.2666*	-0.5426	-0.5426
	(0.03)	(1.80)	(0.77)	(0.80)
Eastern Cape	0.2132	-0.1773	-0.901	1.1898*
	(1.43)	(1.14)	(1.28)	(1.65)
Northern Cape	-0.187	-0.0846	-0.4404	0.2801
	(0.91)	(0.97)	(0.79)	(0.46)
Free State	0.0382	-0.1313	-1.2547**	1.3961**
	(0.22)	(1.26)	(2.41)	(2.50)
KwaZulu-Natal	0.2282	-0.226	-1.4252**	1.7567***
	(1.57)	(1.28)	(2.26)	(2.72)
North West	-0.187	-0.1145	-0.7996*	0.9022*
	(0.13)	(1.25)	(1.74)	(1.87)
Mpumalanga	0.1698	0.0026	-0.0628	0.32
	(0.94)	(0.05)	(0.15)	(0.68)
Limpopo	0.0233	-0.004	-0.0246	0.1363
	(0.14)	(0.08)	(0.07)	(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 child[25]. 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, 2008). 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.

[25] 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 2.8: Mundlak specifications with interaction terms on the caregiver

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

2.5 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.

APPENDIX A2

Table A2.1: 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 7th grade) 2: Some secondary education (until 11th grade, NTC1 (National Technical Certificates), NTC2, certificates and diplomas below 12th grade) 3: Completed secondary education (12th 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 A2.2: 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 A2.3: Regressions on the BMI-z-score

	Pooled OLS	Fixed Effects
Household Expenditure p.c.	0.0999***	0.0463
	(3.48)	(1.49)
Urban	0.1592***	0.4183**
	(2.44)	(2.05)
Caregiver obese (BMI>30)	0.3286***	0.1563***
	(8.04)	(2.61)
Caregiver education	-0.0308	-0.0984**
	(1.22)	(2.11)
Caregiver Employment	-0.0331	0.0283
	(0.66)	(0.47)
Number of children in HH	-0.0573***	-0.0045
	(4.67)	(0.21)
Gender	-0.08*	
	(1.86)	
Age	-0.0027**	0.0015
	(2.03)	(0.14)
TV	0.0622	0.025
	(1.39)	(0.40)
Physical Activity	-0.0932	-0.043
	(1.54)	(0.56)
African	-0.0912	
	(0.43)	
Coloured	-0.4659**	
	(2.05)	
Asian	-0.727*	
	(1.86)	
Year 2010	0.0876	0.0445
	(1.46)	(0.14)
Year 2012	0.1562**	-0.0167
	(1.95)	(0.03)
Western Cape	0.1718	-0.8677*
	(1.21)	(1.72)
Eastern Cape	0.3592***	-0.0419
	(3.23)	(0.08)
Northern Cape	-0.1955	0.2486
	(1.50)	(0.76)
Free State	0.0875	0.2628
	(0.72)	(0.51)
KwaZulu-Natal	0.2539***	0.06
	(3.48)	(0.11)
North West	-0.0533	0.0717
	(0.44)	(0.26)
Mpumalanga	0.1521	0.4704*
	(1.23)	(1.66)
Limpopo	0.0837	0.6144**
	(0.76)	(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 A2.4: Regression on BMI-z-score including lags

	Pooled OLS	Pooled OLS
z-BMI (lagged)	0.3063***	0.3059***
	(10.00)	(9.94)
Household Expenditure p.c.	0.0643*	
	(1.88)	
Household Expenditure p.c. (lagged)		0.0255
		(0.74)
Urban	0.1018	0.1059
	(1.34)	(1.40)
Caregiver obese (BMI>30)	0.2755***	0.2748***
	(5.43)	(5.43)
Caregiver education	-0.0114	-0.0047
	(0.41)	(0.17)
Caregiver Employment	-0.0139	-0.0001
	(0.23)	(0.00)
Number of children in HH	-0.0271**	-0.0335**
	(1.99)	(2.55)
Gender	-0.0022	-0.022
	(0.05)	(0.05)
Age	-0.0024*	-0.0025*
	(1.68)	(1.74)
TV	0.0726	0.0893
	(1.20)	(1.49)
Physical Activity	0.0815	0.0657
	(1.13)	(0.91)
African	-0.2785	-0.3363
	(0.93)	(1.09)
Coloured	-0.5863*	-0.6407**
	(1.89)	(2.03)
Asian	-0.8418**	-0.8728**
	(2.17)	(2.24)
Year 2010	0.1722**	0.2076***
	(2.17)	(2.66)
Year 2012	0.2231**	0.261***
	(2.31)	(2.68)
Western Cape	0.0761	0.0759
	(0.48)	(0.48)
Eastern Cape	0.229*	0.2237*
	(1.85)	(1.80)
Northern Cape	-0.1867	-0.1911
	(1.27)	(1.30)
Free State	-0.0283	-0.0379
	(0.21)	(0.29)
KwaZulu-Natal	0.2317**	0.2272*
	(1.98)	(1.93)
North West	-0.0673	-0.0741
	(0.49)	(0.53)
Mpumalanga	0.0697	0.0653
	(0.49)	(0.45)
Limpopo	0.0178	0.0058
	(0.15)	(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 A2.5: Regressions including variables for the child's biological mother

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

Part 3

Understanding the drivers of overweight and obesity in developing countries: The case of South Africa

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Abstract

The rise of obesity prevalence rates in South Africa has already been noticed in the early 1990s. Since then, several articles have discussed how the nutrition transition has affected people's body weight in the country. This paper is the first one that uses longitudinal data from South Africa to reveal short-term and long-term influences of socio-economic and cultural factors on the probability of becoming obese. The concept of "benign" obesity seems to influence people's perceptions of an ideal body shape and model the preference for a higher body weight. Women are more affected by increasing body weights than men. We find that time invariant characteristics and long-term effects have the largest influence on the probability of becoming obese. Our suggestion to address the problems of obesity is to implement programs that change people's attitudes and behavior regarding food intake and physical activity. If people change their perception of an ideal body, then a mixture of health programs can be successful.

3.1 Introduction

For many years one of the most challenging health risks in African countries used to be undernutrition. Although considerable rates of undernutrition and nutritional deficiencies are still prevailing, many low and middle income countries face a double burden of malnutrition where undernutrition and obesity coexist (Popkin et al., 2012; Römling and Qaim, 2012). The obesity pandemic is especially rising among emerging economies (WHO, 2014), but developing countries are catching up in this regard. Data published by the WHO (2010) reveal that obesity among adults has increased by more than 20% between 2002 and 2010 to an average of 25% in middle- and low-income countries. Even in regions like Sub-Saharan Africa we observe an increase in the prevalence of obesity by over 30% to an average of almost 10% in the region (WHO, 2010).

The WHO already recognized obesity as a chronic disease in 2003 (WHO/FAO, 2003). Obesity is not only a problem in itself, but also causes comorbidities, such as diabetes, hypertension, higher risk of heart attacks, strokes, and various cancers. Several authors also examined the negative economic effects of such health issues (Antipatis and Gill, 2001; Lakdawalla et al., 2005; Cawley, 2006; Grossman and Mocan, 2011). Others introduced the hypothesis of a "nutrition transition" as an explanation for the widespread emergence of unhealthy body weights in developing countries (Drewnowski and Popkin, 1997; Popkin, 1999). The term nutrition transition summarizes several patterns, like shifts in dietary consumption towards high-fat food and lifestyle changes towards a more sedentary lifestyle. Some authors have linked this phenomenon to rising income rates by using cross sectional analysis (for instance Popkin, 2004). This approach resulted in introducing so called fat taxes by policy makers in order to increase high fat food prices and lower obesity rates.[26] These studies, however, do not identify clear transmission channels through which increased income operates and also do not account for unobserved heterogeneity and time invariant characteristics. It is therefore no surprise that the effectiveness of such measures is questioned, especially in the long-run (Schmidhuber, 2004). Moreover, it is imaginable that the effectiveness is likely to be much lower in countries where obesity is traditionally seen as positive outcome in the society and individuals show a clear preference for it.

In South Africa, the nutrition transition goes hand in hand with the concept of "benign obesity" or a kind of "healthy obesity" which has gained ground especially from the 1960s

[26] See for instance (Mytton et al., 2012).

to 1990s. “Benign“ obesity means that individuals are regarded as healthy despite their increased weight, because they have normal metabolic features (Phillips et al., 2013). Different behavioral patterns in a society are established by cultural perceptions and mentalities within a society. These patterns develop in the long term and do not change quickly. It is, therefore, important to distinguish between short-term and long-term factors that influence people’s body weights and also model these time invariant characteristics. To our knowledge there are no articles that try to identify long- and short-term determinants of obesity.

For all these reasons we use *longitudinal* data from a nationally representative sample in South Africa, whereas most of the studies use cross sectional data. The panel structure of the data allows us to control for unobserved heterogeneity, which many of the studies on obesity seem to neglect. We also add to the literature by distinguishing between the short-term and the long-term drivers of the still increasing rates. Time-invariant factors are able to reflect the long-term effects and account for the fact that obesity is regarded as a positive outcome in some societies. By using the Mundlak approach we are able to reveal these long-term effects. This becomes all the more important bearing in mind that the main tool used by policy makers to tackle obesity is a so-called fat tax, which mainly has a short-term impact on consumption patterns and its overall effectiveness is debatable (see for instance Schmidhuber , 2004).

The structure of this paper is as follows: Section 3.2 describes the conceptual framework underlying the research questions, the data and methodology used for the investigation. Section 3.3 gives a first glance of the data and Section 3.4 reflects the results of our regressions. In Section 3.5, we conclude the topic and suggest some policy implications.

3.2 Analytical Approach and Data

3.2.1 Conceptual Framework

We follow a framework, where the individual welfare is a function of consumption and health. The health status can in turn be hampered by a high BMI.

$$\boldsymbol{W_t = f\left(C, H\left(BMI^{high}\right)\right)}$$

A high BMI and subsequently overweight and obesity are caused by an imbalance between calorie intake (CI) and calorie expenditure (CE) over longer periods of time.

$$CI_t > CE_t$$

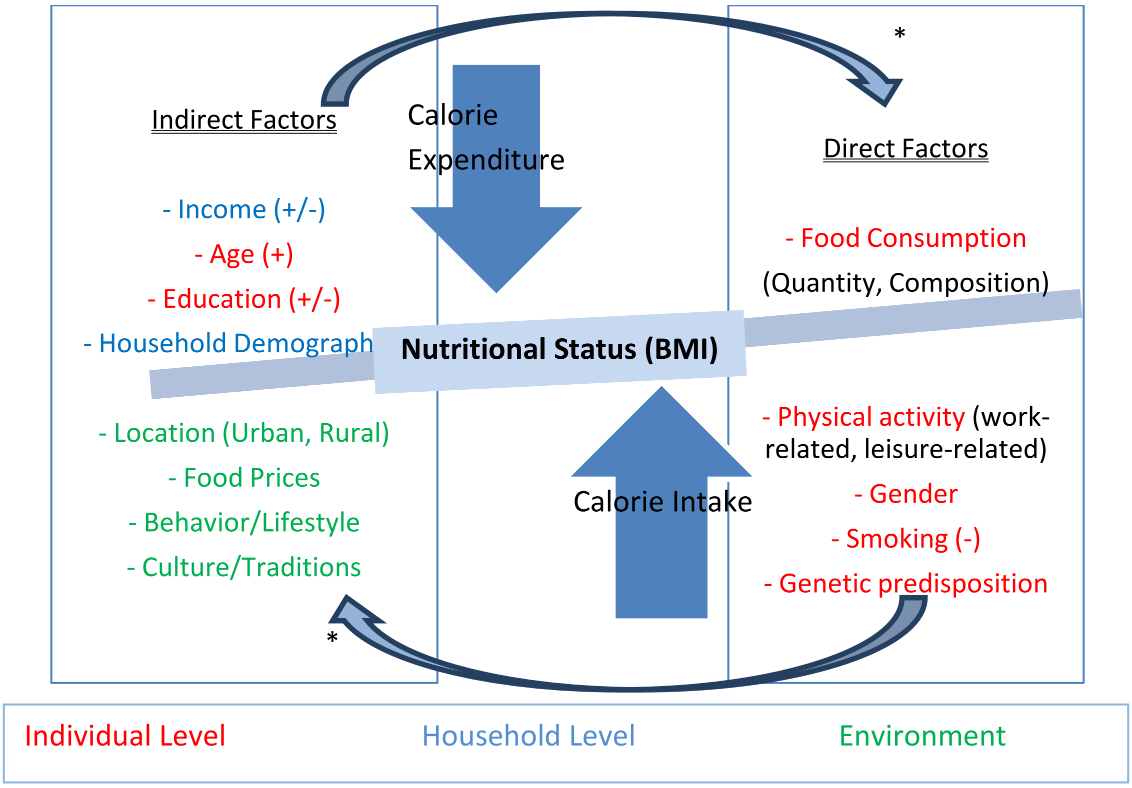
So, the question is what drives daily intake and expenditure. Following a similar framework to Römling and Qaim (2012), one can identify individual, household, and community or environmental characteristics as direct or underlying causes that influence health outcomes.

