GEORG-AUGUST-UNIVERSITÄT
GÖTTINGEN

GlobalFood
www.uni-goettingen.de/globalfood

RTG 1666 GlobalFood

Transformation of Global Agri-Food Systems:
Trends, Driving Forces, and Implications for Developing Countries

Georg-August-University of Göttingen

GlobalFood Discussion Papers

No. 78

Understanding the Drivers of Overweight and Obesity in Developing Countries: The Case of South Africa

Iris Butzlaff
Dimitrios Minos

February 2016

RTG 1666 GlobalFood · Heinrich Düker Weg 12 · 37073 Göttingen · Germany
www.uni-goettingen.de/globalfood

ISSN (2192-3248)

Understanding the Drivers of Overweight and Obesity in Developing Countries: The Case of South Africa

by Iris Butzlaff*+ and Dimitrios Minos+

Research Associates

* RTG1666 GlobalFood

+ Chair of Development Economics

Georg-August-University Goettingen

Goettingen, January 2016

Abstract

The beginning rise in obesity prevalence rates in South Africa was first noticed already in the early 1990s. Since then, several articles have discussed how the nutrition transition has affected people's body weights in the country. This article is the first one that uses longitudinal data from South Africa to reveal the short- and long-term effects that socio-economic and cultural factors have on the probability of becoming obese. The concept of "benign" obesity seems to influence people's perceptions of an ideal body shape and thus 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. To address the problems of obesity, we suggest implementing programs that change people's attitudes and behavior regarding food intake and physical activity. If people change their perception of what kind of body weight can be considered as being healthy, then a combination of different health programs can be successful.

JEL code: I12, I18, P46

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

Table of Contents

List of Tables and Figures

Tables

Figures

Tables in Appendix

Figures in Appendix

List of Abbreviations

AIDS	Acquired Immune Deficiency Syndrome
BMI	Body Mass Index
DALYs	Disability Adjusted Life Years
FAO	Food and Agriculture Organization
FE	Fixed Effects
HIV	Human Immunodeficiency Virus
IHD	Ischaemic Heart Disease
LPM	Linear Probability Model
NIDS	National Income Dynamics Study
NR-NCDs	Nutrition-Related Non-Communicable Diseases
NTC	National Technical Certificates
OLS	Ordinary Least Squares
RE	Random Effects
SADHS	South African Demographic and Health Survey
SALDRU	Southern Africa Labor and Development Research Unit
SSA	Sub-Saharan Africa
VAT	Value Added Tax
WHO	World Health Organization

1. Introduction

For many years one of the most challenging health risks in African countries used to be undernutrition. Although high rates of undernutrition and nutritional deficiencies still prevail, 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 rising especially among emerging economies. Although industrialized countries still have higher prevalence rates (WHO, 2014), developing countries are catching up fast. Data published by the WHO (2014) 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. Rates have increased by over 30% to an average of almost 10% in Sub-Saharan Africa (SSA) (WHO, 2014).

The WHO firstly recognized obesity as a chronic disease in 2003 (WHO/FAO, 2003). Obesity is not only a problem in and of itself, but also because it causes comorbidities, such as diabetes, hypertension, higher risk of heart attacks, strokes, and various cancers. These are in the group of nutrition-related non-communicable diseases (NR-NCDs). The WHO measures the damage caused by NCDs in DALYs (Disability Adjusted Life Years), whereas other studies estimate health care costs and loss in productivity to measure the economic impact of NCDs (Antipatis and Gill, 2001; Lakdawalla et al., 2005; Cawley, 2006; Grossman and Mocan, 2011). Starting in the 1990s, scientists have tried to identify the reasons for rising overweight and obesity prevalence rates as well as for NCDs in industrialized and developed countries, respectively (Sobal, 1991; Dowse et al., 1995; Wei M et al., 1999). The concept of the "nutrition transition" was utilized by Popkin and Drewnowski to explain the widespread emergence of unhealthy body weights in developing countries (Drewnowski and Popkin, 1997; Popkin, 1999). The term nutrition transition summarizes several patterns, such as a shift in dietary consumption from traditional diets high in carbohydrates and low in unsaturated fats towards diets containing more animal proteins, unsaturated fats, sugar, and cholesterol, as well as a more sedentary lifestyle stemming from urbanization, less labor-intensive occupations, and lifestyle changes. Some authors have linked this to rising income rates using cross-sectional analysis (Popkin, 2004), but the transmission channels remain unclear.

In South Africa, the nutrition transition goes hand in hand with the concept of "benign obesity" or a kind of "healthy obesity" which gained ground from the 1960s to 1990s. "Benign" obesity means that people with a bigger body size are regarded as healthy despite their increased adiposity because they have normal metabolic features (Phillips et al., 2013).

There is a broad consensus that globally increasing rates of obesity can be attributed to what is called "obesogenic environments", that is "the sum of influences that the surroundings, opportunities, or conditions of life have on promoting obesity in individuals or populations" (Swinburn and Egger, 2002). Several disciplines have investigated the emergence of obesity in human evolutionary history, yet most research is embedded within disciplinary boundaries (Ulijaszek and Lofink, 2006). Our paper aims to add a cultural dimension as this could explain behavior that leads to increasing levels of body weight. Different behavioral patterns in a society are established by cultural perceptions and mentalities within a society. These patterns are developed over the long term and do not change quickly. It is important to distinguish between short-term and long-term factors that influence people's body weights to be able to implement prevention and mitigation strategies. To our knowledge, there are no articles that try to identify long-term and short-term determinants of obesity. Culture has a big influence on people's behavior in the long run, thus it can give more insights to understanding the rise in obesity (Brown, 1991). The concept of "benign" obesity – which we consider to have a cultural and long-term dimension – has been discussed in the literature and appears to be one reason why, among the South African Black population, larger body size seems to be preferred (Walker et al., 2001; Van Der Merwe and Pepper, 2006), see Section 3. Perceptions and mentalities shape behavior and have long-term effects.

One novelty of our research paper is that we use *longitudinal* data from a nationally representative sample in South Africa, which helps us overcome inconsistencies between papers that have identified drivers regarding the variables age, physical activity, urban vs. rural (Van Der Merwe and Pepper, 2006). Furthermore, South Africa is a very diverse country in terms of incomes and ethnicities. 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 long-term drivers of the ever increasing rates. Time-invariant factors are able to reflect the long-term effects that result from the standing of notions such as “benign” obesity in societies. By using the Mundlak approach we are able to reveal long-term effects; namely we are able to reveal the effect that time-invariant variables have on the dependent variable. Another advantage of the Mundlak model is that we can estimate both the within estimates and the between estimates. This allows us to identify how much of the variation of the dependent variable can be explained by individual error. It is important to identify certain population groups so that programs aiming to prevent overnutrition can be targeted in an appropriate manner (Ulijaszek and Lofink, 2006). If the most affected population groups are identified, it is possible to establish prevention programs, such as food or tax programs. The latter is a very common option for several countries, although its effectiveness is debatable (see for instance Schmidhuber (2004)).

