Association of lifestyle and sleep behaviours with blood pressure and body composition: a cross-sectional study of rural black South African women living in Tshino Nesengani

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Declaration

I Merling Phaswana declare that this Dissertation is my own, unaided work. It is being submitted for the Degree of MSc (Med) in Sport and Exercise Science (dissertation) at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.

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(Signature of candidate)

___________day of__________________20________________in_____________

Dedication

I dedicate this work to my soulmate Phumue

Acknowledgments

I would like to give thanks to God Almighty for the wisdom and strength to undertake this study.

I wish to express my sincere gratitude to the following people who motivated and supported me during this study.

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Abstract

Background: The prevalence of hypertension and obesity is predicted to increase in developing countries particularly in South Africa. Recent literature indicates that rural dwelling South African black women have the higher prevalence of obesity in sub-Saharan Africa. The determinants of obesity and hypertension in rural black South African women are still not yet determined. Therefore the purpose of this study was to determine whether behavioural factors and covariates such as socioeconomic status (SES) were associated with body composition and blood pressure in a cohort of women living in the Tshino Nesengani rural village, Limpopo province.

Methods: A cross-sectional study involving 200 African women aged ≥18 years living in the Tshino Nesengani (Mukondeleli) village was conducted. Data Collection included, anthropometry (weight, height, waist circumference, and hip circumference); systolic blood pressure and diastolic blood pressure and standardized self-reported questionnaires: Global physical activity questionnaire was used for physical activity and sitting time, Beverage intake Questionaire-15 was used to determine sugar-sweetened beverage intake, Pittsburgh sleep questionnaire index was used to determine sleeping index, and socioeconomic status was determined using SES household questionnaire. Pearson's correlation was used to determine the correlation between body composition and blood pressure with lifestyle behaviours. Multivariable linear regression models were used to determine the association of lifestyle behaviours with body composition and blood pressure.

Results: The prevalence of overweight was 25%, obesity 40%, and the prevalence of hypertension was 26%. The prevalence of cigarette smokers was 3%, snuff use was 5%, and alcohol consumption was 14.5%. Age showed a positive correlation with systolic blood pressure, diastolic blood pressure and pulse pressure. Body mass index was positively associated with waist circumference ($r=0.75$, $p<0.0001$). Total work physical activity was positively correlated with diastolic blood pressure ($r=0.14$, $p<0.05$) and total leisure moderate to vigorous physical activity, total moderate physical activity and total moderate to vigorous physical activity were positively correlated with waist circumference. In a multivariable linear regression model, body mass index was positively associated with age (β: 0.20, $p<0.001$), socioeconomic status (β: 0.16, $p<0.02$) and hypertension (β: 0.21, $p<0.0001$). Waist circumference was positively associated with body mass index (β: 0.67, $p<0.0001$), and negatively associated with completion of high school education (β:-0.14, $p<0.001$). Systolic blood pressure showed a positive of association with age (β: 0.40, $p<0.0001$) while, diastolic blood pressure was positively related to age (β: 0.21, $p<0.0001$) and body mass index (β: 0.24, $p<0.0001$), and negatively associated with hours of sleep/night (β: -0.16, $p<0.02$).

Conclusion: The findings show that the majority of the study population were obese and hypertensive, and this confirms the urgency of these diseases to be addressed in rural-dwelling black South African women. Our findings also indicate that longer sleep may protect against hypertension. However, this finding needs to be confirmed with objective measurement of sleeping patterns.

