Association between social economic status and obesity in a rural South African community

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DECLARATION

I, **Songelwayo L Chisi**, declare that this research report is my own work except to the extent indicated in the reference and acknowledgements. It is being submitted for the degree of Master of Science in Epidemiology in the field of Epidemiology and Biostatistics, University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other University.

The University of the Witwatersrand Human Research Ethics Committee approved the study (clearance certificate number M120663).

Signed ....

Date: 15 May 2014

DEDICATION

I dedicate this research work to my late parents, Mr LMH Chisi and Mrs EM Chisi, for the sacrifices they made to educate and make me the person I am today, yet never lived long enough to see the fruits of their sacrifice.

ABSTRACT

Introduction

Obesity is an emerging problem in South Africa, particularly in women for whom prevalence rates well above 40% have been reported. Parallel to this health problem, South Africa continues to experience relatively high poverty levels of 10.5% to 48.0%. The aim of this study was to estimate the prevalence of obesity and low social economic status (SES) levels at Agincourt Health and Socio-Demographic Surveillance System site (AHDSS). The study also sought to investigate the association between low SES and obesity at AHDSS.

Materials and methods

This was a secondary data analysis of the original *Na Nakekela HIV/Non communicable disease (NCD) study* conducted at AHDSS from August 2010 to May 2011. Included in the study presented in this report were residents of AHDSS aged 15 years or older during this time period. Data from 4 502 individuals (2 683 females and 1 819 males) were analysed. Age-specific prevalences of obesity (body mass index ≥ 30kg/m^2), and central obesity (waist hip ratio ≥1.0 and ≥0.85 in men and women, respectively), stratified by sex and SES, were calculated.

SES was assessed by ascertaining the household assets of AHDSS residents and assigning a weighted score to the household assets, using multiple correspondence analysis (MCA). The household score was then computed and used to classify the population into SES categories. The relative ranks of households, using this score, were then used as a measure of SES.

The association between SES and obesity (BMI ≥ 30) was assessed by means of chi-square tests and logistic regression.

Results

The overall prevalence of obesity at the AHDSS in the study period was 20.4%. Overall, sex -specific prevalences of obesity were 29.3% and 7.4% in females and males, respectively. Females aged 50-59 years and males aged 45-49 years had the highest age-specific prevalence of obesity, at 40.1% and 18.3%, respectively. The

overall prevalence of central obesity was 31.1%. Sex-specific prevalence of central obesity in females was 51.1%, while in males it was 4.9%. The highest age-specific prevalence of central obesity in both sexes was for those 70 years and older: 74.3% in females and 11.1% in males.

Around 50% of individuals at the AHDSS were classified as belonging to lower SES categories, with females constituting 56.6% of these individuals. The highest prevalence of individuals in the high SES category was females aged 60-69 (14.5%) and males aged 70 (16.4%) years and older.

After adjusting for other variables, being in a lower SES category was inversely associated with obesity as measured by BMI, as was being male and being HIV positive. The only positive predictor of high BMI was older age. No association between central obesity and lower SES was found after adjusting for confounders and other explanatory variables. However, older age was a predictor of central obesity. Being male, HIV positive and the male head of the household were factors that were inversely associated with central obesity.

Discussion

The high prevalence of individuals in the lower SES group (50.5%) reported in this study is similar to the Mpumalanga provincial poverty estimate of 51%.The ratio of obese females to males was at least 2.2 in every age group. The prevalence of central obesity in females of 51.1% in the AHDSS was higher than the national estimate of 47.1% for females, while the male estimate of 4.9% was lower than the 6.8% national estimate for males. In contrast to other studies, no associations between lower SES and obesity as measured by central obesity were observed.

Conclusion and Recommendations

Specific interventions to reduce obesity in females should be undertaken, including the provision of educational talks. This would empower them to make better informed decisions about food and lifestyle choices. These recommendations should be integrated into already existing HIV prevention programmes because HIV prevention is currently the main focus of policy makers in South Africa. Measures to reduce the number of individuals in the lower SES group, which this study reported to be very high (especially among women), e.g. through job creation, should be considered.

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ABBREVIATIONS

AHDSS	Agincourt Health and Demographic Surveillance Site
BMI	Body mass index
CHD	Coronary heart disease
CI	Confidence interval
DHS	Demographic Health Survey
HIV	Human Immunodeficiency Virus
HH	Head of household
LMIC	Lower and middle income countries
MCA	Multiple correspondence analysis
MRC	Medical Research Council
NALEDI	National Labour and Economic Development Institute
NCD	Non communicable disease
OR	Odds ratio
SADHS	South African Demographic and Health Survey
SANHANES	South African National Health and Nutrition Examination Survey
SD	Standard deviation
SES	Social economic status
SEP	Social economic position
TB	Tuberculosis
THUSA	Transition and Health during Urbanization of South Africa
WHR	Waist to hip ratio
WITS	University of the Witwatersrand
WHO	World Health Organization

CHAPTER 1: INTRODUCTION

This chapter starts by looking at the global burden of obesity before discussing the situation in sub-Sahara Africa and South Africa. The chapter also explores the possible relationship between obesity and social economic status (SES) in different regions of the world before exploring the relationship in South Africa. Published literature on obesity and SES is reviewed. The aim and objectives of the study are defined at the end of the chapter.

1.1 Background

Obesity is a worldwide problem, affecting both developed and developing countries (Abelson and Donald, 2004, Popkin and Gordon-Larsen, 2004, Haslam and James 2005). According to the World Health Organization (WHO), obesity is defined as a body mass index (BMI) equal or greater than ≥30 kg/m^2 (Deitel, 2003, WHO 1995). Using this criterion, the prevalence of obese adults worldwide was estimated to be 9.8% and 10.4% in 2005 and 2010, respectively (Kelly et al., 2008, Wells et al., 2012).

In a review of community based studies that investigated the prevalence, risk, mortality or incidence of non-communicable diseases in sub-Saharan Africa (SSA), obesity was reported to range from 0.4% to 43% (Dalal et al., 2011). In this study, only countries (seven studies from six countries) south of the Sahara were included. South Africa and Nigeria had obesity prevalences of 37% and 43%, respectively (Dalal et al., 2011). Another study in SSA in 2007 estimated the prevalence of obesity to be 3.1% for women and 10.7% for men, respectively (Kelly et al., 2008). In Lesotho and Gambia, respectively, obesity amongst women has been documented to be 23% and 32% (Prentice, 2005). Obesity in rural parts of SSA was estimated to range from 5% in rural Uganda in 2012 to 30% in rural Nigeria in 2012 (Kengne et al., 2013).

Three studies that have involved South African participants (national and provincial in nature) resident in South Africa have estimated obesity to be in the range of 21% to 30% (Kruger et al., 2002, Goedecke et al., 2005, Prentice, 2005) but reports vary. The first South African Demographic and Health Survey (SADHS) of adults aged 15-95 years in South Africa in 2002 reported that 56.6% of women and 29.9% of men were either overweight or obese (Puoane et al., 2002). Bourne et al. (2002) reported that 31% of South African women and 7% of men of all races were obese (Bourne et al., 2002). The latest South African Nutrition Survey (SANHNES) estimated the prevalence of obese females and males in South Africa at 39.2% and 10.6%, respectively (Shisana et al., 2013).

A study in a rural area of KwaZulu Natal (Wand and Ramjee, 2013) reported the prevalence of obesity in a HIV negative cohort of black women to be 36% (Wand and Ramjee, 2013), close to the 31.8% estimated by Shisana in a similar group (Shisana et al., 2013).

Another type of obesity is central obesity, defined as having a waist hip ratio (WHR) ≥ 1.0 and ≥0.85 in men and women, respectively (WHO, 2003). Central obesity is one of the five major risk factors for myocardial infarction (Dalal et al., 2011) and diabetes mellitus (Kengne et al., 2013) in SSA. SANHNES 2012 estimated that 32% and 6.4% of South African women and men are centrally obese (Shisana, et al., 2013).

Parallel to the emerging problem of obesity in South Africa is the problem of poverty, levels of which are persistently high in South Africa. Previous studies have estimated poverty to be in the range of 18 to 58% (Bradshaw et al., 2001, Woolward et al., 2002, Olzer et al., 2007).

The co-existence of poverty and obesity is a phenomenon observed in some other parts of the world (Tanumihardjo et al., 2007). A study by Mendez et al. showed that poor Jamaican women had high levels of obesity, in the range of 30% to 56% (Mendez et al., 2004). In a study in the USA, poor people living in rural areas were more likely to be obese than those residing in urban areas (Bennett et al., 2011).

Community poverty has been suggested as being responsible for the poor food choices poor (rural) people face (Bennett et al., 2011), as large shops that offer a wider and healthier food range are not available in these areas. People living in areas where poverty is high tend to experience food insecurity which may result in choosing foods with high energy, i.e. fat and sugar, to avoid hunger (Tanumihardjo et al., 2007, Bennett et al., 2011) which, in turn, may facilitate the development of obesity (Tanumihardjo et al., 2007).

