Title: **The impact of obesity on employment in South Africa**

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Abstract

Obesity is a growing health problem in South Africa. This health problem could have various implications on the South African economy. The aim of this study is to investigate the impact of obesity on employment status in South Africa using household survey data. The study follows a quantitative research design which involves secondary data analysis of household survey data and the use of an econometric model to validate the relationship between obesity and employment. The secondary 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 for the South African economy.

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1. Introduction

1.1. Background

Obesity is a growing problem world-wide. According to the World Health Organisation, the prevalence of obesity doubled between 1980 and 2008. Furthermore, 35% of adults over the age of 20 are obese which translates into a total of more than half a billion adults worldwide.

Although prominently associated with developed countries, the prevalence of obesity among developing nations has shown an increase in recent decades. The prevalence 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. On 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. On 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 offer an array of interventions for the various role players in society aimed at addressing and ultimately curbing levels of obesity.

1.2. Contribution

In terms of the labour market, there appears to be a relationship between obesity and employment. Scholarly work by Greve (2013), Lindeboom, Lundborg & Klaauw (2010), Johansson, Bokerman, Kiiskinen & Heliovaara (2009), Morris (2004) and Cawley (2004) suggest that there is a relationship between obesity and employment.

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. This is motivated by what appears to be the growing problem of obesity in South Africa. 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.

A further motivation for this study relates to the high unemployment rates experienced in South Africa and the impact of these rates on well-being. 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. Thus, the aim of this study is use the NIDS survey data to investigate whether the growing problem of obesity in South Africa has any impact on a household's employment status.

The aim of this study is to investigate and assess the impact of obesity on employment status using the 2008 NIDS survey data base. To our knowledge, this study is the first of its kind that investigates the relationship between obesity and employment status, using an empirical research design, within the South African context.

1.3. Research Design

The study follows a similar approach to the study conducted by Morris (2004). Morris (2004) conducted an empirical inquiry into the 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 this indicated a small negative effect of obesity and employment for men and an insignificant effect for women. To control for endogeneity, and perhaps estimate a regression that may yield theoretically justifiable results, Morris (2004) went on to control for endogeneity by using a recursive bivariate probit model. This estimate reported a negative relationship between obesity and employment among both men and women.

Similar to Morris (2004), this study uses data from the 2008 NIDS survey data base. The variables selected in this study should differ slightly from the variables used by Morris

(2004). These differences could be attributed to the differences between England and South Africa i.e. context-specific differences. This study will begin estimating by using a single variable probit model to analyse the relationship between the specified dependent and independent variables. If endogeneity is present, then a recursive bivariate probit model will be used to estimate the regression. While this study may use an approach that is very similar to the approach used in Morris (2004), this study is unique because it seeks to establish the impact of obesity on employment through the use of slightly different explanatory variables that account for the uniqueness of the South African context.

The remainder of this study is structured as follows; section two presents a literature review, section three presents the analytical framework, section four presents the results and analyses the results that arise from the execution of the research design and finally, section five offers conclusions and recommendations in light of the findings of this study.

2. Literature Review

2.1. Introduction

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, 1999:53). 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 (1986:996) argue that the weighting of height and weight may distort the composition of lean tissue and fat tissue relative to frame size.

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.

The World Health Organisation 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, 2009:8). 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 (≥ 40 kg/m^2). The BMI classifies moderate as obesity class I, severe as obesity class II and very severe as morbid obesity.

2.2. Theoretical framework

There are three theories that describe the impact of weight on employment. According to Greve (2013:4) 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. Collectively, obese individuals could have a negative impact on the labour force. Obese individuals may also be discriminated against, especially in sectors where physical appearance is more important due to 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.

In this study, the authors’ do not seek to describe the impact of obesity on employment in the South African context as yet. Because this study is the first of a series of studies to be conducted by the authors regarding the economic effects of obesity, this study primarily seeks to establish whether obesity impacts employment or not.

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 (2004) finds evidence of a large negative impact of obesity on employment status in 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 (2013) finds a negative impact of body weight on employment status in Denmark for females with a small effect for males. His results suggest that the impacts also differ across sectors. In the public sector, body mass has no impact on wages and employment status either 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, 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.

