"The Double Burden of Disease" in South Africa

Abstract

South Africa like many other developing countries is undergoing a rapid demographic and nutritional transition. While it continues to deal with the challenge of infectious diseases and child malnutrition, the upsurge in obesity and its accompanying non-communicable diseases present a new set of problems. This paper uses the National Income Dynamics Study to assess and quantify the prevalence of obesity and child malnutrition in South Africa, as well as give an account of the changes that have occurred in the past decade. It also examines a number of household and socio-economic indicators in an attempt to uncover the key determinants of obesity.

1. Introduction

The global and persistent rise in obesity has generated enormous popular interest and policy concern in developing countries, where it is rapidly becoming a major public health problem. According to the World Health Organisation (WHO) an individual who is overweight or obese is defined as someone with abnormal or excessive fat accumulation that may impair health. The WHO reports that the global incidence of obesity has more than doubled since 1980. As a result, economists have dedicated substantial resources to try and understand this phenomenon and uncover its leading determinants.

Many developing countries are undergoing rapid socio-economic and nutritional transitions and find themselves having to deal with the upsurge in obesity and its accompanying non-communicable diseases as well as the long-standing challenge of infectious diseases and child malnutrition, leading to what some have called a 'double burden of disease' (Puone, Steyn, Laubscher, Lambert, Mbananga 2002; Popkin and Doak 1998; Prentice, 2005; Uauy Albala and Kain, 2001; Kruger, Puoane, Senekal and van der Merwe 2005). A recent study by the WHO (WHO, 2004) has revealed an increasing prevalence in overweight and obese individuals in these nations, particularly in urban areas. Lifestyle and dietary changes are considered the crucial contributory factors that explain this rise.

In developed countries such as the United States, the prevalence of obesity has reached epidemic proportions, with just over a third of the adult population being classified as obese (Cutler, Edward and Shapiro 2003). Obesity presents a number of health and economic challenges. It is most commonly associated with a rise in non-communicable diseases and chronic illnesses such as diabetes and hyper tension (WHO 2004; Malhotra, Hoyo, Østbye, Hughes, Schwartz, Tsolekile, Zulu, Puoane 2008).

The emerging black middle class, the rise of urbanisation and the widening socio-economic gap in South Africa are all indications that the country has undergone a major transition and that the country might be characterised by persistent levels of child malnutrition and an increasing level of adult obesity. South Africa, like many other developing countries is experiencing an increase in the prevalence of obesity than it was before (Van de Merwe and Pepper 2006). In fact, Ardington and Case (2009) report that after HIV and AIDS, the largest threat to health in South Africa is chronic diseases associated with obesity. This is especially so among black South African women, who have a very high prevalence rate of obesity. Kruger (2002) suggests that many black South African women do not want to lose weight because obesity is culturally and aesthetically looked upon with far less disfavour in black women than it is in white women**.**

In this paper, I will attempt to uncover the major economic determinants of body mass. More specifically, this paper will be concerned with assessing the effects of income on BMI between white and black South Africans. In his paper "The Weight of Success" Wittenberg (2005) using the 1998 Demographic and Health Survey (DHS) found that BMI increased more or less monotonically with income among black South Africans while white South Africans saw their BMI fall with income. These results may or may not change rapidly over time, however it would be interesting to assess whether or not there have been any changes at all. To this end, this paper replicates as far as possible the analysis in Wittenberg (2005). Furthermore, we will try to establish whether or not there is a strong gender component to these relationships. Black women as a whole have been observed to gain weight quite rapidly, while white women on the other hand, prefer to stay in shape, particularly at high income levels (Wittenberg 2005; Goedecke, Jennings and Lambert 2005). The methodology used in this paper will closely follow that of Wittenberg (2005).

The paper consists of 6 sections. The following section will provide a literary overview of the work that has already been done to try and understand the rising trends in obesity, particularly among South African women. Section 3 will then outline the methodology that will be adopted throughout the paper. Detailed Summary statistics will be provided in Section 4 as well as lengthy discussion on some of the findings made in the paper. Section 5 will then explore the state of under 5 child nutrition in South Africa and determine whether or not there have been any changes by comparing the NIDS results to the 1993 Project for Statistics on Living Standards and Development (PSLSD), which was the last study to collect anthropometric measures for children. Section 6 contains conclusions and alludes to the limitations of the methodology used in this paper.

2. Literature Review

Once considered a high-income country problem, obesity is now on the rise in low and middle-income countries, particularly in urban areas (Prentice 2005; Kruger et al 2005). Much has been written about the rising prevalence rates of obesity and its causes. This literature review will highlight and summarize the most salient points that have been discussed in the past as well as bring to light the major reasons for the high prevalence of obesity among black South African women.

The fundamental cause of obesity is an energy imbalance between the amount of calories consumed and calories expended (WHO 2004, Goedeckea Jennings and Lambert 2005). Dietary and lifestyle changes, technological changes as well as lowered food prices are but some of the reasons that have been cited for the observed increase in the rise in obesity. Many individuals now consume foods that are high in sugar/carbohydrates/fats and that are energy dense, particularly in poorer countries and low income groups because these foods tend to be much cheaper (WHO 2004, Kruger Puoane Senekal Merwe, 2005; Zere and McIntyre, 2003). In conjunction with very little physical activity, these diets have led to a sharp increase in obesity. This is especially relevant in South Africa where rapid urbanisation has been associated with the adoption of a more Western diet (Zere and McIntyre, 2003). Many South Africans, especially black South Africans have abandoned their traditional diets which consist of legumes and proteins as well as changed their activity patterns to fit an industrialised country model (Bourne, Lambert, and Steyn 2002).

From an economic perspective, the rise in obesity can be attributed to the changes in the prices of consuming and expending calories that have been brought about through technological change (Lakdawalla, Darius and Thomson 2002; Cutler, Glaeser and Shapiro 1994; Chou Grossman and Saffer 2003). Innovation in agriculture has significantly reduced the time and resources necessary to produce food, and has improved agricultural productivity significantly. This has led most countries to re-allocate resources from agricultural economies to those based on manufacturing and services. This re-allocation of resources led to technological advances in other forms of production, and the move from manual to more automated processes meant that exercise was no longer a by-product of work. Therefore, while food has become cheaper, exercise in turn has become more expensive because work has become less physically demanding through technologies that raise productivity and lower

calorie spending (Lakdawalla, 2002). Because people must now pay for undertaking, rather than be paid to undertake physical exercise, people engage in less physical activity.
An alternative view of the effects of technological change is provided by Cutler et al (1994) who propose a theory based on the division of labour in food preparation. Whereas previously families and individuals were responsible for their own food preparation, technological innovations have enabled food manufacturers to cook food centrally and ship it to consumers for rapid consumption. Through mass preparation, the time cost of food preparation can be shared over a wide range of consumers, thereby decreasing the cost. They therefore argue that the shift from individual to mass preparation has lowered the time price of the cost of food, which in turn has led to more frequent food consumption of greater variety, and therefore higher body mass.

Chou et al (2003) analysed the extent to which relative price changes determine the variation in body mass. Their findings are that body mass tends to rise with lower relative food prices at home, lower relative prices of convenience foods and full service restaurants and higher relative prices of smoking. The rationale behind these results is that the value of time has changed considerably over the years, particularly for women, as reflected in their increased labour force participation rates and longer working hours. This has led to a reduction in the amount of time they spend at home, and this in turn has led to an increase in their demand for convenience food. As the demand for convenience food grew, fast food became increasing available reducing the search and travel time as well as the relative cost of costs of meals consumed in restaurants. Lastly, the rise in the real cost of cigarette smoking contributed to the increase in obesity.

Other variables which have been found to be positively related with body mass are education and age (Kruger et al 2005; Goedecke et al 2005). Income has been found to be positively related to body mass across countries, and negatively associated with weight within countries (Philipson and Posner 1999). In developing countries, obesity increases with income whereas it decreases with income in high income countries, particularly among women (Uauy et al 2001). Wittenberg (2005) says that this suggest that the relationship between income and weight is non-monotonic, increasing with income at low levels, but decreasing at higher levels. This hypothesis of a non-monotonic relationship between weight and income is supported by Philipson and Posner (1999) who argue that health/preferred weight is likely to be a normal good. This means that for poor, underweight people income growth leads to more food consumption and a drive to increase weight, while among well-off, overweight people income growth might lead to weight loss as people invest resources on striving to attain their ideal weight. Because of the high inequality in South Africa, both the within and across effects of income have been observed, particularly for women.

The last and perhaps the most important determinant of body mass is social attitudes/cultural perceptions. The problem of obesity among black women is well established and it can be attributed to their traditional and cultural perceptions regarding body size. The prevalence of obesity among black women in South Africa parallels that of the United States, with over 50% of South African women classified as overweight or obese (Puone et al 2002; Wittenberg 2005). Mvo, Dick and Steyn (1999) found that being overweight has many positive connotations in the African Community. It is often perceived to reflect affluence and happiness. Furthermore, a larger body size is thought by many to reflect a person who is beautiful, healthy and is not infected with HIV/AIDS (Puone et al 2002). Many scholars find that compounding to the problem is the perception of benign obesity (van de Merwe and Pepper 2006; Kruger et al 2005; Goedecke et al 2005). Previously it was thought that because there was no apparent association between obesity and ischaemic heart disease (IHD) or an artherogenic lipid profile (dyslipidoemia) obesity in black South Africans was without consequence. However these studies were done without considering the correlation between obesity and other co-morbid diseases such as diabetes, which have recently been found to have a high prevalence rate among black women. This misconception was paramount in establishing the concept of benign/healthy obesity among black women. Furthermore, Wittenberg (2005) alongside other scholars has found that many South African women have poor perceptions of their body mass. Wittenberg (2005) found that white women are very quick to classify themselves as overweight, while black women classified themselves as underweight, even at high BMI levels. Goedecke Jennings and Lambert (2005), suggest that the racial difference in body image perception could stem from adolescence as the ideal body size desired by white girls was significantly smaller than that of black girls. Furthermore, it was found that this incorrect perception of body weight was related to lower levels of education, with low levels of education associated with high levels of BMI among black women (Goedecke et al 2005). Lastly, the THUSA study, aimed at understanding the determinants of obesity among black women in the North West Province, found physical inactivity to be the greatest determinant of obesity among black women (Kruger et al).