In South Africa, obesity co-exists with under-nutrition , poverty and infectious diseases, such as tuberculosis and HIV (Goedecke et al., 2005.). This seems to be paradoxical, considering the levels of poverty which are reported to be as high as 18% (UCT, 1999). In South Africa, obesity has been reported to occur in both affluent and very poor areas (Kruger et al., 2002, Barnighausen et al., 2007). A study in a rural South African village in Northern KwaZulu Natal with high poverty levels found that 32% of the community was obese and 58% was overweight (Barnighausen et al., 2007). Obesity in rural areas such as this was observed in those who were relatively well off in relation to the community in which they lived. These findings were similar to those reported by the Medical Research Council (MRC) where obesity was associated with increasing wealth and was highest in women and men in the richest asset index quintile and lowest in the poorest group (Bradshaw, 2001).

At the Agincourt Health and Demographic Surveillance System Site (AHDSS), poverty levels have been estimated to be as high as 64%, and obesity in 15-20 year olds has been estimated to be around 4% (Kimani-Murage et al., 2010).

The latest SANHES survey estimated that 29.5% of households in Mpumalanga province experience food insecurity (Shisana et al., 2013). It is an interesting situation considering the fact that the same study estimated the prevalence of obesity in Mpumalanga province at 13.0% and 35.8% (Shisana et al., 2013) in men and women, respectively. This seems to suggest that obesity is a rising problem in the midst of a prevalent under nutrition problem.

This study investigated the relationship between SES and obesity in a rural South African community.

1.2 Justification

Obesity is a global problem that occurs in both developed and developing countries (Haslam 2005, Kelly et al., 2008 ,). Co-existence of obesity and poverty has been reported globally (Tanumihardjo et al., 2007, Bennett et al., 2011).

Studies in South Africa have estimated that poverty ranges from 10.5% to 48% (Ozler, 2007). Olzer used two methods to measure poverty using data collected from 1995 to 2002. Using the first criterion of the 1995 earnings of below

R354/household/month, he estimated poverty in South Africa at 48%, a decline of 3% compared to the 1995 rate of 45% (Olzer, 2007). Using his second criterion of defining extreme poverty as households living on less than US$1day, poverty increased from 9.4% to 10.5% during the same period of 1995-2002 (Olzer, 2007). Despite these high poverty levels, there are some suggestions that high rates of obesity could also present in these same poor areas (Kimani-Murage et al., 2010). For example, 3.3% of the poorest men and 16.7% of the poorest women who took part in the 1994 South African Demographic and Health Survey (SADHS) were obese (Bradshaw, 2001).

Considering that 72% of poor South Africans live in rural areas (Woolard, 2002), it is important to investigate the association between lower SES and obesity in these communities, and to develop appropriate intervention measures to prevent the development of obesity.

1.3 Literature Review

1.3.1 Causes of obesity

Obesity occurs when there is an imbalance between energy intake and expenditure (Case and Menendez, 2009, Goedecke et al., 2005), resulting in the storage of excess energy in fat cells which either enlarge individually or increase in number (Goedecke et al., 2005). Determinants of obesity can be divided into two groups, i.e. proximate and distal determinants (Case and Menendez, 2009). Proximate factors of obesity are genetic factors, high energy intake, behavioural factors , environmental factors, e.g. community poverty, and lack of physical activity (Case and Menendez, 2009, Johnson, 2011). Distal factors are underlying causes. Table 1 lists both the proximate and distal determinants of obesity.

Table1. Proximate and distal determinants of obesity

Proximate causes	Distal causes
Genetic factors	Low social economic status
High energy consumption	Low educational levels
Physical inactivity	Socio-cultural factors
	Place of residence
	Gender
	Increasing age
	Poverty
	Nutrition transition
	Availability of lower priced calories

1.3.2 Proximate causes of obesity

Genetic factors account for about 25% of obesity cases (Bouchard and Perusee, 1988, Borecki et al., 1998). However, the genes responsible for obesity are polygenic, and therefore difficult to identify (Bouchard and Perusee, 1988). Genes influence the development of obesity in people as they play a crucial role in the body's ability to obtain, expend and store energy (Cabellero, 2005). The increase in energy intake has been demonstrated to have a direct link to the development of overweight and obesity (Misra and Khurana, 2008). This energy imbalance tends to happen over a prolonged length of time. Bourne et al., 2002 reported that urban South Africans had increased energy intake from foods high in fat (Bourne et al., 2002) and that black urban South Africans resident in Johannesburg had increased their dietary fat intake by 59.7%, i.e. from 16.4% to 26.2% over a 50 year period from 1940 to 1990.This trend is no different in the rural population of South Africa (Bourne et al., 2002).

Individuals who are less physically active are more likely to become obese than those who are physically active. These findings were recorded by the THUSA Transition and Health during Urbanization of South Africa (THUSA) study in the

North West province of South Africa (Kruger et al., 2002) which reported that physical activity was protective against obesity (odds ratio [OR] 0.38; 95% CI 0.22 - 0.66 (Kruger et al., 2002). Inactivity was a very strong predictor of obesity (Kruger et al., 2002, Bourne et al., 2002).

These proximate factors of obesity are well documented and undisputed (Case and Menendez, 2009). It is therefore the distal or underlying factors that will be addressed in this report. It must be borne in mind, however, that the proximate factors operate through the distal factors (Kimani-Murage et al., 2011).

1.3.3 Distal causes of obesity

Poverty, gender, age, educational level, and cultural perceptions of body size are some of the distal factors that have been linked to obesity.

The link between obesity and poverty has been documented in developed and developing countries (Phillip et al., 2001, Mendez et al., 2004, Tanumihardjo et al., 2007, Bennett et al., 2011). Poor communities lack family resources and experience food insufficiency, both of which are associated with obesity (Tanumihardjo et al., 2007). When communities experience food insufficiency, they get their energy from foods that are higher in fat and carbohydrates, rather than from fruits and vegetables, which may eventually lead to obesity (Tanumihardjo et al., 2007). The rationale is that refined cereals and foods with added sugar and fats (with very high levels of energy) are amongst the cheapest foods, while foods that are nutrient-dense, such as fish, lean meat, vegetables and fruits, are more expensive (Temple et al., 2011).

The choice of foods high in nutrients but low in energy is lacking in rural areas due to a scarcity of grocery stores which provide this variety (Bennett et al., 2011, Temple et al., 2011). Instead, one finds smaller shops with a narrow range of food choices, which eventually leads to the community making poor food choices.

In South Africa, some studies have provided evidence that the poor are obese. Kimani-Murage et al. conducted a study on the predictors of adolescent weight status and central obesity at AHDSS and observed that, in this poor rural community, a higher SES was positively associated with obesity (Kruger et al., 2002, McLaren, 2007, Kimani-Murage et al., 2010). They used an asset survey in each household to measure SES which was used as a proxy measure for wealth (Kimani-Murage et al., 2011). The study created three SES categories; the lowest, medium and highest SES households in an overall relatively poor community. Compared to the lowest SES group, which was used as the reference, participants in the medium and highest SES categories had higher average BMIs. The odds of being obese or overweight when one was in the higher SES group was twice as high (OR 1.99; 95% CI 1.28-3.09) compared to being in the lowest SES group (Kimani-Murage et al., 2011).

A study in the North West province of South Africa (Kruger et al et al., 2002), which is very similar to the AHDSS in terms of demographic characteristics, established similar findings, i.e. that individuals in a higher SES category were more likely to be obese than those in the lower SES categories. However, it was noted that other factors, such as diet and level of education, were also associated with obesity.

A study in a poor rural South African village in Northern KwaZulu Natal found that being in a higher wealth bracket was a risk factor for obesity (Barnighausen et al., 2007). Holding all other factors equal, the study found that, on average, at every quintile of the household wealth index, people had a higher BMI than those in the wealth index below them.

Sex is another important distal determinant of obesity, with South African women being more likely to be obese than men (Bourne et al., 2002, Goedecke et al., 2005, Kimani-Murage et al., 2011). At AHDSS, female adolescents aged 10-20 years had a 4.24 greater odds of being obese than their male counterparts (95% CI 2.82-6.38) (Kimani-Murage et al., 2011). Case and Menendez demonstrated that the rate of obesity in black South African women is much higher than in men (Case and Menendez, 2009). In a study in the impoverished Cape Town settlement of Khayelitsha, childhood circumstances and adult SES explained the increased risk of obesity in females (Case and Menendez, 2009).

Girls who are exposed to nutritional deprivation during gestation, e.g. famine, have been found to have greater weight gain, higher BMI and greater waist circumferences in their adult years (Ravelli et al., 1999, Luo et al., 2006,). Men with the same experience do not exhibit the same end results. This has led some researchers to conclude that women who experience nutritional deprivation early in life during gestation are more likely to become overweight or obese in their adult lives (Ravelli et al., 1999, Luo et al., 2006). Case and Menendez's findings were similar, i.e. childhood deprivation in women was a determinant for obesity in adulthood (Case and Menendez, 2009).

Kimani-Murange et al. (Kimani-Murange et al., 2011) established that increasing age was a stronger predictor for obesity in adolescence girls at the AHDSS, than in boys: 23% of girls compared to 3% of boys aged 20 years were obese (p = 0.001). This was in contrast to the findings at age 15 where 15% of girls were obese or overweight compared to 7% of boys (p = 0.05.) In the Northwest province study (Kruger et al., 2002), increasing age was also a risk factor (Table 2) which supports the findings of Case and Menendez (Case and Menendez, 2009) .

Table 2. Association of age and obesity for 1040 participants from 37 randomly selected sites (Kruger et al. 2001).