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

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

Figure provides an illustration of the main factors identified in the relevant literature.

Figure 3.1: Conceptual Framework of Determinants of Nutritional Status



Source: Own composition, *some factors might have an influence on each other.

We argue that income, education, household demographics, location, food prices, behavior/lifestyle and culture/traditions influence people's body weight in an indirect way. Direct factors are food consumption, physical activity, gender, smoking, genetic predisposition. Food prices might have an influence on food consumption, whereas physical activity might be influenced by residence area or lifestyle factors. Some factors, especially the indirect ones, can be traced back to culture and traditions. They are not easy to capture and therefore signs are even harder to predict, while some of these factors have short-term and others long-term effects.[27]

The main body of the literature argues that increasing or higher incomes are linked to increased food consumption and weight gain in developing countries (Martorell et al., 2000; Abdulai , 2010; Subramanian et al.,2011; Römling and Qaim, 2012). However, the results are inconclusive and the transmission channels remain unclear. Moreover, these studies indicate that obesity is even expanding across poorer households as well, so that claims about the association between higher incomes and obesity seem more precarious. Moreover, all of these factors contribute in creating obesogenic environments, but it is more likely that individual behaviors and preferences that give the phenomenon the big push, since obesity is culturally accepted as a positive outcome.

The main argument of our paper is that these behaviors and preferences are predetermined by social norms and/or culture. Caprio et al. describe that culture is shaped by experience (2008), and that it can be seen as a dynamic construct which changes over time. As Kleinman and Benson (2006, pp. 1673–1674) argue: "Anthropologists emphasize that culture is not a single variable but rather comprises multiple variables, affecting all aspects of experience. Culture is inseparable from economic, political, religious, psychological, and biological conditions." If culture is understood as a set of norms and rules for behavior (either normative, meaning what a person should do or more pragmatic, meaning how to do it) then we can assume that it is learned and can be influenced over time. This change, however, is a rather slow process and can span over decades.

In the case of South Africa one has to look deeper between ethnic groups in order to explain the positive standing obesity has in the society. Among the South African Black population a high body mass has been interpreted as "benign" obesity for almost three decades (Van Der Merwe and Pepper, 2006). "Benign", or "healthy" obesity means that there are people who are not adversely affected from chronic obesity, meaning they did not show worsened metabolic features, a fact also known as "obesity paradox". Only after the 1990s, scientists accepted that overweight and obesity have the same harmful effects on African women than it has on White women (Walker et al., 2001). Especially in the long run metabolically healthy obese persons face increased risk for cardiac events

[27] For a more detailed discussion on these factors see Case and Menendez (2009), Abdulai (2010) and Römling and Qaim (2012).

compared with metabolically healthy normal-weight persons (Kramer et al., 2013). Hence, one may argue that the actual high numbers of Black obese people can be traced back partly to the misperception of "healthy" obesity (Van Der Merwe and Pepper, 2006). Another argument is that high body weight is considered a sign of wealth and reflects a high social status and economic well-being (Puoane et al., 2002; Wittenberg, 2013). Moreover, among South African females losing weight is often associated with the "slim disease" (which is HIV/AIDS) and hence is not desired (Kruger et al., 2005). This can lead to the view that slimmer individuals are "ill". Therefore, it seems that higher weight is the preferred body status of certain groups in the society (Van Der Merwe and Pepper, 2006).

Another argument is brought by Case and Menendez (2009), who claim that nutritional deprivation in childhood leads to higher risk of being overweight or obese in later life, especially for women in South Africa. This does not seem to be the case for men. This argumentation is related to the "fetal origin hypothesis“, which states that deficits in the nutrition of an expecting mother have severe implications on her children in later life. The metabolism is programmed to manage with less kilocalories which later on – when food is not scarce any more – leads to increased body weight ("thrifty phenotype“) and a higher probability of suffering from NCDs (Stanner et al., 1997; Delisle, 2002; Osmani and Sen, 2003). The same mechanism applies for malnourished children in early childhood when they do not face food insecurity in later life anymore. Another reason for the higher body weight of women compared to men is the positive relationship of higher adult socioeconomic status and weight which is not true for men, according to Case and Menendez (2009). More reasons that they identified are women's perceptions of an "ideal“ female body which are larger than male's perceptions of the "ideal“ male body. Puoane et al. (2002) discuss the magnitude to which adults of 15+ years in South Africa underestimate their own body weight. The higher the actual body weight was the more the self-perception diverged from the true value, so actual overweight and obesity was completely underestimated.

The adaption of behavioral patterns according to reformed mentalities instead takes more time, so mentality can be considered as having long-term effects. If the concept of "benign" obesity has settled in South African's minds then it will take time to change this idea. We assume that in our research we encounter factors that we cannot translate directly into specific variables but that these factors describe a part of the variation of BMI changes. Some of these can be interpreted as cultural factors which can be traced back to people's mentalities and opinions. These can be modeled as fixed effects with the use of a panel dataset and we also assume that they partly influence the long-term effects of explanatory factors.

3.2.2 The Data

The data we use in our study is a three wave panel dataset from South Africa, the National Income Dynamics Study (NIDS), a national longitudinal study, implemented by the Southern Africa Labor and Development Research Unit (SALDRU) based in the School of Economics at the University of Cape Town. The first wave was conducted in 2008 with a nationally representative sample of over 28,000 individuals in approximately 7,300 households across the country.

After cleaning we include in our sample 9,174 females (65.75%) and 4,779 (34.25%) males aged 18 to 65 living in 3,266 households. As the BMI and the probability of being obese is our dependent variable, we excluded observations from our data set when we had missing values for either height or weight[28] and also pregnant women, because weight gain among pregnant women can be considered as temporary and is not caused by the above mentioned factors. We also excluded individuals who have been diagnosed with HIV. Thus, we only kept individuals with available information on weight and height in all 3 waves. The reason for this is to extend the time dimension of the panel as far as possible. However, the final dataset is an unbalanced one, because of several missing values for explanatory variables.

We use the standard WHO/FAO (2003) definitions for overweight (BMI>25) and obesity (BMI>30), despite the well-known shortcomings of these measures.[29]

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[28] Since the NIDS data set has been established to capture income dynamics, the focus has not been on anthropometric measures, this explains the number of missing values for height and weight. This can also to some extent explain the large gap between females and males in the data, since men residing in the household may not have been present at the time of the survey and were therefore not measured.

[29] See Cawley and Burckhauser (2008) for a more detailed discussion.

3.2.3 Methodology

Following our conceptual framework we propose a model using the probability whether a person (either female or male adult in our case) is obese ($y = 1$) which is explained by a function of vectors of individual, household, and environmental/cultural characteristics. To get a first impression of the influencing factors we use a Pooled Probit model as shown below.[30]

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

In this model α is the constant, β is the corresponding parameter capturing the impact of a vector of individual, household and environmental/cultural variables, δ is the parameter capturing the impact of time year dummies, v_{it} is the error term. v_{it} represents the composite error and summarizes the unobserved time fixed effects c_i and the idiosyncratic error term u_{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.

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

Since both common panel models – namely the Fixed Effects (FE) specification and the Random Effects (RE) specification – have their own shortcomings, we use the Mundlak model to reconcile FE and RE. The so called incidental parameter problem often occurs in binary choice models with fixed effects that have a relatively short time dimension and produces inconsistent and biased estimates. Another disadvantage of FE is that the model drops time invariant effects, both observed and unobserved, from the model which are often variables of interest. The unlikely assumption, that the omitted heterogeneity is uncorrelated with the regressors, is softened by including additional terms of the time-varying variables in the Mundlak model (Mundlak, 1978). The Mundlak approach includes within group means which are able to capture long-term effects and can be interpreted as cumulative effects. This means coefficients are constant across time. The advantage of this model is that we can get the same results as of the FE specification for the within variation of the variables but additionally we can account for the between variation in the model as well. Furthermore, we are interested in using binary choice

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30 We also run Pooled OLS regressions with the BMI as our dependent variable as a robustness check, see Appendix A3.

models and also model fixed effects. This can be complex, especially if we use several binary variables on the right hand side that show very little variation over time. As we are interested in the coefficients of many such variables (e.g. gender, location, education), this is a good approach. Wooldridge (2002b) makes the argument that the approach developed by Mundlak (1978) is also appropriate for unbalanced panels and valid for binary choice models.

$$\boldsymbol{P(y=1)_i = \alpha + \beta X_{it} + \delta\, T_t + \gamma \overline{X_i} + v_i}$$

In this equation, β is the corresponding parameter capturing the *short-term* impact of a vector of individual, household and environmental/cultural variables, which can be directly or indirectly related to weight gain. Parameter γ describes the coefficient of the set of variables which includes the within-individual mean values, and therefore describe *long-term* effects.

3.3 Descriptive Statistics

To get a first overview we have a look at Table A3.2 in the Appendix. We have 65.75% females and 34.25% males in our sample[31]. On average, females are 41.4 years old and males 38.4 years. Women have a higher BMI (29.15) than men (23.7), on average. Men, on average, (8.4) have completed more school grades than women (8.0). Women smoke to a much smaller degree (8.0%) than men (37.0%) and do much less exercise (11.0% and 33.0%, respectively). On average, household size is 5.3 members and 40.0% of the people in our sample live in urban areas.

In our sample, the development of the health status regarding BMI categories is shown in Table 3.1. It becomes clear that more people are becoming overweight and obese, both males and females. Although men are a bit lighter than women, it seems they are gaining weight a bit faster.

[31] There are several reasons why the ratio between males and females is so unbalanced. Primary reason for this has been labor migration (Posel, 2001; Collinson, 2010), also premature death predominantly by males brought on by HIV/AIDS (Gilbert et al., 2010). In general, females are less likely to participate in the labor market and in turn more likely to be at home as the survey is conducted (World Bank, 2012), and more likely to respond to surveys or have their anthropometrics measured.

Table 3.1: BMI Categories for males and females in 2008, 2010, and 2012

BMI Categories	All years	2008		2010		2012	
in %	Total	Female	Male	Female	Male	Female	Male
overweight	56.63	64.88	27.62	69.62	35.28	72.24	36.22
obese	31.66	39.66	8.58	43.82	10.61	44.87	11.68
N	13,953	3,058	1,593	3,058	1,593	3,058	1,593

Note: Own calculations using NIDS data.

Population groups are heterogeneous in South Africa, so we include Table 3.2 which gives an overview over the health status among the different population groups.