The structure of this paper is as follows: In Section 2, we give an overview over the study background; we present definitions of overweight and obesity and describe the development of population trends regarding health outcomes in the last decades for both developing and developed countries. In Section 3 we present a literature review reflecting the current state of knowledge with a focus on South Africa. Section 4 describes the conceptual framework underlying the research questions, the data and methodology used for the investigation. Section 5 looks at the data and Section 6 reflects the results of our regressions. In Section 7, we conclude the topic and suggest some policy implications.

2. Background

We use the standard WHO/FAO (2003) definitions for overweight (BMI>25) and obesity (BMI>30), despite the well-known shortcomings of these measures.[1]

Overview of population trends in overweight and obesity

Since overweight and obesity were estimated to account for 3.4 million deaths per year, 93.6 million DALYs in 2010, and the numbers are still increasing in all countries, there is good reason to make this topic a priority on the countries’ political agendas. The prevalence of obesity has nearly doubled worldwide 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 unsettling prevalence

[1] See Cawley and Burckhauser (2006) for a more detailed discussion.

rates of overweight and 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 the 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, the 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 the future (Antipatis and Gill, 2001; Halford et al., 2004; Popkin et al., 2006; Stifel and Averett, 2009).

Many studies on overweight and obesity have focused on developed countries, though the number of articles on developing countries is increasing. In general, drivers that have been identified as having an influence on increasing body weight include: 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 also been 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 people but consumption-contracting effects for poor people; in this particular case pork as source of animal fat would have been taxed. They assume a shift towards substitutes (vegetable oils and fats). The taxation of pork in China would not only reduce the consumption of energy and saturated fatty acids of rich consumers but also cause a decrease in protein consumption by the poor (Guo et al., 1999). 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. Reducing the consumption of high-fat, energy-dense food has thus reduced the number of deaths from coronary heart diseases in Finland (Puska et al., 1995) and Norway (Norum, 1997). National intervention programs in Singapore were successful in decreasing the levels of some cardiovascular risk factors and of childhood obesity (Cutter et al., 2001). Furthermore, Mauritius has successfully implemented and evaluated 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). In the World Health Organization's status report on NCDs (WHO, 2014) it is stated that school is an important setting for promoting healthy diets. Regarding obesity reduction programmes, Sacks et al. (2011) theoretically contrasted nutrition labelling and a junk-food tax. Both were evaluated to be successful, taxes a bit more than labelling at lower costs. A review of 28 studies by Hawley et al. (2013) concludes that a multiple traffic light systems is seen as a trustworthy guide with regard to calorie information and was accepted among the tested people.

3. Situation in South Africa

For about the past 15 years, articles have been published that describe how even some African countries face the obesity epidemic (WHO, 1998), although undernutrition and malnourishment still is an important nutrition issue on the African continent.[2]

The general public perception is that many African countries are facing problems with undernourished people, especially underweight children. But in 1998 the WHO has additionally identified another health problem regarding nutrition (WHO, 1998). Obesity prevalence rates were at 8% for males and 44% for females for adults in the age group 15-64 in 1990 in South Africa (1998). Although South Africa is classified as an upper middle income country by the Worldbank (2014), we consider it as being a developing country because it is still on the way to becoming a developed country and not yet industrialized. South Africa faces manifold problems regarding health, inequality, poverty, and infrastructure even though it has achieved noticeable economic development.[3] The first studies in South Africa on the topic of anthropometric patterns of adults came out in the early 2000s (Bourne et al., 2002; Puoane et al., 2002; Kruger et al., 2005), which confirmed the finding that overweight is a problem for people's health and that South Africa has also been affected by several characteristics of the nutrition transition. The health situation of adults in South Africa has become very similar to that of industrialized countries in some aspects. Although the top cause of death is still HIV/AIDS (33.2%), the second highest number of deaths is caused by strokes (6.5%), diabetes (5.7%) and ischaemic heart disease (4.8%) which altogether are grouped as nutrition-related non-communicable diseases (WHO, 2015). Many of the NCDs are caused by individual's high body weights. Obesity and overweight prevalence rates show increasing rates since the 1990s in South Africa (especially for women), whereas undernutrition rates have remained constant since the early 1990s. Overweight and obesity rates for women aged 15+ are about 68.5% (WHO, 2010a) and for men 41.3% (data from 2010, WHO 2015c). These high prevalence rates for an unhealthy body mass are even higher than the ones for Europe and comparable to the USA, at least for females (Finucane et al., 2011).

---

[2] The Global Nutrition Report (2015) clearly defines the manifold ways of malnutrition. Stunted children, micronutrient-deficient malnourished persons and obese people all count as malnourished. In the above described case we refer to underweight and undernourished persons.

[3] South Africa is classified as an Emerging Industrial Economy by (Upadhyaya, 2013) and sometimes interpreted as somewhere between a developing and developed country (Development Policy and Analysis Division (DPAD), 2012; International Monetary Fund (IMF), 2015).

The data primarily used to describe this development stems from the South African Demographic and Health Survey (SADHS) which was conducted on a nationally representative sample of the population. In its health section SADHS includes a multiethnic measurement of the anthropometrics of adults (Puoane et al., 2002). Thus, for more than 10 years it has been clear that the worrying direction of malnutrition is predominantly about overnutrition rather than undernutrition (see 2002). Nevertheless, undernutrition still remains a problem in South Africa, especially among children. Households that face overweight and undernutrition among their household members at the same time are known as "double burden" households (Doak et al., 2004; Subramanian et al., 2009; Römling and Qaim, 2012).

In the case of South Africa one has to distinguish between ethnic groups since there are clear differences regarding prevalence rates for Blacks, Whites, Coloureds, and Asian people. 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, also known as "obesity paradox". Only after the 1990s did scientists accept that overweight and obesity have the same harmful effects on African women as it has on white women (Walker et al., 2001). Especially in the long run metabolically healthy obese persons face higher risk probability for health problems compared with metabolically healthy normal-weight persons. (Kramer et al., 2013). Hence, one may argue that the actual worrying high numbers of black obese people can partly be traced back to the misperception of "healthy" obesity (Van Der Merwe and Pepper, 2006). If one accepts (as in some early papers) that there may be a "healthy" way to be obese and not suffer from NCDs, and if African or African-American women were considered to more likely face "benign obesity"(Walker and Segal, 1980), then one can follow the argumentation that obesity has not been seen as disadvantageous among the black population. Another argument is that high body weight is considered to reflect a high social status (Puoane et al., 2002; Wittenberg, 2013) as rich people can afford to consume more food. 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".