Keywords: Rural, African, BMI, waist circumference, blood pressure

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List of abbreviations and acronyms

- AHA: American Heart Association
- BEVQ-15: Beverage intake questionnaire
- BMI: Body mass index
- BP: Blood pressure
- cm: Centimetre (s)
- CVD: Cardiovascular disease
- DBP: Diastolic blood pressure
- GPAQ: Global physical activity questionnaire
- HC: Hip circumference
- kcal: Kilocalories
- kg: Kilogram (s)
- Kj: Kilojoules
- LMIC: Low to middle-income countries
- N: Number
- NCD: Non-communicable diseases
- m^2: Metre (s) squared
- MAP: Mean arterial pressure
- METS: Metabolic equivalent (s)
- Min/week: Minute (s) per week
- MVPA: moderate-to-vigorous physical activity
- PA: Physical activity
- PP: Pulse pressure
- PSQI: Pittsburgh Sleep Questionnaire Index
- SBP: Systolic blood pressure
- SES: Socioeconomic status
- SADHS: South African Demographic Health Survey
- SSA: Sub-Saharan Africa
- SSB: Sugar-sweetened beverages
- USA: United States of America
- WC: Waist circumference

- WHO: World Health Organization
- WHR: Waist to hip ratio
- WHtR: Waist to height ratio

Definition of terms

- Physical activity is defined as any bodily movements produced by the contaction of skeletal muscles and requires energy expenditure; such includes working, performing household activities, and engaging in recreational activities (1).
- Hypertension is a medical condition in which the systolic and diastolic blood pressure is increased with a resting pressure of 140 over 90 mm Hg (2, 3).
- Sedentary behaviour is characterized by low energy expenditure, that results from behaviours such as sitting, watching TV and computer use (4, 5).
- Obesity is the accumulation of excessive fat that presents a risk to health such as mortality and morbidity, with a body mass index of 30kg/m^2 or more (6).
- Sugar-sweetened beverages (SSB) are water-based beverages with added sugar including flavoured juice drinks, sweetened tea, non-diet soft drinks/sodas, coffee, sports drinks, energy drinks, and electrolyte replacement drinks (7, 8).

Preface

Non-communicable diseases (NCDs) are recognised as some of the critical causes of early mortality and morbidity worldwide (6, 9). Epidemiological and experimental evidence supports the strong relationship between lifestyle behaviours and the risk of developing NCDs (10). Obesity and hypertension are some of the conditions most directly linked to a transition in lifestyle in South Africa (11). These associations have been observed in men and women of all ages (12), ethnic groups (13), and from both rural and urban areas, and function independently of other risk factors (3). Despite this evidence, there is still a gap in our understanding indicating that more research can be done, focusing on women, and considering the relationship between physical activity and diet with obesity and hypertension.

Most related studies focus on the prevalence of obesity and hypertension in urban areas. However, I believe there is a need to understand these diseases in rural-dwelling African populations. Given that I both lived and grew up in a rural setting, I was then interested in finding the association of lifestyle behaviours including sleeping behaviour and beverage consumption with blood pressure and obesity in rural black South African women.

The prevalence of overweight and obese in women was 70% indicating an increased risk for hypertension and other NCDs (14). The rise in the obesity epidemic may be a result of lifestyle changes such low physical activity, sedentary behaviour and adoption of Western dietary intake(15), particularly in the urban-dwelling South African black adults (16). Research indicates that the association of obesity with NCDs is complex, and may be affected by factors such ethnicity, genetics, socioeconomic status (SES) and lifestyle factors, some of which are particularly unique to black South African women (17). The results of this study will add to the limited evidence lifestyle factors associated with obesity and hypertension in rural black South African women.

CHAPTER 1: BACKGROUND

1.1. Background

Black South African women have the highest rates of excess body weight in the country (18), and the prevalence of obesity is set to increase in South Africa (19, 20). Rapidly, the prevalence of hypertension in black South African women is also high and seems to be increasing in parallel with obesity (21). Different lifestyle factors may influence the increased rates of obesity and chronically elevated blood pressure. These factors may include diet, physical activity, and sleep (22, 23).