Table 3.2: BMI Categories for population groups

BMI Categories	Population Group				
in %	African	Colored	Asian	White	Total
overweight	56.02	57.47	62.09	74.36	56.63
obese	31.31	33.85	23.53	37.36	31.66
N	11,787	1,740	153	273	13,963

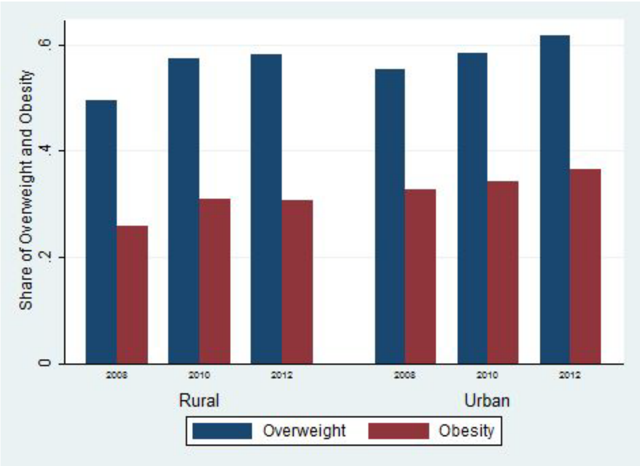
Note: Own calculations using NIDS data.

The largest group is the African group. They exhibit an overweight rate of 56% and an obesity rate of 31%. For so-called Colored people[32] the picture is more or less the same, with the figures being only slightly higher. Asians seem to be less likely to be obese (23.53%), but the share of overweight is higher compared to the other two groups. For Whites again we have a different picture. This population group exhibits the highest overweight and obesity rates in the country. However, these results should be viewed with caution, since the unweighted samples for White and Asian are very small and not entirely reflective of the actual size of each population group in South Africa.

One of the main arguments in the literature is that overweight and obesity are more prevalent in urban areas in developing countries. For the case of South Africa we find a comparable picture, as can be seen in Figure 3.2. We find that there are more overweight and obese people in urban areas than in rural areas. For both regions prevalence rates are increasing over time.

[32] Several years ago this term has been established and has been used since then. A "Colored person" is defined as a person who is not a White person or a native, this definition is based on the principle of exclusion (Patterson, 1953). Colored persons can be seen as mixed race.

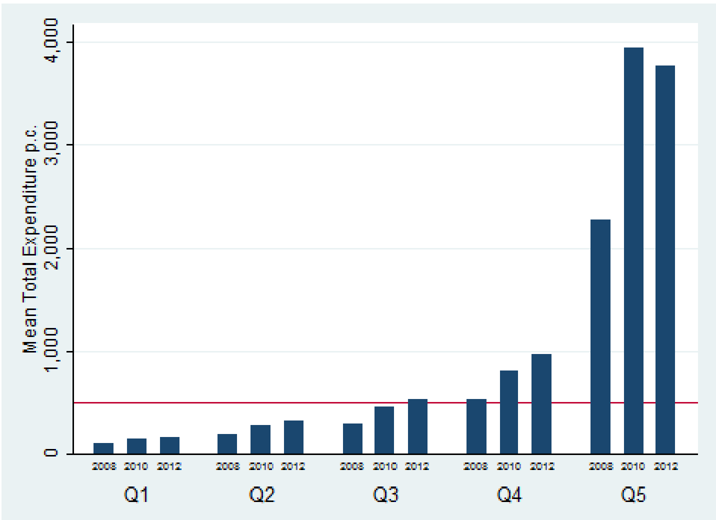
Figure 3.2: Overweight and Obesity in Urban and Rural Areas



Note: Own calculations using NIDS data. Overweight is defined as 25<BMI<30 and obesity as BMI>30.

Moreover, regarding economic growth we observe a massive increase in incomes during the period 2008-2010, see Figure 3.3. In order to control for the monetary well-being of a household, we use real per capita expenditure[33] as a control variable into our model because we follow the standard assumption that this reflects a household's financial situation better than income (e.g. Deaton and Zaidi, 2002).

Figure 3.3: Mean Total Expenditure per capita across quintiles



Note: Own calculations using NIDS data. The quintiles are calculated on total household expenditure per capita. The red line represents the 2008 poverty line at 507 Rand per capita per month[34].

The mean total expenditure per capita almost doubled from 677.88 Rand in 2008 to 1111.02 Rand in 2010 and ultimately stagnated to 1112.65 Rand in 2012. However, it is

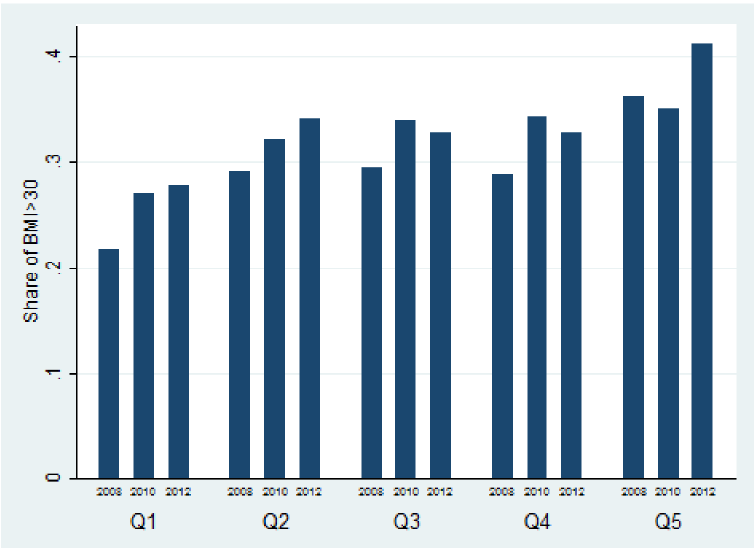
[33] We adjust the calculated NIDS data by using the CPI of the Statistical Office of South Africa (Available at : http://www.statssa.gov.za/?page_id=1854&PPN=P0141&SCH=6039)

[34] The poverty line is the upper bound poverty line calculated in the Poverty Trends Report of 2014, which resulted in 57% of the population living below it (Statistics South Africa, 2014). In this paper it is only used indicative and does not reflect the extent of poverty in South Africa, because the methodologies differ.

worth noting in this regard, that total expenditure kept increasing beyond 2010 for all but the richest quintile of the distribution. Even for the poorest 20% total expenditure per capita increased by another 8.5% in 2010-2012 to a total of 167.23 Rand. One notices immediately the huge differences in spending and the income inequality that is prevalent.

We find, however, in this regard that an increased body weight is highly prevalent across all quintiles of the expenditure distribution, see Figure 3.4. This in turn implies that increases in body weight are by no means proportional to increases in income. We also see that obesity is not only a problem of the richer quintiles but is a problem for the whole population. Still, prevalence rates are highest among the richest 20% of the population. To conclude the last two paragraphs, albeit income is highly unequally distributed among the South African population, we see a relatively equally distributed (high) share of obese persons in the whole population.

Figure 3.4: Share of BMI>30 over expenditure quintiles



Note: Own calculations using NIDS data. The quintiles are calculated on total household expenditure per capita.

3.4 Empirical Results

This section of the paper presents the empirical results of our analysis. We use a dummy for being obese as the dependent variable in our probability models, while we also include simple linear regressions on the Body Mass Index itself as a robustness check. Moreover, we run separate regressions for males and females and also add other definitions of obesity as robustness checks. All the results shown use heteroscedasticity robust standard errors clustered at the household level.

3.4.1 Obesity

The regression results for the Pooled Probit regression on the probability of a person being obese are shown in Table 3.3. The other two specifications take advantage of the panel dimension of the data in order to account for time invariant characteristics and explore the within variance across observations[35]. Although the linear probability model lacks in precision, we feel that the number of observations is adequately high, in order to give useful insight into the within variation and the direction of the coefficient signs and the level of significance (Wooldridge, 2002a). It also serves as a benchmark for the Mundlak Approach. The latter can be seen in the third column and is the preferred way to model fixed effects in a Probit model, where many of the covariates are binary variables and exhibit very little variation.

Table 3.3: Regressions on the probability of being obese

	Pooled Probit	Linear Prob. FE	Mundlak	
				Means
Total Household Expenditure p.c.	0.1171***	0.0215***	0.0796***	0.0112
	(4.58)	(2.78)	(3.63)	(0.19)
Household Food Expenditure p.c.	0.0483	-0.0056	-0.0165	0.1583**
	(1.63)	(-0.70)	(-0.71)	(2.23)
Urban	0.1690***	0.0129	0.0721	0.0867
	(3.59)	(0.39)	(0.70)	(0.76)
Age	0.0088***	0.0023**	0.0094***	-0.0007
	(10.75)	(2.06)	(3.01)	(-0.22)
Age (sq.)	-0.0000***	-0.0000***	-0.0000***	0.0000
	(-8.54)	(-4.03)	(-6.04)	(1.20)
Male	-1.0258***			-0.9774***
	(-22.77)			(-19.99)
Education	0.0660***	-0.0028	-0.0055	0.0583
	(3.56)	(-0.29)	(-0.19)	(1.59)

[35] The Fixed Effects model is in this case preferred to the Random Effects model according to the Hausmann test.

(continued)

Living with Partner	0.2322***	0.0068	0.0142	0.2386***
	(6.19)	(0.44)	(0.32)	(3.81)
Feeling Depressed	-0.1032***	-0.0106	-0.0220	-0.2211**
	(-2.93)	(-1.08)	(-0.77)	(-2.45)
Smoking	-0.4592***	-0.0102	-0.0401	-0.5556***
	(-8.16)	(-0.75)	(-0.69)	(-5.97)
Exercise	-0.1091***	0.0039	0.0108	-0.3025***
	(-2.68)	(0.43)	(0.32)	(-3.34)
Heavy Labour	-0.0392	0.0054	0.0154	-0.0885
	(-1.00)	(0.47)	(0.45)	(-1.21)
TV	0.1715***	0.0003	0.0015	0.2926***
	(4.74)	(0.02)	(0.04)	(4.19)
Household Size	0.0169***	0.0026	0.0070	0.0139
	(2.61)	(1.10)	(0.98)	(1.30)
African	0.4655***			0.4512***
	(2.93)			(2.71)
Colored	0.3641**			0.3834**
	(2.10)			(2.13)
Asian	-0.4446*			-0.5104**
	(-1.77)			(-2.03)
Year 2010	-0.0090	0.0083	0.0733	
	(-0.37)	(0.32)	(1.10)	
Year 2012	-0.0268	0.0039	0.0936	
	(-1.01)	(0.08)	(0.74)	
Western Cape	0.2917***	0.1735	0.8158**	-0.5250
	(2.70)	(1.49)	(2.27)	(-1.38)
Eastern Cape	0.1478*	-0.0055	0.0244	0.1361
	(1.87)	(-0.06)	(0.08)	(0.45)
Northern Cape	0.1866*	-0.0080	-0.0515	0.2215
	(1.71)	(-0.14)	(-0.31)	(1.09)
Free State	0.1606*	0.0240	0.1643	0.0331
	(1.87)	(0.25)	(0.48)	(0.09)
KwaZulu-Natal	0.3339***	0.0309	0.1050	0.2308
	(4.60)	(0.45)	(0.43)	(0.90)
North West	0.1239	-0.0461	-0.2022	0.3431**
	(1.34)	(-1.12)	(-1.54)	(2.08)
Mpumalanga	0.0609	0.0172	0.0751	-0.0125
	(0.69)	(0.36)	(0.45)	(-0.06)
Limpopo	-0.0882	-0.0217	-0.0680	-0.0274
	(-1.00)	(-0.46)	(-0.40)	(-0.14)
Constant	-4.7274***	-0.4711	-5.0874***	
	(-14.87)	(-0.99)	(-12.88)	
Observations	13775	13775	13775	
Individuals	4651	4651	4651	
R-squared (pseudo)	0.1873	0.0136 (within)	0.1948	
Rho		0.6788		

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.