On the contrary, 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 (2004), 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 (2013) 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 (2004) 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 (2004) and Lindeboom *et al*. (2010).

Let’s denote by *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 adopt the following linear probability model:

$$Employed_i = \alpha + \beta Obese_i + \eta X_i + \varepsilon_i \qquad (1)$$

Where $Employed_i = 1$, the respondent i is employed and 0 otherwise; $Obese_i$ refers to respondent i's obesity status and X_i is a set of demographic and socio-economic characteristics affecting the respondent employment status. ε_i is a residual term and α, β, η are constant parameters to be estimated.

Notice that the parameter of interest here is β. The standard OLS regression of (1) produces consistent estimates of β only when the variable $Obese$ is exogenous. Obesity may be endogenous in situations when obesity is correlated to the error 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 affect both obesity and the employment status. Exogeneity requires a variable to be uncorrelated with the error term or in our case, $E(Obese_i|\varepsilon_i) = 0$. 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. In this case we have in addition to equation (1), in the form of a second equation:

$$Obese_i = \delta + \gamma Employed_i + \theta Z_i + u_i \qquad (2)$$

Variable Z refers to other factors than employment status affects obesity. The effect of employment status on obesity can be explained through food consumption. Jobless individuals are likely to consume cheaper fattening foods that may increase their probability of being obese. Notice that in equation (2), Z includes some of the explanatory variables in the vector X of equation (1) and a set of instrumental variables.

Our analytical framework comprises equations (1) and (2) with the following conditions:

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

$$Var(\varepsilon_i) = Var(u_i) = 1$$

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

In this framework, the endogeneity of obesity is captured by the parameter ρ. When ρ=0 obesity is exogenous and thus we can consistently estimate β using a univariate probit. When ρ≠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 here binary variables, 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 and η when $\rho \neq 0$.

3.2. The Data

For this empirical study, we used the first wave of survey data from National Income Dynamics Studies (NIDS). Because our variable of interest is employment, we restrict the sample to the active population aged between 20 and 65.

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.

3.2.2. Independent Variables

Obesity measures

When measuring obesity, we follow the World Health Organization (WHO) guideline by using the Body Mass Index (BMI) which is calculated as Weight in kilograms (kg) divided by height in squared meters (m^2). To control for measurement errors, unrealistic values in the low and high ranges were excluded.

Race

The race classification 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.

Province and Region

The nine provinces in the country are used and the regions are also separated into Rural and Urban.

Education

This was categorised into six categories ranging from ‘no education’ to tertiary education.

Marital Status

This takes the value of I if the respondent is married or in a relationship and 0 otherwise.

Age

For all respondents, the age range is from 20-65 years.