The consumption of fat and cheap processed foods plays a major role in the increased prevalence of obesity in African populations, however evidence of this association is minimal (24, 25). Beverage intake consumption provides an excellent proxy indicator of caloric intake (26). Moreover, a study indicated that there is a rapid increase in the intake of sugar-sweetened beverages (SSBs) over the last two decades, and has become a primary global source of beverage calories for adults today (27). Overconsumption of SSBs contributes to obesity with women consuming approximately 50 grams of added sugar (28), and has resulted in South Africa ranking second in SSBs related deaths worldwide (29). The American Heart Association (AHA) and World Health Organisation recommended that a maximum intake of added sugar should be between 25 to 50 grams a day (30, 31). However, the WHO further recommended that the reduction of added sugars to less than 10% of total energy intake would reduce the likelihood of NCDs (30). Frequent consumption of caffeinated beverages is strongly associated with the risk of developing obesity and oral problems such as tooth decay (32).

Physical inactivity is also recognized as the leading risk factor for the development of obesity and increased blood pressure in the South African population (6, 33). Forty percent of all preventable NCDs related mortality has been attributed to inactivity (34), South Africa is ranked the third physical inactive country in the SSA (35). Moreover, black South African women in lower socio-economic groups are particularly not active enough to prevent cardio-metabolic diseases (33-36). Sitting time is an independent proxy measure from physical activity (37), and is also associated with increased fat deposition in Africans (38, 39).

A study also showed a positive association between sleep patterns and obesity (40). Sleep duration of fewer than 420 minutes per night is strongly associated with excessive weight gain and higher resting blood pressure, while longer duration (>540 minutes per night) is positively correlated with lower socio-economic status (41, 42). Black South African women seem to sleep for longer hours during the day when compared to their white counterparts due to a high rate of unemployment in the African population (40). Other lifestyle behaviours that may influence body composition in African women include tobacco smoking and the consumption of smokeless tobacco (snuff) (43, 44). Therefore, the purpose of this dissertation is to determine the association of lifestyle behaviours (beverage intake, physical activity, smoking), and sleeping patterns with blood pressure and obesity.

1.2. Problem statement

Unhealthy lifestyle behaviours and extended sleep duration are associated with elevated blood pressure and obesity in African black women (36, 38, 42). Also, long hours spent sitting show a strong relationship with a high prevalence of cardiovascular diseases (CVD) (36). As a middle-income country (defined by the World Bank), South Africa has many households that live in poverty primarily those in rural-dwelling areas. These poor households often have limited access to proper healthcare and education (44). Urbanisation and adoption of western lifestyles are responsible for the increase in the prevalence of chronic diseases and are attributable to higher rates of mortality in South Africa (45). Furthermore, black South African women in higher SES (with cars and most household items) present with low levels of physical activity and high prevalence of obesity and NCDs. Little research has been conducted on the association of physical activity, beverage intake, and sleep pattern with blood pressure and body composition in rural-dwelling black South African women (41, 42).

1.3. Aim

To determine whether lifestyle behaviours and sleep behaviour have an influence on blood pressure and body composition in rural-dwelling black South African women.

1.4. Objectives

1. To describe the lifestyle behaviours (physical activity pattern, beverage intake, smoking consumption), sleeping patterns, blood pressure and body composition of black South African women.
2. To determine whether lifestyle behaviours and sleeping patterns have an association with blood pressure of black South African women.
3. To determine whether lifestyle behaviours and sleeping patterns have an association with body composition.

CHAPTER 2: LITERATURE REVIEW

2.1. Introduction.

The prevalence of abdominal obesity is expected to increase in developing countries such as South Africa, in view of recent data which shows that black South African women have the highest prevalence of obesity within sub-Saharan Africa (46). Cardio-metabolic diseases such as obesity and chronic hypertension are increasing in prevalence globally (47), and have a strong association with lifestyle behaviours, in particular physical inactivity and diet (48, 49). Obesity is one of the essential risk factors of NCDs and is associated with lack of physical activity. A study stated that South Africa is considered as the third country in Africa with high physical inactivity levels of about 51.1% (50). Also, there is a significant concern that 63% of South African women were sedentary due to reduced participation in physical activity (51). The global transition of individuals from rural to urban areas is mostly for economic reasons, such as employment and education (52). However, black South African people living in urban areas are still at higher risk of obesity and NCDs (53). Again, related data on rural dwelling black South African women are still limited.