Moreover, the Mundlak approach allows us to distinguish between short- and long-term effects. One can argue that the coefficient of x_{it} depicts the within variation or short-term effect, whereas the $\bar{x}_i$ component can be seen as the between variation or long-term effect (Wooldridge, 2002a; Egger and Pfaffermayr, 2005). Although this method does not allow us to perfectly distinguish between the unobserved heterogeneity and the long term effect, we feel that it is the appropriate model for our analysis.

The first thing to notice in the Pooled Probit regression is that we are able to confirm a positive non-linear relationship between income or household expenditure per capita and increased body weight,[36] i.e. the higher the income the higher people's body weight is. However, the transmission channel does not seem to be food expenditure, since the coefficient is not statistically different from zero. This implies that individuals do not gain weight through increased spending on food items caused by higher incomes.[37] Thus, one could argue that higher incomes do not necessarily lead to higher body weight, but that we merely observe a spurious correlation.

We also find that residing in an urban environment is associated with an increase in the probability of being obese. From the literature we expected this, since living in urban areas can increase the probability of gaining weight due to a higher density of fast food restaurants, higher fat-food availability, an increased use of vehicles and public transport, and other factors.

We are able to confirm a positive non-linear relationship between age and the probability of being overweight, whereas this probability seems to be lower for males. Moreover, we find a positive relationship between education and the probability of high body weight, which comes in stark contrast to the findings of other studies in developed countries. One interpretation could be that higher body weights are indeed regarded as a status symbol (see also Puoane et al. (2002)). Another explanation could be that better educated individuals have less free time to prepare healthier meals at home and prefer to consume meals outside which are higher in calories. This argument applies mostly for developed countries. It does not seem to be the case here, since we find very little spending on ready meals and meals consumed away from home in our data.[38] A third explanation might be that school education does not necessarily imply health education and that the concept of 'benign obesity' still exists in peoples' minds among all education groups.

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[36] The variable used is the natural logarithm of Total Household Expenditure per capita adjusted by the CPI. We also run separate regressions including the squared term, which can be seen in the Appendix.

[37] A more detailed discussion on the impact of increased food expenditure can be found in the Appendix.

[38] Not shown. The accuracy of the data may be a subject here, especially in the third wave.

Furthermore, we find a positive relationship between the dummy for being married or living with one's partner and a higher Body Mass Index. Another expected relationship concerns smoking. Smokers have a lower probability of being obese and the same applies to individuals that reported feelings of depression. Both factors are known to influence appetite. Finally, we find an expected negative coefficient for the dummy on whether an individual exercises regularly. However, we do not have information on either the duration or the intensity of the exercise, in order to fully capture high physical activity that directly leads to increased calorie expenditure. The dummy on engaging in heavy labor, on the other hand, is statistically insignificant. Reason for this can be a misspecification of the variable, since we only have broad categories for occupation.[39]

Moving on to the rest of the household characteristics, we find a positive relationship between owning a television set and the probability of being obese. This seems to be a good proxy for leading a more sedentary lifestyle, although we do not have information on the use of a television (e.g. time spent watching etc.). The size of the household also has a positive and significant sign on said probability. An explanation for this could be economies of scale within the household and the allocation of resources.

We also find some significant differences across ethnic groups on increased body weight, which in turn might be an indication for cultural or genetic differences across ethnic groups.

The year dummies are insignificant.[40] Our model is thus able to explain the differences in overweight rates between 2008 and 2012. Finally, there are some regional differences and especially in Western Cape and KwaZulu-Natal, where people have a higher probability of being obese in comparison to Gauteng.

The linear probability fixed effects specification[41] shows once again that increases in total expenditure can increase the probability of becoming obese. However, the story remains the same with regard to food expenditure. Here again, we find that the transmission channel is not the increase in food expenditure, which leads us to the conclusion that unobserved factors correlated with income may be behind this finding. Moreover, we find that all other variables do not have a significant effect on the

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39 This changes if we replace the variable with a dummy for agriculture. The coefficient of the dummy variable agriculture is then negative and significant.

40 The significance weakens with the introduction of the education and exercise variables. Naturally, there is also a high correlation with age.

41 Note, that all Mundlak Probit regressions also include dummies for gender and ethnicity as part of the fixed effect.

probability of becoming obese, except for age. The signs remain largely the same, but none of the coefficients is significant. The explanation for this with regard to some of the factors like urbanization is that we have a relatively short panel that spans over 4 years and in many cases their effects follow a rather slow process, while other factors like education exhibit very little variation over time. Thus, they are captured by the fixed effects component. It seems that the largest part of the variation stems from this component and short-term changes in our explanatory variables do not seem to change the weight status of individuals. This is underlined by the high rho, which indicates that close to 70% of the error term stems from the differences between observations.

The Mundlak specification confirms the fact that short-term changes do not seem to matter much, with the exception of the natural logarithm of total expenditure per capita. The coefficient is positive and significant, whereas the one for food expenditure is not. Nearly all other explanatory variables are insignificant. The inclusion of time means, however, allows us to interpret their coefficients as long-term effects. Here we obtain a picture very similar to the Pooled Probit. As expected, most of our explanatory variables resemble the results of the Pooled Probit, with some exceptions. Firstly, we find that total expenditure is insignificant, but long-term higher food expenditure is significant, which is also what one would expect.

Although some part of the unobserved factors may contaminate the coefficients, we can gain some useful insight. This is especially the case for behavioral variables that can affect calorie intake and expenditure, like living with the partner, feeling depressed and owning a TV. Adapting to a certain lifestyle for long periods of time seems to affect the probability of an individual being obese. This is an indication that certain behavioral patterns over longer periods of time are mainly responsible for weight gain.

This is also confirmed by the fact that the explanatory power of the Mundlak specification is only marginally higher than that of the Pooled Probit, which means that the largest part of the differences observed across individuals stems from the time invariant component and the between variation. Comparing the R-squared of the Pooled Probit and the Mundlak Probit clearly underlines this finding. An interpretation of this finding could be that lifestyle choices over longer periods of time, which are nested within a culture or society and do not change over short periods of time, contribute to higher obesity rates. This leads us to believe that it is a slow process and that time invariant characteristics like traditions, culture or the standing of obesity in the South

African society have shaped clear preferences towards higher body weight. Short term changes do not seem have a significant effect on the probability of being obese.[42]

3.4.2 BMI

The general picture obtained in our binary choice models is to a large extent replicated in Table 3.4, where we show the results for the Body Mass Index regressions. Here we simply use the BMI as the dependent variable, which allows us to run a simple Pooled OLS, another Pooled OLS with the lag of the BMI as an additional explanatory variable, as well as a Fixed Effects Model to account for unobserved heterogeneity. Using the Body Mass Index as a dependent variable may not be appropriate, since an increasing BMI does not necessarily pose a problem, especially in a country where undernutrition is still prevalent. We therefore exclude individuals with a BMI below 18.5 and end up with 13,020 observations for all years. This exercise allows us to overcome some of the problems associated with binary choice models and also allows us to better interpret the coefficients. Nevertheless, the results remain largely unchanged.[43] In the second column, we add the lagged BMI as an explanatory variable. This way we lose the first wave of our dataset, but we add some more time depth in a Pooled OLS regression. The results are rather interesting. The coefficient of the lagged BMI is naturally very large and highly significant. It is however significantly different from 1. This means that the BMI of the past does not fully explain the BMI in the present. However, all the other coefficients become significantly smaller, which in turn implies that the factors under investigation matter less in the short run. Furthermore, it suggests that the effects of these factors are cumulative over longer periods of time. Another interesting finding is that the coefficients for owning a TV set, for exercise and for feeling depressed are no longer significant. These variables capture lifestyle and long term behavioral factors and their effects seem to have been absorbed by the lagged BMI. One could therefore assume that these factors act slowly, are deep rooted in behavioral patterns that lead to increased body weight and that long term decisions are the main source of high obesity rates. Finally, the fixed effects specification in column 3 allows us to more accurately model fixed effects and account for unobserved heterogeneity, but the results remain

[42] We repeat the same exercise for overweight with very similar results. Moreover, we run separate regressions by gender. Here we find some differences that would be worth investigating in subsequent research. All of these can be seen in Appendix A3.

[43] We repeat the same exercise with the natural logarithm of the BMI as our dependent variable. The results do not differ largely and can be seen in Appendix A3.

largely unchanged compared to the binary choice models. Once again the rho is very high and accounts for nearly 80% of the error term.

The fixed effects specifications for overweight, obesity and the BMI itself have the positive and significant non-linear relationship between total household expenditure and the dependent variable in common. Since we are looking at the within variation, one could come to the conclusion that increases in income lead to increases in the BMI. We have discussed, however, that this does not happen through increased food consumption.[44]

Table 3.4: Regressions on the Body Mass Index

	Pooled OLS	Pooled OLS	Fixed Effects
BMI lagged		0.6821***	
		(51.138)	
Total Household Expenditure p.c.	0.5631***	0.3331***	0.3596***
	(5.23)	(4.326)	(4.20)
Household Food Expenditure p.c.	0.1075	-0.0598	-0.1067
	(0.90)	(-0.642)	(-1.16)
Urban	0.7006***	0.1615	0.1159
	(3.25)	(1.498)	(0.33)
Age	0.0380***	0.0082***	0.0488***
	(11.17)	(4.612)	(3.24)
Age (sq.)	-0.0000***	-0.0000***	-0.0000***
	(-8.46)	(-4.211)	(-7.10)
Male	-4.4587***	-1.4179***	
	(-28.18)	(-14.110)	
Education	0.2713***	0.0593	0.0198
	(3.21)	(1.401)	(0.15)
Living with Partner	0.9626***	0.3658***	0.0980
	(5.26)	(3.879)	(0.52)
Feeling Depressed	-0.5179***	-0.1798	-0.1209
	(-3.44)	(-1.408)	(-0.98)
Smoking	-2.1140***	-0.7006***	-0.1953
	(-10.84)	(-6.262)	(-0.92)
Exercise	-0.3563**	-0.0963	0.0233
	(-2.47)	(-0.842)	(0.21)
Heavy Labour	-0.2396	-0.0280	-0.0062
	(-1.44)	(-0.252)	(-0.05)
TV	0.8494***	0.1679	0.2023
	(5.53)	(1.440)	(1.44)
Household Size	0.0753***	0.0322**	0.0386
	(2.69)	(2.025)	(1.33)
African	1.8489**	0.4650	
	(2.50)	(1.618)	

[44] This also applies for the poorest 20% of the population, as can be seen in Figure A3.3: in the Appendix.

(continued)

Coloured	1.1142	0.0698	
	(1.41)	(0.226)	
Asian	-1.5837	-0.6545*	
	(-1.49)	(-1.784)	
Year 2010	-0.0921		0.1558
	(-0.97)		(0.46)
Year 2012	-0.2143**	-0.2533**	0.1386
	(-2.11)	(-2.440)	(0.21)
Western Cape	1.6985***	0.5433**	0.7731
	(3.41)	(2.301)	(0.65)
Eastern Cape	0.8944**	0.1864	0.2679
	(2.55)	(1.078)	(0.29)
Northern Cape	0.9462*	0.1613	0.4374
	(1.88)	(0.623)	(0.51)
Free State	0.7484*	0.2292	0.2407
	(1.95)	(1.324)	(0.27)
KwaZulu-Natal	1.5288***	0.3495**	0.6155
	(4.84)	(2.212)	(0.84)
North West	0.3668	0.3310*	-0.6988
	(0.94)	(1.666)	(-1.64)
Mpumalanga	0.3546	0.1336	0.7507
	(0.94)	(0.726)	(1.28)
Limpopo	-0.5014	0.0656	0.2367
	(-1.43)	(0.354)	(0.42)
Constant	10.3466***	4.9190***	12.0178*
	(8.11)	(6.846)	(1.84)
Observations	13020	8802	13020
Individuals	4574	4554	4574
R-squared (pseudo)	0.2569	0.6278	0.0365 (within)
Rho			0.7836

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. Excluding individuals with BMI<18.5.