3. Data and Methodology

The data that was used for this paper comes from the first wave (2008) of the National Income Dynamics study (NIDS). NIDS is a nationally representative household survey that covers 7305 households and 28 225 individuals. A stratified, two-stage cluster sample design was employed in sampling the households to be included in the base wave. Contrary to Wittenberg (2005) this paper will use weighted estimates since there is some discrepancy between weighted and unweighted estimates, for both the white and black population. In constructing the weights, the sample design as well as household non-response is taken into account, so that the application of the weights makes the sample representative of the general population in terms of its distribution across provinces and its demographic characteristics. All results will be weighted using post stratification weights.

The focus of the empirical work in the paper will be on the Body Mass Index as defined by the weight of an individual (kg) divided by the height (m) squared.

$$\text{BMI} = \frac{weight\ (kg)}{height\ (m)^2}$$

BMI is a measure of the nutritional status of adults. The sample of interest is restricted to individuals of age 20 and older, and those who have a BMI that falls within a range of 15-55 as any values outside of this range are deemed biologically impossible. According to the WHO growth standards, children grow in height until age 19 such that at age 20 variations in BMI are due solely to fluctuations in weight and not height.

WHO classifications are followed for individuals aged 20 and older where an individual with a BMI below 18.5 is classified as underweight, between 18.5 and 24.9 normal weight, between 25 and 29.9 overweight, and above 30 obese.

In order to minimise the potential measurement error in BMI, NIDS enumerators took three measurements of each individual's height and weight. They compared the first two measurements, and if the difference between these two measurements exceeded 1 unit (cm/kg) they had to take a third measurement. In creating the height and weight variable, I followed this procedure and create a new variable (best weight and best height) which incorporated this data collection in the variable. In table 2 we show that the mean absolute difference in the best weight and the first weight measure is 0.017 for weight and 0.01 for height. These results indicate that our variable of interest, BMI is subject to very little measurement error.

Table 2: Mean absolute weight and height differences

Height (m)					
Gender	Black	Coloured	Asian-Indian	White	**Total**
Male	0.023	0.009	0.000	0.000	**0.020**
Female	0.002	0.005	0.000	0.023	**0.003**
Total	**0.010**	**0.007**	**0.000**	**0.013**	**0.010**

Weight (Kg)					
Gender	Black	Coloured	Asian-Indian	White	**Total**
Male	0.011	0.034	0.001	0.039	**0.016**
Female	0.020	0.011	0.000	0.001	**0.017**
Total	**0.016**	**0.020**	**0.001**	**0.018**	**0.017**

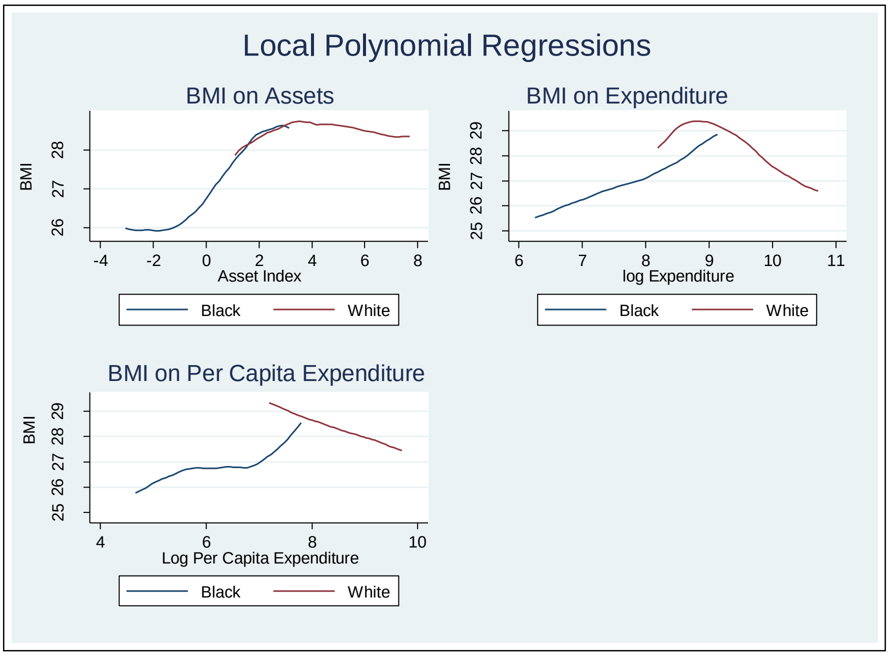
This table reports the mean absolute differences between the variables best weight and bestheight respectively and the first weight and height measurement taken by NIDS enumerators. The mean absolute difference in the best weight and the first weight measure is 0.017 for weight and 0.01 for height. The sample consists of adults aged 20 to 70.

Wittenberg (2005) set out to investigate the relationship between body mass and income among the black population, and encountered a few data problems. The author works with three data sets: The Langeberg Survey, the DHS survey and KIDS. The Langeberg and Kids surveys both have anthropometric as well as socio-economic data, which is necessary to conduct this sort of analysis. However, the chief drawback of both datasets is that they are small, and unrepresentative of the general population. The DHS on the other hand, is a large dataset that is fairly representative and therefore has the power to answer all the questions that were posed earlier. The only drawback of the DHS is that is contains no data on income or expenditure, but only data on assets. This is rather unfortunate since consumption has been widely accepted as a measure of socio-economic status (Deaton 1997).

In order to investigate the relationships stated above, Wittenberg (2005) constructs an asset Index as suggested by Filmer and Pritchet (2001). Filmer and Pritchet (2001) argued that in the absence of information on consumption expenditure, one can construct a linear asset index which proxies for socio-economic status just as well as expenditure using a technique called Principal Component Analysis (PCA). Principal component analysis is a technique to extract from a set of variables, those few orthogonal (uncorrelated) linear combinations of the variables that capture the common information most successfully (that account for the maximum variance). The first factor accounts for the maximum possible of the total variance. The crucial assumption underlying this procedure is that household long run wealth explains the maximum variance in the asset variables. Thus, the asset index is constructed by extracting the first principal component from all the available asset variables. I standardised all the asset variables to each have a mean of zero and a variance of 1 as before doing principal component analysis as is convention (Deaton and Zaidi 1999; Filmer and Pritchet 2001). The chief strength of this method is that it implicitly allocates weights to all the assets in the index, with the variable accounting for the most variance allocated the greatest weight (Filmer and Pritchet 2001).

In the NIDS survey, data is collected on 27 durable assets ranging from motor vehicles to motorised boats. The DHS however, only contains data on 5 assets. The methodology followed by Wittenberg (2005) of constructing the indices separately across datasets is maintained. This means that the indices provide consistent internal rankings, but are not necessarily comparable. The fact that NIDS has data on income and expenditure, enables the measurement of the reliability and performance of the Filmer and Pritchet (2001) asset index, perhaps even more accurately than Wittenberg (2005), as all our data is contained in one dataset. In the analysis, the log of total household expenditure is used as opposed to per capita expenditures which are adjusted for household size because Filmer and Pritchet (2001) found that the asset index classifications fit total expenditure data better than was reported and fits per capita expenditures worse than was reported. Indeed when one looks at figure 1 below, where BMI is graphed against per capita expenditure, it can be seen that the asset index mimics total expenditure much more closely. Following the Filmer and Pritchet (2001) method, I do not adjust the index for household size because the benefits of many of the assets are present at the household level. As many of the conclusions reached by Wittenberg were done so mainly from the DHS survey, the results found in this paper will be largely compared to those found in the DHS.

Figure 1: Regression of BMI on the Asset Index, (log) Expenditure and Per Capita Expenditure



Model Specification

The model we will be estimating is as follows:

$\mathbf{BMI} = \alpha + \beta_1$ *expenditure* + β_2 *employed*+ β_3 *age*+ β_4 *age squared*+ β_5 *years of education*+ β_6 number *of adults in hh* + β_7 *number of children in hh* + β_8 *female* + β_9 *urban* + β_{10} *smoker* + β_{11} *race* +ε

OLS is used to obtain the results. This means that it is assumed that the data is derived from a random sample and that there is no perfect collinearity between variables. Furthermore we assume that the model is linear in its parameters and that the error has a zero conditional mean. These assumptions ensure that our OLS estimators are unbiased. Furthermore, we need to assume that there is no presence of heteroskedasticity. This assumption in addition to the others will ensure that the OLS estimators are the best (smallest variance) linear unbiased estimators. The svy suit of commands adjusts for heteroskedasticity, particularly the effects of clustering thereby ensuring that our standard errors are robust.

4. Results

4.1. Summary Statistics

Table 1: Summary Statistics

variable	All	Black	Black Female	Black Male	White	White Female	White Male
BMI	26.74	26.55	28.62	23.75	27.99	28.46	27.43
	[0.11]	[0.13]	[0.18]	[0.16]	[0.39]	[0.57]	[0.46]
obese	0.26	0.25	0.36	0.11	0.33	0.40	0.25
	[0.01]	[0.01]	[0.01]	[0.01]	[0.04]	[0.05]	[0.04]
overweight	0.26	0.24	0.27	0.20	0.33	0.28	0.38
	[0.01]	[0.01]	[0.01]	[0.01]	[0.04]	[0.04]	[0.05]
age	37.98	36.84	37.65	36.26	44.79	45.01	46.17
	[0.28]	[0.23]	[0.25]	[0.38]	[1.01]	[0.90]	[1.41]
household size	4.83	5.10	5.40	4.48	2.95	2.95	2.86
	[0.14]	[0.16]	[0.15]	[0.18]	[0.08]	[0.09]	[0.11]
years of education	8.86	8.38	8.26	8.40	12.13	11.92	12.43
	[0.11]	[0.09]	[0.10]	[0.11]	[0.26]	[0.27]	[0.32]
household expenditure	5417.31	3214.69	3095.28	3123.45	18000.64	18412.62	16220.06
	[502.75]	[155.89]	[158.59]	[172.49]	[2694.31]	[2633.63]	[1796.17]
household income	6251.35	3893.01	3667.46	4025.85	2066.62	21620.93	20281.89
	[529.10]	[193.43]	[209.31]	[219.86]	[2446.32]	[3109.98]	[2623.81]
index	0.48	-0.30	-0.36	-0.37	4.44	4.39	4.33
	[0.13]	[0.09]	[0.08]	[0.09]	[0.22]	[0.25]	[0.25]
Employed (strict definition)	0.69	0.66	0.57	0.75	0.85	0.78	0.91
	[0.01]	[0.01]	[0.01]	[0.01]	[0.03]	[0.05]	[0.03]
urban	0.63	0.55	0.52	0.55	0.97	0.97	0.97
	0.02	[0.03]	[0.03]	[0.03]	[0.01]	[0.01]	[0.01]
number of adults in household	3.05	3.16	3.16	2.96	2.17	2.08	2.10
	[0.08]	[0.09]	[0.08]	[0.10]	[0.08]	[0.07]	[0.08]
Number of children in household	2.42	2.53	2.57	2.45	1.54	1.56	1.47
	[0.06]	[0.07]	[0.06]	[0.09]	[0.07]	[0.07]	[0.10]

smoker	0.21	0.16	0.04	0.32	0.37	0.29	0.46
	[0.01]	[0.01]	[0.00]	[0.01]	[0.03]	[0.03]	[0.05]
female	0.56	0.56			0.55		
	[0.01]	[0.01]			[0.02]		
black	0.78						
	0.02						
coloured	0.09						
	[0.02]						
asian-indian	0.03						
	[0.01]						
n	**10146**	**8004**	**4955**	**3049**	**553**	**313**	**240**

This sample consists of adults aged 20 to 70. The table reports summary statistics for key variables of interest. The results are weighted using post-stratification weights. Robust standard errors are reported in parenthesis. Standard errors are corrected for clustering. The sample all refers to all south African adults aged 20 to 70. The table is a replication of Wittenberg (2005).

