The Impact of Obesity on Employment in South Africa

Modeste Some, Naiefa Rashied, Abieyuwa Ohonba

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Modeste Some[*] Naiefa Rashied[†] Abieyuwa Ohonba[‡]

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Abstract

Obesity is a growing health problem in South Africa. This health problem could have various implications for the South African economy. The aim of this study was to investigate the impact of obesity on employment status in South Africa with the use of household survey data. The study followed a quantitative research design that involved household survey data analysis through the use of a bivariate probit model to validate the relationship between obesity and employment. The data was gathered in the National Income Dynamic Study (NIDS) and administered by the South African Labour and Development Research Unit (SALDRU). The findings suggest that obesity has a negative impact on employment status in South Africa.

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[*]University of Johannesburg msome@uj.ac.za

[†]University of Johannesburg, naiefar@uj.ac.za

[‡]University of Johannesburg, aohonba@uj.ac.za

1 Introduction

Obesity is a growing problem worldwide. According to the World Health Organization, the prevalence of obesity doubled between 1980 and 2008. Furthermore, 35% of adults over the age of 20 are obese, which translates to a total of more than half a billion adults worldwide (Hattingh, 2009).

Although prominently associated with developed countries, the prevalence of obesity among developing nations has shown an increase in recent years. The pervasiveness of obesity among developing nations could be attributed to a variety of factors. According to Martorell, Khan, Hughes and Strawn (2000:54), developing countries have undergone a nutrition transition where traditional diets have been swapped for western diets. The authors argue that this, combined with reduced levels of physical activity and increased stress, has triggered an alarming increase in obesity in developing countries. Furthermore, Caballero (2005:1514) argues that the dietary energy among people in developing countries may be limited by the scarcity or unaffordability of certain foods which, together with long work hours and inadequate leisure time for physical activity, may also contribute to the prevalence of obesity in developing countries.

Obesity is a problem because it imposes a significant burden on the economy at a micro and macro level. At a micro-level, obesity imposes a substantial burden on the individual. According to McCormick (2006:161), morbidity, mortality, social exclusion, discrimination, sickness and under-productivity are all increased with obesity. At a macro-level, pressure on the healthcare system, a reduction in the national output level, a reduction in tax revenue, increased government expenditure on incapacity and unemployment benefits and increased operating costs for businesses are all affected with increased levels of obesity (McCormick, 2006: 161). In light of the global prevalence of obesity, scholars worldwide have called for action at many levels to address increasing levels of obesity. Lobstein, Baur & Uauy (2004), Hattingh (2009) and Gortmaker et al. (2011) all suggest interventions for the various role players in society, such as governments, companies, the media and individuals, aimed at addressing and ultimately curbing levels of obesity.

In terms of the labour market, there appears to be a relationship between obesity and employment. Previous work by Lindeboom, Lundborg & Klaauw (2010), Johansson, Bokerman, Kiiskinen & Heliovaara (2009), Greve (2007), Morris (2007) and Cawley (2004) suggests that there is a negative relationship between obesity and employment. Furthermore, Johansson, Bokerman, Kiiskinen & Heliovaara (2009) find that obesity among women in Finland could adversely affect their wage levels. In contrast, Garcia and Domeque (2007) find weak evidence to suggest that obesity affects wages in Europe.

In this paper, we focus on the impact of obesity at a micro-economic level. More specifically, we study the relationship between obesity and the labour market in South Africa and whether obesity influences an individual's employment status in South Africa. To our knowledge, no South African study has examined this relationship. Studies related to Health in South Africa such as those conducted by Gomez-Olive *et al.* (2010), Meintjes *et al.* (2010) Richter and Desmond (2008), Madhavan and Schatz (2007), Kahn *et al.* (2007), Hunter, Twine and Patterson (2007) and Wittenburg and Collinson (2007) either relate to the relationship between the environment and public health or investigate the relationship between socio-economic status and the HIV/AIDS pandemic in South Africa. Other studies such as that of Ardington and Gasealahwe (2012) or Rossouw *et al.* (2012) examine the links between health, mortality and childhood obesity in south Africa through the analysis of NIDS datasets 1 and 2.

An investigation into this relationship is further motivated by what appears to be two growing concerns in South Africa; the problem of obesity and the problem of unemployment. According to Goedecke, Jennings and Lambert (2005:65), South Africa has the highest prevalence of obesity among African countries, with 29% of men and 56% of women classified as obese or overweight in 2002. Moreover, recent studies have found that this prevalence has increased in recent years. Ardington and Case (2009) found that 31% and 60% of South African men and women respectively were classified as obese or overweight in 2008. Furthermore, the author highlighted that obesity has substantially increased among both men and women and across all age groups and Child (2013) reported that 70% and 40% of women and men respectively over the age of 35 were overweight in South Africa. In addition to obesity, unemployment seems to be increasing. In 2013, Statistics South Africa reported that between quarter four of 2012 and quarter one of 2013, unemployment increased by "100 000 to 4.6 million resulting in an increase in the unemployment rate to 25.2% " (Statistics South Africa, 2013). However, it is not known whether there is any causal relationship between the increasing levels of obesity and unemployment in South Africa.

Thus, the aim of this article is to investigate and assess the impact of obesity on employment status using the 2008 NIDS survey data base. In 2008, the South African government sponsored the National Income Dynamics Studies (NIDS) survey in order to collect relevant information to monitor South Africans' conditions of life. The NIDS survey periodically collects a variety of data on households related to variables such as health status, changes in poverty, household composition and employment status. This allows the study to use the NIDS survey data to investigate whether the growing problem of obesity in South Africa has any impact on employment status within household.