In the literature on obesity in industrialized countries, the relation and the transmission channels are clearer. Most studies find a negative relationship between obesity and income and the theoretical justification is that "healthy living" has become very expensive, both in terms of money and time, so that not everybody can afford it. Moreover, richer individuals tend to care more about their own health. In developing countries, on the other hand, the main argument was that increase in income would allow individuals to afford more food (Philipson and Posner, 1999; Römling and Qaim, 2012). However, this does not seem to be the case in South Africa and the fact that a positive relationship between income and BMI is found raises new questions as to what exactly it captures. Answering these questions is essential in order to design the appropriate policies. The answers may be found in the arguments of Brown (1991), Case and Menendez (2009) and Wittenberg (2013). Increased body weight seems to be viewed as a positive outcome in the society, especially after experiencing deprivation in recent memory. Income growth may not necessarily directly affect this outcome, but what we merely observe is a spurious correlation that could be interpreted as the reflection and validation of perceived or desired social status in South Africa.

3.5 Conclusions

In all estimated models – namely Pooled Probit, LPM with Fixed Effects, and the Mundlak Approach – we find positive significant effects for expenditure on the probability of being obese. However, we can be fairly certain that the weight gain is not due to increases in food expenditure and hence directly related to increased food intake. High body weight is still seen as a sign of wealth and also of a good health constitution. Since White people are still richer than African people in South Africa and also heavier it is possible that African people take it as an example and also alter their preferences towards higher weight to represent and validate their social status. The same argument can be used to explain the positive relationship between education and BMI found in the Pooled regressions, since school education does not necessarily imply health education.

This line of thinking is also strengthened by the fact that we find time invariant characteristics and long-term effects to matter the most. These seem to be deep rooted in the South African society and further explain the observed behavioral patterns.

It seems that there are mentalities that are translated into behavior which have to be changed in order to initiate a rethinking regarding health issues. Patterns and mentalities influence an individual's behavior. Hence, we are convinced that a changing of these patterns (though it might take long) will lead to a modification in behavior regarding calorie intake and calorie expenditure and subsequently lead to a healthier lifestyle.

For implementing the right strategies it is necessary to bear these findings in mind. A tax on unhealthy food and drinks would need to be relatively high (at least 20% according to Mytton et al. (2012)) to have any significant effects. But this would be difficult for policymakers to implement and the long-term effectiveness is disputed. Consumption patterns tend to adjust after a period of time, especially if there is a clear preference towards these food items and the demand is inelastic.

According to our findings, we think it is more important to increase awareness of negative health impacts of obesity which finally changes preferences for larger body sizes. As long as a high body weight reflects a high social status the most effective strategy in the long term would be an extensive program that covers health knowledge, involves mass media and schools. This might adjust individuals' perceptions of an ideal body shape. Norum (1997) suggests a mix of food price interventions and food education programs. Increasing health knowledge would hopefully have long-term effects on people's perceptions of a healthy body. Katz (2012), the founding director of Yale University's Prevention Research Center, at least has hope that humans can change culture and can overcome the curse of increased food availability and subsequently the burden of obesity.

APPENDIX A3

Table A3.1: 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.
Household Food Expenditure	The natural logarithm of total household expenditure for food, as calculated by the SALDRU, adjusted by the Food 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 respondent at the time of the interview.
Gender	Dummy variable, which takes the value 1 for males.
Education	Categorical variable, which takes values 0-4 0: No education 1: Primary education (until 7th grade) 2: Some secondary education (until 11th grade, NTC1 (National Technical Certificates), NTC2, certificates and diplomas below 12th grade) 3: Completed secondary education (12th grade, NTC3) 4: Tertiary education
Living with partner	Dummy variable, which takes the value 1, if an individual lives with spouse or partner.
Feeling Depressed	Dummy variable, which takes the value 1, if an individual reported feeling depressed more than 3 days a week.
Smoking	Dummy variable, which takes the value 1, if an individual reported smoking regularly.
Exercise	Dummy variable, which takes the value 1, if an individual reported doing exercise more than once per week.
Heavy Labor	Dummy variable, which takes the value 1, if an individual reported working as skilled agricultural or fishery worker, craft and trade related worker, plant and machinery operator and assembler, elementary occupations, or reported engaging in personal agriculture.
TV	Dummy variable, which takes the value 1, if the household owns a television set

Table A3.1: Summary Statistics for NIDS data

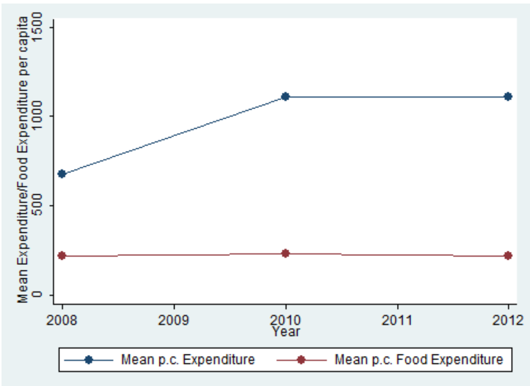
	Total		Females		Males	
Variable	Obs	Mean	Obs	Mean	Obs	Mean
Male	13,968	0.343	9,180	0	4,788	1
Age	13,968	40.39	9,180	41.44	4,788	38.39
BMI	13,968	27.41	9,180	29.36	4,788	23.67
Weight	13,968	71.72	9,180	73.76	4,788	67.80
Height	13,968	1.62	9,180	1.584	4,788	1.69
Married	13,968	0.40	9,180	0.394	4,783	0.42
Employment	13,953	0.30	9,170	0.25	4,771	0.39
Own PC	13,917	1.95	9,146	1.96	4,767	1.93
School grade	13,927	7.974	9,160	7.75	4,769	8.41
Diabetes	13,910	0.044	9,141	0.049	4,759	0.034
Depressed	13,890	1.67	9,131	1.70	4,779	1.61
Smoking	13,947	0.18	9,168	0.08	4,768	0.37
Exercise	13,925	0.19	9,157	0.11	4,275	0.33
HH Expend	12,398	1997	8,123	2005	3,979	1982
HH TotInco	11,559	3807	7,580	3893	4,457	3644
HH FoodExp	12,986	940.6	8,529	959.9	4,783	903.6
Urban	13,947	0.40	9,164	0.38	4,788	0.42
HH Size	13,968	5.25	9,180	5.57	3,182	4.64
Sport Member	9,283	0.05	6,101	0.016	4,788	0.12

Note: Own calculations using NIDS data

Comment 1: On the relationship between total expenditure and food expenditure

Including food expenditure along with total expenditure does not likely cause any problems with serial correlation as can be seen in Figure A3.1.

Figure A3.1: Total and Food Expenditure (2008-2012)

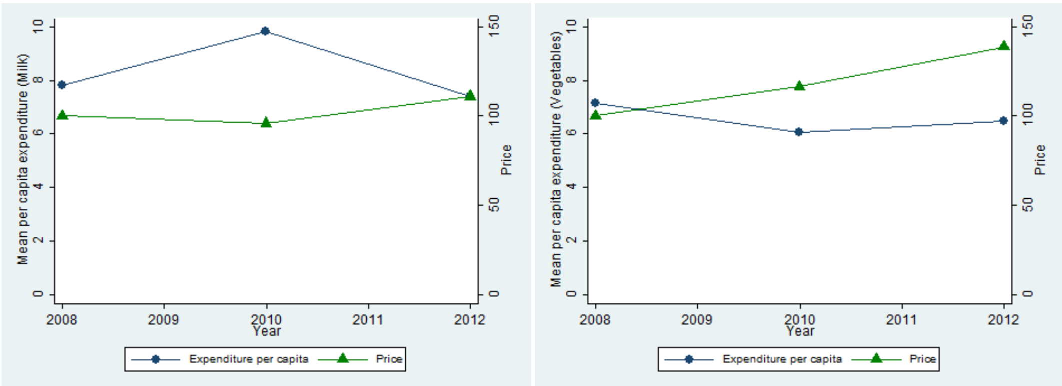


Note: Own calculations using NIDS data. Mean Total and Food Expenditure per capita, deflated by the CPI and the Food CPI, respectively.

Mean per capita expenditure on food items has remained constant over the time period, while total expenditure has increased. However, it may be the case that preferences and diets have shifted towards equally priced calorie intense items. People could consume more food items that have a higher energy density but pay the same prices as for the previously consumed food and hence, consume more kilocalories for the same price.

A glimpse behind this can be seen in Figure A3.2 where we show the average spending on dairy products and vegetables, for example, in comparison to their mean prices.[45] A slight drop in the price of dairy products seems to be associated with an over-proportional increase in spending, while it took a much higher price increase in 2012 to reduce spending to its original levels. For vegetables on the other hand, prices kept increasing, which seems to be correlated with a reduction in spending between 2008 and 2010, while expenditure increased very slightly in the next period. Unfortunately, the dataset at hand does not offer detailed consumption and price data that would allow us to fully investigate this side of the relationship between expenditure and increased body weight, but we can get an idea of the mechanisms behind the phenomenon.

Figure A3.2: Expenditure on high- and low-fat food (2008-2012)

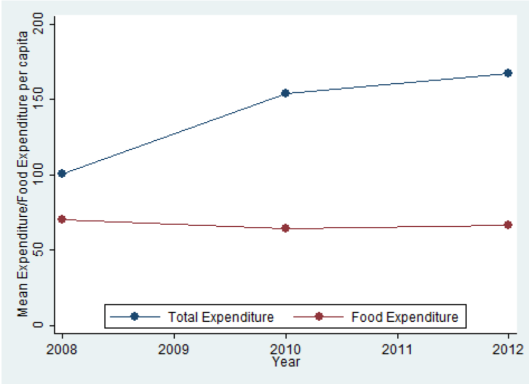


Note: Own calculation using NIDS data. Mean Expenditure per capita for dairy products and vegetables, deflated by the respective mean FAO prices. The prices are depicted by the FAO producer price index with the base year being 2008.

Increases in total per capita expenditure do not necessarily mean a higher expenditure for food items as well. This also holds for the poorest 20% of households (seeFigure A3.3). While total expenditure (or income) increased in the observed period by more than 50% on average, food expenditure remained largely constant over the period and even dropped slightly between 2008 and 2010.

[45] One should be cautious with these results, since detailed expenditure data are only available for a fraction of the households in the 3rd wave. Although we did not find any obvious systematic bias, caution is still advised.

Figure A3.3: Total and Food Expenditure for the lowest quintile



Source: Own calculations using NIDS data. Mean Total and Food Expenditure per capita for the poorest 20% in terms of total expenditure deflated by the CPI and the Food CPI respectively.

Table A3.3: Regressions on the probability of being obese (including the square of Expenditure p.c.)

	Overweight	Obesity
Total Household Expenditure p.c.	0.2179*	0.3398**
	(1.70)	(2.53)
Total Household Expenditure p.c. (sq.)	-0.0044	-0.0164*
	(-0.45)	(-1.65)
Household Food Expenditure p.c.	0.0027	0.0368
	(0.09)	(1.22)
Urban	0.0709	0.1678***
	(1.57)	(3.57)
Age	0.0072***	0.0088***
	(9.81)	(10.83)
Age (sq.)	-0.0000***	-0.0000***
	(-7.02)	(-8.61)
Male	-0.7984***	-1.0226***
	(-21.37)	(-22.73)
Education	0.1053***	0.0674***
	(5.85)	(3.63)
Living with Partner	0.2062***	0.2295***
	(5.65)	(6.14)
Feeling Depressed	-0.1193***	-0.1022***
	(-3.61)	(-2.90)
Smoking	-0.5504***	-0.4609***
	(-11.57)	(-8.20)
	(-4.08)	(-2.66)
Heavy Labour	0.0072	-0.0422
	(0.20)	(-1.08)
TV	0.1756***	0.1642***
	(5.13)	(4.52)
Household Size	0.0243***	0.0181***
	(4.01)	(2.78)
African	0.1824	0.4111**
	(1.09)	(2.55)

(continued)		
Coloured	0.1987	0.3088*
	(1.13)	(1.76)
Asian	-0.3038	-0.4784*
	(-1.07)	(-1.92)
Year 2010	0.0094	-0.0180
	(0.39)	(-0.74)
Year 2012	0.0003	-0.0380
	(0.01)	(-1.41)
Western Cape	0.2074**	0.2887***
	(2.00)	(2.68)
	(2.09)	(1.86)
Northern Cape	-0.0481	0.1855*
	(-0.47)	(1.71)
Free State	0.1001	0.1607*
	(1.20)	(1.87)
KwaZulu-Natal	0.3292***	0.3340***
	(4.74)	(4.61)
North West	0.0114	0.1241
	(0.14)	(1.34)
Mpumalanga	0.1050	0.0618
	(1.230)	(0.70)
Limpopo	-0.0635	-0.0851
	(-0.78)	(-0.97)
Constant	-3.6330***	-5.3575***
	(-7.87)	(-11.20)
Observations	13775	13775
Individuals	4651	4651
R-squared (pseudo)	0.1874	0.1671

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.