Van der Merwe and Pepper (2006) highlight the importance of high body mass for nutrition-related non-communicable disease, in particular type 2 diabetes. They argue that the myth of "benign" obesity partly explains the perception that high body weight can be interpreted as healthy and is hence desired (see also Mvo, Dick, and Steyn (1999)). It therefore seems that obesity is the preferred body status of certain groups in the society, holding true for females more than for males (Van Der Merwe and Pepper, 2006). A high body weight seems to reflect a high social status and economic well-being. Obese people that do not have high blood pressure, heart disease or diabetes are regarded as "healthy obese". Several older articles have reported that obese black people seem to suffer less from ischaemic heart disease (IHD), dyslipidaemia, and high blood pressure (Walker et al., 1979, 1988; Walker and Segal, 1980). But still in 2001 some of the above mentioned authors proved that, when compared with white women, African women seem to be less affected by hypertension, coronary heart disease and breast cancer caused by obesity (Walker et al., 2001). By contrast, a meta-analysis from 2013 rebutted this opinion and found that in the long-term (over 10 years and more) obese people also have a 24% increased risk for heart attack, stroke and death compared with normal-weight people (Kramer et al., 2013). One reason might be that weight gain as fat in the liver is considered to be more harmful than weight gain in the lower extremities. Suffering from metabolic disease (such as high cholesterol and high blood sugar) regardless of weight implies a higher risk of a heart attack, stroke and death (Kramer et al., 2013).

Case and Menendez (2009) claim that nutritional deprivation in childhood leads to a 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 an 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 to malnourished children in early childhood when they do not face food insecurity in later life. 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). Another reason that has been identified is women's perceptions of an "ideal" female body, which are larger than male's perceptions of the “ideal“ male body (p. 277ff.). 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, thus the amount was completely underestimated (2002). They emphasize that these inaccurate perceptions can be distinguished between population groups. Women had a higher BMI than men, urban people higher than rural, old people higher than younger people, and better educated women lower than less educated women, on average. Furthermore, Wittenberg (2013) argues that a higher body weight can also be seen as a sign of wealth in the South African society and reflects a higher social standing.

In the next sub-section we explain our conceptual framework and describe the data and the methodology used.

4. Analytical Approach and Data

4.1. Conceptual Framework

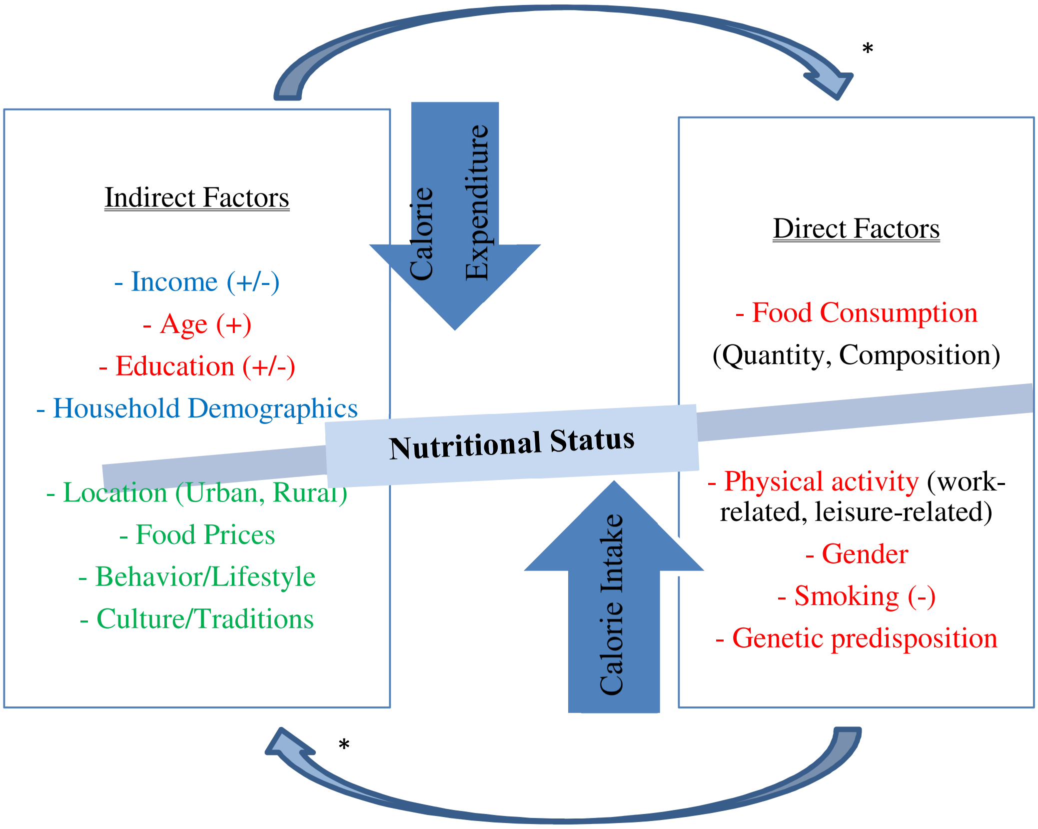
Our analysis is based on a conceptual framework that identifies the drivers of weight and weight gain. For the graphical illustration of the conceptual framework see Figure 1.

BMI is expected to increase with age since the digestive system starts to lose its efficiency and capacity. This has been shown in the literature, we further expect a negative effect from the variable age^2 (Huffman and Rizov 2007).

Some articles have shown that females have higher prevalence rates of overweight and obesity compared to men (Monteiro et al., 2004; Crosnoe, 2007; Ball et al., 2011). Hence, we expect a negative sign for the dummy variable male (which is 1 for males and 0 for females).

We use a categorical variable for education to capture the educational level (see Table A1). We expect that higher education is negatively related to body weight and BMI growth because better educated people are more conscious about healthy food and lifestyles and are therefore less likely to be overweight or obese. Additionally, less educated people probably earn less and hence are not able to afford the more expensive healthy food and consume more food items dense in kilocalories. Since we control for per capita expenditure we will not be able to directly identify the latter effect.

Figure 1 Conceptual Framework of Determinants of Nutritional Status[4]



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

The variable household size includes all members living in the household. We did not drop extreme values (in only 1.8% of all households did the members size exceed 10 people).