BMI

Table 1 allows better perspective of the distribution of the data. As previously mentioned, the variable of interest is BMI. The average BMI figures in NIDS are about 1 unit higher than those in the DHS for all sub-samples, with white women seeing the greatest increase in their BMI. The overall BMI average increased from 25.9 to 26.7, and white women saw an increase in their BMI from 27 to 28.5, a 1.5 unit increase. This suggests that South Africans are possibly getting larger. The incidence of obesity (BMI>30) has increased by roughly 4 percentage points to 26.4% and the prevalence of obesity is highest among white women (40%). This is an unexpected result, since this group of women are often thought of as being relatively slim. This could possibly be due to the high urbanisation rates of white women, with 97% of them residing in urban areas as opposed to 52% of black women. A more detailed discussion about other possible reasons will be provided in later sections. Black women saw a 4percentage point increase in their prevalence of obesity, from 32% to 36%.

Age

It is interesting to note that the average age of individuals sampled in NIDS is slightly smaller than that of individuals sampled in the DHS, with the two samples averaging 40.0 and 41.7 respectively. Furthermore, the black population is much younger than the white population with an average age of 35 years in contrast to an average age of 47 years for the white sample, with black males being the youngest. This age difference is most likely attributable to the low life expectancy among blacks (especially black males) due to HIV/AIDS. (Tanser Hosegood Bärnighausen Herbst Nyirenda Muhwava Newell Viljoen Mutevedzi and Newell 2007). The fact that the white sub-population is relatively older than the black-subsample could explain why they have higher BMI values on average, since body mass tends to increase with age.

Years of Education

The average number of years of education has increased to 8.86 years from 7.4 in the DHS. This level of education is almost twice that of the Langeberg and the KIDS survey. This translates to a one unit increase across the population, with white males being the most educated. White individuals are more educated than black individuals on average and black females are the least educated.

Household characteristics

The NIDS data is very similar to the DHS where certain variables are concerned. Average household sizes have remained the same across both datasets however; the composition of white households seems to have changed quite dramatically. These households now have relatively fewer adults and significantly more children. The average white household has gone from 2.6 adults and 0.6 children to 2.17 adults and 1.56 children. Another similarity between the datasets is that they are both of a similar size, with the number of observations just over 10 000 for both datasets. However, it is quite misleading to look at the total figure, because the sample sizes of the different subgroups are quite different. The black population accounts for 8004 of these observations and the white population a mere 553. More specifically, white females account for 313 of these observations and white men 240. The DHS had a white sample size that is almost double the size of NIDS (915) with white females accounting for 497 observations and white men 418. This small sample size coupled with high non-response rates in the white population, and high rates of missing BMI data calls for caution in the interpretations of findings for this subpopulation. Ardington and Case(2009),using NIDS found that those respondents living in urban areas, wealthier households and with more education were more likely to have missing anthropometric measurements and this could bias our results.

Employment

Using the strict definition of unemployment, on average 69% of individuals interviewed were employed at the time the survey was conducted. Black individuals enjoy relatively lower levels of employment as compared to white South Africans, with 66% of the black population employed as compared to 85% of white individuals. Black women have the lowest levels of employment, and with only 9% of white men being unemployed, this sub-sample of individuals enjoys the highest levels of employment. These rankings are consistent with those found in Wittenberg (2005); however the levels of employment recorded in NIDS are noticeably higher than those of the DHS and KIDS, particularly among the black sub-sample which recorded very low levels of employment. This growth in employment is largely due to the robust growth that the economy experienced from early 2000 to 2007 (Hodge, 2009).

Race and Gender

The demographic breakdown of the NIDS survey closely resemble those of the population (Wittenberg 2009) and are far more representative than those of the DHS and this is possibly due to the fact that Wittenberg (2005) used unweighted means. Black South Africans are in the majority, making up 78% of the population in NIDS and 73% of the population in the DHS. The coloured population sits at about 9% of the population, as compared to 14% in the DHS, with the Asian-Indian subpopulation constituting a mere 3% of the population. South Africa has far more females than males, with females making up 57% of the population.

Smoking

Average smoking rates have decreased by 9%, with 21% of individuals identifying themselves as smokers. The black population seems to contribute to this apparent decrease in smoking rates since they are the only race that has decreased their cigarette consumption. The proportion of black men who smoke has decreased from 50% to 32%. The proportion of both white men and women who smoke has increased by 6 percentage points.

Socio Economic Status

The stark difference in socio economic status between black and white South Africans is confirmed by all three (expenditure, index, income). Black people have an average household expenditure of R3212.69 compared to R18 000.64 for white people and this difference in expenditure is significant. The average white household expenditure is about six times that of the average black household. White expenditures are far above the mean while black expenditures are below it. White women have the highest household expenditure and black women have the lowest.

A Further Analysis of Obesity Rates among White Women

The incidence of obesity among white women is unexpectedly high. Forty percent of all white women are obese, compared to just 36% of women in the black population. Upon further inspection, it seems as if though urbanisation is the best explanation for this high incidence of obesity among white women. Indeed when one looks at Figure 2, they can see that the distribution of BMI for urban individuals lies slightly to the right of that of rural individuals. This result confirms the hypothesis that individuals who live in urban areas have higher BMI due to high dietary energy and fat intake (Goedecke et al 2005).

Figure 2: Distribution of Body Mass by geographic Location

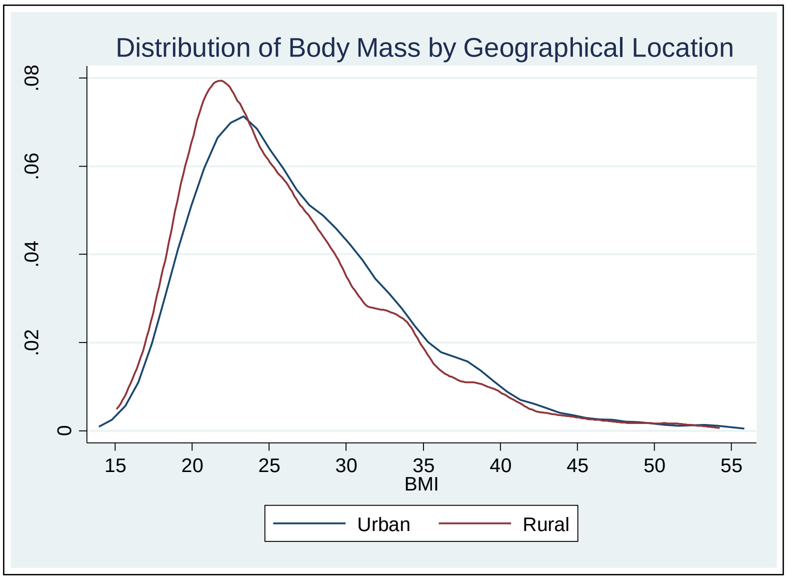


Table 3: Distribution of age among women						
Age Group	**20-29**	**30-39**	**40-49**	**50-59**	**60-70**	**n**
White women	0.18	0.19	0.23	0.22	0.19	437
Black Women	0.34	0.27	0.17	0.13	0.08	5623

The disparity in age among black and white females is quite large with White females having an average age of 45 years compared to just 37 years for black women. This age difference is significant at the 1% level and confirms that the distribution of age among white and black women is very different. When one looks at table 3 above it is clear that the white female population consists mainly of older women, while that of black women consists mainly of younger women.

In fact, from table 3 we see that over 62.5 % of black women are between the ages of 20-39 while 63.2% of white women are between the ages of 40-70. The difference in this age distribution could be a plausible reason for the high incidence of obesity among white women. This means that we are likely to find that the population of white women is characterised by old white women who have a high BMI and this could be distorting our obesity rates.

Table 4: Distribution of BMI by age group among women						
Age Group	**20-29**	**30-39**	**40-49**	**50-59**	**60-70**	**n**
Obese						
Whitewomen	0.13	0.13	0.23	0.30	0.21	313
Black Women	0.19	0.27	0.24	0.18	0.11	4955
Overweight						
Whitewomen	0.08	0.29	0.30	0.19	0.14	313
Black Women	0.36	0.29	0.15	0.11	0.08	4955

This table looks at the distribution of the prevalence of obesity and overweight across the entire femalepopulation by race and gender. All women in these samples are aged 20 to 70. The results are weighted using post stratification weights. BMI is used to classify individuals. For example, of all white women that are obese, 30% are between the ages of 50 to 59.

Upon further inspection (table 4), we find that the majority of white women who are obese are relatively old, with 74% of all white women who are obese falling in the range of 40-70 years. In light of the fact that over 50% of all white women who are obese fall between the ages of 50-70, compared to just 29% among black women, it might be better to exclude these old women when calculating obesity rates. This will allow us to get a better understanding of the incidence of obesity among a more youthful cohort of women. If we restrict our sample to women between the ages of 20-50, the incidence of obesity falls from 40% to 32% among white women, and this difference is significant at the 5% level. This is an indication of the fact that the batch of obese old women distorted the rates of obesity among white women. The decrease in obesity rates for black women was much smaller, falling only by 3 percentage points from 36% to 33%. Among the restricted subset of women (i.e. 20-50), black women have the highest rate of obesity as to be expected. Given this apparent relationship between BMI and age, it is not informative to compare the prevalence rate of obesity among population groups without first controlling for age.