Table A3.4: Regressions on the probability of being overweight

	Pooled Probit	Linear Prob. FE	Mundlak	
				Means
Total Household Expenditure p.c.	0.1596***	0.0255***	0.0836***	0.1019*
	(6.41)	(3.12)	(3.79)	(1.87)
Household Food Expenditure p.c.	0.0056	-0.0126	-0.0385	0.0861
	(0.20)	(-1.44)	(-1.64)	(1.29)
Urban	0.0710	0.0177	0.0574	-0.0053
	(1.58)	(0.45)	(0.59)	(-0.05)
Age	0.0072***	0.0031***	0.0073***	-0.0003
	(9.79)	(2.72)	(2.75)	(-0.12)
Age (sq.)	-0.0000***	-0.0000***	-0.0000***	0.0000**
	(-7.00)	(-5.54)	(-6.17)	(2.24)
Male	-0.7990***			-0.7510***
	(-21.43)			(-18.08)
Education	0.1049***	0.0144	0.0463	0.0368
	(5.84)	(1.30)	(1.61)	(1.03)
Living with Partner	0.2067***	-0.0034	-0.0166	0.2427***
	(5.66)	(-0.18)	(-0.35)	(3.72)
Feeling Depressed	-0.1196***	-0.0055	-0.0044	-0.3196***
	(-3.63)	(-0.50)	(-0.15)	(-3.73)
Smoking	-0.5499***	-0.0249	-0.0703	-0.6441***
	(-11.56)	(-1.28)	(-1.37)	(-8.05)
Exercise	-0.1410***	-0.0176	-0.0649**	-0.1985**
	(-4.09)	(-1.61)	(-2.19)	(-2.49)
Heavy Labour	0.0078	0.0004	-0.0038	0.0179
	(0.22)	(0.03)	(-0.11)	(0.27)
TV	0.1773***	0.0111	0.0342	0.2322***
	(5.20)	(0.90)	(1.09)	(3.49)
Household Size	0.0240***	0.0015	0.0035	0.0272**
	(3.98)	(0.54)	(0.48)	(2.55)
African	0.1984			0.2312
	(1.16)			(1.31)
Colored	0.2151			0.2778
	(1.20)			(1.51)
Asian	-0.2935			-0.3109
	(-1.02)			(-1.06)
Year 2010	0.0117	0.0330	0.1565***	
	(0.49)	(1.28)	(2.59)	
Year 2012	0.0032	0.0440	0.2331**	
	(0.12)	(0.89)	(2.03)	
Western Cape	0.2082**	0.0100	0.0123	0.2045
	(2.01)	(0.07)	(0.03)	(0.53)
Eastern Cape	0.1562**	0.0951	0.2355	-0.0744
	(2.10)	(0.91)	(0.88)	(-0.27)
Northern Cape	-0.0477	-0.0097	-0.0139	-0.0489
	(-0.47)	(-0.12)	(-0.07)	(-0.23)
Free State	0.1002	0.0126	0.0268	0.0995
	(1.21)	(0.12)	(0.12)	(0.40)
KwaZulu-Natal	0.3292***	0.1199	0.3967	-0.0762
	(4.74)	(1.24)	(1.64)	(-0.30)

(continued)				
North West	0.0112	-0.0201	-0.0556	0.0692
	(0.14)	(-0.38)	(-0.43)	(0.43)
Mpumalanga	0.1049	0.0947	0.2983**	-0.2056
	(1.30)	(1.58)	(1.96)	(-1.17)
Limpopo	-0.0644	0.0655	0.2356	-0.3274*
	(-0.80)	(1.14)	(1.62)	(-1.89)
Constant	-3.4730***	-0.4063	-3.9317***	
	(-12.01)	(-0.83)	(-10.89)	
Observations	13775	13775	13775	
Individuals	4651	4651	4651	
R-squared (pseudo)	0.1874	0.0264 (within)	0.1968	
Rho		0.6464		

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.

Table A3.5: Regressions on the probability of being overweight/obese by gender

	Overweight		Obesity	
	Female	Male	Female	Male
Total Household Expenditure p.c.	0.1114***	0.2539***	0.0725**	0.2566***
	(3.66)	(6.26)	(2.52)	(5.25)
Household Food Expenditure p.c.	0.0481	-0.0608	0.0772**	-0.0363
	(1.39)	(-1.29)	(2.33)	(-0.63)
Urban	0.0724	0.0532	0.1516***	0.2102**
	(1.31)	(0.75)	(2.82)	(2.19)
Age	0.0082***	0.0049***	0.0099***	0.0038**
	(9.26)	(4.01)	(10.79)	(2.25)
Age (sq.)	-0.0000***	-0.0000**	-0.0000***	-0.0000
	(-7.09)	(-2.34)	(-8.77)	(-1.44)
Education	0.0803***	0.1466***	0.0657***	0.0803**
	(3.50)	(5.05)	(3.05)	(2.20)
Living with Partner	0.1642***	0.3203***	0.1978***	0.4694***
	(3.74)	(4.97)	(4.71)	(5.41)
Feeling Depressed	-0.1868***	0.0235	-0.1334***	0.0127
	(-4.81)	(0.39)	(-3.45)	(0.15)
Smoking	-0.5541***	-0.5275***	-0.4290***	-0.4315***
	(-6.75)	(-9.25)	(-5.20)	(-5.41)
Exercise	-0.1211**	-0.1624***	-0.1069**	-0.1158*
	(-2.39)	(-3.38)	(-2.16)	(-1.66)
Heavy Labour	-0.0511	0.0807	-0.0744*	0.0239
	(-1.10)	(1.47)	(-1.65)	(0.31)
TV	0.1598***	0.2181***	0.1702***	0.1976**
	(3.83)	(3.75)	(4.11)	(2.56)
Household Size	0.0244***	0.0216**	0.0174**	0.0054
	(3.33)	(2.18)	(2.40)	(0.37)
African	0.4782**	-0.3213	0.6374***	0.0856
	(2.53)	(-1.23)	(3.72)	(0.32)
Colored	0.4506**	-0.2120	0.4518**	0.2626
	(2.24)	(-0.80)	(2.47)	(0.91)

(continued)

Asian	-0.3267	-0.1480	-0.2310	-0.9677**
	(-1.13)	(-0.33)	(-0.83)	(-2.36)
Year 2010	-0.0012	0.0491	0.0065	-0.0438
	(-0.04)	(1.15)	(0.24)	(-0.82)
Year 2012	0.0140	-0.0037	-0.0194	-0.0311
	(0.44)	(-0.08)	(-0.66)	(-0.54)
Western Cape	0.2439*	0.0789	0.3370***	0.0871
	(1.91)	(0.47)	(2.73)	(0.42)
Eastern Cape	0.1134	0.2433**	0.1074	0.3201**
	(1.21)	(2.09)	(1.17)	(2.12)
Northern Cape	-0.0828	-0.0151	0.1818	0.1540
	(-0.66)	(-0.09)	(1.45)	(0.75)
Free State	0.1634	-0.0375	0.2119**	-0.0231
	(1.54)	(-0.27)	(2.13)	(-0.13)
KwaZulu-Natal	0.2609***	0.4333***	0.3044***	0.4185***
	(2.96)	(4.07)	(3.55)	(3.12)
North West	-0.0886	0.1697	0.0798	0.2846*
	(-0.84)	(1.38)	(0.74)	(1.68)
Mpumalanga	0.0164	0.2314*	0.0101	0.2049
	(0.16)	(1.80)	(0.10)	(1.28)
Limpopo	-0.1730*	0.1531	-0.1363	0.0952
	(-1.71)	(1.20)	(-1.35)	(0.52)
Constant	-3.7420***	-3.7745***	-4.9887***	-4.8331***
	(-10.76)	(-8.04)	(-14.30)	(-7.66)
Observations	9067	4708	9067	4708
Individuals	3058	1593	3058	1593
R-squared (pseudo)	0.0942	0.1618	0.0903	0.1594

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. Overweight is defined as 25<BMI<30 (BMI>30 are left out). Obesity is defined as BMI>30.
Pooled Probit regressions.

Table A3.6: Regressions on the natural logarithm of the Body Mass Index

	Pooled OLS	Pooled OLS	Fixed Effects
ln(BMI) lagged		0.6405***	
		(57.68)	
Total Household Expenditure p.c.	0.0207***	0.0123***	0.0125***
	(5.74)	(4.61)	(4.25)
Household Food Expenditure p.c.	0.0035	-0.0032	-0.0038
	(0.87)	(-0.96)	(-1.22)
Urban	0.0225***	0.0059	0.0067
	(3.13)	(1.57)	(0.52)
Age	0.0013***	0.0003***	0.0018***
	(11.77)	(4.67)	(3.27)
Age (sq.)	-0.0000***	-0.0000***	-0.0000***
	(-8.91)	(-4.12)	(-7.71)
Male	-0.1560***	-0.0528***	
	(-28.38)	(-14.69)	
Education	0.0106***	0.0026*	0.0022
	(3.86)	(1.74)	(0.505)

(continued)

Living with Partner	0.0346***	0.0138***	0.0028
	(5.80)	(4.22)	(0.42)
Feeling Depressed	-0.0182***	-0.0063	-0.0038
	(-3.58)	(-1.42)	(-0.91)
Smoking	-0.0779***	-0.0282***	-0.0086
	(-11.39)	(-6.50)	(-1.12)
Exercise	-0.0149***	-0.0055	0.0004
	(-3.04)	(-1.36)	(0.09)
Heavy Labour	-0.0062	-0.0016	0.0001
	(-1.13)	(-0.41)	(0.01)
TV	0.0301***	0.0045	0.0074
	(5.81)	(1.11)	(1.57)
Household Size	0.0027***	0.0011**	0.0012
	(2.91)	(1.98)	(1.25)
African	0.0593**	0.0153	
	(2.43)	(1.55)	
Colored	0.0372	0.0038	
	(1.43)	(0.35)	
Asian	-0.0544	-0.0241*	
	(-1.47)	(-1.78)	
Year 2010	-0.0013		0.0087
	(-0.41)		(0.71)
Year 2012	-0.0055	-0.0097***	0.0094
	(-1.620)	(-2.78)	(0.40)
Western Cape	0.0557***	0.0195**	0.0254
	(3.40)	(2.34)	(0.63)
Eastern Cape	0.0299***	0.0074	0.0085
	(2.58)	(1.22)	(0.26)
Northern Cape	0.0251	0.0032	0.0146
	(1.48)	(0.35)	(0.51)
Free State	0.0228*	0.0074	0.0087
	(1.78)	(1.20)	(0.28)
KwaZulu-Natal	0.0538***	0.0144**	0.0233
	(5.10)	(2.54)	(0.86)
(continued)			
North West	0.0096	0.0129*	-0.0215
	(0.73)	(1.81)	(-1.36)
Mpumalanga	0.0121	0.0051	0.0351
	(0.97)	(0.76)	(1.62)
Limpopo	-0.0170	0.0020	0.0163
	(-1.42)	(0.29)	(0.78)
Constant	2.6864***	2.7382***	1.0498***
	(63.46)	(11.66)	(27.52)
Observations	13020	8802	13020
Individuals	4574	4554	4574
R-squared (pseudo)	0.2799	0.6156	0.0448 (within)
Rho			0.7841