Age group	OR	95% CI	P value
20-24 (Reference)	1		
25-34	3.08	1.30- 7.28	0.01
35-44	6.90	2.82-16.92	<0.0001
45-54	7.91	2.97-21.06	<0.0001
55 +	7.22	2.59-20.14	<0.0001

Amongst adolescents, those coming from households in which the head did not possess a secondary school education were protected from obesity. The odds of these adolescents being obese were 40% lower than in those households in which the head did have a secondary or higher education (Kimani-Murage et al., 2011).

Body perception is another risk factor for obesity. Black South Africans are very comfortable with being overweight as they associate it with being happy, beautiful , affluent , healthy and HIV negative (Mvo et al., 1999). In African communities, women have big bodies because a big body is culturally acceptable (Monteiro et al., 2004).

1.3.4 Obesity as a risk factor for chronic disease

A number of health risks can result from being obese. These risks can be divided into two categories (Goedecke et al., 2005):

1. Those associated with excessive adipose tissue, e.g. osteoarthritis, sleep apnoea, and psychological problems (Goedecke et al., 2005).
2. Those associated with metabolic effects of adipose tissue, e.g. diabetes type II, coronary heart disease (CHD), and some forms of cancer (Goedecke et al., 2005, Case and Menendez, 2009).

In a USA study of 114 281 female nurses, the risk for diabetes type II increased 40 fold when the BMI increased from 22 to 35 kg/m^2 (Colditz et al., 1995). Similar findings were recorded in a UK study (Chan et al., 1994) that reported a relative risk of developing diabetes of 42 in men who had a BMI greater than 35 kg/m^2 compared to those who had a BMI of less than 23 kg/m^2. A prospective study conducted in 2010 in Japan among 52 014 men and women also reported that increased BMI was a risk factor for diabetes type II (Nanri et al., 2011).

In an American study of 195 005 randomly sampled individuals, the relative risk of developing hypertension was 3.5 when one was obese compared to when one was not obese (Mokdad et al., 2001).

Obesity increases the risk of an individual developing CHD (Willet et al., 1999, Honda et al., 2013). Willet et al calculated the relative risk of developing CHD when one is obese as 2.8 and 3.4 in men and women, respectively (Willet et al., 1999). However, despite the prevalence of obesity being high amongst black South Africans, the prevalence of CHD remains low, at 2.4 % (Seedat et al., 1993).

Central obesity presents a much higher risk for diabetes type II. The risk of type II diabetes increases with the degree and extent of being overweight and central obesity (Goedecke et al., 2005, Gray, 2004).

In summary, obesity and central obesity seem to be of increasing importance in urban and rural areas of lower and middle-income countries (LMIC), such as South Africa (Pampel et al., 2012).

1.3.5 The nutrition transition and obesity

Nutrition transition can be understood as a shift from traditional foods high in carbohydrates and fibre to those high in energy and fat (Popkin, 2001, Bourne et al., 2002, Kimani-Murage et al., 20111). This shift in dietary preference is compounded by a reduction in physical activity resulting in sedentary activity (Popkin et al., 2012). This phenomenon has been noticed in LMIC (Popkin et al., 2012). Although this transition is evident worldwide, it is happening at a faster rate in LMIC (Popkin and Larsen, 2004). This transition has been shown to be associated with rapid urbanisation and technological advancement, and has been linked to increased prevalence of obesity (Popkin, 2001). The nutrition transition is behind the rapid increase of obesity in LMIC (Kimani-Murage et al., 2013) including South Africa (Goedecke et al., 2005). Two historic processes of change, i.e. the demographic and epidemiologic transitions, precede or occur simultaneously with the nutrition transition (Popkin and Larsen, 2004). During the demographic transition, countries move from a pattern of high fertility and mortality to one of low fertility and mortality. In the epidemiologic transition, nations move from a pattern of high prevalence of infectious diseases to one of high prevalence of chronic and degenerative diseases (Popkin and Larsen, 2004).

1.3.6 Double burden of under nutrition and obesity

The unique co-existence of under nutrition and obesity in a community (Kimani-Murage, 2013) leads to a substantial increase in burden of disease (WHO, 2002). The nutrition transition has been reported as the reason behind the increasing prevalence of obesity in lower to middle income countries, including South Africa (Popkin, 2003, Popkin et al., 2012,). Lower levels of physical activity and sedentary life styles (Kruger et al., 2005) are also causes of obesity. Obesity predisposes individuals to develop non- communicable diseases, e.g. diabetes and cardiovascular diseases.

The high level of food insecurity at household level contributes to the high levels of under nutrition in South Africa (Kimani-Murage, 2013). Under nutrition leads to diseases such as Kwashiorkor and Marasmus (Bain et al., 2013).

1.3.7 Association between obesity and SES

There is evidence supporting the notion that SES and weight are positively associated in less developed countries but negatively associated in high income countries (Pampel et al., 2012). In less developed countries individuals with a higher SES status are more likely to be obese compared to those with a lower SES status (Pampel et al., 2012, Fez et al., 2005). Food insecurity, which is very prevalent in less developed countries, especially amongst individuals with a lower SES status, could be one of the reasons why individuals weigh less in this SES category (Pampel et al., 2012). These individuals also tend to get more labour demanding jobs which limit their chances of weight gain but the opposite is true in those with a higher SES status (Pampel et al., 2012). In less developed countries, being heavier is seen as a symbol of power and physical prowess and may be a reason why those with a higher SES status tend to be obese (McLaren, 2007).

1.4 Objectives

Broad objective

To investigate the association between SES and obesity in a rural South African community.

Specific objectives

1. To measure the prevalence of obesity and to assess SES in residents aged 15 years and older at AHDSS, participating in the *Ha Nakekela study* from August 2010 to May 2011.

2. To investigate the association between SES and obesity in individuals aged 15 years and older, resident at AHDSS and participating in the *Ha Nakekela' study* from August 2010 to May 2011.

1.5 Hypothesis

Null hypothesis: SES is not associated with obesity at AHDSS.

Alternative hypothesis: SES is associated with obesity at AHDSS.

CHAPTER 2: MATERIALS AND METHODS

Introduction

In this chapter, the study site, study population and the methods used to gather and analyse data are described. Descriptions and definitions of exposure and outcome variables are provided, as well as other explanatory variables and possible confounders. Statistical methods that were used are also described. Ethical issues are discussed at the end of the chapter.

2.1 Study setting and study population

The study participants were permanent residents of the AHDSS. The AHDSS is operated by the Medical Research Council / University of the Witwatersrand Rural Public Health and Health Transitions Research Unit. It is located in the rural south east part of South Africa on the eastern border of the Kruger National Park. The AHDSS constitutes Bushbuck Ridge, a sub-district of Ehlanseni district which is approximately 500 km north east of Johannesburg in Mpumalanga province (Kahn et al,. 2007). It had a population of approximately 90 000 people in 2007, with 24 village settlements and around 15 500 households. The proportion of females and males was 52% and 48%, respectively, in 2003; 73% of the total population was younger than 15 years and 13% was 59 years or older. Approximately one third of this population is Mozambican immigrants who entered South Africa in the early to mid-1980s, while fleeing the civil war there.

The AHDSS is located in a province with very high levels of poverty, i.e. 64% in 1996 (Gelb, 2003), coupled with high unemployment levels estimated at 29% for men and 46% for women, using 2004 AHDSS labour data (Collison, 2009). Migrant work is common where men work mostly in the mining, agricultural and game farming, and construction sectors, whilst women are mostly employed on farms or as domestic workers. The unique coexistence of obesity and under nutrition has been documented at the AHDSS (Kimani-Murage et al., 2010). The levels of illiteracy are still very high (80% in 2006 in those aged 60 years or older) (Collison, 2009).

2.2 Study design

This was a cross-sectional study. It was a secondary analysis of data collected by the AHDSS as part of the *Ha Nakekela HIV/NCD study* which was conducted from August 2010 to May 2011.

2.2.1 Sample size and sampling method

Individuals were randomly selected from the 2009 Agincourt Census data, stratified by age (15 years and older) and sex. The total eligible population (permanent residents defined as those persons who lived in the house for 6-12 months up to the time of the census in 2009) was 34 413. A total of 4 764 participants (1 892 males and 2 872 females) took part in this primary study. Two participants were excluded because they were younger than 15 years at the time of sampling. A further 260 potential participants were excluded because the outcome variable, BMI, was missing from the database. The final study sample that was analysed compromised 4 502 individuals.

2.3 Data collection methods for the *Ha Nakekela HIV/NCD study*

All participants were visited up to three times in their homes by the research team, from August 2010 to May 2011. The visit lasted approximately 45 minutes and included obtaining informed consent, anthropometric data (height, weight, hip and waist circumference), and collecting information on chronic disease risk factors (age, educational level, consumption of fruits, levels of physical activity) by use of an adapted WHO STEPS questionnaire. The questionnaire is based on the WHO stepwise approach to chronic disease risk factor surveillance and the WHO/INDEPTH study on Global Aging and Adult Health. Socio demographic information such as age, sex, educational and sex of HH were also collected. Data for SES and household consumption were derived from the annual census at the AHDSS.

Height was measured in meters (m) to the nearest 0.1 m in a standing position without shoes, using a flexible stadiometer. Weight was measured in kilograms (kg) to the nearest 0.1 kg with study participants wearing no shoes and only light clothing. Hip and waist circumferences were recorded in centimetres (cm) to the nearest 0.1 cm, using a flexible seca tape.