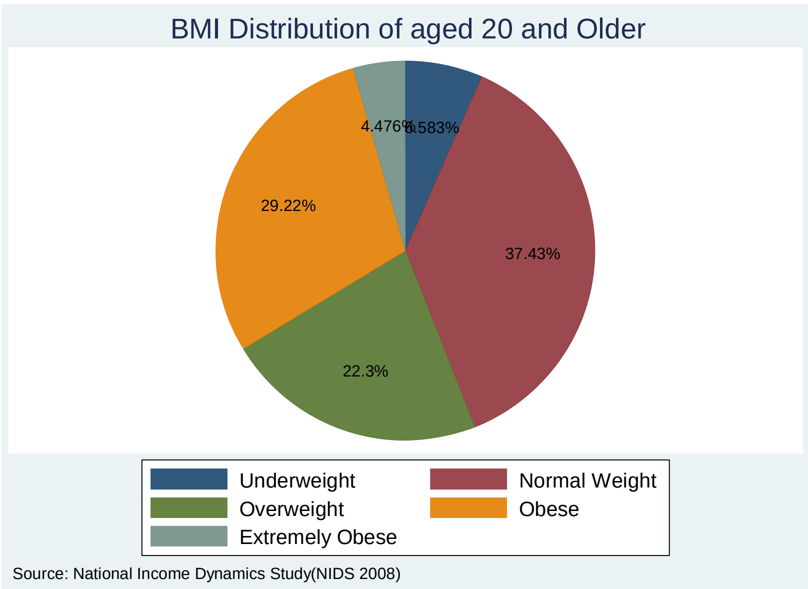
4. Results

4.1. Descriptive statistics

Table 4.1: BMI Distribution for South Africans

The results from our estimate indicate that over a quarter of the estimated sample is obese and extremely obese. Furthermore, it is pertinent to find the range of people who are classified as obese or extremely obese in terms of age so as to establish the extent to which the working age group is obese or extremely obese. The pie chart below indicates that, over 30% in the age group over the age of 20 are obese and extremely obese.

Figure 4.1: Graphical BMI Distribution



Based on the descriptive statistics that could be found in Appendix B, a larger percentage of females could be classified as obese. Furthermore, individuals with tertiary qualifications also show a higher BMI average than other categories. Interestingly, both male and female respondents in our study who reside in the urban areas have higher means of BMI perhaps indicating lifestyle differences.

4.2. Estimation Results

The baseline univariate probit model is shown in Table B.11 in the Appendix. This estimation includes all the covariates used-(age, marital status, race, education, area and region) without controlling for endogeneity. The coefficient for obesity measure is not significant at the 5% level. For males, the value of the effect of obesity on employment is significant and negative but not for females.

Results from the impact of obesity on employment from the bivariate probit model are shown in Table B.12. Using the Wald test of exogeneity the hypothesis that $\rho = 0$ is rejected for obesity measures, as it is significantly different from 0. The implication of this is that employment and obesity are endogenously determined and therefore the results from the univariate probit in table B.11 are biased.

The likelihood log and the p-value show that as a whole, our model is statistically significant. Results from the bivariate probit estimation including the instrumental variables - perceived health status and frequency of exercises per week indicate a significant negative relationship between obesity measures and employment status for both men and women. (the instrumental variable of the father's education was not significant and so was not used in the final estimation).

Comparatively, Regarding Race, and using whites as the reference level, the coefficients are all significant at the 5% interval level.

The coefficient for the frequency of exercises has a negative sign indicating that it is negatively associated with obesity; while the perceived health status has the expected positive sign. These show that the instruments satisfy the non-weakness criteria. This is in line with our theoretical predictions and in line with the findings that emerge from the bulk of the literature.

A quarter of the survey respondent showed that more obese people had fewer jobs that those with normal weight.

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. This is to our knowledge, this was the first South African study using a Probit IV model in estimating this relationship between obesity and employment.

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

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. Such areas include:

- The relationship between obesity and wages in South Africa
- The relationship between obesity, employment and wages in South Africa
- The relationship between obesity, lifestyle and socio-economic status in South Africa

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.

The South African government has initiated a number of obesity-targeting interventions as part of its obesity management programme. The first of these initiatives is the South African Comprehensive Healthcare Plan (SACHP). The main objective of the SACHP for 2004 – 2007 was to transform unhealthy lifestyle behaviour into healthy lifestyle behaviour. The SACHP identified healthy lifestyle behaviour as active living, healthy eating, reduced alcohol consumption and reduced tobacco use (Hattingh, 2009:61). Many companies in the private sector supported this initiative by initiating wellness programmes and on-going health risk assessments. The SACHP for 2008 – 2011 continued to promote healthy living.

The South African government also introduced food-based dietary guidelines aimed at encouraging South Africans to become healthy and stay healthy. The South African Department of Health, as part of its Integrated Nutrition Programme, adopted eleven of the food-based dietary guidelines for use as a communication tool for dietary recommendations and as part of the public health nutritional strategy (Hattingh, 2009:61).

The South African Department of Sport and Recreation promoted population-level and multi-sectoral programmes aimed at the promotion of physical activity. Interventions such as

“Getting the nation to play”, the “Youth Fitness and Wellness Charter” and “Move for your Health” aimed at creating awareness for healthy living among youth and adults. Despite these efforts from the South African government, there are still no specific interventions, strategies or objectives for obesity control in South Africa (Hattingh, 2009:62).