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. Excluding individuals with BMI<18.5

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

Antipatis V.J., and T.P. Gill (2001). Obesity as a Global Problem. In: *International Textbook of Obesity*. P. Björntorp, (ed.), John Wiley & Sons, Ltd, pp.1–22, (ISBN: 978-0-470-84673-5)
Available at: http://onlinelibrary.wiley.com/doi/10.1002/0470846739.ch1/summary

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)

Asfaw A. (2007). Do Government Food Price Policies Affect the Prevalence of Obesity? Empirical Evidence from Egypt. *World Development* **35**, 687–701 (DOI: 10.1016/j.worlddev.2006.05.005)

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

Bourne L.T., E.V. Lambert, and K. Steyn (2002). Where does the Black population of South Africa stand on the nutrition transition? *Public Health Nutrition* **5**, 157–162 (DOI: 10.1079/PHN2001288)

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)

Cawley J.H. (2006). Markets and Childhood Obesity. *The Future of Children* **16**, 69–88 (DOI: 10.1353/foc.2006.0003)

Cawley J.H. and Burkhauser, R.V. (2008). Beyond BMI: The Value of More Accurate Measures of Fatness and Obesity in Social Science Research. *Journal of Health Economics* **27:2**, 519-529 (DOI:10.1016/j.jhealeco.2007.05.005)

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**

Collinson M.A. (2010). Striving against adversity: the dynamics of migration, health and poverty in rural South Africa. *Global Health Action* **3**
(DOI: 10.3402/gha.v3i0.5080)
Available at: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2882287/

Cutler, D.M., Glaeser, E.L., and Shapiro, J.M. (2003). Why Have Americans Become More Obese? *Journal of Economic Perspectives* **17:3**, 93-118
(DOI: 10.2139/ssrn.373121)

Cutter J., B.Y. Tan, and S.K. Chew (2001). Levels of cardiovascular disease risk factors in Singapore following a national intervention programme. *Bulletin of the World Health Organization* **79**, 908–915
(DOI: 10.1590/S0042-96862001001000003)

Deaton A., and S. Zaidi (2002). *Guidelines for Constructing Consumption Aggregates for Welfare Analysis*. The World Bank
Available at: https://ideas.repec.org/b/wbk/wbpubs/14101.html

Delisle H. (2002). Foetal programming of nutrition-related chronic diseases. *Santé (Montrouge, France)* **12**, 56–63

Deuchert E., S.J. Cabus, and D. Tafreschi (2012). *A Short Note on Economic Development and Socioeconomic Inequality in Female Body Weight*. University of St. Gallen, School of Economics and Political Science
Available at: http://ideas.repec.org/p/usg/econwp/201204.html

Development Policy and Analysis Division (DPAD) D. of E. and S.A. of the U.N.S. (UN/DESA) (2012). Country Classification - Statistical Annex to World Economic Situation and Prospects

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

Dowse G.K., H. Gareeboo, K.G.M.M. Alberti, P. Zimmet, J. Tuomilehto, A. Purran, D. Fareed, P. Chitsono, V.R. Collins, and F. Hemraj (1995). Changes in population cholesterol concentrations and other cardiovascular risk factor levels after five years of the non-communicable disease intervention programme in Mauritius. *BMJ* **311**, 1255–1259 (DOI: 10.1136/bmj.311.7015.1255)

Dreher, A. (2006). Does Globalization Affect Growth? Evidence from a new Index of Globalization. *Applied Economics* **38:10**, 1091-1110
(DOI: 10.1080/00036840500392078)

Drewnowski A., and B.M. Popkin (1997). The nutrition transition: new trends in the global diet. *Nutrition Reviews* **55**, 31–43

Egger P., and M. Pfaffermayr (2005). Estimating Long and Short Run Effects in Static Panel Models. *Econometric Reviews* **23**, 199–214
(DOI: 10.1081/ETC-200028201)

Fernald L. (2007). Socioeconomic Status and Body Mass Index in Low-income Mexican Adults. *Social Science and Medicine* **64**, 2030-2042
(DOI: 10.1016/j.socscimed.2007.02.002)

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)

Finn A., M. Leibbrandt, and J. Levinsohn (2012). Income mobility in South Africa: Evidence from the first two waves of the National Income Dynamics Study. *NIDS Discussion Paper* **5**
Available at:
http://www.google.de/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&cad=rja&uact=8&ved=0CCwQFjAB&url=http%3A%2F%2Fwww.nids.uct.ac.za%2Fpublications%2Fdiscussion-papers%2Fwave-2-papers%2F133-income-mobility-in-south-africa%2Ffile&ei=3A6UVeHXKIyYsAHawKqQBg&usg=AFQjCNHElUltMuDGLjbfEjY0BTWCJi93lw&bvm=bv.96952980,d.bGg.

Finucane M.M., G.A. Stevens, M.J. Cowan, G. Danaei, J.K. Lin, C.J. Paciorek, G.M. Singh, H.R. Gutierrez, Y. Lu, A.N. Bahalim, F. Farzadfar, L.M. Riley, and M. Ezzati (2011). National, regional, and global trends in body-mass index since 1980: systematic analysis of health examination surveys and epidemiological studies with 960 country-years and 9·1 million participants. *The Lancet* **377**, 557–567 (DOI: 10.1016/S0140-6736(10)62037-5)

Garcia, E., Labeaga, J.M. and Ortega, C. (2006). Maternal Employment and Childhood Obesity in Spain. *FEDEA Documento de Trabajo* **2006-17**

Gibson, J. (2001). Literacy and Intrahousehold Externalities. *World Development* **29:1**, 155-166 (DOI: 10.1016/S0305-750X(00)00082-6)

Gilbert L., T.A. Selikow, and L. Walker (2010). Society, Health and Disease in a time of HIV/AIDS. Johannesburg: Macmillan. ISBN: 978-1-77010-159-3

Greene, W.H. (2003). Econometric Analysis, *5th Edition, Pearson Education Inc.*

Grossman M., and N. Mocan (2011). *Economic Aspects of Obesity*. University of Chicago Press, 407 pp., (ISBN: 978-0-226-31009-1)

Guo X., B.M. Popkin, T.A. Mroz, and F. Zhai (1999). Food Price Policy Can Favorably Alter Macronutrient Intake in China. *The Journal of Nutrition* **129**, 994–1001

Halford J.C.G., J. Gillespie, V. Brown, E.E. Pontin, and T.M. Dovey (2004). Effect of television advertisements for foods on food consumption in children. *Appetite* **42**, 221–225. (DOI: 10.1016/j.appet.2003.11.006)

Hawley K.L., C.A. Roberto, M.A. Bragg, P.J. Liu, M.B. Schwartz, and K.D. Brownell (2013). The science on front-of-package food labels. *Public Health Nutrition* **16**, 430–439. (DOI: 10.1017/S1368980012000754)

Holt E. (2011). Hungary to introduce broad range of fat taxes. *Lancet* **378**

Huffman S.K., and M. Rizov (2010). The Rise of Obesity in Transition: Theory and Empirical Evidence from Russia. *Journal of Development Studies* **46**, 574–594. (DOI: 10.1080/00220380903383230)

International Food Policy Research Institute (IFPRI) (2015). *Global Nutrition Report 2015: Actions and accountability to advance nutrition and sustainable development.* Washington, D.C., 168 pp. (ISBN: 978-0-89629-883-5)
Available at: http://www.ifpri.org/publication/global-nutrition-report-2015?utm_source=New+At+IFPRI&utm_campaign=c5a0fa829d-New_at_IFPRI_Sept_24_2015&utm_medium=email&utm_term=0_7b974d57a5-c5a0fa829d-69104149

International Monetary Fund (IMF) (2015). *World Economic Outlook - Uneven Growth-Short- and Long-Term Factors*. Washington D.C., USA. 230 pp

James P.T., R. Leach, E. Kalamara, and M. Shayeghi (2001). The Worldwide Obesity Epidemic. *Obesity Research* **9**, 228S–233S (DOI: 10.1038/oby.2001.123)

Jones-Smith J.C., P. Gordon-Larsen, A. Siddiqi, and B.M. Popkin (2011). Cross-National Comparisons of Time Trends in Overweight Inequality by Socioeconomic Status Among Women Using Repeated Cross-Sectional Surveys From 37 Developing Countries, 1989–2007. *American Journal of Epidemiology* **173**, 667–675 (DOI: 10.1093/aje/kwq428)

Katz D.L. (2012). Is Obesity Cultural? - US News. *US News & World Report* Available at: http://health.usnews.com/health-news/blogs/eat-run/2012/10/04/is-obesity-cultural

Kimenju S.C., R. Rischke, S. Klasen, and M. Qaim (2015). Do supermarkets contribute to the obesity pandemic in developing countries? *Public Health Nutrition* **FirstView**, 1–10 (DOI: 10.1017/S1368980015000919)

Kleinman A., and P. Benson (2006). Anthropology in the Clinic: The Problem of Cultural Competency and How to Fix It. *PLoS Med* **3**, e294
(DOI: 10.1371/journal.pmed.0030294)

Kramer C.K., B. Zinman, and R. Retnakaran (2013). Are metabolically healthy overweight and obesity benign conditions?: A systematic review and meta-analysis. *Annals of Internal Medicine* **159**, 758–769
(DOI: 10.7326/0003-4819-159-11-201312030-00008)

Krebs, N.F. and Jacobson, M.S. (2003). Prevention of Pediatric Overweight and Obesity. *Pediatrics* **112**, 424-430

Kruger H.S., T. Puoane, M. Senekal, and M.-T. van der Merwe (2005). Obesity in South Africa: challenges for government and health professionals. *Public Health Nutrition* **8**, 491–500 (DOI: 10.1079/PHN2005785)

Lakdawalla D.N., D. Goldman, and B. Shang (2005). The Health And Cost Consequences Of Obesity Among The Future Elderly. *Health Affairs* **10**
Available at: http://works.bepress.com/dana_goldman/49

Lakdawalla D., and T. Philipson (2002). The Growth of Obesity and Technological Change: A Theoretical and Empirical Examination. *National Bureau of Economic Research*. Available at: http://www.nber.org/papers/w8946

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**

Lu Y., and D. Goldman (2010). *The Effects of Relative Food Prices on Obesity – Evidence from China: 1991-2006*. National Bureau of Economic Research. Available at: http://www.nber.org/papers/w15720

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)

Martorell, R., Kettel Khan, L., Hughes, M.L. and Grummer-Strawn, L.M. (1998). Obesity in Latin American Women and Children. *Journal of Nutrition* **128,** 1464-1473

Martorell, R., Kettel Khan, L., Hughes, M.L. and Grummer-Strawn, L.M. (2000). Obesity in women in developing countries. *European Journal of Clinical Nutrition* **54**, 247-252

McCaffrey, D.F., Lockwood, J.R., Mihaly, K. and Sass, T.R. (2012). A review of Stata commands for fixed-effects estimation in normal linear models. *The Stata Journal* **12**, 406-432
Available at: http://www.stata-journal.com/article.html?article=st0267

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)

Mvo Z., J. Dick, and K. Steyn (1999). Perceptions of overweight African women about acceptable body size of women and children. *Curationis* **22** (DOI: 10.4102/curationis.v22i2.719) Available at: http://www.curationis.org.za/index.php/curationis/article/view/719