The study follows a similar approach to the study conducted by Morris (2007). Morris (2007) conducted an empirical inquiry into the causal impact of obesity on employment in England. The author used data from the Health Survey for England and initially presented baseline estimates using single-variable probit models that did not account for endogeneity. The results from Morris (2007) indicate a small negative effect of obesity on employment for men and an insignificant effect for women. To control for endogeneity, which may yield inconsistent estimates, Morris (2007) used a recursive bivariate probit model. The results after controlling for endogeneity show a negative relationship between obesity and employment among both men and women.

As in Morris (2007), we begin by estimating a univariate probit model. Because endogeneity was present, a recursive bivariate probit model was used thereafter to estimate the model. However, in the bivariate probit model case, we use different instrumental variables. In his article, Morris (2007) employs only one instrument (degree of physical activity) whereas in this paper we use three instruments: the degree of physical activity, the obesity status of the respondent's head of household, and whether the respondent has ever been diagnosed with illness associated to obesity. These differences can be justified by the fact that, in a preliminary analysis, all three instruments are non - weak instruments and thus provide more explanatory power than using only the degree of physical activity as an instrument for obesity.

Results indicate that there is a negative relationship between obesity and the probability of obtaining employment in South Africa. These findings are in line with the findings observed by Morris (2007).

The remainder of this article is structured as follows: Section 2 presents a literature review; Section 3 presents the analytical framework; Section 4 presents the results and analyses the results that arise from the execution of the research design; and, finally, Section 5 offers conclusions and recommendations in light of the findings of this study.

2 Literature Review

"Obesity" refers to the medical condition where excessive fat accumulation may impair health. Obesity is usually measured using the Body Mass Index (BMI), which is defined as a person's weight in kilograms divided by the square of height (in metres) (Costa & Steckel, 1999). However, there are various scholars who argue that the BMI is a flawed measure of obesity. The study by Pan and Yeh (2008) argues that the BMI does not necessarily account for ethnicity which may indicate that the BMI does not respond to the variance in "fatness" especially because human body frame size, composition of bone, muscle and fat vary among the different ethnic groups. Furthermore, Garn, Leonard and Hawthorne (1986) argue that the weighting of height and weight may distort the composition of lean tissue and fat tissue relative to frame size.

The World Health Organization (WHO) defines the Body Mass Index (BMI) as an accurate weight-to-height ratio that "defines obesity and the associated risk to the development of health consequences" (Hattingh, 2009). A person is classified as obese if their weight-to-height ratio is either moderate (30 – 34.9 kg/m^2), severe (35 – 39.9 kg/m^2) or very severe ($\geq$40 kg/m^2). The BMI classifies moderate as obesity class I, severe as obesity class II and very severe as morbid obesity.

However, some scholars have offered alternative measures of health relative to the BMI. Heineck (2007:4) argues that the BMI cannot differentiate between fatness and fat-free mass. As a result, Ashwell and Hsieh (2005:303) recommend that the weight-to-height ratio be used to avoid measurement complications that arise through the use of the BMI. Heineck (2007:5) recommends that estimates of total body fat, fat-free mass and body fat percentage be used as an alternative to the BMI. While the authors of this study concur with Pan and Yeh (2008:370) that "an ideal measure of obesity would be an index that reflects the degree of fatness, which is associated with adverse health risks in a unified way across gender, age and ethnic groups", this study retains the use of BMI for now. This study does not aim to delve into the medical complexities of total versus intermediate obesity and instead, aims to use the BMI as an indicator of general health.

There are three theories that describe the impact of weight on employment. According to Greve (2007:4) and Heineck (2007:2), these three theories are: i) the collective effect of individual body weight on labour supply; ii) employment discrimination based on physical appearance; and iii) statistical discrimination. An obese individual may experience lower levels of productivity in the workplace and, as a result, may not enjoy the same incentives as a healthy individual. Firstly, collectively, obese individuals could have a negative impact on the labour force. Secondly, obese individuals may also be discriminated against, especially in sectors where physical appearance is more important as a result of increased customer contact. Lastly, and from a statistical perspective, obese people may have poorer health, more sick days, and higher quitting rates and may cost the employer more to retain. The relationship between obesity and labour market outcomes such as employment status and wages has been investigated in many countries including the United States (US), United Kingdom (UK), Australia, China and Europe. The evidence is mixed and results differ across countries and socioeconomic groups. Cawley (2000) finds a negative impact of obesity on the earnings of white females in the US. Morris (2007) finds evidence of a large negative impact of obesity on employment status in the UK for both males and females. More specifically, obesity has important indirect effects on employment via impact on health status, home and family variables. Similarly, in 2010, Lindeboom, Lundborg and Klaauw found that a negative association exists between obesity and employment in Britain. More recently, Greve (2007) finds a negative impact of body weight on employment status in Denmark for females with a small effect for males. This author's results suggest that the impacts also differ across sectors. In the public sector, body mass has no impact on wages and employment status, for males and females. However in the private sector, body weight has a large negative impact on wages for women but a positive impact for men. For Europe, Johansson, Bokerman, Kiiskinen and Heliovaara (2009) argue that all measures of obesity are negatively associated with employment probability for women and fat mass is negatively associated with employment probability for men.

In contrast, Garcia & Quintana-Domeque (2005) argue that in Europe, there is weak evidence to suggest that obese workers are more likely to be unemployed or tend to be segregated in self-employment. Similarly, Norton and Han (2007) argue that obesity has no effect on the probability of employment or earnings. In China, Luo and Zang (2011) found that a non-linear relationship exists between BMI and employment.

Internationally, most scholars have used similar approaches to the one used in this study. For the British case, studies by Morris (2007), Harper (2000) and Sargent and Blanch flower (1994) investigate the impact of obesity on employment and wages by using the BMI as the main explanatory variable of interest and employing IV estimations in addition to OLS due to endogeneity (Heineck, 2007:4). For the Danish exploration, Heineck (2007:7) used a multinomial logit model. However, since the coefficients of a multinomial logit model were not easily interpretable, the marginal effects are calculated and discussed.