4.2. Data Distribution

BMI by Race

Figure 3: Distribution of Body Mass by race

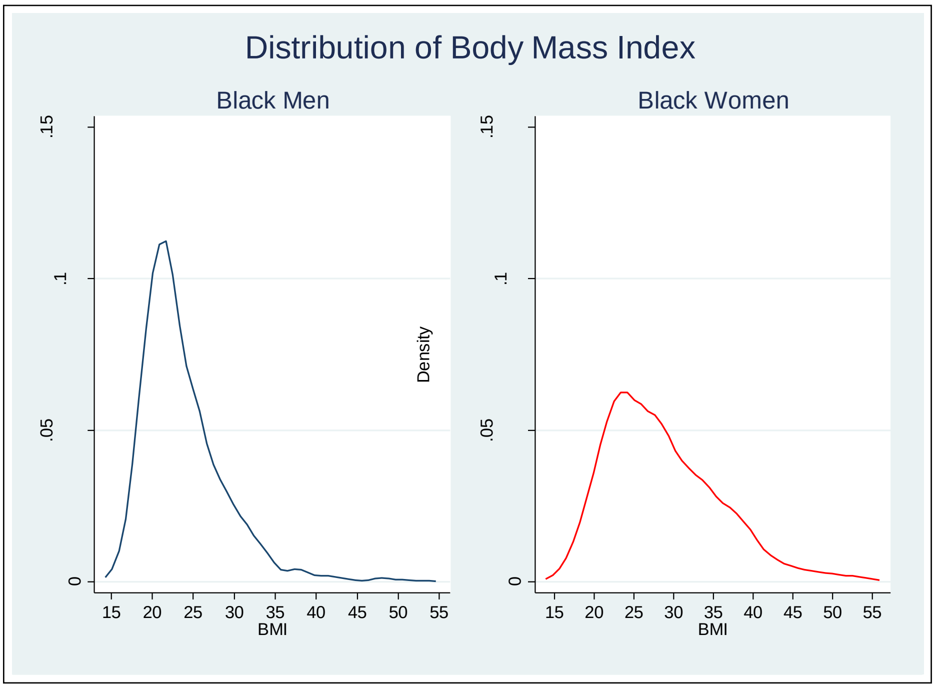
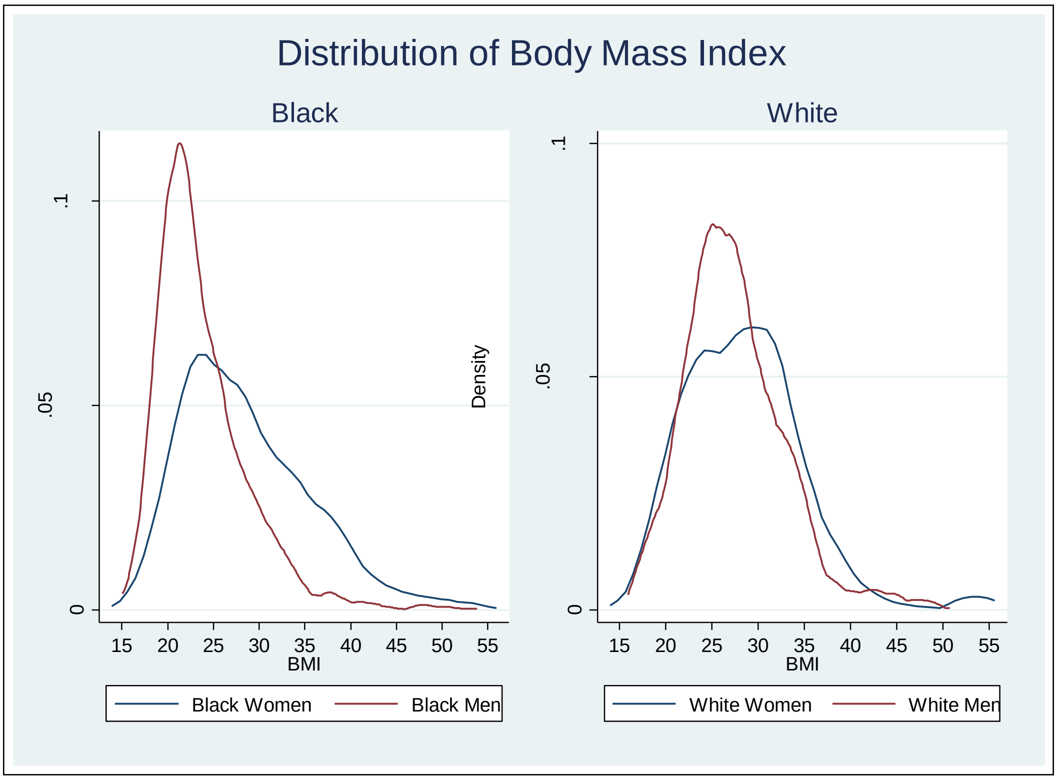


Figure 3, which is a replication of Wittenberg (2005) provides a comparison of the distribution of body mass across the black sub-population. It indicates that the mode for black men is much higher than that for black women. Furthermore the distribution of BMI for black men is slightly skewed to the right with most of the observations lying within a range of 15 and 35, while that of women covers a wider range. The mean BMI for black men is 23.5 and that of women is 28.6 which to be expected since the upper tail of the women's distribution extends beyond that of men. It can be read that black women on average, are much heavier than black men. This finding is consistent with that of Wittenberg (2005) where black women displayed a body mass higher than that of black men across all three samples that he analysed. The data also followed a similar distribution, with the exception of KIDS, where the data was right-shifted for both black men and women. So since 1998 there hasn't been significant change in BMI for blacks.

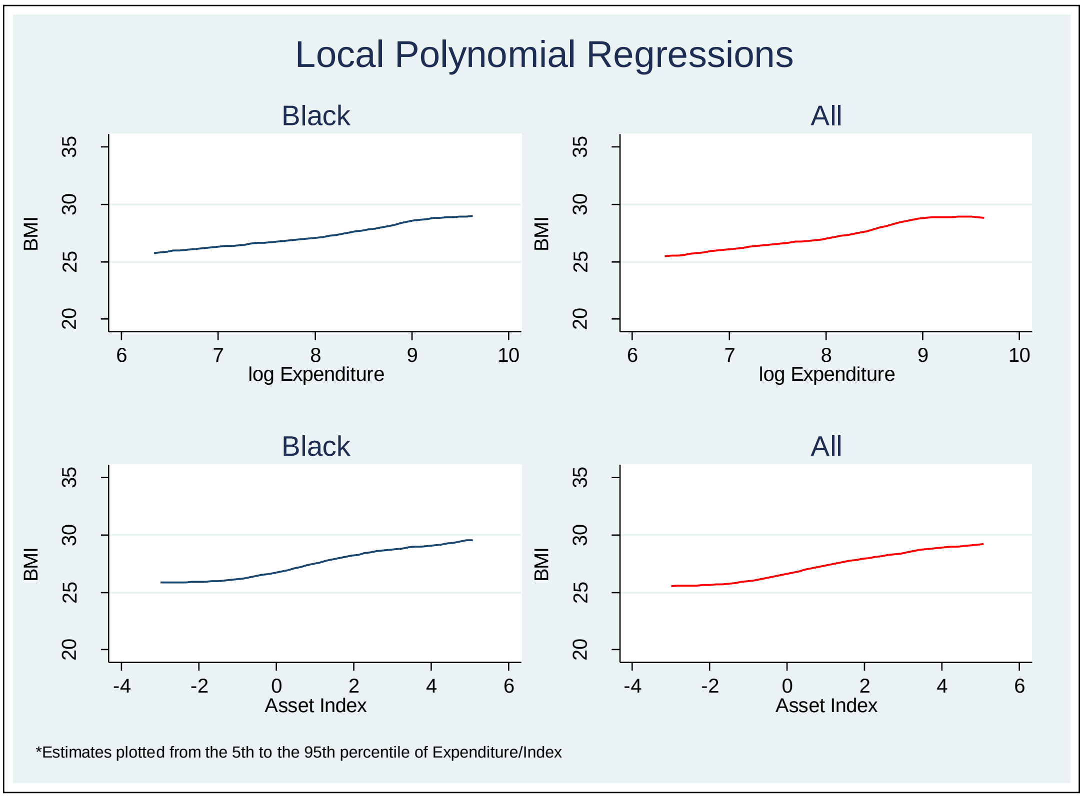
Figure 4: Distribution of BMI by Race and Gender



I further analysed the distribution of body mass in both the white and black sub-populations by analysing figure 4, also a replication of Wittenberg (2005). The mean of the BMI distribution is higher for white men than for white women with black men displaying the highest mode. It is interesting to note that the distributions of body mass for the white subpopulation are slightly more symmetric than those of the black population and the difference in the peaks is not as defined as in the black population. The mean BMI for white males and females and is 27.4 and 28.5 respectively. The fact that white women have a higher BMI than white men is supported by the fact that the distribution of their BMI lies to the right of that of white men. The distribution of BMI for white males lies further to the right when compared to that of black men. This suggests that on average white males are noticeably heavier than black males, a result which is consistent with that of the DHS. Furthermore, on average white females are lighter than black females, but only marginally so. Black men are light, when compared to the other three subgroups mainly due to the effect of HIV/AIDS.