2.4 Study Variables

2.4.1 Definition and assessment of SES (exposure variable)

Availability of household assets (Appendix I) was ascertained in the annual AHDSS census and used to compute a household score using multiple correspondence analysis (MCA) because of the categorical nature of the household data. A weighted score was assigned to various household assets (Appendix II) to compute a household score (HHS) that was then used to classify the population into wealth categories. The relative rank of households, using this score, was then used as a measure of social economic status (SES). A wealth score was created, using the formula:

$$MCA_{Pi} = R_{i1}W_1 + R_{i2}W_2 + \ldots + R_{ij}W_j$$

Where:

MCA_{Pi} is the i^{th} population unit's composite poverty indicator score arising from MCA;

R_{ij} is the response of population unit i to category j;

W_j is the MCA weight applied to category j.

Computations for generating this HHS were performed using the mca command of Stata 11.

SES is considered to be a long term predictor of household expenditure consumption in rural areas where conventional methods of measuring expenditure consumption are absent.

SES was aggregated into four categories of rural wealth status. Households with scores equivalent to the value of the 25th percentile or lower were classified as "lower 1". Those with scores from the 25th to the 50th percentile were classified as "lower 2". Those with scores from the 50th to the 75th percentile were classified as "middle". Those with scores higher than the value of the 75th percentile were considered to be "high".

2.4.2 Assessment and description of obesity (outcome variable)

Obesity was assessed in terms of BMI and WHR. BMI was calculated as weight in kilograms divided by the height in square metres [weight (kg)/height (m^2)]. Obesity was defined, according to WHO criteria, as BMI ≥ 30 kg/m^2 (WHO, 1995). Four BMI categories were created, i.e. underweight (< 18.5 kg/m^2), normal (18.5 - 25.0 kg/m^2), overweight (25.0 - 30 kg/m^2) and obese (≥30 kg/m^2).

WHR was calculated by dividing the waist circumference by the hip circumference (both measured in cm) [waist circumference (cm)/hip circumference (cm)]. Central obesity in men was defined as WHR ≥ 1.00 and, in women, as WHR ≥ 0.85 (Han et al. 1997).

2.4.3. Confounders/ other explanatory variables

Age was calculated in years as a continuous variable and also categorised into 5-year age groups from 15-19 years to 70 years and older. Sex was recoded as M for male or F for female. Sex of head of household was also recoded as M or F. Education was recoded as none, primary, secondary or tertiary. HIV status was recoded as positive or negative. The number of fruits consumed per day per individual was recorded as none, one, two, three, four, five or more per day.

2.5 Data entry

Corrected records and records without errors were copied into a database during the primary study. The variables and data were then transferred to Stata where all statistical analyses were performed.

2.6 Data cleaning

Using a series of queries, checks were performed to identify possible errors. Relevant variables were chosen for inclusion in the final data set for analysis.

All observations with missing values for the outcomes (BMI, WHR) or the exposure (poverty) variables were dropped.

2.7 Statistical analysis

The study population was stratified by sex. The number of individuals with each characteristic was calculated, using the tabulate command, and statistically significant differences between the two sexes for each characteristic were assessed using the ranksum command. The means and standard deviations of continuous variables were assessed, using the summarise command of Stata 11. Histogram graphs were constructed, using Microsoft Excel 2010 to show the distribution of obesity and SES in the different age groups.

The prevalence of low SES status was determined by dividing the number of participants with low SES (lower 1 and lower 2) by the total number of participants. Prevalence of obesity was determined by dividing the number of obese people by the total number of participants of the study. The prevalences of obesity and SES were computed in the different age groups and SES categories, stratified by sex. Age-specific proportion rates (of poverty, obesity and central obesity), stratified by sex, were calculated by dividing the number of individuals in a particular age group who were obese by the total number of individuals in that age group.

Depending on the nature of the distribution of the continuous variable in the population, the Pearson correlation coefficient or the Spearman's rank correlation coefficient was used to assess correlation between obesity (as measured by BMI) and the continuous variable, e.g. age. The strength of association was displayed graphically, using the scatter command of Stata 11.

The Chi-square test was used to assess any associations between obesity and the categorical variables, using the tab, chi command.

Ordinal logistic regression was used to test for any associations between explanatory variables and obesity since the outcome was ordered. Dummy variables for the outcome (obesity) were 1 (underweight), 0 (normal, used as the reference category), 2 (overweight), and 3 (obese).

For central obesity, logistic regression was used to test the association between poverty and central obesity since the outcome was binary. Dummy variables for the outcome (central obesity) were 0 (normal, used as the reference category) and 1 (central obesity).

Uni- and bivariate ordinal logistic regression analyses were used to investigate each exposure factor to test if it was associated with obesity and/or central obesity. Variables significantly associated with obesity in the univariate model, i.e. those with a p-value of 0.2 or less, were included in the multivariate model.

2.8 Ethical clearance

Ethics clearance for the *Ha Nakekela HIV/NCD study* was granted by the University of the Witwatersrand Human Research Ethics Committee (certificate number M10458). A separate clearance certificate was obtained for this secondary data analysis by the same Committee (certificate number M120663); a copy is attached in Appendix III.

3: RESULTS

Introduction

This chapter is a presentation of the results of the statistical analyses of this study. It describes the study population and the associations between obesity/central obesity and SES (and other variables) at the AHDSS. Predictors of obesity (and central obesity) are identified.

3.1 Description of study population

A total of 4 502 participants aged 15 years or older and residing at the AHDSS in the period August 2010 to May 2011 were included in this secondary data analysis. Table 3 summarises the characteristics of the study population. The mean age was 41.4 years (standard deviation (SD) 18.9 years). The majority of the respondents were female (59.6%; n=2 683); males comprised 40.4% (n = 1 819) of the participants. The age groups were evenly represented because of the sampling methods employed in the primary study.

3.2 Obesity/central obesity and SES

3.2.1 Obesity

Table 4 compares the prevalence of underweight, normal weight, overweight and obese individuals at the AHDSS across age group categories. The overall prevalence of obesity was 20.4%. The highest percentage (31.9%) of obese individuals was in the age group 45-49 years. Females with the lowest prevalence of obesity were in the 15-19 year old age group (7.0%), whilst the 50-59 year olds had the highest prevalence of obesity (40.1%), as shown in Appendix IV. Among men, the 20–24 year olds had the lowest prevalence of obesity (0.5%) and the 45-49 year olds had the highest (18.3%) (Appendix V). The ratio of obese females to males was 2.2 or greater in all age categories. Females had higher BMIs than males across all age groups (Fig 1).

Table 3. Characteristics of study participants

	Females		Males		Overall		P-value
	N	%	n	%	N	%	
Age group (years)							
15-19	242	5.4	254	5.7	496	11.1	0.450
20-24	262	5.9	213	4.8	475	10.6	0.000*
25-29	289	6.5	175	3.9	464	10.4	0.173
30-34	299	6.7	168	3.8	467	10.5	0.975
35-39	332	7.4	193	4.3	525	11.8	0.020*
40-44	203	4.5	110	2.5	313	7.0	0.896
45-49	238	5.3	126	2.8	364	8.1	0.065
50-59	269	6.0	158	3.5	427	9.6	0.813
60-69	284	6.4	201	4.5	485	10.9	0.427
70 +	245	5.5	208	4.7	453	10.1	0.999
BMI							
Underweight	103	2.3	219	4.9	322	7.2	0.144
Normal	1 054	23.6	1 110	24.8	2 164	48.4	0.000*
Over weight	727	16.3	343	7.7	1 070	23.9	0.005*
Obese	779	17.4	134	3.0	913	20.4	0.012*
WHR							
Normal	1 296	29.0	1711	38.3	3 007	67.3	0.000*
Abnormal	1 363	30.5	89	2.0	1 452	32.5	0.000*
Educational level							
None or primary	1 292	28.9	815	18.1	2 049	45.9	0.000*
Secondary	1 165	26.1	884	19.8	2 107	47.2	0.008*
Tertiary	196	2.8	68	1.52	194	4.3	0.158
SES status							
Lower 1	702	15.7	462	10.3	1 164	26.0	0.112
Lower 2	652	14.6	426	9.5	1 078	24.1	0.160
Middle	682	15.3	437	9.8	1 119	25.0	0.921
High	627	14.1	481	10.8	1 108	24.8	0.774
Sex of HH	1 671	37.4	2 772	67.0	4 443	100	0.000*
HIV status							
Negative	1 838	41.1	1 313	29.4	3 151	76.5	0.000*
Positive	701	15.7	347	7.8	1 048	23.5	0.000*

Table 4. Number of individuals in each weight category across age group categories

Age group n (%)		15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-59	60-69	70+	P-value
Normal	2 164	341	305	252	206	233	126	144	160	175	222	0.000
Weight	(48.4)	(68.8)	(64.2)	(54.3)	(44.1)	(44.4)	(40.2)	(39.6)	(37.5)	(36.1)	(49.0)	
Under	322	84	45	19	23	34	16	13	22	34	22	0.242
Weight	(7.2)	(16.9)	(9.5)	(4.1)	(4.9)	(6.5)	(5.1)	(3.5)	(5.2)	(7.0)	(4.9)	
Over	1 070	46	81	116	125	141	78	91	122	149	121	0.000
Weight	(23.9)	(9.3)	(17.1)	(0.25)	(26.8)	(26.9)	(24.9)	(25.0)	(28.6)	(30.7)	(26.7)	
Obese	913	25	44	77	113	117	93	116	123	127	78	0.417
	(20.4)	(5.0)	(9.3)	(16.6)	(24.1)	(22.3)	(29.7)	(31.9)	(29.9)	(30.7)	(17.2)	
Total	**4 469**	**496**	**475**	**464**	**467**	**525**	**313**	**364**	**427**	**485**	**453**	