As a social preference for thinness in some westernized societies exists – which has been argued to be stronger for people who are still searching for their future spouse – we include a dummy variable for living with a partner or not (Sobal et al., 1995; Macdiarmid and Blundell, 1998). We do not rely on the marital status alone because we also want to include people who live with their partner in an "informal marriage". We hence include all persons who live in a registered marriage and those who live together but are not registered and value them as 1. People receive the value 0 for this dummy when they have never been married, are divorced or widowed. We assume this dummy to be positively correlated with BMI growth.

A dummy for whether the respondent is a smoker or not is included because several studies, including medical studies, have shown a negative effect of smoking on body

[4] Color codes: Individual Level, Household Level, Environmental Level.

weight (Wardle and Steptoe, 2003; Williams et al., 2007; Baum and Chou, 2011; Rizov et al., 2012). Smoking tends to increase metabolism and suppress appetite, thus having a negative effect on BMI.

To control for urbanization, we include a binary variable which shows the effect for the location of the respondent's residence in an urban or a rural area on BMI growth. Urbanization has been found to have a positive impact on body weight as living in urban areas tends to increase the intake of processed food, sugar, fat and salt, while reducing physical activity due to better infrastructure and transportation facilities (Drewnowski and Popkin, 1997; Hoffman, 2001; Popkin, 2004; Schmidhuber and Shetty, 2005; Kearney, 2010).

The year dummy variable controls for changes over time related to transition processes, e.g. regarding the organization of the health system.

For more information on the construction of the control variables see Table A1 in the Annex.

Many surveys that have been conducted in the last years include information on the individual level (e.g. anthropometric measures, education, age, sex, job), on the household level (e.g. household size, household income, food consumed at home and assets) and some on the community level (infrastructure, access to health services, recreational facilities). But in general, information that can be interpreted as environmental factors or culture is more difficult to capture. We interpret food prices and food availability, place of residence (urban/rural), ethnicity, and public transport as environmental factors. But there still seem to be more factors that are not easily captured which can be described with the term culture. Caprio et al. state that culture is shaped by experience (2008), and that it can be seen as a dynamic construct which changes over time.[5] 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,

[5] First researchers that have discussed the long-lasting effects of culture and the relationship to society are Max Weber and Émile Durkheim, for instance.

however, is a rather slow process and can span over decades. Sobal (2001) claims that "acculturation" is often associated with an increase in weight, which at least holds true for the US. In the previously mentioned paper, the author refers to acculturation to Western societies. People adapt to a "new" culture and change their behavior. Migration and the globalization of Western culture with a strong influence on food, eating and weight is often regarded as social processes which carry along the dilution of geographic borders (Caprio et al., 2008). This means that lifestyle and hence behavior changes lead to a higher body weight. TV and the news, media, and internet could also serve as means of acculturation, as these forms of media allow people to get in contact with the world and the manifold views of life very easily. Different mentalities are being spread more easily and at a faster rate. The adaption of behavioral patterns according to reformed mentalities takes more time, thus mentality can be considered as having long-term effects.[6] 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 in BMI changes. Some of these can be interpreted as cultural factors which can be traced back to people's mentalities and opinions.

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

$$W_t = f\left(C, H\left(BMI^{high}\right)\right) \quad (1)$$

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.

$$CI_t > CE_t \quad (2)$$

So, the question is 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 health outcomes.

$$CI_t = f(I, H, E) \quad (3)$$

$$CE_t = f(I', H', E') \quad (4)$$

We distinguish between direct, indirect and environmental factors, as shown in Figure 1.

[6] Sociologists talk about "longue durée" when meaning long-term changes in mentalities (Schwaabe, 2006).

We argue that income, education, household demographics, location, food prices, behavior/lifestyle and culture/traditions influence people's body weights in an indirect way. Direct factors are food consumption, physical activity, gender, smoking, and genetic predisposition. Food prices might have an influence on food consumption and 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 signs are even harder to predict. Some factors have short-term influences and some have long-term effects.

4.2. Data

The data we use in our study is a three wave panel study from South Africa, the National Income Dynamics Study (NIDS). It is the first national longitudinal study in this country, 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 of the study was conducted in 2008 with a nationally representative sample of over 28,000 individuals in approximately 7,300 households across the country. In order to provide an assessment of income dynamics and its consequences, the survey has continued to be repeated with these same household members every two years and examines the livelihoods of individuals and households over time (Finn et al., 2012). Although the survey has been conducted to track income dynamics, it also includes a comprehensive health section which covers anthropometric measures and information on diseases that are partly nutrition-related, e.g. information on the prevalence and medical treatment of diseases like high blood pressure, diabetes or high blood sugar, stroke and heart problems.

In our sample, after cleaning we include 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 overweight or obese is our dependent variable, we excluded observations from our data set when we had missing values for either height or weight[7] 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

[7] Since the NIDS data set has been established to capture income dynamics, the focus has not been on anthropometric measures, which explains the number of missing values for height and weight.

as far as possible. However, the final dataset is an unbalanced one, because of several missing values for explanatory variables. Moreover, we include people that have been in the adults file of the original dataset but excluded people younger than 18 years and old people, hence we restrict the sample to individuals that were between 18 and 65 in 2008.

For our model we refer to being overweight as having a BMI greater than 25, being obese as having a BMI greater than 30 and being hyperobese with a BMI of more than 35. We distinguish between these two forms of adiposity because we assume that it gives a more detailed picture of the health problems in South Africa.

4.3. Methodology

Following our theoretical model we propose a model using the probability of 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.

Pooled Probit Model

$$P(y = 1)_{it} = \alpha + \beta X_{it} + \delta T_t + v_{it} \tag{5}$$

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. The v_{it} represents the composite error and summarizes the unobserved time fixed effects c_i and the idiosyncratic error term u_{it}. To get a first impression of the influencing factors we use a Pooled Probit model, as shown in Equation 5.[8]

Since both common panel models – namely the Fixed Effects (FE) specification and the Random Effects (RE) specification – have their own shortcomings which we discuss below, 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 from the model, both observed and unobserved, which often are variables of interest. The unlikely assumption of RE, 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 time means which are able to capture long-term

[8] We also run Pooled OLS regressions with the BMI as our dependent variable as a robustness check.

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 the FE specification for the within variation of the variables and can additionally include more variables and more specific group mean values to account for the between variation in the model. We can obtain the fixed effects estimator by simply adding the time average of our explanatory variables. Another advantage of the Mundlak approach is that "parameters can be estimated by pooled probit, greatly conserving on degrees of freedom" (Wooldridge, 2002). Hence, we combine the advantages of both, the FE and the RE model. Furthermore, we are interested in using binary choice 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 time-invariant variables (e.g. gender, location, education), this is a good approach. Wooldridge (2006) makes the argument that the approach developed by Mundlak (1978) is also appropriate for unbalanced panels and valid for binary choice models.