Apart from the use of the BMI as a measure of health, a number of econometric issues emerge as problematic. Greve (2007) highlights that endogeneity, measurement error and selection pose estimation problems for the explanatory variables used. This study seeks to use a model similar to that of Morris (2007) to control for these empirical problems.

3 Analytical Framework

3.1 The model

In this section, we present the analytical framework of the study. As mentioned previously, the model used in this study is similar to the frameworks used in Cawley (2004), Morris (2007) and Lindeboom *et al.* (2010).

Let's denote *Employed* as the respondents' employment status. *Employed* is an indicator variable taking the value of 1 if the respondent is employed and 0 if the respondent is unemployed. Since the dependent variable (employment) is binary, we will estimate the probability of being employed based on the following latent variables model

$$Employed_i^* = \alpha + \beta obese_i + \eta X_i + \varepsilon_i \tag{1}$$

$$\begin{cases} Employed_i = 1 \text{ if } Employed_i^* > 0 \\ Employed_i = 0 \text{ if } Employed_i^* \leq 0 \end{cases} \tag{2}$$

where $Employed_i^*$ is the underlying unobserved continuous variable of employment; $obese_i$ refers to respondent i's obesity status and X_i is a set of demographic and socio-demographic characteristics affecting the respondent employment status. ε_i is the residual term that follows a standard normal distribution; and α, β, η are constant parameters to be estimated.

Notice that the parameter of interest here is β. As shown in Wooldridge (2002:477), a standard probit estimation of (1) will produce consistent estimates of β only when the variable *obese* is exogenous. When *obese* is endogenous, simple probit regression (1) will deliver invalid estimates of β. Obesity may be endogenous in situations where obesity is correlated to the error term in (1) or when there is reversal causality between employment and obesity. In the first situation, this means that the vector X does not include all important variables that may potentially affect both obesity and the employment status. Moreover, factors such as fattening foods may affect employment status and obesity simultaneously. In fact, jobless individuals are likely to consume cheaper fattening foods that may increase their probability of being obese. Exogeneity requires a variable to be uncorrelated with the error term. In our case, this translates to the condition:$E(obese_i|\varepsilon_i) = 0$. In the reversal causality situation, obesity and employment are simultaneously determined. That is, we have a system of two equations that determines the two variables. To correct for a potential endogeneity of obesity we need in addition to equations (1) and (2), the following equations:

$$obese_i^* = \theta Z_i + u_i \tag{3}$$

$$\begin{cases} obese_i = 1 \text{ if } obese_i^* > 0 \\ obese_i = 0 \text{ if } obese_i^* \leq 0 \end{cases} \tag{4}$$

Z is a vector of variables which refers to a set of exogenous factors affecting obesity and $obese_i^*$ is the unobserved underlying obesity variable. Notice that Z includes in equation (3) all the explanatory variables in the vector X of equation (1) and a set of instrumental variables.

Our analytical framework comprises equations (1) - (4) with the following conditions:

$$E(\varepsilon_i) = 0, E(u_i) = 0$$

$$V(\varepsilon_i) = 1, V(u_i) = 1$$

$$cov(\varepsilon_i, u_i) = \rho$$

In addition, (ε_i, u_i) is required to follow a bivariate normal distribution. In this framework, the endogeneity of obesity is captured by the parameter ρ. When $\rho = 0$ obesity is exogenous and we can consistently estimate β using a univariate probit. When $\rho \neq 0$, obesity is endogenous and estimates of β using a univariate probit are invalid. Interestingly, this framework allows us to directly test whether obesity is exogenous or not through the parameter ρ. The null hypothesis of exogeneity is then given by H_0: $\rho = 0$.

Since both employment status and obesity are binary variables in this instance, we follow the framework adopted by Wooldridge (2002:477) to estimate a bivariate probit and test the endogeneity of obesity. As highlighted by Wooldridge (2002), a probit estimation of the equation (1) yields inconsistent estimates of β when $\rho \neq 0$. Also, the standard two - steps procedure, which would consist in estimating (3) by a probit method in a first step and using the fitted values of obese in a second step to estimate (1) , will yield inconsitent estimates of β. To obtain consistent estimates of the parameters, equations (1) and (3) must be jointly estimated.

The estimation of the parameters is based on the likelihood function of the joint distribution of $(Employed, obese)$ given the exogenous variables X and Z. To simplify the notations let $y_1 = Employed$ and $y_2 = Obese$. The joint distribution of (y_1, y_2) conditional on X, Z can be decomposed as:

$$f(y_1, y_2|X, Z, \Theta) = f(y_1|y_2, X, Z, \Theta)f(y_2|Z, \Theta)$$

where Θ is the vector of all the model parameters, that is, $\Theta = (\alpha,\ \beta,\ \eta, \theta, \rho)$. From (3) it is easy to see that the distribution of y_2 conditional on Z is a normal distribution and $\Pr(y_2 = 1|Z) = \Phi(\theta Z)$ where Φ is the standard normal cumulative distribution function. The distribution of y_1 conditional on y_2, X, Z is a bit cumbersome to present here and we refer the reader to Wooldridge(2002:478) for more details.

After estimating the parameters α, β, η (from the bivariate probit approach), we can obtain estimates of the conditional probabilities of being employed for each observation. That is, if $\widehat{\alpha}$, $\widehat{\beta}$, $\widehat{\eta}$ are the consistent estimates of the respective parameters, the predicted conditional probability of being employed for an observation i is given by:

$$\Phi(\widehat{\alpha} + \widehat{\beta} obese_i + \widehat{\eta} X_i)$$

We define the percentage marginal effect (M.E.) of obesity on the probability of being employed at a given point i as

$$M.E._i = \frac{\Phi(\widehat{\alpha} + \widehat{\beta} + \widehat{\eta} X_i) - \Phi(\widehat{\alpha} + \widehat{\eta} X_i)}{\Phi(\widehat{\alpha} + \widehat{\eta} X_i)} \tag{5}$$

We compute the average marginal effect by taking (5) at the mean point. That is the average marginal effect (A.M.E) is computed as:

$$A.M.E. = \frac{\Phi(\widehat{\alpha} + \widehat{\beta} + \widehat{\eta} \overline{X}) - \Phi(\widehat{\alpha} + \widehat{\eta} \overline{X})}{\Phi(\widehat{\alpha} + \widehat{\eta} \overline{X})} \tag{6}$$

Where $\overline{X}$ is the sample average of X.