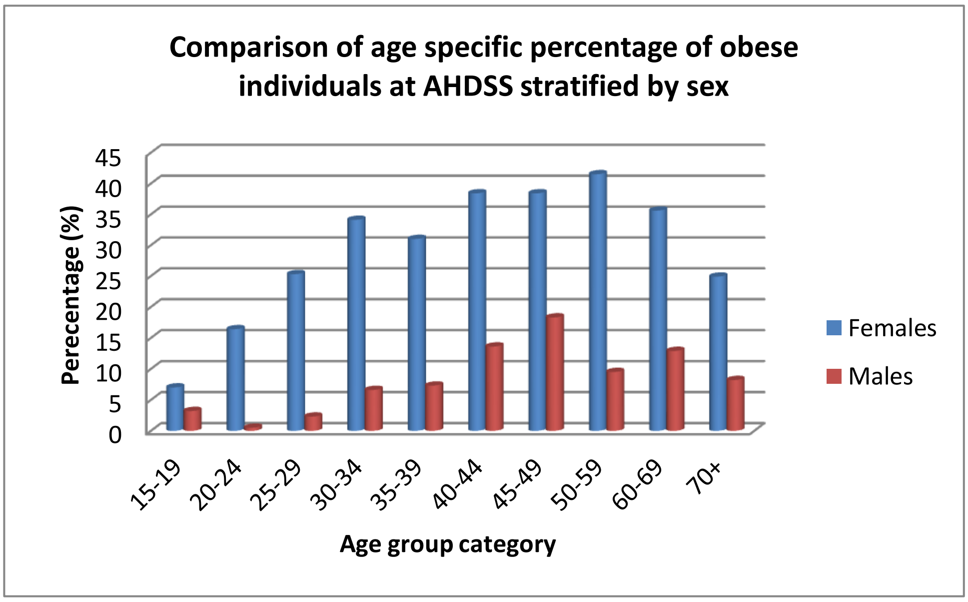

Figure1. Distribution of obesity among males and females, by age group

3.2.2 Central obesity

Table 5 displays the distribution of centrally obese individuals. The age group 15-19 years had the lowest percentage (14.3%) of centrally obese individuals, while the age group 50-59 years had the highest percentage (57.4%).

Table 5. Comparison of the distribution of centrally obese individuals at AHDSS across age groups

Age group n (%)		15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-59	60-69	70+	P-value
Normal	2 485	425	350	271	229	267	142	157	182	209	254	0.000
	(55.6)	(85.7)	(73.7)	(58.4)	(49.0)	(50.9)	(45.4)	(43.1)	(42.6)	(43.1)	(56.1)	
Obese	1 982	71	125	193	238	258	171	207	245	276	199	0.000
	(44.)	(14.3)	(26.3)	(41.6)	(51.0)	(49.1)	(54.6)	(56.9)	(57.4)	(56.9)	(43.9)	
Total	4 467	496	475	464	467	525	313	364	427	485	453	

More than 70% of females in the age group 50-59 years were centrally obese (Appendix VI). The highest percentage (45.2%) of centrally obese males was in the age group category 45-49 (Appendix VII).

Central obesity increased with age in both males and females, and females had a much higher prevalence of central obesity than males across all age groups (Figure 2).

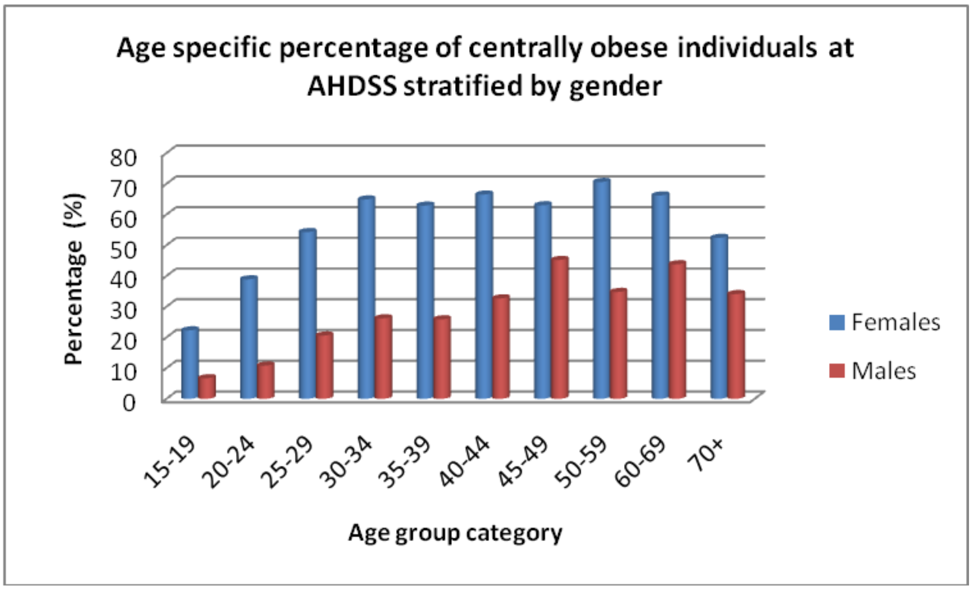

Figure 2. Distribution of centrally obese individuals, by gender.

3.2.3 Classification of social economic status

The proportion of individuals in the lower SES category (those in the "lower 1" and "lower 2" categories) was estimated to be 50.5% (n = 2 242) as per the definition of SES. Of these individuals, 1354 (60.4%) were females. More males than females in the 20-24 age group were in the "lower 1" category, i.e. 15.4% and 10.0%, respectively. There were 24.8% (1 108) individuals in the "high" SES category, 56.6% (627) of whom were female.

The prevalence of females in the high SES category (Appendix VIII) was highest in the age group 60-69 years (14.8%), while in males, the highest prevalence was in those aged 70 years and older (38%) (Appendix IX).

The numbers of individuals in the SES indices were evenly distributed. The median HHS was 2.60 with the lowest score being -2.77 and the highest 18.14. A negative score was associated with a lower SES whilst a larger positive score was associated with high SES.

Table 6. Prevalence of SES by age group at AHDSS

	Age group years n (%)	**15-19**	**20-24**	**25-29**	**30-34**	**35-39**	**40-44**	**45-49**	**50-59**	**60-69**	**70+**	**P-value**
Lower 1	1 116	122	136	125	95	135	82	84	(103	128	106	0.450
	(25.0)	(10.9)	(12.9)	(11.2)	(8.5)	(12.1)	(7.4)	(7.5)	(9.2)	(11.5)	(9.5)	
Lower 2	1 116	131	104	112	118	140	71	101	121	89	129	0.142
	(25.0)	(11.74)	(9.3)	(10.0)	(10.6)	(12.5)	(6.4)	(9.1)	(10.8)	(8.0)	(11.6)	
Middle	1 129	128	149	109	155	132	80	93	97	104	82	0.051
	(25.3)	(11.3)	(13.2))	(9.7)	(13.7)	(11.7)	(7.1)	(8.2)	(8.6)	(9.2)	(7.3)	
High	1 108	115	86	118	99	118	80	86	106	164	136	0.835
	(24.8)	(10.4)	(7.7)	(10.7)	(8.9)	(10.7)	(7.2)	(7.8)	(9.6)	(14.8)	(12.3)	
	4 469	**496**	**475**	**464**	**467**	**525**	**313**	**364**	**427**	**485**	**453**	

Table 6 compares the distribution of individuals across age groups in the different SES categories. The age group 20-24 years had the highest percentage (12.9%) of individuals in the "lower 1" category, while the age group 40-44 years had the lowest percentage (7.4%). Most of the individuals in the high SES category were aged 60-69 years (14.8%); the lowest percentage (7.2%) was in the group aged 40-44 years. For both sexes, the highest proportion of individuals with high SES was in the 60-69 year age group, i.e. 14.5% and 15.2% for males and females, respectively (Appendix VIII and IX). There were more males categorised as "lower 1" SES in the age groups 15-19 and 20-24 years old (Figure 3).

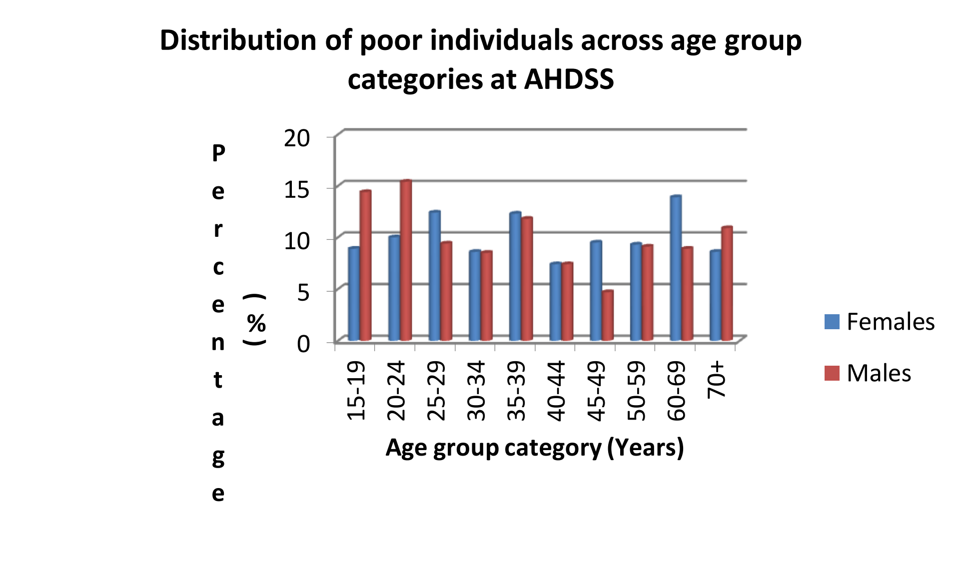

Figure 3 Distribution of individuals across SES categories at AHDSS.