BMI by Socio Economic Status (Expenditure and Asset Index)

Figure 5: Relationship between body mass and affluence

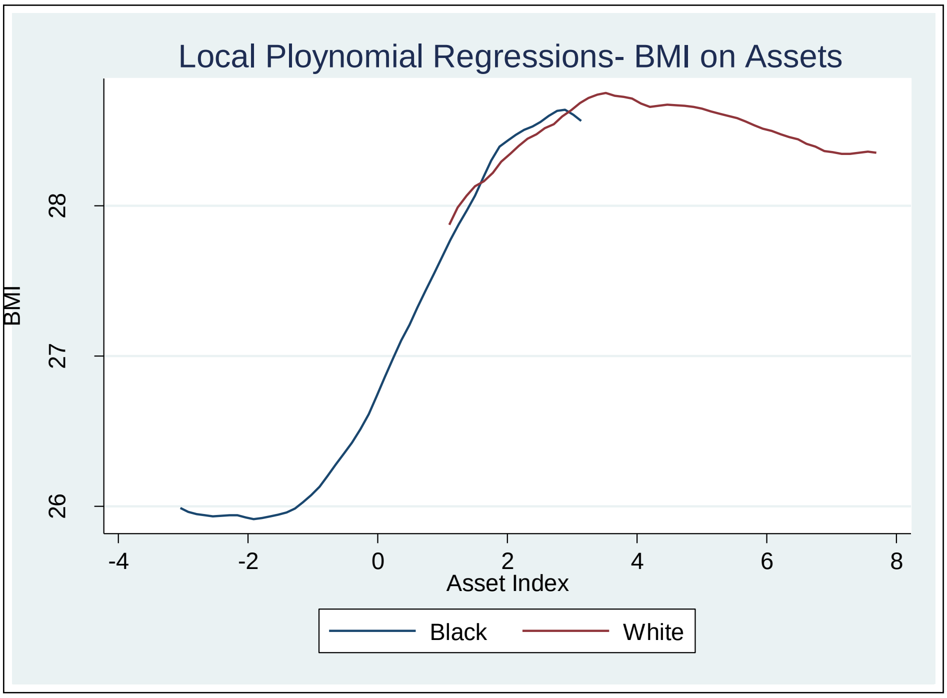


The series of graphs above provide a useful starting point to start exploring the relationship between BMI and a few socio-economic factors. Figure 5 (a replication of Wittenberg 2005) above plots the relationship between body mass and socio-economic factors, as indicated by log expenditure and the asset Index. The model used to estimate this relationship is:

$BMI = \alpha + \beta_1$ *Socio-Economic Status*

An interesting feature of the graphs is that the relationship between BMI and the index seems to display a linear trend. However, the relationship with expenditure seems to flatten for wealthy individuals. This suggests that a turning point in body weight for wealthy individuals, both black and white may be seen. This is an interesting result as it may suggest that body mass may not increase monotonically with income among the black sub-population, indicating a shift in the mind-set of wealthy black individuals towards body weight. Furthermore, the expenditure variable and asset index provide similar results, as is the case in Wittenberg (2005). The only difference between 1999 and 2008 is that the expenditure graph suggests a reduction in body mass for wealthy black individuals. Given the small sample size of the white population, we cannot make any inferences.

Figure 6: Local Polynomial Regressions: BMI on Asset Index

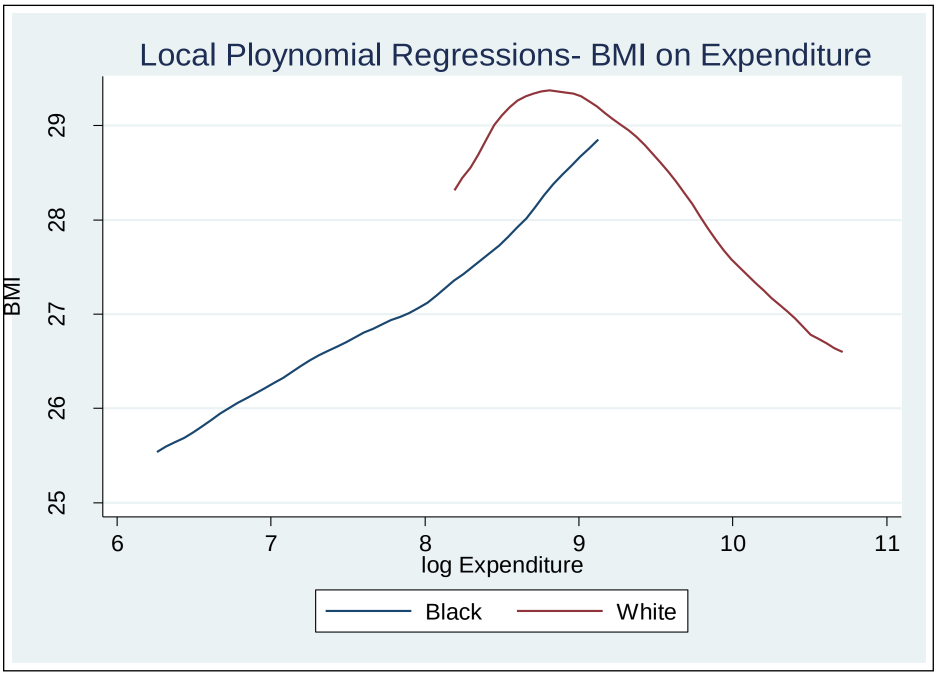


To further investigate the relationship between body mass and socio-economic status we replicated Figure 6 (Wittenberg 2005) which is constructed by plotting BMI for black and white individuals from the 5th to the 95th percentile of each subsample's asset distribution. One cannot help but immediately notice that the 5th percentile of the white sub-population lies far beyond that of the black sub-population. This can be attributed to the fact that white individuals were afforded more economic opportunities than black individuals under Apartheid and therefore have a higher standard of living than black people. Furthermore, as in Wittenberg (2005), the plot suggests that there may exist a turning point in body mass at high income levels i.e. that people tend to lose body mass as income rises.

Another interesting feature of this graph is that the opposite seems to happen at the bottom end of the asset distribution. At very low levels of income, individuals lose body mass, up until a certain point, where body mass increases with body weight. The strength of these results of course, lies in the reliability of the asset index as a proxy for socio-economic status and its ability to differentiate individuals at the two extremes from one another.

The chief strength of the NIDS data set is that it possible to repeat the same exercise as above using expenditure, which is a far more direct and accurate measure of socio-economic status. Figure 7, like figure 6, supports our hypothesis that body mass increases monotonically with income among the black subpopulation.

Figure 7: Local Polynomial Regressions: BMI on Expenditure



BMI by Race, Age and Gender

Figure 8: The relationship between BMI and Age by Race and Gender

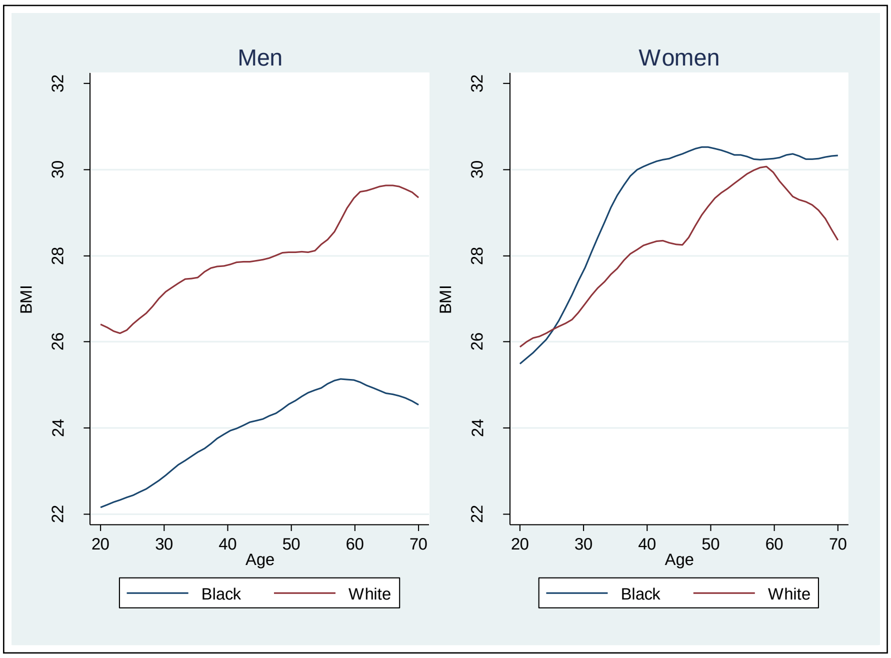


Figure 8 plots the relationship between BMI and age, by race and gender. From the graph, one can see that body mass increases at a decreasing rate with age, until it reaches a maximum at age 57, after which it starts to decrease. Furthermore, it appears as if BMI increases more steeply with age for women than for men, especially for black women. These findings are consistent with those found in figure 2 and Wittenberg (2005) again implying no change over time. It is therefore going to be crucial to control for age when doing the analysis on the correlates of BMI.

4.3. Determining the reliability of the Asset Index

Table 4: Comparing the performance of the asset index

	(1)	(2)	(3)
Dependent Variable: BMI	**Index**	**Expenditure**	**Income**
employed	0.768***	0.639***	0.702***
	(0.244)	(0.241)	(0.254)
age	0.405***	0.401***	0.423***
	(0.076)	(0.076)	(0.075)
age squared	-0.003***	-0.003***	-0.003***
	(0.000)	(0.000)	(0.000)
years of completed education	0.0202	-0.00343	0.0511
	(0.046)	(0.043)	(0.044)
Socio-economic status	0.322***	0.846***	0.368*
	(0.087)	(0.198)	(0.189)
number of adults in household	0.104	0.0284	0.0609
	(0.084)	(0.084)	(0.092)
number of children in household	-0.151*	-0.165**	-0.163*
	(0.088)	(0.083)	(0.084)
Female	4.207***	4.195***	4.227***
	(0.329)	(0.324)	(0.318)
urban	0.805***	0.769***	0.994***
	(0.303)	(0.296)	(0.313)
smoker	-2.122***	-2.171***	-2.191***
	(0.299)	(0.292)	(0.298)
black	-0.162	0.263	-0.395
	(1.073)	(1.127)	(1.047)
coloured	-1.111	-0.465	-0.942
	(1.016)	(1.076)	(1.017)
Asian-Indian	-3.415**	-2.691*	-2.702*
	(1.342)	(1.456)	(1.425)

_cons	14.020***	7.725***	10.660***
	(2.007)	(2.354)	(2.234)
N	4409	4678	4678
R-squared	0.221	0.224	0.217

*The sample includes adults aged 20 to 70. This table compares the performance of the asset index against other measures of socio-economic status. I control for personal and other socio-economic variables. The asset index underestimates the expenditure effect. Standard errors are reported in parenthesis. They are corrected for clustering. Significant at *10, **5%, ***1%.*

In order to assess the effect of expenditure, income and the asset index, BMI is regressed separately on these variables in table 4, while controlling for household and personal characteristics. The coefficient on expenditure suggests that a standard deviation increase in log expenditure will increase BMI by 0.85 units. The coefficient of 0.32 on the asset index is much smaller than that of expenditure. This result is to be expected and Wittenberg (2005) argues that the first principal component, is likely to extract some noise, and may therefore suffer from some attenuation bias. This is because the measurement error in the asset index may lead to a downward bias in the OLS estimate. Furthermore Wittenberg (2005) argues that because the distribution of the asset index is different to that of expenditure, the effects on a one standard deviation in each variable should have a different effect on BMI.

I also look at the coefficient on income. Like the asset index, this variable is likely to extract some noise since income is not the best measure of an individual's standard of living as it does not reflect the net resources available to individuals (Deaton, 1997). Only 26 out of 7305 household reported zero income as compared to 22% of all individuals in Wittenberg (2005), therefore this group will not have a material impact on the results. The coefficient on income is 0.37, which is over 50% smaller than that on expenditure. This coefficient is fairly similar to that of the asset index.