3.2 Data

For this empirical study, we used the first wave of survey data from National Income Dynamics Studies (NIDS). NIDS is a national household panel study that was conducted for the first time in 2008. The NIDS data is a nationally representative sample of 28 000 individuals in 7 300 households across South Africa. Because we are interested in employment, we restrict the sample to the active population aged between 18 and 65 years.

3.2.1 Dependent Variable: Employment Status

Since the aim of this study is to investigate the impact of obesity on the probability of being employed, we use employment status at the time of the survey as our dependent variable. The NIDS records different types of employment including self-employment and paid employment. The measure of employment used in this study includes paid employment as well as self-employment.

3.2.2 Independent Variables

Obesity measures

The NIDS records the weight, height and waist of respondents in its data base. We use the measures of height and weight to construct a measure of Body Mass Index (BMI) as weight (in kgs) divided by height in meters squared (in m^2). To obtain an obesity measure, we follow the World Health Organization (WHO) guideline using the BMI variable. We classify an individual as obese when having a BMI of greater than 30. To control for measurement errors, unrealistic values in the low and high ranges were excluded.

Race

In countries like South Africa, race could be viewed as a discriminatory factor in the job market. White individuals are assumed to have a higher probability of getting a job relative to the other racial groups. The race classification here is in line with the NIDS questionnaire where the respondents are asked which racial group they belong to. Thus, we have four categories namely White, African, Coloured and Asian-Indian. The "White" group has been chosen as the reference category in the estimation.

Province and Region

Obviously there is some heterogeneity among South African regions in terms of job market due to economic differences. The nine provinces in the country are used and the regions are also separated into Rural and Urban. Generally, there are more job opportunities in urban areas than in rural areas and in South Africa the province of Gauteng contributes more than 35% in the country's GDP.[1] Thus, we use the province of Gauteng as the reference category.

Education

Education is one of the key determinants of the job market in terms of getting a job as well as earning a higher remuneration. This is because education is believed to increase individuals productivity and skill. This variable was categorized into six categories ranging from 'no education' to tertiary education. Education at a tertiary level is the reference category.

Marital Status

Marital status is also an important factor in the job market. Married individuals are believed to put more effort into job search and thus increase their probability of

[1] See Statistics Saout Africa Release (fourth quarter 2013)

getting a job. We categorized the marital status as 1 if the respondent is married or in a relationship and 0 otherwise.

Age

Age and functions of age (age squared, age cube) are usually used in the job market literature. In our case, responsibilites come with age and older individuals are likely to be employed because of factors such as work experience, level of education, etc.. However, we also use age squared to take into account the fact there is a cutoff age where the probability of being employed decreases with age (life cycle profile). To account for the legal working age, we use an age range of 18-65 years.

Health

We also include the individual's self-perceived health status as an independent variable. This variable ranges from 1 "Excellent" to 5 "Poor". The first category, "Excellent", is the reference category.

3.2.3 Instrumental Variables

As mentioned above, the estimates of the coefficient of obesity using the standard probit technique are invalid under the assumption of endogeneity of obesity. To curb the endogeneity issue we need some valid instruments in order to get consistent and valid estimates of the model. The validity of an instrument requires typically two conditions: (*i*) the instrument must be correlated with the suspected endogenous variable[2] (in this case, Obese), (*ii*) the instrument must not be correlated with the error term of the structural model, that is, the instrument must be uncorrelated with the dependent variable. The first condition can be easily tested using a simple Wald test whereas the second cannot be tested directly. In our case, it means that for an instrument to be valid it must be correlated with obesity and uncorrelated with the labor market outcome (employment status). Ideally, genetic or parental factors such as biological parents obesity status, which are proven to be correlated with obesity (Linderboom *et al.* 2010) but are not associated with labor market outcome, would constitute good candidates in this case. Such variables are difficult to find in the context of the NIDS database. Instead, we propose the use of three instruments; one related to physical activity, one related to the head of household obesity status, and the other one to various illnesses associated with obesity status.

The NIDS questionnaire asked the respondents the frequency of their exercise activity. Obviously, the degree of physical activity variable can easily pass the test of the first

[2] when this condition is violated, the instrument is said to be a weak instrument.

condition. It is widely accepted that the degree of physical activity (sport) and obesity are negatively correlated. However, it is not guaranteed that the degree of physical activity will pass the second instruments validity condition test. In fact, if the level of physical activity in question is costly - for example gym membership - there may be a correlation between the employment status and that specific physical activity. But if it is costless - for example walking or running - it may also pass the second condition test.

The obesity status of the head of the household could affect a respondent's obesity through biological transmission or through sharing some common behaviour (such as dietary habits or eating patterns). It is difficult to ascertain a direct link between a respondent's or head of household's obesity status and their respective employment status. Thus, if there is any impact of the respondent's head of household's obesity on their employment status, that would likely be through the impact of the respondent's head of household's obesity on their obesity status.

The NIDS questionnaire also asked the respondents whether they had ever been diagnosed or treated by a doctor with diseases such as high or low blood pressure, heart problems, diabetes or a stroke. Obese individuals are likely to contract one of these cited deseases and we expect a correlation between individuals obesity status and these illnesses. We also assume that being diagnosed in the past with one these illnesses does not have a direct impact on current individuals' employment status. We created a dummy variable taking the value of 1 when the respondent's response to one of these questions is yes and 0 otherwise.