3.3 The association between obesity and SES

3.3.1 Correlation

There was a moderate correlation (r=0.321, p=0.000) between BMI and WHR, as expected (Table 7 and Appendix X). Nine hundred and thirteen individuals (913; 20.4%) were obese (BMI), while 1 451(32.6%) were centrally obese. Age (r=0.229, p=0.000) and HH (0.128, p=0.000) had weak correlations with BMI. No correlation was found between years of education and BMI.

Table 7. Correlation between BMI and continuous variables of individuals (n= 4 469)

Characteristic	Spearman's rho	n	P value	Strength*
Age	0.229	4 469	0.000	Weak
Education (Years)	-0.008	4 350	0.589	None
WHR	0.321	4 494	0.000	Moderate
Household score	0.128	4 469	0.000	Weak

*Key: -1 to -0.5 or 0.5 to 1.0 strong, -0.5 to -0.3 or 0.3 to 0.5 moderate, -0.3 to -0.1 or 0.1 to 0.3 weak, -0.1 to 0 or 0 to 0.1 none.

3.3.2 Association between obesity (BMI) and selected categorical variables

There was a strong association (P= 0.000) between obesity and SES status, sex, age group, HIV status, sex of HH, and educational level, but no association (P =0.854) between obesity and the gender of head of household (Table 8).

Table 8. Association between obesity and selected categorical variables

Characteristic	n	Pearson Chi-square	P value
SES status	4 459	69.1	0.000
Sex	4 469	490.4	0.000
Age group	4 469	427.2	0.000
HIV status	4 199	21.9	0.000
Sex of HH	4 443	0.8	0.854
Educational level	4 350	81.9	0.000

3.3.3 Univariate analysis

3.3.3.1 Obesity (BMI)

In the univariate analysis, being in a lower SES category, being male, and being HIV positive were inversely related to obesity, whilst being in a higher age category was a risk factor for obesity. Individuals who were in the “lower 1” SES category were 44% less likely to be obese compared to those who were in the high SES category. An HIV positive individual was 21% times less likely to be obese compared to an HIV negative individual. Being older than 19 years was a risk factor for obesity. Individuals aged 45-49 years had the highest odds (OR 4.60; 95% CI 3.52-6.01) of being obese compared to those in the 15-19 year age group. Consumption of fruits, gender of head of household and education were not significantly associated with obesity.

Table 9. Variables associated with obesity (BMI) at AHDSS (univariate analysis)

Exposure variable	N	OR	95% CI	P-Value
SES category				
High (Reference)	1 108	1		
Middle	1 129	0.86	0.73-0.99	0.046
Lower 2	1 116	0.75	0.64-0.88	0.000
Lower 1	1 116	0.56	0.48-0.60	0.000
Sex				
Female	2 263	1		
Male	1 806	0.32	0.29-0.37	0.000
Age group				
15-19	496	1		
20-24	475	1.34	1.04-1.74	0.023
25-29	464	2.24	1.74-2.89	0.000
30-34	467	3.44	2.69-4.43	0.000
35-39	525	3.25	2.55-4.14	0.000
40-44	313	4.24	3.21-5.60	0.000
45-49	364	4.60	3.52-6.01	0.000
50-59	427	4.49	3.49-5.80	0.000
60-69	485	4.34	3.40-5.56	0.000
70+	453	2.59	2.02-3.34	0.000
Educational level				
Primary (Ref)	2 067	1		
Secondary	2 120	1.02	0.91-1.14	0.704
Tertiary	196	2.83	2.15-3.71	0.812
Sex of HH				
Female (Ref)	671	1		
Male	2 772	1.04	0.93-1.16	0.520
Fruits eaten/Day				
None or one (Ref)	2 238	1		
Two	1 100	0.98	0.85-1.11	0.727
Three	405	0.91	0.74-1.11	0.322
Four	155	1.14	0.84-1.53	0.400
Five or more	75	1.24	0.82-1.92	0.306
HIV status				
Negative (Ref)	3 151			
Positive	1 048	0.79	0.69-0.90	0.000

3.3.3.2 Central obesity

Table 10 shows ORs of variables in the univariate ordinal regression model for central obesity. Being older was identified as a predictor of central obesity. Individuals aged 60-69 years were 10.61 times (95% CI 7.31-15.40) more likely to be centrally obese compared to those aged 15-19 years.

Being male and HIV positive was protective against central obesity, while wealth status and consumption of fruits were not significantly associated with central obesity.

3.3.4 Multivariate analysis

3.3.4.1 Obesity (BMI)

Table 11 shows ORs for variables included in the multivariate model, identifying predictors for obesity. Being in the “lower 1” and “lower 2” SES categories, being male and being in an older age group were factors associated with obesity. Individuals in the “lower 1” SES category were 48% less likely to be obese compared to those in the “high” SES category. Being older than 24 years and younger than 60 years was a predictor of obesity.

After adjusting for other variables, being in a lower SES category was found to be inversely associated with central obesity. However, being male was protective against obesity: males were 66% less likely to be obese compared to females.

Table10. Univariate logistic regression analysis of variables influencing central obesity

Exposure variable	n	OR	95% CI	P-Value
SES index				
High (reference)		1		
Middle	1 108	0.90	0.75-1.07	0.238
Lower 2	1 119	1.02	0.85-1.21	0.846
Lower 1	1 078	0.93	0.78-1.11	0.425
Sex				
Female ref		1		
Male	1 806	0.05	0.04-0.06	0.000
Age group				
15-19 ref	496	1		
20-24	475	1.73	1.13-2.64	0.000
25-29	464	3.43	2.31-5.08	0.000
30-34	467	5.71	3.90-8.35	0.000
35-39	525	5.86	4.03-8.52	0.000
40-44	313	8.43	5.67-12.54	0.000
45-49	364	8.79	5.97-12.95	0.000
50-59	427	10.27	7.03-14.99	0.000
60-69	485	10.61	7.31-15.40	0.000
70+	453	9.80	6.73-14.28	0.000
Education level				
Primary/None Ref	2 120	1		
Secondary	2 067	1.02	0.90-1.15	0.808
Tertiary	196	1.16	0.86-1.55	0.332
Sex of HH				
Female ref	679	1		
Male	2 272	1.04	0.92-1.18	0.486
Fruits eaten/Day				
None or one (Ref)	2 238	1		
Two	1 100	0.94	0.81-1.20	0.441
Three	405	0.83	0.66-1.44	0.105
Four	155	0.91	0.64-1.29	0.588
Five or more	75	0.83	0.50-1.38	0.471
HIV status				
Negative ref	3 151	1		
Positive	1 048	0.82	0.71-0.94	0.005

Table 11.Multivariate ordinal regression analysis of obesity.

Exposure variable	n	OR	95% CI	P-value
SES status				
High (ref)		1		
Middle	1 108	0.96	0.79-1.16	0.643
Lower 2	1 119	0.74	0.62-0.88	0.001
Lower 1	1 078	0.52	0.44-0.61	0.000
Gender				
Female		1		
Male	1 806	0.33	0.28-0.38	0.000
Age group				
15-19 (ref)	496	1		
20-24	475	1.37	0.96-1.96	0.079
25-29	464	2.11	1.41-3.16	0.000
30-34	467	3.01	1.88-4.84	0.000
35-39	525	2.64	1.53-4.58	0.001
40-44	313	3.31	1.73-6.36	0.000
45-49	364	2.77	1.32-5.82	0.007
50-59	427	2.80	1.16-6.74	0.022
60-69	485	2.62	0.90-7.59	0.076
70 +	453	1.92	0.51-7.21	0.332
HIV status				
Negative ref	3 149	1		
Positive	1 048	0.64	0.54-0.76	0.000

3.3.4.2 Central obesity

Being aged 70 years or older was associated with the highest odds of 17.43 of being centrally obese (95% CI 11.00-27.63) compared to being aged 15-19 years. Being male and HIV positive were inversely associated with being centrally obese.