Mundlak Approach

$$P(y=1)_i = \alpha + \beta X_{it} + \delta T_t + \gamma \overline{X_i} + v_i \qquad (6)$$

The parameters α, δ, and v are the same as those in Equation 6. 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. In Equation 6, the parameter γ describes the coefficient of the set of variables which includes the within-individual mean values, and therefore describe *long-term* effects.

5. Descriptives

To get a first overview we have a look at Table A2 in the Appendix. Both, direct and indirect factor are discussed so that we get a better picture of the determinants of obesity and overweight. We have 65.75% females and 34.25% males in our sample.[9] On average, females are 41.4 years old and males 38.4 years old. Women have a higher BMI (29.15)

[9] There are several reasons why the ratio between males and females is so unbalanced. The primary reason for this has been labor migration (Posel, 2001; Collinson, 2010), also premature death (predominantly occurring for 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 are more likely to be at home as the survey is conducted (World Bank, 2012), and are more likely to respond to surveys.

than men (23.7), on average. Men, on average, have completed more school grades (8.4) than women (8.0). Women smoke to a much smaller degree (8.0%) than men (37.0%) and do much less exercise (11.0% to 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 1. It becomes clear that being underweight is becoming less and less of a problem; however more and more males and females are becoming overweight and obese instead. Although men are a bit lighter than women, it seems they are gaining weight a bit faster, which can be interpreted as a convergence effect. Note, that in Table 1 obese people are included in overweight.[10]

Table 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**
underweight	5.50	4.37	12.52	3.30	10.02	2.27	6.63
normal	37.87	30.75	59.86	27.08	54.61	25.49	57.15
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

Source: Own calculations using NIDS data. Overweight: BMI>25; Obesity: BMI>30.

Population groups are heterogeneous in South Africa, so we include Table 2 which gives an overview over the health status among the different population groups. 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[11] 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 their shared 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

[10] Overweight: BMI>25; Obesity: BMI>30.

[11] Several years ago this term was 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.

unweighted samples for white and Asian are very small and not reflective of the actual size of each population group in South Africa.

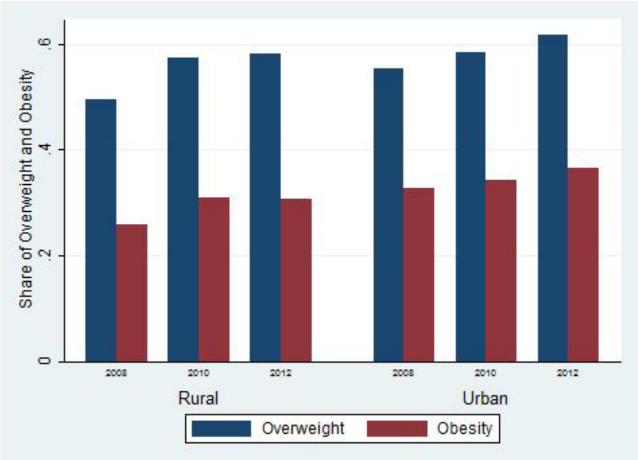
Table 2 BMI Categories for population groups

BMI CATEGORIES	Population Group				
in %	African	Colored	Asian	White	Total
underweight	4.93	9.84	7.05	1.10	5.49
Normal	39.05	32.69	31.86	24.54	37.88
overweight	56.02	57.47	61.09	74.36	56.63
obese	31.31	33.85	23.53	37.36	31.66
N	11,787	1,740	153	273	13,963

Source: Own calculations using NIDS data. Overweight: BMI>25; Obesity: BMI>30.

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 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.

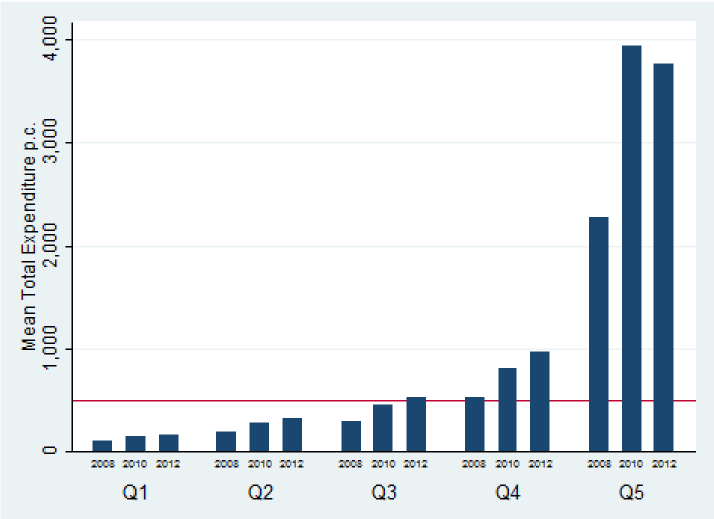
Figure 2 Overweight and Obesity in Urban and Rural Areas



Source: 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, as seen in Figure 3. In order to control for the monetary well-being of a household, we use real per capita expenditure[12] 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 Mean Total Expenditure per capita across quintiles



Source: 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.[13]

The mean total expenditure per capita almost doubled from 675.88 Rand in 2008 to 1,111.02 Rand in 2010 and ultimately stagnated at 1,112.65 Rand in 2012. However, it is worth noting 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.

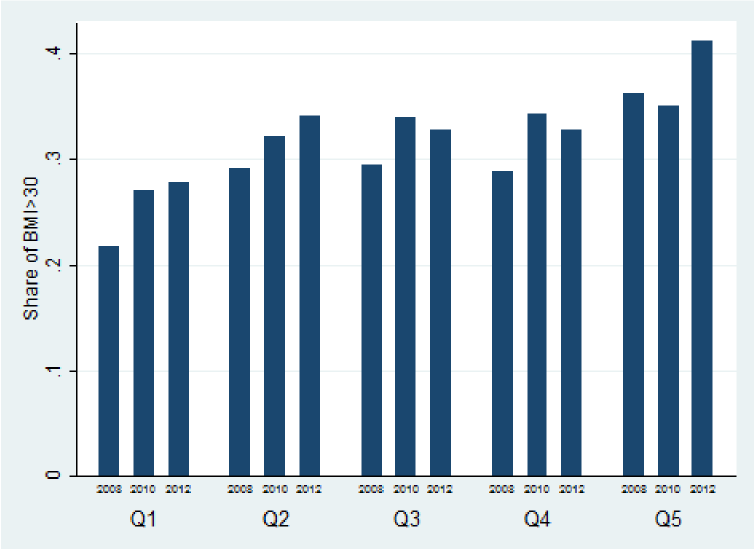
We find, however, that an increased body weight is highly prevalent across all quintiles of the expenditure distribution, as seen in Figure 4. This in turn implies that increases in the body weight are by no means proportional to increases in income. We also see that obesity is not only a problem of the richer quintiles but is a problem for the whole population. But still prevalence rates are highest among the richest 20% of the population. To conclude,

[12] 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).