Mytton O.T., D. Clarke, and M. Rayner (2012). Taxing unhealthy food and drinks to improve health. *The BMJ* **344**, e2931. (DOI: 10.1136/bmj.e2931)

Norum K.R. (1997). Some aspects of Norwegian nutrition and food policy. In: *Diet, nutrition and chronic disease: lessons from contrasting worlds*. P. Shetty,, K. McPherson, (eds.), John Wiley & Sons, Ltd, London pp.318 (ISBN: ISBN: 978-0-471-97133-7)

Ono, T., Guthold, R. and Strong, K. (2010) WHO Global Comparable Estimates, World Health Organization

Osmani S., and A. Sen (2003). The hidden penalties of gender inequality: fetal origins of ill-health. *Economics & Human Biology* **1**, 105–121 (DOI: 10.1016/S1570-677X(02)00006-0)

Patterson S. (1953). *Colour and Culture in South Africa: A Study of the Status of the Cape Coloured People Within the Social Structure of the Union of South Africa*. Taylor & Francis, 412 pp. (ISBN: 978-0-415-17621-7)

Philipson T.J., and R.A. Posner (1999). *The Long-Run Growth in Obesity as a Function of Technological Change*. National Bureau of Economic Research Available at: http://www.nber.org/papers/w7423

Philipson T.J., and R.A. Posner (2003). The Long-Run Growth in Obesity as a Function of Technological Change. *Perspectives in Biology and Medicine* **46**, S87–S107 (DOI: 10.1353/pbm.2003.0072)

Phillips C.M., C. Dillon, J.M. Harrington, V.J.C. McCarthy, P.M. Kearney, A.P. Fitzgerald, and I.J. Perry (2013). Defining Metabolically Healthy Obesity: Role of Dietary and Lifestyle Factors. *PLoS ONE* **8** (DOI: 10.1371/journal.pone.0076188) Available at: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3798285/

Popkin B.M. (1999). Urbanization, Lifestyle Changes and the Nutrition Transition. *World Development* **27**, 1905–1916 (DOI: 10.1016/S0305-750X(99)00094-7)

Popkin, B.M. (2003). The Nutrition Transition in the Developing World. *Development Policy Review* **21:5,** 581-597

Popkin B.M. (2004). The nutrition transition: an overview of world patterns of change. *Nutrition Reviews* **62**, S140–143

Popkin B.M., L.S. Adair, and S.W. Ng (2012). Global nutrition transition and the pandemic of obesity in developing countries. *Nutrition Reviews* **70**, 3–21 (DOI: 10.1111/j.1753-4887.2011.00456.x)

Popkin B.M., W. Conde, N. Hou, and C. Monteiro (2006). Is There a Lag Globally in Overweight Trends for Children Compared with Adults? *Obesity* **14**, 1846–1853 (DOI: 10.1038/oby.2006.213)

Posel D. (2001). Who are the heads of household, what do they do, and is the concept of headship useful? An analysis of headship in South Africa. *Development Southern Africa* **18**, 651–670

Puoane T., K. Steyn, D. Bradshaw, R. Laubscher, J. Fourie, V. Lambert, and N. Mbananga (2002). Obesity in South Africa: The South African Demographic and Health Survey. *Obesity Research* **10**, 1038–1048 (DOI: 10.1038/oby.2002.141)

Puska P., J. Tuomilehto, A. Nissinen, E. Vartiainen, and editors (1995). *The North Karelia Project: 20 year results and experiences*. Helsinki University Press, Helsinki, 363 pp. (ISBN: 978-951-53-0549-7)

Reardon T., P. Timmer, and J. Berdegue (2004). The Rapid Rise of Supermarkets in Developing Countries: Induced Organizational, Institutional, and Technological Change in Agrifood Systems. *electronic Journal of Agricultural and Development Economics* **1**, 168–183

Rischke R., S.C. Kimenju, S. Klasen, and M. Qaim (2015). Supermarkets and food consumption patterns: The case of small towns in Kenya. *Food Policy* **52**, 9–21 (DOI: 10.1016/j.foodpol.2015.02.001)

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

Rosin O. (2008). The Economic Causes of Obesity: A Survey. *Journal of Economic Surveys* **22**, 617–647 (DOI: 10.1111/j.1467-6419.2007.00544.x)

Sacks G., J.L. Veerman, M. Moodie, and B. Swinburn (2011). "Traffic-light" nutrition labelling and "junk-food" tax: a modelled comparison of cost-effectiveness for obesity prevention. *International Journal of Obesity* **35**, 1001–1009. (DOI: 10.1038/ijo.2010.228)

Schmidhuber J. (2004). The growing global obesity problem: Some policy options to address it. *electronic Journal of Agricultural and Development Economics* **1**, 272-290

Schwaabe C. (2006). Die deutsche Modernitätskrise. Politische Kultur und Mentalität von der Reichsgründung bis zur Wiedervereinigung (W. Bergem, Ed.). *Politische Vierteljahresschrift* **47**, 749–751 (DOI: 10.1007/s11615-006-0381-7)

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

Sobal J. (1991). Obesity and socioeconomic status: A framework for examining relationships between physical and social variables. *Medical Anthropology* **13**, 231–247 (DOI: 10.1080/01459740.1991.9966050)

Sobal J. (2001). Social and Cultural Influences on Obesity. In: *International Textbook of Obesity*. P. Björntorp, (ed.), John Wiley & Sons, Ltd, pp.305–322 (ISBN: 978-0-470-84673-5) (DOI: 10.1002/0470846739.ch21)

Speliotes, E.K., Willer, C.J., Berndt, S.I., Monda, K.L. et al. (2010). Association analyses of 249,796 individuals reveal 18 new loci associated with body mass index. *Nature Genetics* **42**, 937-948 (DOI: 10.1038/ng.686)

Stanner S.A., K. Bulmer, C. Andres, O.E. Lantseva, V. Borodina, V.V. Poteen, and J.S. Yudkin (1997). Does malnutrition in utero determine diabetes and coronary heart disease in adulthood? Results from the Leningrad siege study, a cross sectional study. *BMJ : British Medical Journal* **315**, 1342–1348

Statistics South Africa (2014). *Poverty Trends in South Africa: An examination of absolute poverty between 2006 and 2011.* Pretoria, South Africa

Stifel D.C., and S.L. Averett (2009). Childhood overweight in the United States: A quantile regression approach. *Economics & Human Biology* **7**, 387–397 (DOI: 10.1016/j.ehb.2009.05.005)

Subramanian S.V., J.M. Perkins, and K.T. Khan (2009). Do burdens of underweight and overweight coexist among lower socioeconomic groups in India? *The American Journal of Clinical Nutrition* **90**, 369–376 (DOI: 10.3945/ajcn.2009.27487)

Subramanian, S.V., Perkins, J.M., Özaltin, E. and Davey Smith, G. (2011). Weight of nations: a socioeconomic analysis of women in low– to middle-income countries. *American Journal of Clinical Nutrition* **93**, 413-421

Subramanian S.V., and G.D. Smith (2006). Patterns, distribution, and determinants of under- and overnutrition: a population-based study of women in India. *The American Journal of Clinical Nutrition* **84**, 633–640

Swinburn B., and G. Egger (2002). Preventive strategies against weight gain and obesity. *Obesity Reviews: An Official Journal of the International Association for the Study of Obesity* **3**, 289–301

Tabellini G. (2010). Culture and Institutions: Economic Development in the Regions of Europe. *Journal of the European Economic Association* **8:4**, 677-716 (DOI: 10.1111/j.1542-4774.2010.tb00537.x)

Tafreschi D. (2014). The income body weight gradients in the developing economy of China. *Economics & Human Biology* (DOI: 10.1016/j.ehb.2014.02.001)

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)

Upadhyaya S. (2013). Country grouping in UNIDO statistics. *United Nations Industrial Development Organization* **1/2013**, 36

Van Der Merwe M.-T., and M.S. Pepper (2006). Obesity in South Africa. *Obesity Reviews* **7**, 315–322 (DOI: 10.1111/j.1467-789X.2006.00237.x)

Villanueva T. (2011). European nations launch tax attack on unhealthy foods. *Canadian Medical Association Journal* **183**, E1229–E1230 (DOI: 10.1503/cmaj.109-4031)

Walker A., F. Adam, and B. Walker (2001). World pandemic of obesity: the situation in Southern African populations. *Public Health* **115**, 368–372 (DOI: 10.1038/sj.ph.1900790)

Walker A.R.P., D. Bhamjee, B.F. Walker, and A.P. Mart (1979). Serum High-Density Lipoprotein Cholesterol, Glucose Tolerance and Other Variables in Obese Black Adolescent. *S. Afr. med. J* **56**, 221

Walker A.R.P., and I. Segal (1980). The puzzle of obesity in the African Black female. *The Lancet* **315**, 263

Walker A.R., B.F. Walker, A.J. Walker, and H.H. Vorster (1988). Low frequency of adverse sequelae of obesity in South African rural Black women. *International journal for vitamin and nutrition research* **59**, 224–228

Wei M, Kampert JB, Barlow CE, and et al (1999). Relationship between low cardiorespiratory fitness and mortality in normal-weight, overweight, and obese men. *JAMA* **282**, 1547–1553 (DOI: 10.1001/jama.282.16.1547)

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 (1998). Obesity: preventing and managing the global epidemic. Report of a WHO consultation. *World Health Organization Technical Report Series* **894**, i–xii, 1–253

WHO (2010a). WHO Global Infobase : International Comparisons (Females) Available at:
https://apps.who.int/infobase/Comparisons.aspx?l=&NodeVal=WGIE_BMI_5_cd.0704&DO=1&DDLReg=ALL&DDLSex=2&DDLAgeGrp=15-100&DDLYear=2010&DDLMethod=INTMDCTM&DDLCateNum=6&TxtBxCtmNum=20,35,50,65,80&CBLC1=ON&CBLC3=ON&CBLC4=ON&CBLC6=ON&CBLC8=ON&CBLC10=ON&DDLMapsize=800x480&DDLMapLabels=none&DDLTmpRangBK=0&DDLTmpColor=-3342388

WHO (2010b). WHO Global Infobase : International Comparisons (Males) Available at: https://apps.who.int/infobase/Comparisons.aspx?l=&NodeVal=WGIE_BMI_5_cd.0704&DO=1&DDLReg=ALL&DDLSex=2&DDLAgeGrp=15-100&DDLYear=2010&DDLMethod=INTMDCTM&DDLCateNum=6&TxtBxCtmNum=20,35,50,65,80&CBLC1=ON&CBLC3=ON&CBLC4=ON&CBLC6=ON&CBLC8=ON&CBLC10=ON&DDLMapsize=800x480&DDLMapLabels=none&DDLTmpRangBK=0&DDLTmpColor=-3342388

WHO (2014). *Global status report on noncommunicable diseases 2014*.
(ISBN: 978 92 4 156485 4).
Available at: http://www.who.int/nmh/publications/ncd-status-report-2014/en/

WHO (2015). South Africa: country profiles
Available at: http://www.who.int/gho/countries/zaf/country_profiles/en/

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/

Wittenberg M. (2013). The Weight of Success: The Body Mass Index and Economic Well-Being in Southern Africa. *Review of Income and Wealth* **59**, S62–S83 (DOI: 10.1111/roiw.12029)

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)

World Bank (2012). Women are less likely than men to participate in the labor market in most countries | Data.
Available at: http://data.worldbank.org/news/women-less-likely-than-men-to-participate-in-labor-market

1. Hiermit erkläre ich, dass diese Arbeit weder in gleicher noch in ähnlicher Form bereits anderen Prüfungsbehörden vorgelegen hat.
   Weiter erkläre ich, dass ich mich an keiner anderen Hochschule um einen Doktorgrad beworben habe.

   Göttingen, den ....

   ....

   (Unterschrift)

2. Hiermit erkläre ich eidesstattlich, dass diese Dissertation selbständig und ohne unerlaubte Hilfe angefertigt wurde.

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