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Appendix A: Obesity Classifications

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

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

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

Appendix B: Descriptive Statistics

BMI_cat	Freq.	Percent	Cum.
Underweight	31	2.80	2.80
Normal Weight	373	33.63	36.43
Overweight	346	31.20	67.63
Obese	309	27.86	95.49
Extremely Obese	50	4.51	100.00
Total	1,109	100.00	

Table B.1: BMI Distribution

```
. /*descriptive statistics*/
. /*BMI distribution*/
. tabu BMI_cat if age>=18 & age<=65
```

BMI_cat	Freq.	Percent	Cum.
Underweight	725	6.58	6.58
Normal Weight	4,122	37.43	44.01
Overweight	2,456	22.30	66.31
Obese	3,218	29.22	95.52
Extremely Obese	493	4.48	100.00
Total	11,014	100.00	

Table B.2: BMI Distribution by Gender

```
. /*BMI distribution by sex*/
. tabu sex if age>=18 & age<=65, sum(BMI)
```

	Summary of BMI		
sex	Mean	Std. Dev.	Freq.
male	23.421984	5.3550298	4350
female	28.227676	7.2777858	6664
Total	26.329659	6.9920453	11014

Table B.3: BMI Distribution by BMI Category and Gender

BMI_cat	sex male	female	Total
Underweight	434 3.94	291 2.64	725 6.58
Normal Weight	2,190 19.88	1,932 17.54	4,122 37.43
Overweight	821 7.45	1,635 14.84	2,456 22.30
Obese	849 7.71	2,369 21.51	3,218 29.22
Extremely Obese	56 0.51	437 3.97	493 4.48
Total	4,350 39.50	6,664 60.50	11,014 100.00

Table B.4: BMI Distribution by Race

```
.
. /*BMI distribution by race*/
.
. tabu race if age>=18 & age<=65, sum(BMI)
```

race	Summary of BMI Mean	Std. Dev.	Freq.
Africans	26.261297	6.9918085	8776
Coloured	26.132667	7.4313894	1553
Asian-Ind	26.16357	5.7758602	149
White	28.076668	5.6622757	528
Total	26.328914	6.9934082	11006

```
. sort(race)

. by race:tabu BMI_cat if age>=18 & age<=65
```

-> race = Africans

BMI_cat	Freq.	Percent	Cum.
Underweight	519	5.91	5.91
Normal Weight	3,376	38.47	44.38
Overweight	1,914	21.81	66.19
Obese	2,574	29.33	95.52
Extremely Obese	393	4.48	100.00
Total	8,776	100.00	

-> race = Coloured

BMI_cat	Freq.	Percent	Cum.
Underweight	190	12.23	12.23
Normal Weight	547	35.22	47.46
Overweight	309	19.90	67.35
Obese	430	27.69	95.04
Extremely Obese	77	4.96	100.00
Total	1,553	100.00	

Table B.5: Summary of the BMI according to Area

RECODE of Area1	Summary of BMI Mean	Std. Dev.	Freq.
Urban	26.827044	7.1813145	5325
Rural	25.864098	6.7777572	5689
Total	26.329659	6.9920453	11014

Table B.6: Summary of BMI Category according to Area

BMI_cat	Freq.	Percent	Cum.
Underweight	355	6.67	6.67
Normal Weight	1,885	35.40	42.07
Overweight	1,196	22.46	64.53
Obese	1,620	30.42	94.95
Extremely Obese	269	5.05	100.00
Total	5,325	100.00	

-> area = Rural

BMI_cat	Freq.	Percent	Cum.
Underweight	370	6.50	6.50
Normal Weight	2,237	39.32	45.83
Overweight	1,260	22.15	67.97
Obese	1,598	28.09	96.06
Extremely Obese	224	3.94	100.00
Total	5,689	100.00	

Table B.7: BMI Distribution by Education

```
.
. /*BMI distribution by Education*/
.
. tabu educ_cat if age>=18 & age<=65, sum(BMI)
```