Wittenberg (2005) finds the coefficient on expenditure to be 1.35 in the Langeberg Survey and 1.55 in the KIDS survey. These coefficients are both larger than my estimate. This could suggest that the effect of expenditure on BMI has decreased over the years. In the Langeberg Survey, the coefficient on the asset index was larger than the expenditure index and smaller than the asset index in the KIDS Survey. In both datasets, Wittenberg (2005) found the coefficient on income underestimates the true effect, assuming that expenditure is the true effect.

One must note that the coefficients on all the other covariates (excluding number of adults and black) are very similar, suggesting that these measures will not distort the conclusions that one can draw from the regressions. Furthermore, the correlation between the asset index and expenditure is 0.76 which indicates that they are highly correlated and should therefore be measuring the same thing. I can therefore conclude that the Filmer and Pritchet (2001) asset index works well in proxying for expenditure, although the magnitude of the coefficient is smaller than that of expenditure.

4.4. Correlates of BMI

It is worth examining the coefficients on the other variables in table 4. From this table, it is clear that gender is the single most important determinant of BMI. Across all indicators (expenditure, asset index, income) the coefficient on female of 4.2 is the largest. This result is highly plausible, given that the highest incidence of obesity is indeed found among women.

Other variables that are found to be positively correlated with BMI are age, urban, and employment while smoking is negatively correlated with BMI. The coefficient on age (using asset index) is 0.4 and that on urban is 0.1. These figures are very similar to those of Wittenberg (2005) who finds a coefficient of 0.38 and 0.7 for age and urban respectively, in the KIDS dataset and similar results in the Langeberg survey. The coefficient on employed is 0.76, which is higher than the 0.21 found by Wittenberg in the KIDS survey. The reason for this difference is the disparity in employment rates between NIDs and KIDS. The average employment level in NIDS is 70% roughly twice that of KIDS, which is 38%. This is largely due to the strong growth the economy experienced between 2000 and 2007 (Hodge 2009).

The coefficient on smoker is -2.12, suggesting that smoking leads to a 2.12 unit decrease in BMI. Smoking suppresses appetite and therefore leads to one eating less. The effects of household size, as proxied by the number of adults and the number of children as well as race have been found to be statistically insignificant. This suggests that the distribution of resources in the household does not play a significant role in determining an individual's body mass or that it is not the most important determinant of BMI.

Thus far in the analysis I have pooled all individuals across race and gender. Wittenberg (2005) finds that this sort of pooling may distort certain underlying relationships. In light of the fact that this paper is interested in determining the effect of certain variables on race and gender, it critical to assess how these variables relate to one another across these different subpopulations.

4.4.1. Racial and Gender Differences

Again, I highlight the fact that the small sample size of the white population (153), coupled with high non-response rates and high levels of missing data, are all reasons to be cautious with our interpretations.

Looking at table 5 (see appendix), it is clear that some correlates have a different relationship across the different races. While gender is a significant determinant of BMI, its effect differs across races. The coefficient on gender of 4.8 for blacks and 2.8 for whites indicates that black women are on average heavier than white women. Furthermore, the negative correlation between BMI and smoking is stronger in the white population.

Table 6, allows us to further explore the correlates of BMI across race and gender. It is interesting to note that the effect of location differs significantly between black and white women. White women gain weight more rapidly when living in urban areas as compared to black women. In fact it seems that location is by far the single most important determinant of body mass among white women. The coefficient of 5.3 (the highest observed thus far), tells us that women who reside in urban areas have a BMI that is 5 units higher than those who reside in rural areas. Lastly the relationship between BMI and expenditure is positive among the black population, but changes sign in the black population.

Furthermore, while the number of adults is positively associated with BMI in the white population, the number of children is negatively associated with BMI in the black population, particularly for black women. The negative coefficient on the number of children could be indicative of the fact that black women are often left to care for many children and therefore have to share their resources among them (Duflo 2003). Within the black population, the number of adults has differing effects across genders. The number of adults in the household was found to have a positive effect on BMI for black women; however this effect is negative among men. Since men are traditionally viewed as breadwinners, they often have to share their resources with their spouses and other household members, leading to them consuming less food, and therefore a lower body mass.

Education decreases BMI in the white population, particularly white women while it is associated with higher BMI in the black population. Obesity is a preventable disease, and knowledge about factors such as nutritional diets and the negative health consequences of obesity could encourage educated white women to keep their weight at a desirable level. This relationship between obesity and the level of education supported by Goedecke et al 2005 who find that low levels of education are associated with high BMI in among the black population, especially among black women.

Table 6: Racial and Gender Differences in the correlates of BMI

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Black Women		**Black Men**		**White Women**		**White Men**	
Dependent Variable: BMI	**FP Index**	**Expenditure**	**FP Index**	**Expenditure**	**FP Index**	**Expenditure**	**FP Index**	**Expenditure**
employed	0.942**	0.782**	0.267	0.317	3.707	0.0905	3.707	1.342
	(0.379)	(0.353)	(0.365)	(0.340)	(3.132)	(2.740)	(3.132)	(2.714)
age	0.522***	0.491***	0.140	0.109	-0.845	0.447	-0.845	0.277
	(0.102)	(0.096)	(0.067)	(0.099)	(0.566)	(0.604)	(0.566)	(0.492)
age squared	-0.004***	-0.004***	0.000	0.000	0.017**	-0.001	0.017**	-0.002
	(0.001)	(0.001)	(0.001)	(0.001)	(0.007)	(0.008)	(0.007)	(0.006)
years of completed education	0.0428	0.0146	0.141**	0.0878	-2.498***	-1.670***	-2.498***	0.471***
	(0.0649)	(0.0641)	(0.0595)	(0.0582)	(0.616)	(0.507)	(0.616)	(0.179)
asset/expenditure	0.352***	1.008***	0.290**	0.902***	0.00181	0.664	0.00181	-1.316*
	(0.125)	(0.267)	(0.116)	(0.252)	(0.443)	(1.762)	(0.443)	(0.767)
number of adults in hh	0.193	0.0828	-0.159**	-0.239***	2.316**	2.909**	2.316**	2.791***
	(0.133)	(0.126)	(0.0798)	(0.0858)	(1.083)	(1.333)	(1.083)	(0.708)
number of children in hh	-0.189	-0.197*	-0.0163	-0.0178	0.0141	-0.339	0.0141	0.953
	(0.123)	(0.118)	(0.121)	(0.119)	(1.344)	(1.270)	(1.344)	(0.742)
urban	1.012**	0.991**	0.482	0.396	4.618***	5.316***	4.618***	-4.406
	(0.467)	(0.442)	(0.430)	(0.417)	(1.443)	(1.339)	(1.443)	(3.751)

smoker	-2.592**	-2.773***	- 1.487***	-1.421***	-3.031*	-4.741*	-3.031*	-2.934***
	(1.067)	(0.892)	(0.311)	(0.298)	(1.718)	(2.540)	(1.718)	(0.821)
_cons	14.83***	8.329***	18.34***	12.86***	58.10***	20.81	58.10***	23.43***
	(2.514)	(2.563)	(2.109)	(2.682)	(15.23)	(16.78)	(15.23)	(8.695)
N	2311	2467	1192	1247	83	91	70	72
R-squared	0.141	0.149	0.184	0.182	0.512	0.383	0.512	0.389

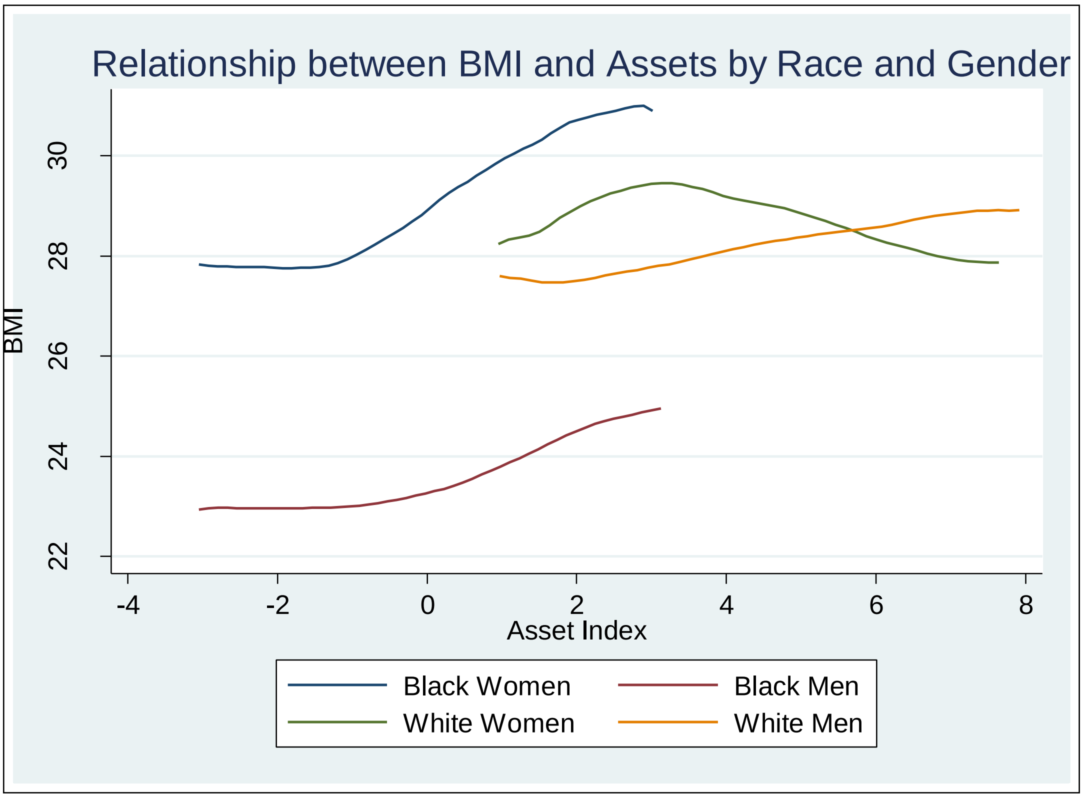
Note: significant at *10, **5%, ***1%

Standard errors in parentheses

4.4.2. Non-Linearity's in the Impact of Assets

It is of interest to us to determine whether or not the relationship between BMI across the population is linear, particularly between the different races and genders. Figure 6 (previous section), suggest that the relationship may be non-monotonic across the entire population, while figure 7 (previous section) suggests that this may be the case only for the white sub-population. The output in table 7 shows that the notion of a common quadratic in income is rejected.