4 Results

4.1 Descriptive Statistics

As mentioned previously, the sample is restricted to the active population (6652 individuals) recorded in the first wave of the NIDS.

Table A.1 reports the distribution of the sample according to employment status and obesity. 63.5% of the sample are employed whereas 37.5% are unemployed. The employment rate is 73.2% among active men and 53% among women.

Figure 1 shows the repartition of individuals according to the WHO body weight classification. 25% of individuals above 18 years old are classified as obese whereas 4.3% are extremely obese. Thus, 29.3% are classified in the category 1 (obese) of our measure of obesity. Table A.1 shows that 15.6% of males are classified as obese while nearly 40% of women are also classified as obese.

Table A.2 reports the distribution of employment by obesity categories. As shown in Table 2, 29% of the sample individuals who are employed are obese and 30% of those who are unemployed are also obese. We report in the appendix the descriptive statistics of other variables.

4.2 Univariate Probit Results

The baseline univariate probit model is shown in Table B.1 in the Appendix. This estimation includes all the covariates used (age, marital status, race, education, area and region) without controlling for endogeneity and sex.

The coefficient for obesity measure is negative and significantly different from zero. This means that, controlling for the other socio-economic and demographic characteristics (except sex), an obese individual has, on average, a lower probability of obtaining employment when compared to a non-obese individual. The average marginal effect is negative (-0.04) and significantly different from zero at the 1% level. It means that, keeping all other factors fixed at their sample means, an obese individual has a 0.04% less chance of being employed relative to a non-obese individual. When we control for sex without controlling for the endogeneity of obesity, the coefficient of obesity becomes insignificant at the 10% confidence level. Table B.2 reports the results of separate regressions for males and females. In neither case, the coefficient of obesity is significant.

However, as mentioned in the previous section, these estimates may be biased and invalid if obesity is endogenous. A likelihood ratio test will be used in the next section to test the exogeneity of obesity.

4.3 Bivariate Probit Results

Results of the impact of obesity on employment from the bivariate probit model are shown in Table B.3 and Table B.4. Table B.3 reports the results of the estimation of the obesity status equation in (4) whereas Table B.4 reports the results for the employment status equation in (1).

Firstly, we test the null hypothesis that obesity is exogenous in equation (1), that is, we test the hypothesis that $\rho = 0$ using a likelihood ratio test. The results of the test are reported at the bottom of Table B.4. The likelihood ratio statistic is 12.55. Therefore, the null hypothesis is rejected at the 1% level and thus ρ is significantly different from 0. The implication of this is that obesity is endogenous in (1) and therefore the results from the univariate probit in table B.2 are invalid. Next, we present the results of the bivariate probit model estimation where instrumental variables are used to control for obesity.

The instruments used include the respondent's degree of physical exercises per week, whether the respondent has ever been diagnosed or treated with a disease such as high or low blood pressure, diabetes, heart problems and/or a stroke; and the obesity status of the respondent's head of household. Results in Table B.3 show that the coefficients of all instruments are significant in equation (4) and a Wald test indicates that the three instruments signicantly have explanatory power for obesity. Thus, the instruments used are non - weak instruments and pass the first condition of the instruments validity stated above.

The coefficient of obesity is negative (-0.97) and significantly different from zero at the 1% level. Notice that this coefficient is higher in magnitude compared to the univariate probit case. This confirms the theoretical view and previous finding that obesity has a negative impact on the job market outcome. Here this finding implies that given the same other factors we control for, on average an obese individual has a lower probability of getting a job relative to a non-obese individual (overweight, normal, underweight). The average marginal effect is -0.37 and statistically significant. Nonetheless, this result must be interpreted with caution in terms of discrimination against obese people in the job market. In fact, there are probably some unobserved factors that we do not control for and these results are based on the assumption that the instruments we use for obesity are uncorrelated with employment status.

Once again, we perform separate regressions for males and females using the same instruments. The results are reported in Table B.6. For females, we are not able to reject the null hypothesis of exogeneity of obesity whereas for males we can reject this hypothesis at the 10% level. Also, the results show that the coefficient of obesity for females is not statistically significant while it is significant at 1% for males (-0.97). The average marginal effect for males is now higher (-0.36) and statistically significant at the 1% level.

In addition, the different estimated models produce some interesting results. Most of the variables coefficients have the expected signs. For example, with regard to race, and using the 'White' race group as the reference level, the coefficients of the 'African' and 'Coloured' race groups are negative and significant. This means that compared to Whites, Blacks and Coloureds, on average, have a lower probability of getting a job. However, in the separate estimations by sex, only Black women have a lower probability of getting a job when compared to white women. Black and Coloured males have less of a chance of getting a job compare to white males. Education seems to play a major factor in the job market. Results indicate that a higher education level increases the probability of getting a job. The living area seemingly influences the probability of finding employment. Living in the province of Gauteng increases the probability of getting a job compared to Northern Cape, Limpopo, North West, Eastern Cape and Free State.

5 Conclusion

This study examines the impact of obesity on employment status in South Africa using the National Income Dynamic Study (NIDS) data which is a nationally representative household survey. To our knowledge, this is the first South African study using a recursive bivariate probit model in estimating the relationship between obesity and employment.

The results suggest that obesity has a negative effect on employment. Our results are in line with the findings that emerge from the bulk of the existing literature regarding obesity and employment.

In terms of policy implications, the most important result of this study is that obesity could be a serious hindrance to employment opportunities in South Africa and therefore requires government intervention in respect of policies that control obesity especially because current policy and policy implications in South Africa regarding obesity are limited. However, as we already mentioned, further investigation is necessary to interpret these results in terms of discrimination against obese people in the job market in South Africa.