2.2. Conceptual Framework.

The conceptual framework used for this dissertation is displayed in Figure 1. South African women living in a rural area potentially experience an increased risk of obesity influenced by lifestyle behaviours (54). Health risk factors such as obesity, hypertension, improper nutrition, smoking (tobacco and smokeless tobacco) and frequent consumption of excessive alcohol are common in South Africa and are a result of increased rates of mortality and morbidity (55). In addition, dietary changes and physical inactivity may influence excess fat accumulation (53). Moreover, a higher level of modifiable health risk factors has been observed in the South African adult population, with women having the highest levels of obesity compared to their male counterparts who have highest levels of smoking and alcohol consumption (56).

Physical inactivity is an essential risk factor contributing to a decrease in the risk of CVD (57) and in a sedentary person this only makes up 25% of energy expenditure in a day. However, regular recommended physical activity is associated with numerous health benefits (58). Physical inactivity and prolonged sitting are associated with increased risk for type 2 diabetes, CVDs, and premature mortality (59, 60). Moreover, physical inactivity and sedentary behaviour are associated with an increase in the prevalence of obesity with more than 80% in adults population (51). The importance of physical activity in health promotion has been widely researched and is recognised as crucial health behaviour, associated with preventing CVDs and reduced risks of premature deaths (14, 51). Determinants and barriers to various physical activity in Black women must be identified, in order to promote an active lifestyle in this particular group (51). In addition, individuals need to be made aware of 150 minutes of moderate-intensity aerobic physical activity throughout the week (61).

Black South Africans, women, in particular, are at increased risks for NCDs given that this population group has the highest levels of physical inactivity and obesity (62). Moreover, elevated blood pressure, smokeless and tobacco smoking, increased blood glucose levels, physical inactivity and excessive weight gain, are responsible for 33% of mortality rates worldwide (63). Lifestyle transitions from traditional to modern trends in diet, physical activity levels, and behaviouristic factors such as smoking and alcohol consumption are associated with changes in sleeping patterns such as sleep deprivation and disturbance (64). Reduction in the quantity and quality of sleep is most familiar to the younger adults compared with, the older population due to lifestyles that include habits that are dysfunctional for sleep such as consuming excess coffee and caffeinated beverages or using technology through the night (65, 66). Literature shows a strong relationship between excessive adiposity and diseases of lifestyle such as obesity, hypertension, and diabetes, in developing countries such as Russia, India, China, and South Africa (67). Moreover, risk factors associated with obesity and hypertension in black South African women dwelling in both rural and urban areas are of importance for the development of community based management and prevention strategies (68).