[13] 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 indicative and does not reflect the extent of poverty in South Africa because the methodologies differ.

although income is highly unequally distributed among the South African population, we see a relatively equally distributed (high) share of obese people in the whole population.

Figure 4 Share of BMI>30 over expenditure quintiles



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

6. 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 linear regressions on the Body Mass Index itself. 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.

6.1. Obesity

The regression results for the Pooled Probit regression on the probability of a person being obese are shown in Table 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. The fixed effects model is in this case preferred over the random effects model according to the Hausman test. Although the linear probability model lacks in precision, we feel that the number of observations is high enough to give useful insight into the within variation and the direction of the coefficient signs and the level of significance (Wooldridge, 2002). 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 Regressions on the probability of a person being obese

VARIABLES	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)
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)

VARIABLES	Pooled Probit	Linear Prob. FE	Mundlak	
				Means
(continued)				
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.
*** p<0.01, ** p<0.05, * p<0.1. Left out province is Gauteng. Source: own calculations using NIDS sample.

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, 2002; 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,[14] i.e. the higher a person's income the higher the body weight. 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.[15] One could thus argue that higher incomes do not necessarily lead to a 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

[14] 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 in Table A3.
[15] A more detailed discussion on the impact of increased food expenditure can be found in the Appendix.

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, however this probability seems to be lower for males. We moreover find a positive relationship between education and increased 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 the home which tend to be higher in calories. This argument applies mostly to 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.[16] 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.

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. The reasoning behind this can be a misspecification of the variable, since we only have broad categories for occupation.[17]

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 television (e.g. time spent watching etc.). The size of the household also has a

[16] Not shown. The accuracy of the data may be a subject here, especially in the third wave.
[17] This changes if we replace the variable with a dummy for agriculture. The coefficient of the dummy variable agriculture is then negative and significant.

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, as discussed in Section 4.1.

The year dummies are insignificant.[18] Our model is thus able to explain the differences in overweight rates between 2008 and 2012. Finally, there are some regional differences, 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[19] 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. We moreover find that all other variables do not have a significant effect on the probability of becoming obese, except for age. The signs remain largely the same, but none of the coefficients are 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

[18] The significance weakens with the introduction of the education and exercise variables. Naturally, there is also a high correlation with age.
[19] Note, that all Mundlak Probit regressions also include dummies for gender and ethnicity as part of the fixed effect.

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.

We moreover observe that the coefficients of the time means for our other explanatory variables are somewhat larger compared to those in the first column. 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 observed differences 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 South African society have shaped clear preferences towards a higher body weight. Short term changes do not seem have a significant effect on the probability of being obese

6.2. BMI

The general picture obtained in our binary choice models is to a large extent replicated in Table 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.

Table 4 Regressions on the Body Mass Index

VARIABLES	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)	
Colored	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)

VARIABLES	Pooled OLS	Pooled OLS	Fixed Effects
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

Source: own calculations using NIDS sample. Robust absolute values of t-statistics in parentheses, using clustered standard errors at the household level. *** p<0.01, ** p<0.05, * p<0.1. Left out province is Gauteng.
Excluding individuals with BMI<18.5.

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.[20] 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 to the 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, exercising and 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 deeply 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 largely

[20] 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 the Appendix in Table A4.

unchanged compared to the binary choice models. Once again the Rho is very high and accounts for nearly 80% of the error term, reflecting the idiosyncratic error between individuals.

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.[21]

In the literature on obesity in industrialized countries, the relation and the transmission channels are clear. 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 although the weight increase of the population could be attributed to shifts in diets and the availability of low cost energy dense food items that replaced traditional diets, the fact that the positive relationship between income and BMI seems to be robust raises new questions as to what exactly it captures. Answering these questions is essential to designing 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 deprivations 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 the perceived or desired social status in South Africa.

7. 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 overweight or obese. For this positive relationship we can think about the different

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

transmission channels of income/expenditure on body weight. As we could rule out that the increased expenditure is due to rises in food expenditure and hence directly related to increased food intake, we find that in the South African society high income is highly correlated with higher body weight. High body weight is still seen as a sign of wealth and also promises a good health constitution. Behind these patterns are the negative image of slim people that is associated with the "slim disease" (HIV/AIDS) which often affects poor people and is not a sign of wealth and power. Since white people are still richer and heavier than African people in South Africa, it is possible that African people take it as an example and also alter their preferences towards higher weights to represent their social status. The same argument can be used to explain the positive relationship between education and BMI. The mentality regarding high body weight seems to be positive, at least among black South Africans and among females. Females have a much higher probability of becoming overweight or obese compared to males.

This line of thinking is also strengthened by the fact that we find time invariant characteristics and long-term effects as mattering the most. These seem to be deeply 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. We are hence convinced that a changing of these patterns (though it might take a long time) will lead to a modification in behavior regarding calorie intake and calorie expenditure and subsequently lead to a healthier lifestyle.

For implementing strategies that seduce people to healthier lifestyles governments of different countries have tried several programs with different outcomes regarding success. It is necessary to identify the risk of being overweight and obesity in children and adults and addressing it early. There are several reasons why women should be in the focus of health programs. They are more likely to have a high body weights that are too high compared to men, they are more often the caretakers of children and hence, have an influence on their eating behavior and on their perception of a healthy lifestyle. The last argument is that more often women are responsible in food preparation and have an influence on the food composition of the other household members. According to our findings, we find it most 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 seems to reflect a high social status (as does education) the most important strategy to convince people that losing weight is good for their health might be an extensive program that covers health knowledge involving mass media and schools. This might adjust people's (especially women's) perceptions of an ideal body shape. Measuring and reporting, learning from successful initiatives is essential for target-oriented strategies.

Several governmental programs have been evaluated as being successful, thus we would recommend implementing programs that change people's attitudes and behavior regarding food intake and physical activity. In Section 2 we discussed some programs that have been evaluated as having shown success in reducing obesity prevalence rates. Keeping this in mind, we conclude that a taxation of unhealthy food and drinks would need to be relatively high (at least 20% according to (Mytton et al., 2012)) to have significant effects. But this would be difficult for policymakers to implement. This is even of greater relevance as there is a time-lag between the implementation of measures and first measurable success, thus election periods might be too short. 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 having food available everywhere that according to him leads to overweight and obesity.