Because this is the first study of its kind in South Africa, areas related to the economics of obesity in South Africa require further academic investigation. For example, it would be interesting to investigate whether there is a wage discrimination between obese and non - obese individuals in the job market.

In addition, this study opens the door for more investigations from an econometric analysis perspective. A panel data econometric analysis will provide more robust results in terms of controlling unobserved factors and using more valid instrumental variables in the estimation. We are currently working on introducing a dynamic dimension in the study by using the several waves of the NIDS data.

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<u>Appendix A</u>: Descriptive Statistics

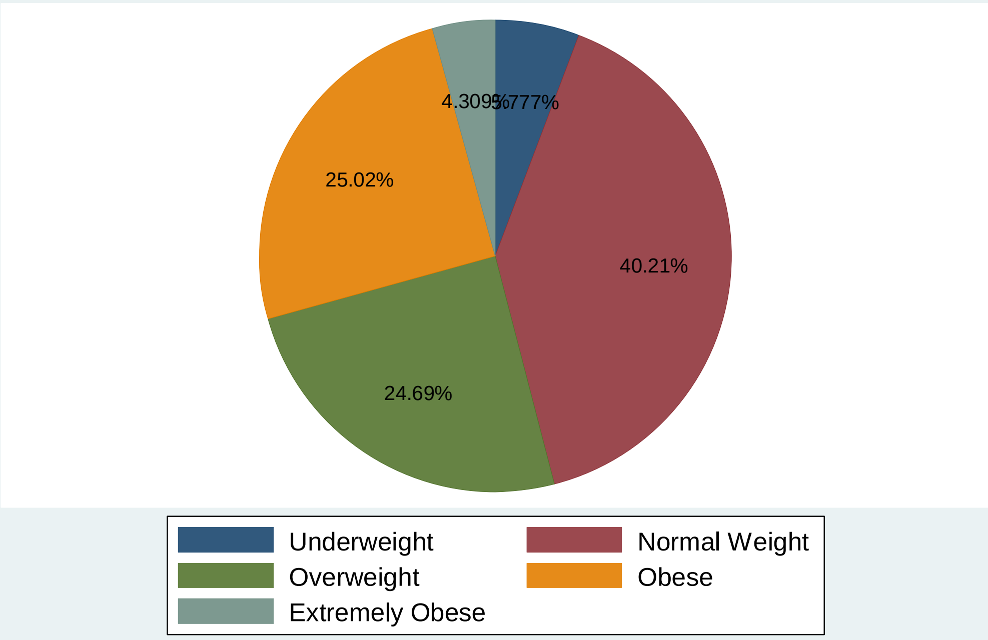
Table A.1. Sex by Employment and Obesity

	Employment		**Obesity**	
	Unemployed	Employed	Obese	Non-obese
Males	26.80	73.20	15.62	84.38
Females	45.92	54.08	39.92	60.08
Total	37.47	62.53	29.33	70.67

Table A.2. Employment and Obesity

	Non-obese	**Obese**	**Total**
Unemployed	70.06	29.94	100.00
Employed	71.06	28.94	100.00
Total	70.67	29.33	100.00

Figure 1: BMI Distribution of aged 18 and Older



Source: National Income Dynamics Study(NIDS 2008)

<u>Appendix B</u>: Estimation Results

Table B.1. Univariate Probit Regression of the Impact of Obesity on Employment: All

obese	-0.109***
	(0.04)
Area	-0.007
	(0.04)
Age	0.102***
	(0.01)
Age2	-0.001***
	(0.00)
Married	0.091**
	(0.04)
Health	
Very good	-0.040
	(0.04)
Good	-0.105**
	(0.05)
Fair	-0.155**
	(0.06)
Poor	-0.158*
	(0.09)
Race	
Africans	-0.460***
	(0.10)
Coloured	-0.256**
	(0.11)
Asian - Indians	-0.060

	(0.19)
Education	
None	-0.526***
	(0.08)
Grade 0 - 6	-0.612***
	(0.07)
Grade 7 - 9	-0.584***
	(0.06)
Grade 10 - 11	-0.609***
	(0.06)
Grade 12	-0.395***
	(0.06)
Province	
Western Cape	0.046
	(0.09)
Eastern Cape	-0.481***
	(0.07)
Northern cape	-0.381***
	(0.09)
Free State	-0.332***
	(0.08)
Kwazulu Natal	-0.295***
	(0.07)
North West	-0.398***
	(0.07)
Mpumalanga	-0.149*
	(0.08)
Limpopo	-0.460***

	(0.09)
Constant	-0.896***
	(0.22)
Marginal effect of obesity	**-0.042*** **
	(0.01)
N****	6284
ll*****	-3686.02
chi2	1028.513

standard errors in parenthesis, * p<0.1, ** p<0.05, *** p<0.01, **** N is the number of observations, ***** ll is the log-likelihood

Table B.2 Univariate Probit Regression of the Impact of Obesity on Employment by sex

	Females	Males
obese	0.053	0.001
	(0.05)	(0.08)
Area	-0.027	0.020
	(0.06)	(0.07)
Age	0.125***	0.086***
	(0.01)	(0.02)
Age2	-0.001***	-0.001***
	(0.00)	(0.00)
Married	-0.131***	0.543***
	(0.05)	(0.07)
Health		
Very good	0.011	-0.035
	(0.06)	(0.07)
Good	-0.031	-0.053
	(0.06)	(0.07)
Fair	-0.105	-0.024
	(0.08)	(0.11)
Poor	0.014	-0.228
	(0.11)	(0.16)
Race		
Africans	-0.387***	-0.614***
	(0.13)	(0.18)
Coloured	-0.104	-0.479**
	(0.14)	(0.19)
Asian - Indians	0.042	-0.310
	(0.24)	(0.31)