RECODE of educ	Summary of BMI Mean	Std. Dev.	Freq.
none	26.480347	7.4962935	1251
grade 0-6	26.713259	7.5317385	1894
grade 7-9	26.202416	7.165348	2473
grade 10-	25.61296	6.6267068	2504
grade 12	26.083952	6.4013235	1782
tertiary	27.800054	6.5012101	1109
Total	26.32953	6.9923497	11013

Table B.8: BMI Distribution per Age Group

BMI_cat	age_group 20-29	30-39	40-49	50-59	60-69	Total
Underweight	263 2.62	154 1.53	135 1.34	130 1.29	42 0.42	724 7.20
Normal Weight	1,792 17.82	940 9.35	717 7.13	484 4.81	189 1.88	4,122 40.99
Overweight	729 7.25	611 6.08	510 5.07	431 4.29	175 1.74	2,456 24.43
Obese	429 4.27	563 5.60	577 5.74	502 4.99	189 1.88	2,260 22.48
Extremely Obese	65 0.65	124 1.23	136 1.35	126 1.25	42 0.42	493 4.90
Total	3,278 32.60	2,392 23.79	2,075 20.64	1,673 16.64	637 6.34	10,055 100.00

Table B.9: Means of BMI per Age Group

Means of BMI

empl	age_group 20-29	30-39	40-49	50-59	60-69	Total
Unemploye	24.822973	26.861261	27.667351	28.122804	25.346047	26.079636
Employed	24.814962	26.733005	27.933222	28.040417	27.346278	26.751554
Total	24.819576	26.781565	27.846964	28.061632	26.777585	26.468777

Table B.10: Means of BMI according to Gender

Means of BMI

sex	age_group 20-29	30-39	40-49	50-59	60-69	Total
male	22.483778	23.65624	24.060453	25.124807	25.148773	23.653149
female	26.072685	28.961092	29.992387	30.055822	30.100622	28.532905
Total	24.61654	26.887498	27.802574	28.278534	28.266028	26.654769

Table B.11: Univaraite Probit Regression

```
Probit regression                                 Number of obs   =       5657
                                                  LR chi2(21)     =    1180.66
                                                  Prob > chi2     =     0.0000
Log likelihood = -3281.8672                       Pseudo R2       =     0.1525
```

empl	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
obese	.0138857	.0415539	0.33	0.738	-.0675585	.0953299
age	.0306698	.0019606	15.64	0.000	.0268271	.0345126
married	.0958109	.0398589	2.40	0.016	.0176889	.1739328
race						
1	-.3820458	.1070621	-3.57	0.000	-.5918838	-.1722079
2	-.0465318	.1137509	-0.41	0.682	-.2694795	.1764159
3	.0180923	.1962399	0.09	0.927	-.3665308	.4027154
sex	-.6217296	.0380832	-16.33	0.000	-.6963713	-.547088
educ_cat						
0	-.6779681	.0872594	-7.77	0.000	-.8489934	-.5069427
1	-.7830895	.0726291	-10.78	0.000	-.9254399	-.6407391
2	-.722938	.0656863	-11.01	0.000	-.8516808	-.5941952
3	-.7619776	.0657889	-11.58	0.000	-.8909215	-.6330337
4	-.5207617	.0656887	-7.93	0.000	-.6495092	-.3920142
area	-.0113107	.0447534	-0.25	0.800	-.0990257	.0764042
region						
1	.0526658	.0911168	0.58	0.563	-.1259198	.2312514
2	-.5192785	.0759036	-6.84	0.000	-.6680468	-.3705101
3	-.4261473	.0946357	-4.50	0.000	-.6116299	-.2406646
4	-.3483775	.083062	-4.19	0.000	-.511176	-.185579
5	-.3245028	.0692146	-4.69	0.000	-.4601609	-.1888446
6	-.4316091	.0787079	-5.48	0.000	-.5858738	-.2773444
8	-.1301554	.0841196	-1.55	0.122	-.2950269	.0347161
9	-.4748339	.0911014	-5.21	0.000	-.6533894	-.2962785
_cons	.5978861	.1393378	4.29	0.000	.324789	.8709832