In a nutshell, the most important lesson we learn is that policies should focus on long-term measures. People adapt to short-term policies and after a while might customize undesired effects, e.g. too low fat taxes. It is more important that people change their mentality and finally their behavior in the long-run.

References

Abdulai A. 2010. Socio-economic characteristics and obesity in underdeveloped economies: does income really matter? *Applied Economics* 42, 157–169.

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.

Asfaw A. 2007. Do Government Food Price Policies Affect the Prevalence of Obesity? Empirical Evidence from Egypt. *World Development* 35, 687–701.

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.

Brown P. J. 1991. Culture and the evolution of obesity. *Human Nature* 2, 31–57.

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.

Case A., and A. Menendez. 2009. Sex differences in obesity rates in poor countries: Evidence from South Africa. *Economics & Human Biology* 7, 271–282.

Cawley J. H. 2006. Markets and Childhood Obesity. *The Future of Children* 16, 69–88.

Collinson M. A. 2010. Striving against adversity: the dynamics of migration, health and poverty in rural South Africa. *Global Health Action* **3**.

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.

Deaton A., and S. Zaidi. 2002. *Guidelines for Constructing Consumption Aggregates for Welfare Analysis*. The World Bank.

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.

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.

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.

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.

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.

Gilbert L. , T. A. Selikow, and L. Walker. 2010. Society, Health and Disease in a time of HIV/AIDS.

Grossman M., and N. Mocan. 2011. *Economic Aspects of Obesity*. University of Chicago Press, 407 pp..

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.

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.

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.

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..

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

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.

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.

Kleinman A., and P. Benson. 2006. Anthropology in the Clinic: The Problem of Cultural Competency and How to Fix It. *PLoS Med* 3, e294.

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.

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.

Lakdawalla D. N., D. Goldman, and B. Shang. 2005. The Health And Cost Consequences Of Obesity Among The Future Elderly. *Health Affairs* 10.

Lakdawalla D., and T. Philipson. 2002**.** *The Growth of Obesity and Technological Change: A Theoretical and Empirical Examination*. National Bureau of Economic Research.

Lu Y., and D. Goldman. 2010. *The Effects of Relative Food Prices on Obesity – Evidence from China: 1991-2006*. National Bureau of Economic Research.

Mundlak Y. 1978. On the pooling of time series and cross section data. *Econometrica* 46, 69–85.

Mvo Z., J. Dick, and K. Steyn. 1999. Perceptions of overweight African women about acceptable body size of women and children. *Curationis* 22.

Mytton O. T., D. Clarke, and M. Rayner. 2012. Taxing unhealthy food and drinks to improve health. *The BMJ* 344, 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.

Osmani S., and A. Sen. 2003. The hidden penalties of gender inequality: fetal origins of ill-health. *Economics & Human Biology* 1, 105–121.

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..

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.

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.

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.

Popkin B. M. 1999. Urbanization, Lifestyle Changes and the Nutrition Transition. *World Development* 27, 1905–1916.

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.

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.

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.

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..

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.

Römling C., and M. Qaim. 2012. Obesity trends and determinants in Indonesia. *Appetite* 58, 1005–1013.

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.

Schmidhuber J. 2004. The growing global obesity problem: Some policy options to address it. *electronic Journal of Agricultural and Development Economics* 1, 18.

Schwaabe C. 2006. Die deutsche Modernitätskrise. Politische Kultur und Mentalität von der Reichsgründung bis zur Wiedervereinigung (W. Bergem, Ed.). *Politische Vierteljahresschrift* 47, 749–751.

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

Sobal J. 2001. Social and Cultural Influences on Obesity. In: *International Textbook of Obesity*. P. Björntorp, (ed.), John Wiley & Sons, Ltd, pp.305–322.

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.

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.

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.

Tafreschi D. 2014. The income body weight gradients in the developing economy of China. *Economics & Human Biology*.

Ulijaszek S. J., and H. Lofink. 2006. Obesity in Biocultural Perspective. *Annual Review of Anthropology* 35, 337–360.

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.

Villanueva T. 2011. European nations launch tax attack on unhealthy foods. *Canadian Medical Association Journal* 183, E1229–E1230.

Walker A., F. Adam, and B. Walker. 2001. World pandemic of obesity: the situation in Southern African populations. *Public Health* 115, 368–372.

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. P., 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., J. B. Kampert, C. E. Barlow, M. Z. Nichaman, L. W. Gibbons, R. S. Paffenbarger, S. N. Blair. 1999. Relationship between low cardiorespiratory fitness and mortality in normal-weight, overweight, and obese men. *JAMA* 282, 1547–1553.

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*. 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.

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.

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

Wooldridge J. M. 2006. *Introductory Econometrics - A Modern Approach*. Thomson South-Western.

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.

Appendix

Table A 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 FoodCPI 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

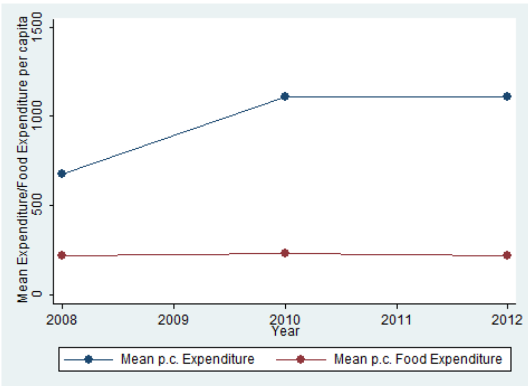
Table A 2 Summary Statistics for NIDS data

	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

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 A1.

Figure A1 Total and Food Expenditure (2008-2012)

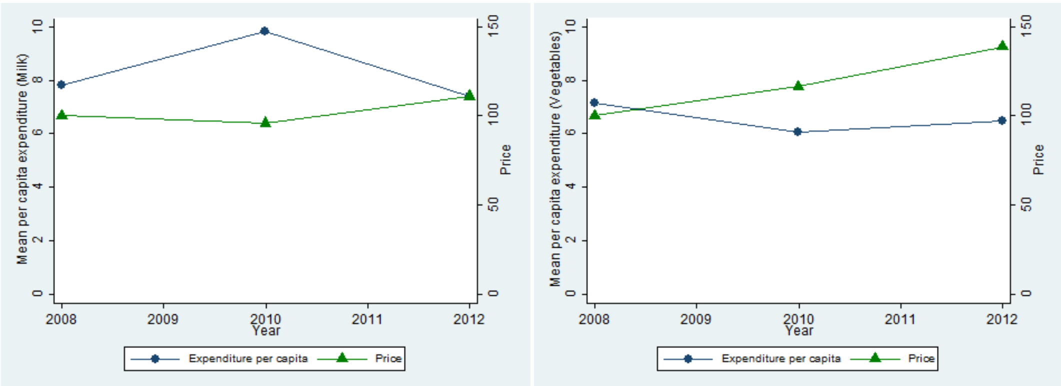


Source: Own calculations using NIDS data. Mean Total and Food Expenditure per capita, deflated by the CPI and the Food CPI, respectively.