Figure 9: The relationship between BMI and the Asset Index by Race and Gender



In figure 9, it can be seen that that white women may be the only subgroup with a non-monotonic relationship between BMI and income. This turning point is more clearly defined with the use of expenditure as opposed to the asset index. When I turn to the data however, I get conflicting results. In table 7, the asset index and expenditure give us consistent results for the black population. The results for the white population however, are all insignificant, even though the data shows a clear turning point for the white population and white women respectively. The small sample size of the white population could explain these results as already mentioned. The white population as a whole has 153 observations, compared to 3503 for the black population. When one further divides this by gender, the female sample is 83 and the male 70.

For the black population however, even across gender, the quadratic in income is insignificant. We can therefore conclude that BMI increases monotonically with income in the Black population. From figure 9, it seems as if though black women accumulate weight at the fastest rate, particularly at high income levels. White women on the other hand, accumulate weight at the lower end of the income distribution, and then lose it aggressively at higher income levels. Black men accumulate weight at a faster rate than white men.

Table 7: Racial and Gender Non-Linearity's in the impact of assets

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Black Women		**Black Men**		**White Women**		**White Men**	
Dependent Variable: BMI	**Index**	**Expenditure**	**Index**	**Expenditure**	**Index**	**Expenditure**	**Index**	**Expenditure**
employed	0.946**	0.867**	0.264	0.376	3.725	0.350	3.725	1.660
	(0.379)	(0.353)	(0.362)	(0.328)	(3.207)	(2.579)	(3.207)	(2.981)
age	0.525***	0.496***	0.137	0.100	-0.733	0.456	-0.733	0.264
	(0.102)	(0.0973)	(0.0967)	(0.0995)	(0.567)	(0.700)	(0.567)	(0.475)
age squared	-0.004**	-0.003***	0.000	0.000	0.015**	-0.001	0.015**	-0.002
	(0.001)	(0.001)	(0.001)	(0.001)	(0.006)	(0.010)	(0.007)	(0.006)
years of completed education	0.043	0.048	0.138**	0.102*	-2.364***	-1.502***	-2.364***	0.454***
	(0.0650)	(0.0636)	(0.0594)	(0.0562)	(0.617)	(0.571)	(0.617)	(0.170)
socio-economic status	0.369***	0.000**	0.248**	0.000***	0.677	-0.000	0.677	-0.000
	(0.138)	(0.000)	(0.120)	(0.000)	(0.627)	(0.000)	(0.627)	(0.000)
Index/expenditure squared	-0.014	-2.610	0.0280	-7.470*	-0.109	3.370	-0.109	4.540
	(0.034)	(2.190)	(0.0434)	(4.340)	(0.067)	(1.170)	(0.067)	(4.840)
number of adults in household	0.188	0.117	-0.153*	-0.235***	2.452**	2.900**	2.452**	2.789***
	(0.133)	(0.126)	(0.080)	(0.089)	(0.981)	(1.264)	(0.981)	(0.938)
number of children in household	-0.187	-0.177	-0.0170	0.006	-0.191	-0.303	-0.191	0.917
	(0.124)	(0.118)	(0.120)	(0.119)	(1.438)	(1.293)	(1.438)	(0.727)
urban	1.007**	1.137**	0.498	0.431	4.861***	5.574***	4.861***	-4.175

	(0.469)	(0.446)	(0.424)	(0.396)	(1.344)	(1.378)	(1.344)	(3.673)
smoker	-2.585**	-2.837***	-1.480***	-1.380***	-2.531	-4.775*	-2.531	-2.944***
	(1.073)	(0.882)	(0.308)	(0.293)	(1.908)	(2.482)	(1.908)	(0.902)
_cons	14.84***	14.69***	18.29***	18.81***	53.83***	24.71	53.83***	12.21
	(2.510)	(2.317)	(2.106)	(2.066)	(15.060)	(15.960)	(15.060)	(7.790)
N	11222	11378	12137	12192	7390	7398	7390	7537
R-squared	0.141	0.144	0.185	0.180	0.519	0.384	0.519	0.396

The sample includes adults aged 20-70. This table tests whether or not the relationship between BMI and income is monotonic across race and gender. Robust standard errors in parentheses. Standard errors are corrected for clustering. Significant at *10%, **5%, ***1%.

5. Malnutrition in under-five children

Given the rapidity with which traditional diets and lifestyles are changing in many developing countries, it is not uncommon to find child malnutrition and obesity existing side-by-side within the same country, the same community and the same household. Poor nutrition, particularly in the formative years of childhood can have adverse effects on the intellectual development of a child and have negative effects on productivity and earnings of children way into their adulthood often contributing to the inter-generational transmission of poverty (Woolard, Aguero and Carter 2007; Duflo 2003).

This section of the paper seeks to uncover and assess the prevalence rate of under-five child malnutrition (as measured by stunting and wasting) and assess whether there have been any changes over time. The results will be compared to those of Zere and McIntyre (2003) who used the 1993 PSLSD, in which anthropometric measures were taken only for those children under the age of five.

There are a number of ways to assess child nutrition, however anthropometric measures are the most commonly used as they are less subject to measurement error, and are very easy to obtain (de Onis Monteiro Akre Clugston 1993). The anthropometry measures used in the NIDS data are very reliable as each measure was taken three times. Table 8 summarises the mean differences in the measures and it can be seen that the mean differences in height or weight never exceed 0.02 units.

Table 8: Mean Absolute Height and Weight Differences

Year of Birth	Gender: Boys	Girls	Total	Year of Birth	Gender: Boys	Girls	Total
2003	0.012	0.000	0.006	2003	0.005	0.008	0.007
2004	0.004	0.002	0.003	2004	0.000	0.000	0.000
2005	0.000	0.008	0.004	2005	0.000	0.000	0.000
2006	0.011	0.010	0.010	2006	0.000	0.000	0.000
2007	0.018	0.002	0.010	2007	0.000	0.017	0.008
2008	0.000	0.000	0.000	2008	0.000	0.000	0.000
Total	0.007	0.004	0.006		0.001	0.004	0.003
Absolute height differences in centimetres				Absolute weight differences in kilograms			

This table reports the mean absolute differences between the variables best weight and best height respectively and the first weight and height measurement taken by NIDS

Enumerators. The mean absolute difference in the best height and the first height measure 0.006cm and 0.003kg for weight The sample consists of children aged 0 to 60 months

Weight for Height and Height for Age are the most commonly used anthropometric indicators in economic literature to assess child nutritional status (Woolard, Aguero and Carter 2007; Duflo 2003). In order to make meaningful analysis, z-scores for height for age and weight for height are constructed using the WHO international child growth standards as the reference group (WHO 2006). For example the height-for-age Z-score of child "i" is given as:

$$Z - score = \frac{H_{\mathrm{i}} - H_{\mathrm{r}}}{SD\ of\ the\ reference\ group}$$

where, H_i is the height of the child; H_r is the median height of the reference population; and *SD* is the standard deviation of height of the same reference population.

Height for age (stunting) is a measure of long-term/ chronic nutritional as it reflects a process of failure to reach linear growth potential as a result of poor nutrition, while weight for height (wasting) is a measure of short-term/acute malnutrition in the sense that it is more sensitive to temporary food shortages and episodes of illness.

Following WHO guidelines a child is considered stunted or wasted if his or her height for age or weight for height respectively, is more than two standard deviations below the median for the reference group. Furthermore a child is considered severely malnourished if his or her height for age or weight for height respectively, is more than three standard deviations below the median for the reference group. Furthermore using the WHO cut-off points I considered absolute z-scores for height for age greater than 5 and weight for height z-scores greater than 6 biologically impossible and these children were excluded in the analysis that follows.

Table 9: The prevalence of under-five child malnutrition

		Stunting		Wasting	
Age(months)	**N**	**Severe**	**Normal**	**Severe**	**Normal**
(0-5)	13	0	0	0	0
(6-11)	165	4.8	10.3	4.8	10.3
(12-23)	359	11.7	27	1.9	5.6
(24-35)	400	8.3	26.8	1	2
(36-47)	440	6.8	25.2	2	4.3
(48-60)	453	4.4	17	1.5	4.2
All	**1830**	**7.3**	**22.3**	1.9	4.5

		Stunting		Wasting	
	N	**Severe**	**Normal**	**Severe**	**Normal**
Male	895	9.4	25.1	1.6	4.2
Female	935	5	19.4	2.2	4.9

From table 9 above, it is clear that stunting is the most prevalent form of malnutrition in under-five children. Overall, 22.3% of all pre-school children are considered stunted as opposed to 4.5% who are wasting. It is quite alarming that 7.5% of all pre-school children are severely stunted and 1.9% is acutely wasting. In light of the fact that the negative effects of poor nutrition are greatest in one's formative years, these are disturbing statistics. The prevalence of stunting is highest in the 2-4 year old cohort while the prevalence of wasting is highest in the 0-24months cohort, particularly between 6months and 12 months of age (10.3%). No form of malnutrition is observed for children under 6 months of age. This is most likely due to the fact that the WHO and most national health departments promote the idea that infants should be exclusively breastfed for the first six months of life to achieve optimal growth, development and health.

The transition from exclusive breastfeeding to full use of family foods (which generally starts at 6 months) is a very vulnerable period in which most infants become malnourished. From table 9, we see that the prevalence of stunting increases sharply after 6 months until it peaks at 36 months, after which it starts to decrease gradually. The prevalence of wasting on the other hand, increases at a decreasing rate until it stabilises just above 4%.The rates of stunting are much higher for male children while that of wasting are higher among female children.

Zere and McIntyre (2003) found stunting to be the most prevalent form of malnutrition. The rate of stunting has decreased from 24.5% in 1993 to 22.3% in 2008. Furthermore, the overall rate of wasting almost halved from 8.9% to 4.5%. We can therefore conclude that malnutrition has decreased between 1993 and 2008. The rate of stunting is still highest among male children in 2008; however the prevalence rate has decreased from 26.8% to 25.1% (female children decreased from 22.2% to 19.4%). Female children still have the highest rates of wasting.