Table B.12: Bivariate Probit Regression

```
Seemingly unrelated bivariate probit              Number of obs   =       3184
                                                  Wald chi2(41)   =    1057.70
Log likelihood = -3935.1787                       Prob > chi2     =     0.0000
```

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
obese						
health	.0401733	.0189442	2.12	0.034	.0030433	.0773032
do_sport	-.0200027	.0173526	-1.15	0.249	-.0540132	.0140078
age	.0166303	.0024444	6.80	0.000	.0118393	.0214213
married	.0926785	.0493639	1.88	0.060	-.0040731	.18943
area	-.1283653	.0571299	-2.25	0.025	-.240338	-.0163927
educ_cat						
0	-.437279	.1126895	-3.88	0.000	-.6581464	-.2164116
1	-.2533402	.0913656	-2.77	0.006	-.4324136	-.0742669
2	-.1490458	.0798058	-1.87	0.062	-.3054622	.0073707
3	-.0688048	.0789762	-0.87	0.384	-.2235952	.0859857
4	.0163267	.0790218	0.21	0.836	-.1385532	.1712067
race						
1	.2575898	.1236198	2.08	0.037	.0152993	.4998802
2	.1426674	.1292227	1.10	0.270	-.1106043	.3959392
3	.0320727	.2335403	0.14	0.891	-.4256579	.4898034
region						
1	.1951524	.110902	1.76	0.078	-.0222114	.4125163
2	.1485926	.0963735	1.54	0.123	-.0402959	.3374811
3	.1695714	.1178668	1.44	0.150	-.0614432	.400586
4	.0855848	.1069781	0.80	0.424	-.1240883	.295258
5	.055759	.0876165	0.64	0.525	-.1159661	.2274842
6	-.0099326	.1014036	-0.10	0.922	-.20868	.1888149
8	-.170105	.111281	-1.53	0.126	-.3882117	.0480017
9	-.2909345	.1197483	-2.43	0.015	-.5256369	-.056232
_cons	-1.059677	.1755105	-6.04	0.000	-1.403671	-.7156822
empl						
obese	-1.117233	.3111728	-3.59	0.000	-1.727121	-.5073457
age	.0436132	.0038339	11.38	0.000	.0360989	.0511274
married	-.0561846	.0564757	-0.99	0.320	-.1668749	.0545058
race						
1	-.1553838	.1535189	-1.01	0.311	-.4562753	.1455078
2	.1417606	.1324556	1.07	0.285	-.1178476	.4013689
3	.1064311	.2331796	0.46	0.648	-.3505926	.5634547
educ_cat						
0	-.9496993	.1236564	-7.68	0.000	-1.192061	-.7073373
1	-.8771668	.1241237	-7.07	0.000	-1.120445	-.6338887
2	-.7768339	.1205391	-6.44	0.000	-1.013086	-.5405817
3	-.76118	.1309441	-5.81	0.000	-1.017826	-.5045342
4	-.4636927	.1075202	-4.31	0.000	-.6744285	-.252957
area	-.108711	.0569926	-1.91	0.056	-.2204144	.0029925
region						
1	.1239485	.1121026	1.11	0.269	-.0957687	.3436656
2	-.2118947	.1166396	-1.82	0.069	-.4405041	.0167147
3	-.2884477	.1423049	-2.03	0.043	-.5673601	-.0095353
4	-.180909	.1154828	-1.57	0.117	-.4072511	.0454332
5	-.0788664	.0899705	-0.88	0.381	-.2552053	.0974725
6	-.2813771	.1087088	-2.59	0.010	-.4944424	-.0683118
8	-.081222	.1072769	-0.76	0.449	-.2914809	.1290369
9	-.3617147	.1133213	-3.19	0.001	-.5838204	-.139609
_cons	-.2523823	.1716897	-1.47	0.142	-.588888	.0841233
/athrho	.906616	.4477399	2.02	0.043	.0290618	1.78417
rho	.7195041	.2159512			.0290537	.9451419

```
Wald test of rho=0:                 chi2(1) =  4.10011    Prob > chi2 = 0.0429
```