Education		
None	-0.768***	-0.227*
	(0.11)	(0.13)
Grade 0 - 6	-0.825***	-0.444***
	(0.09)	(0.11)
Grade 7 - 9	-0.749***	-0.407***
	(0.08)	(0.10)
Grade 10 - 11	-0.759***	-0.387***
	(0.08)	(0.11)
Grade 12	-0.455***	-0.310***
	(0.08)	(0.10)
Province		
Western Cape	0.072	0.078
	(0.11)	(0.15)
Eastern Cape	-0.346***	-0.655***
	(0.10)	(0.11)
Northern cape	-0.390***	-0.344**
	(0.12)	(0.15)
Free State	-0.257**	-0.454***
	(0.11)	(0.13)
Kwazulu Natal	-0.114	-0.510***
	(0.09)	(0.11)
North West	-0.342***	-0.478***
	(0.10)	(0.12)
Mpumalanga	-0.029	-0.283**
	(0.11)	(0.13)
Limpopo	-0.285**	-0.633***
	(0.11)	(0.14)

Constant	-1.783***	-0.034
	(0.30)	(0.35)
Marginal effect of obesity	0.021	0.000
	(0.02)	(0.02)
N****	3551	2733
ll*****	-2084.882	-1396.542
chi2	746.0233	416.8411

standard errors in parenthesis, * p<0.1, ** p<0.05, *** p<0.01, **** N is the number of observations, ***** ll is the log-likelihood

Table B.3 Bivariate Probit (First Stage) Regression of Obesity on Covariates: All

Area	-0.150**
	(0.06)
Age	0.132***
	(0.02)
Age2	-0.001***
	(0.00)
Married	0.297***
	(0.06)
Health	
Very good	0.027
	(0.07)
Good	-0.006
	(0.07)
Fair	-0.034
	(0.10)
Poor	-0.043
	(0.14)
Race	
Africans	0.154
	(0.14)
Coloured	0.128
	(0.14)
Asian - Indians	-0.082
	(0.29)
Education	
None	-0.410***
	(0.12)
Grade 0 - 6	-0.326***
	(0.10)
Grade 7 - 9	-0.189**
	(0.09)
Grade 10 - 11	-0.066
	(0.09)
Grade 12	0.002
	(0.09)
Province	
Western Cape	0.081
	(0.13)
Eastern Cape	0.060
	(0.11)
Northern cape	-0.087
	(0.13)
Free State	-0.124
	(0.12)
Kwazulu Natal	-0.092
	(0.10)

North West	-0.078
	(0.12)
Mpumalanga	-0.197
	(0.13)
Limpopo	-0.013
	(0.14)
Exercise	**-0.352*** **
	(0.06)
Disease	**0.547*** **
	(0.08)
Head of household_obese	**1.842*** **
	(0.06)
Constant	-4.310***
	(0.37)

Standard errors in parenthesis. * p<0.1, ** p<0.05, *** p<0.01, ****. The dependent variable is the obesity status (Obese). The instruments used are: Sporting activities (**Exercise**), whether the respondent has ever been diagnosed with high or low blood pressure, diabetes, heart disease and/or a stroke (**Disease**); and the obesity status of the respondent's head of household (**Head of household_obese**).

Table B.4 Bivariate Probit (Second Stage) Regression of the Impact of Obesity on Employment: All

obese	-0.969***
	(0.20)
Area	-0.059
	(0.04)
Age	0.080***
	(0.01)
Age2	-0.001***
	(0.00)
Married	0.113***

	(0.04)
Health	
Very good	-0.006
	(0.04)
Good	-0.044
	(0.05)
Fair	-0.075
	(0.06)
Poor	-0.092
	(0.09)
Race	
Africans	-0.383***
	(0.10)
Coloured	-0.213**
	(0.10)
Asian - Indians	-0.090
	(0.18)
Education	
None	-0.613***
	(0.08)
Grade 0 - 6	-0.647***
	(0.07)
Grade 7 - 9	-0.591***
	(0.06)
Grade 10 - 11	-0.579***
	(0.06)
Grade 12	-0.375***
	(0.06)

Province		
Western Cape		0.097
		(0.08)
Eastern Cape		-0.391***
		(0.08)
Northern cape		-0.305***
		(0.09)
Free State		-0.294***
		(0.08)
Kwazulu Natal		-0.225***
		(0.07)
North West		-0.348***
		(0.07)
Mpumalanga		-0.143*
		(0.08)
Limpopo		-0.427***
		(0.08)
Constant		-0.431*
		(0.25)
Marginal effect of obesity		**-0.370****
		(0.07)
ρ		**0.53**
Likelihood-ratio test Statistics for ρ=0		**12.552*****
N****	3539	2721

ll*****	-4363.692	-2467.707
chi2	836.885	623.8857

Standard errors in parenthesis. * p<0.1, ** p<0.05, *** p<0.01, **** N is the number of observations, ll***** is the log likelihood. The instruments used are: Sporting activities (**Exercise**), whether the respondent has ever been diagnosed with high or low blood pressure, diabetes, heart disease and/or a stroke (**Disease**).; and the obesity status of the respondent's head of household (**Head of household_obese**).. The parameter ρ is the correlation between obesity and employment status equations' error terms. It measures the endogeneity of obesity in the employment equation. Here, the likelihood ratio test rejects the null hypothesis that ρ=0 meaning that we reject the exogeneity of obesity.