Table 12. Multivariate logistical regression analysis of central obesity

Characteristic	n	OR	95% CI	P-Value
SES Status				
High (Ref)		1		
Middle	1 108	0.87	0.70-1.09	0.253
Lower 2	1 119	0.92	0.73-1.16	0.500
Lower 1	1 078	0.87	0.68-1.09	0.236
Gender				
Female	2 663	1		
Male	1 806	0.03	0.02-0.04	0.000
Age group				
15-19 ref	496	1		
20-24	475	1.79	1.11-2.97	0.019
25-29	464	3.26	2.07-5.16	0.000
30-34	467	5.92	3.76-9.31	0.000
35-39	525	6.23	4.01-9.72	0.000
40-44	313	9.73	2.25-14.55	0.000
45-49	364	10.00	6.03-15.07	0.000
50-59	427	12.53	6.29-15.86	0.000
60-69	485	17.29	7.96-19.73	0.000
70+	453	17.43	11.00-27.63	0.000
HIV Status				
Negative (ref)	3 151	1		
Positive	1 048	0.72	0.59-0.87	0.001

CHAPTER 4: DISCUSSION

The aim of this study was to measure the prevalence of obesity, central obesity, and to assess SES; and to investigate the relationship between poverty and SES, in a rural South African community. The results of this secondary data analysis estimated overall obesity, central obesity and lower SES status to be 20.4%, 32.6% and 50%, respectively. Belonging to a lower SES status was protective against obesity, compared to belonging to a higher one. However, there was no significant association between central obesity and lower SES. Detailed discussion of the findings follows.

4.1. Prevalence of obesity (BMI)

The overall prevalence of obesity at the AHDSS was estimated to be 20.4%. The prevalence of obese males was 7.4% which is lower than the national and Mpumalanga provincial estimates of 10.6% and 13.0%, respectively, reported in the South African National Health and Nutritional Examination Survey (SANHANES-1) (Shisana et al., 2013). The prevalence of 20.4% for females was also lower than the 35.8% and 31.3% estimated in the SA NHANES-1 (Shisana et al., 2013).

This study estimated prevalences of obesity in narrower age group categories of five years, starting from the 15-19 years up to 70 years and older, in contrast to other studies at AHDSS that used wider age group categories (Kimani-Murage, 2010). The highest prevalences of obesity in females were in the age groups 45-49 and 50-59 years (40% and 39.1%, respectively); in males, those aged 40-44 and 45-49 years had the highest prevalence of obesity at 13.6% and 18.3%, respectively. These findings are in agreement with what other studies (Shisana et al., 2013) have reported, in that individuals become more obese as they get older.

The prevalence of obese males was very low in the age group 20-24 years, i.e. 0.5%, which is very close to Kimani-Murage et al.'s 2010 estimate of 0% in those aged 20 years. The agreement with Kimani-Murage et al.'s study supports the evidence that obesity is not a problem in young males.

The proportion of obese individuals increased with age as reported in other studies (Kruger et al., 2002., Malaza et al., 2012, Wand and Ramjee, 2013). The prevalence of obese or overweight females was higher than males in every age category except the 60-69 year age group where the prevalences were similar. This is in agreement with what has been reported in studies elsewhere (Kruger et al. 2002, Case and Menendez, 2009, Malaza et al., 2012).

4.2 Prevalence of central obesity

The overall prevalence of central obesity at the AHDSS was 32.6%. Sex-specific prevalence of central obesity was 51.1% and 4.9% for women and men, respectively. The prevalence of central obesity in females was higher than the 2013 national estimate of 47.1%, while the male estimate of 4.9% was lower than the national estimate of 6.8% (Shisana et al., 2013). The estimates of central obesity in the AHDSS were also higher than the Mpumalanga provincial estimates of 6.8% and 49.6% for males and females, respectively (Shisana et al., 2013). The estimates were also higher than those reported in a study conducted between December 2005 and 2007 in a rural area of Limpopo (Mkhonto et al., 2012) where 24.4% of all individuals and 29.6% of women were centrally obese. However, a study in rural and semi-urban areas in Uganda (Mayega et al., 2012), an SSA country, estimated lower and higher figures in females and males, respectively (47% and 6%). These differences could have been due to differences in the measure of outcome. The Ugandan study used waist circumference only, while this study used waist circumference/hip ratio as the outcome.

For almost every age category, the ratio of females to males that were centrally obese was greater than 10 except for the age groups 50-59, 60-69 and 70+ years, where the ratio was 7.0. This finding was also reported by Kimani-Murage et al. in 2010 and Shisana et al. in 2013. The AHDSS study also established that the prevalence of centrally obese females compared to males was different in the age groups 15-19 and 20-24 years, i.e. 22.3% and 38.9% of females in the two age groups were centrally obese, compared to 6.7% and 10.8% of males. These differences could be due to the fact that males in these age groups are more physically active than females. This study not only replicated what other studies have shown (that the level of central obesity is far higher in women than men) but also provided evidence for age-category-specific prevalence, viz. central obesity increases as women age.

4.3 Predictors of obesity (BMI)

In the univariate analysis, being aged 20-≥70 years predicted obesity, while being HIV positive, male, and in the “lower 1” or “lower 2” SES categories were inversely related to obesity. In the multivariate analysis, being older (25 to 59 years) was established as a predictor of obesity, supporting findings of other studies (Malaza et al., 2012, Wand and Ramjee, 2013). HIV positivity was inversely associated with obesity as has being reported in other settings (Barnighausen et al., 2007, Malaza et al., 2012). Education did not influence whether one was obese or not in the multivariate analysis, which was in agreement with previous studies conducted in South Africa (Malaza et al., 2012).

4.4 Predictors of central obesity

Age was a predictor of central obesity unless an individual was younger than 20 years old, which is in agreement with a previous study conducted at the AHDSS (Kimani-Murage et al., 2011). The reason that increasing age is a predictor may be because the abdominal muscles weaken as an individual gets older, increasing waist circumference (Mongre et al., 2012). Increasing age has been associated with both types of obesity, viz. obesity as determined by BMI and central obesity (Hickson 2006).

Another possible reason for high prevalence rates is that the cut-offs for WHR used in this study were not validated for use in Africa but were based on European and Asian standards (Crowther and Norris, 2012). This could influence the outcome as African women have larger hip and waist circumferences than European or Asian women, which would result in most of them being centrally obese, using this classification.

Being a male and HIV positive were both protective against central obesity, whereas a higher SES and tertiary education were not associated with central obesity. The finding of a lack of an association between SES and central obesity is in contrast with findings from a study in Cameroon which reported a positive relationship between the two (Fezu et al., 2005). One possible reason for this could be that there were no adjustments for eating behaviour and energy intake in this study. Studies in other parts of the world have shown that increasing income leads to an increase in the amount of protein and fat consumed by individuals (Popkin et al. 1993).

4.5 Association between SES and obesity (BMI)

After adjusting for age, gender and HIV status, this study established that there was an inverse relationship between being poor and being obese. This finding is in line with other studies conducted in rural areas of South Africa which have reported that belonging to a higher SES category or having a higher income is a predictor of obesity (Kruger et al., 2002, Kimani-Murage et al., 2011). Studies conducted in rural areas have mostly used the lowest SES category as the reference and assessed how obesity was associated with the higher categories of SES. This study used the highest category of SES as a reference and assessed whether the lower SES categories were associated with obesity. Using this approach, belonging to "lower 1" and "lower" 2 SES categories was protective against obesity in this community. The World Health Survey of 2010 (WHO, 2010) established that individuals of a higher social status tend to be obese in developing countries (Pempel et al., 2012). This was found to be the case at the AHDSS.

4.6 Association between SES and central obesity

It is worth noting that very few studies have investigated the association between central obesity and poverty in developing countries, especially SSA (Fezu et al., 2005); most studies in developing countries have been conducted in Latin America and Asia (Fezu et al., 2005).

After adjusting for age, sex and HIV status, no association was found between central obesity and poverty. This is in contrast to a study conducted in Cameroon, a very poor country in SSA, where a strong association was demonstrated between central obesity and increasing wealth (OR 4.1, CI:95% 2.3-7.3). This study in the AHDSS also found no association between central obesity and diet, which is in agreement with a study in Ghana among civil servants (Mongre et al., 2012). These findings suggest that the high prevalence of central obesity is due to other factors, such as ageing.

4.7 Conclusion

In this rural community, the prevalences of obesity (20.4%), central obesity (49%) and low SES 50.1% are very high, suggesting that the community is undergoing a nutritional transition, which occurs in countries that are experiencing an increase in their gross domestic product (GDP). Therefore, it is important for policy makers to implement educational programmes that will dissuade community members from adapting negative western habits such as smoking, being sedentary and eating foods high in fats and sugars, all of which propagate obesity and central obesity.

Women, in particular, should be targeted, as the proportion of both forms of obesity is high in women.

Since it is known that obesity is the highest risk factor for diabetes mellitus type II (Goedecke, et al. 2005), measures need to be put in place to arrest this impending epidemic. Known interventions that can control diabetes and other conditions associated with obesity include exercise programmes, good nutritional choices and educational programmes about lifestyle choices. These interventions should be incorporated into already existing HIV/tuberculosis programmes so as to avoid competition for resources and priority.

Measures to reduce the proportion of individuals with low SES, which this study reported to be very high (50.1%), should be also be considered.

Further studies need to be done in the area of validating the methods used in this study, e.g. cut off values used to assess central obesity, as those currently being used were validated in Caucasians. This will ensure that central obesity is correctly assessed and measured in an African community.

This study had limitations that are common to all cross-sectional studies. One such limitation is temporality. The study could not ascertain if the study participants had a low SES before or after they became obese. As this was a secondary data analysis, there was no control over what data were collected, or how they were collected or managed.