Seemingly unrelated bivariate probit   Number of obs = 5609
Wald chi2(41) = 2162.95
Log likelihood = -6662.517   Prob > chi2 = 0.0000

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
obese						
health	.0814345	.0145519	5.60	0.000	.0529133	.1099558
do_sport	-.0575419	.0111506	-5.16	0.000	-.0793968	-.0356871
age	.0067026	.0018868	3.55	0.000	.0030046	.0104006
married	.0497562	.0390057	1.28	0.202	-.0266936	.1262059
area	-.170361	.0442784	-3.85	0.000	-.2571451	-.083577
educ_cat						
0	-.4830517	.0860829	-5.61	0.000	-.6517711	-.3143322
1	-.2987084	.0693036	-4.31	0.000	-.434541	-.1628758
2	-.1660559	.061477	-2.70	0.007	-.2865486	-.0455631
3	-.060921	.0615592	-0.99	0.322	-.1815748	.0597328
4	-.0290502	.0609678	-0.48	0.634	-.1485448	.0904445
race						
1	-.0073695	.089202	-0.08	0.934	-.1822022	.1674631
2	-.0218765	.0956796	-0.23	0.819	-.2094051	.1656521
3	-.1383324	.1748135	-0.79	0.429	-.4809605	.2042957
region						
1	.1462344	.0831841	1.76	0.079	-.0168035	.3092722
2	.0978322	.0735846	1.33	0.184	-.046391	.2420555
3	.1205963	.0903914	1.33	0.182	-.0565676	.2977602
4	-.0142127	.0818197	-0.17	0.862	-.1745765	.146151
5	.0682787	.0667273	1.02	0.306	-.0625044	.1990618
6	.0171001	.0772208	0.22	0.825	-.1342499	.1684501
8	-.1144565	.0831538	-1.38	0.169	-.2774349	.048522
9	-.0926317	.0924715	-1.00	0.316	-.2738725	.088609
_cons	-.7184076	.1274927	-5.63	0.000	-.9682888	-.4685265
empl						
obese	-1.457997	.0771882	-18.89	0.000	-1.609283	-1.306711
age	.0286951	.0019	15.10	0.000	.0249711	.0324191
married	.1126622	.0360958	3.12	0.002	.0419158	.1834086
race						
1	-.2768771	.0949709	-2.92	0.004	-.4630167	-.0907376
2	-.0617187	.0994358	-0.62	0.535	-.2566092	.1331718
3	-.0240895	.1738964	-0.14	0.890	-.3649202	.3167411
educ_cat						
0	-.6938401	.0791948	-8.76	0.000	-.849059	-.5386212
1	-.6884234	.0674291	-10.21	0.000	-.820582	-.5562648
2	-.6086774	.0617085	-9.86	0.000	-.7296239	-.4877309
3	-.6045848	.0634842	-9.52	0.000	-.7290115	-.4801581
4	-.4049518	.0608816	-6.65	0.000	-.5242775	-.2856261
area	-.0939048	.0409828	-2.29	0.022	-.1742295	-.01358
region						
1	.097562	.0808713	1.21	0.228	-.0609428	.2560668
2	-.3335872	.0718118	-4.65	0.000	-.4743358	-.1928385
3	-.2554867	.087015	-2.94	0.003	-.4260329	-.0849405
4	-.2706998	.0760058	-3.56	0.000	-.4196684	-.1217312
5	-.217829	.0641175	-3.40	0.001	-.3434971	-.0921609
6	-.3094001	.0727499	-4.25	0.000	-.4519872	-.166813
8	-.1349663	.0761744	-1.77	0.076	-.2842653	.0143327
9	-.4395376	.0839248	-5.24	0.000	-.6040272	-.2750481
_cons	.4423834	.1214335	3.64	0.000	.2043781	.6803886
/athrho	1.165187	.1701357	6.85	0.000	.8317273	1.498647
rho	.8227232	.0549754			.6814024	.9049035

Wald test of rho=0:   chi2(1) = 46.903   Prob > chi2 = 0.0000