Table B.5 Bivariate Probit (First Stage) Regression of Obesity on Covariates: by sex

	Females	Males
Area	-0.128	-0.162
	(0.08)	(0.13)
Age	0.148***	0.056
	(0.02)	(0.04)
Age2	-0.001***	-0.000
	(0.00)	(0.00)
Married	0.353***	0.676***
	(0.07)	(0.13)
Health		
Very good	-0.004	-0.080
	(0.09)	(0.14)
Good	-0.095	-0.071
	(0.09)	(0.15)
Fair	-0.134	0.024
	(0.12)	(0.19)
Poor	-0.134	-0.382
	(0.17)	(0.30)
Race		
Africans	0.659***	-0.486**
	(0.18)	(0.23)
Coloured	0.491**	-0.359
	(0.19)	(0.25)
Asian - Indians	0.053	-0.021
	(0.39)	(0.47)
Education		
None	-0.276*	-0.355
	(0.16)	(0.26)
Grade 0 - 6	-0.153	-0.335
	(0.14)	(0.21)
Grade 7 - 9	-0.069	-0.209
	(0.12)	(0.18)
Grade 10 - 11	-0.004	-0.148
	(0.12)	(0.18)
Grade 12	0.039	0.014
	(0.12)	(0.17)
Province		
Western Cape	0.203	-0.231
	(0.16)	(0.24)
Eastern Cape	0.156	-0.233
	(0.14)	(0.21)
Northern cape	-0.069	-0.233
	(0.17)	(0.25)
Free State	-0.086	-0.324
	(0.15)	(0.23)
Kwazulu Natal	-0.022	-0.440**

	(0.13)	(0.20)
North West	-0.003	-0.461**
	(0.15)	(0.23)
Mpumalanga	-0.227	-0.380
	(0.16)	(0.24)
Limpopo	-0.252	0.146
	(0.18)	(0.28)
Exercise	-0.081	-0.104
	(0.09)	(0.11)
Disease	0.365***	0.463***
	(0.09)	(0.16)
Head of household_obese	1.700***	2.500***
	(0.07)	(0.13)
Constant	-4.881***	-3.457***
	(0.47)	(0.76)

Standard errors in parenthesis. * p<0.1, ** p<0.05, *** p<0.01, ****. The dependent variable is the obesity status (Obese). The instruments used are: Sporting activities (**Exercise**), whether the respondent has ever been diagnosed with high or low blood pressure, diabetes, heart disease and/or a stroke (**Disease**); and the obesity status of the respondent's head of household (**Head of household_obese**).

Table B.4 Bivariate Probit (Second Stage Regression) of the Impact of Obesity on Employment: by sex

	Females	**Males**
obese	-0.487	-0.974***
	(0.37)	(0.37)
Area	-0.063	-0.022
	(0.06)	(0.07)

Age	0.122***	0.040*
	(0.02)	(0.02)
Age2	-0.001***	-0.000
	(0.00)	(0.00)
Married	-0.100*	0.588***
	(0.06)	(0.07)
Health		
Very good	0.022	-0.010
	(0.06)	(0.07)
Good	-0.010	-0.014
	(0.06)	(0.07)
Fair	-0.084	0.044
	(0.08)	(0.11)
Poor	0.014	-0.190
	(0.11)	(0.16)
Race		
Africans	-0.299**	-0.644***
	(0.15)	(0.17)
Coloured	-0.055	-0.522***
	(0.14)	(0.18)
Asian - Indians	0.037	-0.359
	(0.24)	(0.30)
Education		
None	-0.820***	-0.304**
	(0.11)	(0.13)
Grade 0 - 6	-0.838***	-0.488***
	(0.09)	(0.11)
Grade 7 - 9	-0.753***	-0.435***

	(0.08)	(0.10)
Grade 10 - 11	-0.743***	-0.399***
	(0.09)	(0.10)
Grade 12	-0.438***	-0.314***
	(0.09)	(0.10)
Province		
Western Cape	0.123	0.091
	(0.12)	(0.14)
Eastern Cape	-0.290***	-0.612***
	(0.10)	(0.11)
Northern cape	-0.340***	-0.292**
	(0.12)	(0.15)
Free State	-0.220**	-0.463***
	(0.11)	(0.12)
Kwazulu Natal	-0.078	-0.475***
	(0.09)	(0.11)
North West	-0.309***	-0.449***
	(0.10)	(0.12)
Mpumalanga	-0.047	-0.265**
	(0.11)	(0.13)
Limpopo	-0.315***	-0.567***
	(0.11)	(0.14)
Constant	-1.663***	0.909*
	(0.33)	(0.47)
Marginal effect of obesity	**-0.192**	**-0.356****
	(0.14)	**(0.14)**

ρ	**0.336**	**0.528**
Likelihood ratio Statistics for ρ = 0	**1.820**	**3.588***
N****	3539	2721
ll*****	-4363.692	-2467.707
chi2	836.885	623.8857

Standard errors in parenthesis. * p<0.1, ** p<0.05, *** p<0.01, N**** refers to the number of observations and ll***** refers to the log likelihood. The instruments used are: Sporting activities (**Exercise**), whether the respondent has ever been diagnosed with high or low blood pressure, diabetes, heart disease and/or a stroke (**Disease**).; and the obesity status of the respondent's head of household (**Head of household_obese**). The parameter ρ is the correlation between obesity and employment status equations' error terms. It measures the endogeneity of obesity in the employment equation.

Appendix C: Obesity Classifications

Table C.1: The International Classification of adult underweight, overweight and obesity according to BMI

Classification	BMI(kg/m^2)	
	Principal cut-off points	Additional cut-off points
Underweight	**<18.50**	**<18.50**
Severe thinness	<16.00	<16.00
Moderate thinness	16.00 - 16.99	16.00 - 16.99
Mild thinness	17.00 - 18.49	17.00 - 18.49
Normal range	**18.50 - 24.99**	**18.50 - 22.99**
		23.00 - 24.99
Overweight	**≥25.00**	**≥25.00**
Pre-obese	25.00 - 29.99	25.00 - 27.49
		27.50 - 29.99
Obese	**≥30.00**	**≥30.00**
Obese class I	30.00 - 34.99	30.00 - 32.49

		32.50 - 34.99
Obese class II	35.00 - 39.99	35.00 - 37.49
		37.50 - 39.99
Obese class III	≥40.00	≥40.00

Source: Adapted from WHO, 1995, WHO, 2000 and WHO 2004