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APPENDICES

Appendix I. Asset Ownership; number and percentage of households in possession of selected assets at AHDSS

Asset	**Overall (N)**	**Percentage (%)**
Water supply		
Tap in the house	76	1.71
Tap in the yard	1 275	28.66
Truck	2 872	64.55
Well	211	4.74
Others (e.g. pond , river, rain)	13	0.34
Toilet facility		
Modern	7	0.16
VIP	447	10.05
Pit latrine	3 623	81.43
None	369	8.29
Power for cooking		
Electricity	1 408	31.65
Gas bottle	37	0.83
Paraffin	13	0.29
Wood	2 987	67.14
Other	4	0.09
Household floor construction material		
Tiles	163	3.66
Cement	4 216	94.76
Modern carpet	6	0.13
Wood	4	0.09
Other modern	3	0.07
Dirt	26	0.58
Mat	7	0.16
Other traditional	24	0.54
Radio		
No	3 195	71.81
Yes	1 254	28.19
TV		
No	1 035	23.26
Yes	3 414	76.74
Bicycle		
No	3 910	87.88
Yes	539	12.12

Car		
No	3 616	81.28
Yes	833	18.72
Motor bike		
No	4 430	99.57
Yes	19	0.43
Livestock		
Cattle		
No	3 697	83.10
Yes	752	16.90
Cart		
No	4 305	96.76
Yes	144	3.24
Goats		
No	3 886	87.35
Yes	563	12.65
Pigs		
No	4 324	97.19
Yes	125	2.81
Poultry		
No	1 979	44.48
Yes	2 470	55.52

Appendix II. Weights assigned to each household asset using MCA

Household asset	MCA weight
Toilet facility	
VIP	2.081
Pit latrine or other	0.515
Power for cooking	
Stove	2.537
Others	-0.153
Type of floor	
Concrete	0.613
Others	-0.154
Radio	
Have radio	0.007
No radio	-0.009
TV	
Present	1.726
Absent	-0.07
Bicycle	
Present	0.002
Absent	-0.001
Car	
Present	2.247
Absent	-0.028
Motor bike	
Present	0.869
Absent	-0.003
Water supply	
Piped into house	0.161
Others	-0.138
Cattle	
Owns	1.498
Does not own	-0.501
Goats	
Owns	2.236
Does not own	-0.358
Poultry	
Owns	0.326
Does not own	-0.871
Pigs	
Owns	3.17
Does not own	-0.109
Cart	
Owns	-0.174
Does not own	5.698

Appendix III: University of the Witwatersrand Human Reserach EthicsClearance Certificate

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG
Division of the Deputy Registrar (Research)

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
R14/49 Songelwayo L Chisi

CLEARANCE CERTIFICATE M120663

PROJECT Obsesity and Poverty Coexisting in a Rural South African Community

INVESTIGATORS Songelwayo L Chisi.

DEPARTMENT School of Public Health

DATE CONSIDERED 29/06/2012

DECISION OF THE COMMITTEE* Approved unconditionally

Unless otherwise specified this ethical clearance is valid for 5 years and may be renewed upon application.

DATE 29/06/2012 **CHAIRPERSON** ....
(Professor PE Cleaton-Jones)

*Guidelines for written 'informed consent' attached where applicable
cc: Supervisor : Dr Gill Nelson

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10004, 10th Floor, Senate House, University.

I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. **I agree to a completion of a yearly progress report.**

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES...

Appendix IV. Distribution of females in various weight categories across age group categories

Age group	n (%)	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-59	60-69	70+	P-value
Normal Weight	1054	167 (69.0)	147 (56.1)	124 (42.9)	100 (33.4)	112 (33.7)	62 (30.5)	83 (34.9)	71 (26.39)	82 (28.8)	106 (43.3)	0.163
Under Weight	103	21 (8.7)	13 (5.0)	8 (2.8)	5 (1.7)	12 (3.6)	6 (3.0)	5 (2.1)	8 (3.0)	14 (4.9)	11 (4.5)	0.271
Over weight	726	37 (15.3)	59 (22.5)	84 (29.1)	92 (30.8)	105 (31.6)	57 (28.1)	57 (28.1)	82 (30.5)	87 (30.6)	67 (27.4)	0.020
Obese	779	17 (7.0)	43 (16.4)	73 (25.3)	102 (34.1)	103 (31.0)	78 (38.4)	93 (38.4)	108 (41.5)	101 (35.6)	61 (24.9)	0.209
Total	**2 262**	**242**	**262**	**289**	**299**	**332**	**203**	**238**	**269**	**284**	**254**	

Appendix V. Distribution of males in various weight categories across age group categories

Age group n (%)		15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-59	60-69	70+	P-value
Normal Weight	1 109	174 (68.5)	158 (74.2)	128 (73.1)	106 (63.1)	121 (62.7)	64 (58.2)	61 (48.4)	89 (56.3)	93 (46.3)	116 (55.8)	0.000
Under Weight	219	63 (24.8)	32 (15.0)	11 (6.3)	18 (10.7)	22 (11.4)	10 (9.1)	8 (6.4)	14 (8.9)	20 (10.0)	21 (10.1)	0.666
Over Weight	342	9 (3.5)	22 (10.3)	32 (18.3)	33 (19.6)	36 (18.6)	21 (19.1)	34 (27.0)	40 (25.3)	62 (30.9)	54 (26.0)	0.000
Obese	134	8 (3.2)	1 (0.5)	4 (2.3)	11 (6.6)	14 (7.3)	15 (13.6)	23 (18.3)	15 (9.5)	26 (12.9)	17 (8.2)	0.239
Total	**1804**	**254**	**213**	**175**	**168**	**193**	**110**	**126**	**158**	**201**	**208**	

Appendix VI. Distribution of females in central obesity weight categories across age group categories

Age group	n (%)	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-59	60-69	70+	P-value
Normal	1 157 (43.5)	188 (77.7)	160 (61.1)	132 (45.6)	105 (35.1)	124 (37.4)	68 (33.5)	88 (37)	79 (29.4)	96 (33.8)	117 (47.8)	0.000
Obese	1 506 (56.6)	54 (22.3)	102 (38.9)	157 (54.3)	194 (64.9)	208 (62.9)	135 (66.5)	150 (63.0)	190 (70.6)	188 (66.2)	128 (52.4)	0.000
Total	**2 663**	**242**	**262**	**289**	**299**	**332**	**203**	**238**	**269**	**284**	**245**	

Appendix VII. Distribution of males in central obesity weight categories across age group categories

Age group	**n (%)**	**15-19**	**20-24**	**25-29**	**30-34**	**35-39**	**40-44**	**45-49**	**50-59**	**60-69**	**70+**	**P-value**
Normal	1 329 (73.9)	237 (93.3)	190 (89.2)	139 (79.4)	124 (73.8)	143 (74.1)	74 (67.3)	69 (54.8)	103 (65.2)	113 (56.2)	137 (65.9)	0.000
Obese	477 (26.4)	17 (6.7)	23 (10.8)	36 (20.6)	44 (26.2)	50 (25.9)	36 (32.7)	57 (45.2)	55 (34.8)	88 (43.8)	71 (34.1)	0.075
	1 806	**254**	**213**	**175**	**168**	**193**	**110**	**126**	**158**	**201**	**208**	

Appendix VIII. Comparison of number of females in the various SES categories across age categories

Age group	n (%)	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-59	60-69	70+	P-value
Very poor	667	59 (8.9)	67 (10.0)	83 (12.4)	57 (8.6)	82 (12.3)	49 (7.4)	63 (9.5)	62 (9.3)	88 (13.9)	57 (8.6)	0.304
Poor	681	66 (9.7)	57 (8.4)	65 (9.5)	73 (10.7)	93 (13.7)	46 (6.8)	71 (10.4)	81 (11.9)	45 (6.6)	84 (12.3)	0.439
Not poor	688	64 (9.3)	90 (13.1)	71 (10.3)	107 (15.6)	78 (11.3)	56 (8.1)	54 (7.9)	61 (8.9)	60 (8.7)	47 (6.8)	0.608
Well off	627	53 (8.5)	48 (7.7)	70 (11.16)	62 (9.9)	79 (10.6)	52 (8.3)	50 (8.0)	65 (10.4)	91 (14.5)	57 (9.1)	0.396
	2 663	**242**	**262**	**289**	**299**	**332**	**203**	**238**	**269**	**284**	**245**	

Appendix IX. Comparison of number of males in the various SES categories across age categories

Age group	n(%)	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-59	60-69	70+	P-value
Very poor	449	63 (14.0)	69 (15.4)	42 (9.4)	38 (8.5)	53 (11.8)	33 (7.4)	21 (4.7)	41 (9.1)	40 (8.9)	49 (10.9)	0.332
Poor	435	65 (14.9)	47 (10.8)	47 (10.8)	45 (10.3)	47 (10.8)	25 (5.8)	30 (6.9)	40 (9.2)	44 (10.1)	45 (10.3)	0.332
Not poor	441	64 (14.5)	59 (13.4)	38 (8.6)	48 (10.9)	54 (12.2)	24 (5.4)	39 (8.8)	36 (8.2)	44 (10.0)	35 (7.9)	0.025
Well off	481	62 (12.9)	38 (7.9)	48 (10.0)	37 (7.7)	39 (8.1)	28 (5.8)	36 (7.5)	41 (8.5)	73 (15.2)	79 (16.4)	0.411
		254	**213**	**175**	**168**	**193**	**110**	**126**	**158**	**201**	**208**	

APPENDIX X. Two way scatter graph for BMI and WHR.

The correlation between BMI and WHR is displayed below