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 A2, where we show the average spending on dairy products and vegetables, for example, in comparison to their mean prices.[22] 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, in order 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 A2 Expenditure on high- and low-fat food (2008-2012)

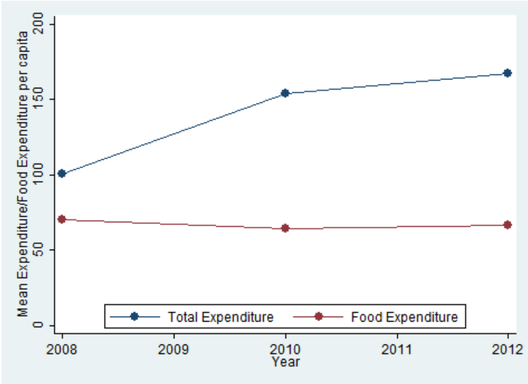


Source: Own calculation using NIDS data. Mean Expenditure per capita for dairy products and vegetables, deflated by the respective mean FAO prices. The prices are depicted by the FAO producer price index with the base year being 2008.

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 (see Figure A3). 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.

[22] 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 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 Regressions on the probability of a person being obese (Expend. squared)

VARIABLES	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)
Exercise	-0.1408***	-0.1081***
	(-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)

VARIABLES	Overweight	Obesity
(continued)		
African	0.1824	0.4111**
	(1.09)	(2.55)
Colored	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)
Eastern Cape	0.1557**	0.1464*
	(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.
*** p<0.01, ** p<0.05, * p<0.1. Left out province is Gauteng. Source: own calculations using NIDS sample.

Table A 4 Regressions on the probability of a person being hyperobese

VARIABLES	Pooled Probit	Linear Prob. FE	Mundlak	
				Means
Total Household Expenditure p.c.	0.0988***	0.0192***	0.1010***	-0.0449
	(3.32)	(3.41)	(4.30)	(-0.68)
Household Food Expenditure p.c.	0.0229	-0.0057	-0.0258	0.1231
	(0.64)	(-0.90)	(-0.92)	(1.49)
Urban	0.1959***	-0.0183	-0.0760	0.2796**
	(3.42)	(-0.92)	(-0.72)	(2.27)
Age	0.0087***	0.0011**	0.0087***	0.0001
	(8.58)	(2.19)	(2.81)	(0.04)
Age (sq.)	-0.0000***	-0.0000**	-0.0000***	0.0000
	(-7.24)	(-2.00)	(-3.92)	(0.01)
Male	-1.1399***			-1.0883***
	(-16.98)			(-15.34)
Education	0.0314	-0.0020	-0.0102	0.0378
	(1.39)	(-0.24)	(-0.25)	(0.78)
Living with Partner	0.1565***	0.0050	0.0083	0.1615**
	(3.55)	(0.42)	(0.17)	(2.26)
Feeling Depressed	-0.0512	0.0016	0.0140	-0.1836*
	(-1.27)	(0.20)	(0.41)	(-1.75)
Smoking	-0.4252***	-0.0046	-0.0186	-0.5423***
	(-5.68)	(-0.57)	(-0.27)	(-4.46)
Exercise	-0.0930*	0.0032	0.0306	-0.3029***
	(-1.82)	(0.49)	(0.79)	(-2.59)
Heavy Labour	-0.0723	0.0008	-0.0111	-0.1063
	(-1.49)	(0.10)	(-0.29)	(-1.19)
TV	0.1971***	0.0134*	0.0802**	0.2012**
	(4.53)	(1.65)	(2.07)	(2.38)
Household Size	0.0139*	0.0011	0.0044	0.0112
	(1.81)	(0.56)	(0.48)	(0.81)
African	0.5631***			0.5109***
	(3.26)			(2.85)
Colored	0.3257*			0.2971
	(1.82)			(1.62)
Asian	-0.2488			-0.3018
	(-0.87)			(-1.05)
Year 2010	-0.0277	-0.0062	0.0028	
	(-0.97)	(-0.58)	(0.04)	
Year 2012	-0.0235	-0.0094	0.0132	
	(-0.78)	(-0.50)	(0.12)	
Western Cape	0.3556***	0.0552	0.3485	0.0243
	(2.98)	(0.52)	(0.71)	(0.04)
Eastern Cape	0.1890**	-0.0028	0.0936	0.0963
	(2.07)	(-0.04)	(0.27)	(0.26)
Northern Cape	0.3144***	-0.0190	-0.2097	0.5246*
	(2.60)	(-0.35)	(-0.78)	(1.74)
Free State	0.2358**	-0.0445	-0.4157	0.6856*
	(2.38)	(-0.62)	(-1.10)	(1.76)
KwaZulu-Natal	0.2571***	0.0117	0.1405	0.1135
	(3.05)	(0.21)	(0.43)	(0.33)

VARIABLES	Pooled Probit	Linear Prob. FE		Mundlak Means
(continued)				
North West	0.1093	-0.0342	-0.2676*	0.3849**
	(1.03)	(-1.15)	(-1.69)	(1.99)
Mpumalanga	0.0366	-0.0214	-0.1486	0.1946
	(0.33)	(-0.59)	(-0.57)	(0.68)
Limpopo	-0.1070	-0.0252	-0.1780	0.0578
	(-1.01)	(-0.73)	(-0.64)	(0.19)
Observations	13775	13775		13775
Individuals	4651	4651		4651
R-squared (pseudo)	0.1668	0.0076 (within)		0.1719
Rho		0.6696		

Robust absolute values of t-statistics in parentheses, using clustered standard errors at the household level.
*** p<0.01, ** p<0.05, * p<0.1. Left out province is Gauteng. Source: own calculations using NIDS sample.

Table A 5 Regressions on the natural logarithm of the Body Mass Index

VARIABLES	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)
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)	

VARIABLES	Pooled OLS	Pooled OLS	Fixed Effects
(continued)			
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)
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.
*** p<0.01, ** p<0.05, * p<0.1. Left out province is Gauteng. Source: own calculations using NIDS sample.
Excluding individuals with BMI<18.5