Large cash transfers (in the form of the child support grant and the old age pension) to the poor in South Africa have played a significant role in decreasing child malnutrition (Woolard, Aguero and Carter 2007; Duflo 2003). Woolard, Aguero and Carter (2007) found that the child support grant bolstered early childhood nutrition (as signalled by stunting) while Duflo (2003) found that pensions received by women had a large effect on child nutrition. In particular Duflo (2003) found that pensions received by women had a large impact on the nutritional status girls but not boys and this could explain why stunting is biased towards male children. It is also not surprising that we see a decline in the prevalence of malnutrition, particularly wasting as it is quite responsive to improvements in household income status (Zere and McIntyre, 2003).

6. Conclusion

Using the first wave of the national Income Dynamics Study, this paper studied 10 146 adults over the age of 20 and 2029 children under the age of five to assess and quantify the extent of adult obesity and child malnutrition. These results were compared to the 1993 DHS and PSLSD to determine whether or not any changes had occurred in the last decade. It also examined a number of household and socio-economic variables, particularly income in an attempt to uncover the key determinants of obesity across race and gender in South Africa.

The insufficient number of observations in the white population coupled with high non-response rates and high levels of missing data meant that a high level of caution had to be taken in interpreting the results. In certain cases, it limited our ability to know with confidence the effects of certain variables on BMI.

Gender and location are found to be the most significant determinants of body mass, with obesity found to be most prevalent among women and urban dwellers. Furthermore, body mass is found to increase monotonically with income among the black population, particularly among black women. This is a reflection of the positive connotations that are associated with a larger body mass in the black population.

The paradoxical coexistence of adult obesity and child malnutrition that been observed in many developing countries is also observed in South Africa. The results show that it is characterised by rising levels of adult obesity particularly among women and urban areas and a decline in the prevalence of child malnutrition, especially wasting. South Africa's health system is currently under tremendous pressure as a result of the HIV/AIDS pandemic and is still battling with child malnutrition. Together with its accompanying non-communicable diseases, the rise in obesity threatens to bring the already struggling health system to its knees. In order to address this problem; location and gender specific education and lifestyle interventions aimed at optimizing nutrition and reducing obesity are needed at all levels of society.

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Appendix

Table A1: The distribution of body mass across the population

	all	black	black women	black men	white	white women	white men
Underweight	0.051	0.051	0.031	0.079	0.014	0.021	0.007
Normal	0.426	0.451	0.333	0.611	0.329	0.297	0.367
Overweight	0.259	0.243	0.272	0.203	0.325	0.281	0.379
Obese	0.265	0.255	0.364	0.106	0.332	0.402	0.247

This table looks at the distribution of weight across the entire population by race and gender.
All individuals in these samples are aged 20 to 70. The results are weighted using post stratification weights.
BMI is used to classify individuals. The full sample refers to the entire adult population of South Africa.
For example, 38% of all white men are overweight

Table A2: Asset Variables collected in NIDS

1	Radio
2	Hi-Fi stereo , CD player, MP3 player
3	Television
4	Satellite dish
5	Video cassette recorder, DVD player
6	Computer
7	Camera
8	Cell phone
9	Electric stove
10	Gas stove
11	Paraffin stove
12	Microwave
13	Fridge/ freezer
14	Washing machine
15	Sewing/knitting machine
16	Lounge suite
17	Private motor vehicle in running condition
18	Commercial motor vehicle in running condition
19	Motorcycle/scooter
20	Bicycle
21	Non-motorised boat
22	Motor boat
23	Donkey cart or ox cart
24	Plough
25	Tractor
26	Wheelbarrow
27	Grinding mill

These are the variables used to construct the asset index (which proxies for socio-economic status) using Principle component analysis

TABLE 3: Unweighted Summary Statistics

variable	All	Black	Black Female	Black Male	White	White Female	White Male
BMI	26.74	26.71	28.69	23.50	28.25	28.40	28.07
	[0.068]	[0.076]	[0.101]	[0.090]	[0.243]	[0.340]	[0.341]
obese	0.28	0.27	0.38	0.10	0.35	0.39	0.29
	[0.004]	[0.005]	[0.007]	[0.005]	[0.020]	[0.028]	[0.029]
overweight	0.24	0.24	0.26	0.19	0.35	0.30	0.42
	[0.004]	[0.005]	[0.006]	[0.007]	[0.020]	[0.026]	[0.032]
age	39.54	38.69	39.44	38.08	46.19	46.62	46.66
	[0.123]	[0.141]	[0.187]	[0.231]	[0.477]	[0.659]	[0.738]
household size	5.07	5.25	5.44	4.81	2.92	2.91	2.86
	[0.024]	[0.028]	[0.038]	[0.046]	[0.039]	[0.056]	[0.061]
Years of education	7.92	7.58	7.39	7.69	12.00	11.81	12.22
	[0.032]	[0.037]	[0.051]	[0.057]	[0.073]	[0.102]	[0.118]

household expenditure	4028.99	2758.35	2655.30	2653.24	17033.94	16895.84	16865.37
	[7390.201]	[4438.31]	[4392.87]	[3963.95]	[16176.12]	[15010.58]	[15010.58]
household income	4750.34	3384.21	3162.62	3551.31	18709.84	18871.62	18913.63
	[7994.06]	[5088.66]	[4495.51]	[5701.20]	[17971.74]	[18457.20]	[17658.56]
index	0.10	-0.51	-0.60	-0.54	4.75	4.67	4.80
	[0.020]	[0.018]	[0.023]	[0.029]	[0.068]	[0.097]	[0.107]
employed	0.68	0.65	0.58	0.74	0.88	0.85	0.91
	[0.005]	[0.006]	[0.008]	[0.008]	[0.013]	[0.020]	[0.016]
urban	0.50	0.41	0.38	0.42	0.89	0.90	0.87
	[0.004]	[0.004]	[0.006]	[0.007]	[0.010]	[0.014]	[0.016]
number of adults in household	3.13	3.19	3.14	3.12	2.18	2.09	2.14
	[0.013]	[0.016]	[0.020]	[0.025]	[0.029]	[0.041]	[0.043]

Number of children in household	2.46	2.55	2.61	2.45	1.56	1.59	1.49
	[0.015]	[0.018]	[0.023]	[0.030]	[0.038]	[0.053]	[0.055]
smoker	0.21	0.15	0.04	0.32	0.34	0.29	0.40
	[0.003]	[0.003]	[0.002]	[0.007]	[0.016]	[0.020]	[0.024]
female	0.60	0.60			0.56		
	[0.004]	[0.004]			[0.016]		
black	0.78						
	[0.003]						
coloured	0.15						
	[0.003]						
asian-indian	0.02						
	[0.001]						
n	**10146**	**8004**	**4955**	**3049**	**553**	**313**	**240**

This samples includes adults aged 20 to 70. The sample all refers to the entire adult population of South Africa. The table provides unweighted

summary statistics for the key variables of interest Standard deviations reported in parenthesis. There is a significant difference between weighted

and unweighted estimates, particularly for BMI, income, expenditure, the asset index and urban which are particularly our variables of interest

Table A4: Racial Non-Linearities in the Impact of Assets

	(1)	(2)	(3)	(4)
	Black		White	
Dependent Variable: BMI	**FP Index**	**Expenditure**	**FP Index**	**Expenditure**
employed	0.088	0.122	-1.394	-1.196
	(0.280)	(0.289)	(1.937)	(1.870)
age	0.421***	0.392***	0.616	0.854*
	(0.076)	(0.0750)	(0.582)	(0.468)
age squared	- 0.003***	-0.003***	-0.006	-0.009
	(0.001)	(0.001)	(0.007)	(0.006)
years of completed education	0.069	0.057	-0.407	-0.165
	(0.049)	(0.047)	(0.310)	(0.306)
asset/expenditure	0.285***	0.000**	1.245***	-0.000
	(0.107)	(0.000)	(0.473)	(0.000)
asset Squared	-0.007	-0.001	-0.156**	-0.001
	(0.0313)	(0.000)	(0.0763)	(0.000)
number of adults in household	-0.0141	-0.083	2.613**	2.918***
	(0.0900)	(0.087)	(1.082)	(1.059)
number of children in household	-0.064	-0.049	-0.198	0.033
	(0.105)	(0.0986)	(0.917)	(0.933)
urban	0.791**	0.935***	2.499	2.316
	(0.357)	(0.345)	(2.197)	(2.358)
smoker	- 4.711***	-4.673***	-3.383**	-4.216***
	(0.306)	(0.290)	(1.438)	(1.288)
_cons	16.35***	16.53***	13.04	7.787
	(1.788)	(1.719)	(12.90)	(11.30)
N	3503	3714	153	163
R-squared	0.164	0.165	0.266	0.268

The sample includes adults aged 20-70. This table tests whether or not the relationship between BMI and income is monotonic across race and race. Robust Standard errors are reported in parenthesis. Standard errors are corrected for clustering. Significant at *10%, **5%, ***1%

Table 5: Racial Differences in the correlates of BMI

	(1)	(2)	(3)	(4)
Dependent Variable: BMI	**FP Black**	**Expenditure Black**	**FP White**	**Expenditure White**
employed	0.779***	0.700***	0.719	0.436
	(0.258)	(0.254)	(2.411)	(2.213)
age	0.394***	0.368***	0.601	0.866*
	(0.0764)	(0.0735)	(0.588)	(0.490)
age squared	-0.002***	-0.002***	-0.006	-0.009
	(0.001)	(0.001)	(0.007)	(0.006)
years of completed education	0.0788*	0.0380	-0.476	-0.151
	(0.047)	(0.045)	(0.310)	(0.281)
asset/expenditure	0.328***	0.964***	0.085	-1.285
	(0.0951)	(0.180)	(0.323)	(1.237)
number of adults in household	0.097	0.001	2.820**	3.190***
	(0.0879)	(0.0828)	(1.203)	(1.118)
number of children in household	-0.150	-0.157*	-0.115	-0.083
	(0.0945)	(0.0869)	(0.891)	(0.860)
Female	4.775***	4.821***	2.881**	2.491*
	(0.327)	(0.322)	(1.315)	(1.419)
urban	0.793**	0.751**	2.689	2.118
	(0.320)	(0.303)	(2.306)	(2.454)
smoker	-1.663***	-1.673***	-3.116***	-3.330***
	(0.314)	(0.288)	(1.153)	(1.141)
_cons	12.67***	6.529***	11.07	14.51
	(1.866)	(2.012)	(13.93)	(10.75)
N	3503	3714	153	163
R-squared	0.246	0.254	0.270	0.291

The sample includes adults aged 20-70. This table examines the correlates of BMI across the different races using the FP asset index and expenditure. I control for various personal and household characteristics. Robust standard errors are reported in parenthesis. Standard errors are corrected for clustering. Significant at *10%, **5%, ***1%.