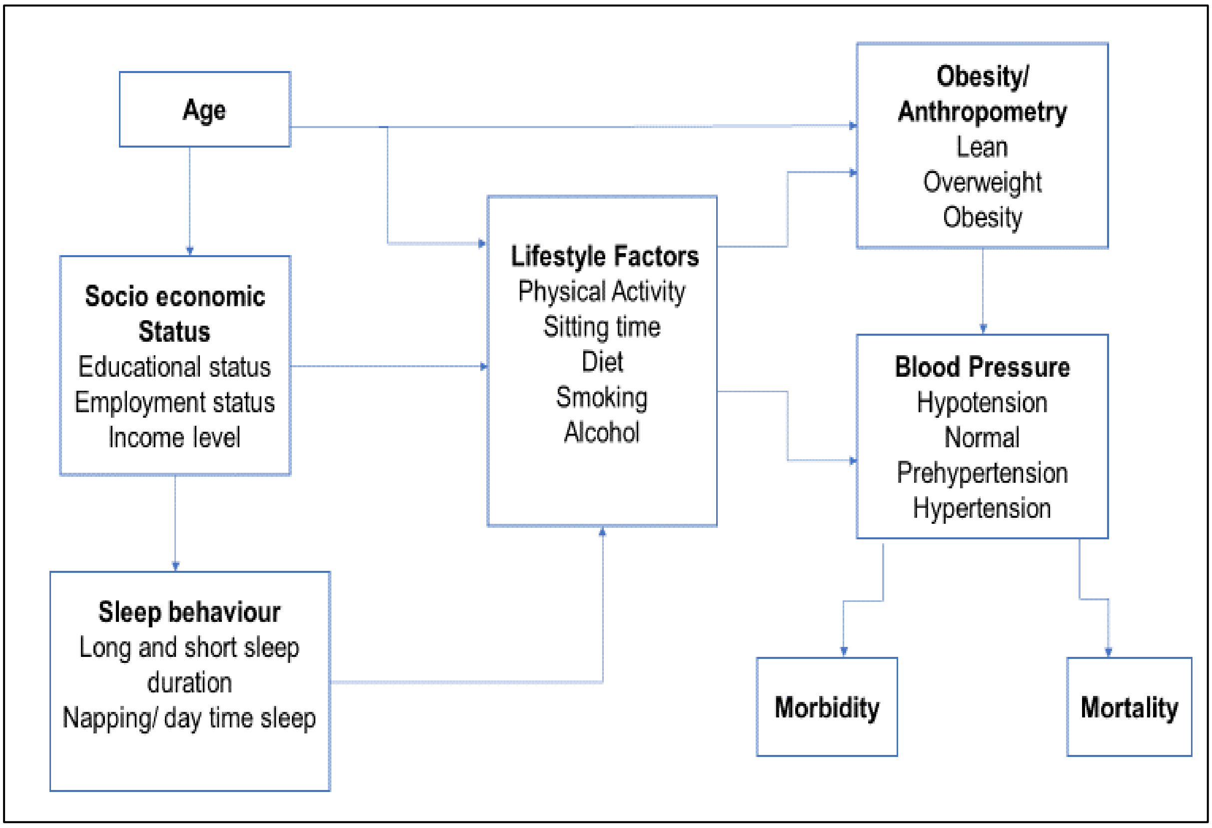

Figure 1. The conceptual framework of the behaviours associated with body composition and blood pressure in rural African women (67).

2.3. Obesity

Obesity has reached an epidemic status worldwide with almost a double prevalence of the disease since 1980 (69). Also, the obesity epidemic is growing at an alarming rate in developing countries compared to developed countries worldwide (61). Overweight and obesity are conditions with excessive accumulation of unnecessary fats to the extent of health impairment (69). Overweight and obesity results from an imbalance of energy intake and expenditure that results in the storage of excess energy in fat cells which enlarges and increases in number (70). The changes in lifestyle resulting from enhanced technology and processed food have led to a high incidence of overweight and obesity in South Africa (71). In addition, South Africa is also under an epidemiological transition that is accompanied by an increased prevalence of NCDs and infectious diseases (72, 73). Black women in South Africa are more affected by obesity compared with men (22), this development is observed in most countries on the African continent and low and middle income countries (LMICs) (74, 75). As a result, increased weight gain is associated with happiness, wellness and the absence of disease, and having a wealthy husband (76). In addition, factors associated with obesity in South African women include genetics, marital status, sedentary behaviour, birth weight, illiteracy and unbalanced diet (77).

2.3.1. Epidemiology of obesity.

Obesity is a preventable complex condition affecting, both developed and developing countries (78), with 500 million victims around the world, and is projected to double to one billion victims in 2030 (45, 79). The global burden of obesity in 2016 was 13%, and 39% of adults were overweight (80), with females having the highest prevalence compared to their male counterparts (79). Furthermore, the National Health and Nutrition Examination Survey (NHANES) in the USA, in 2011 – 2014, reported the prevalence of obesity to be higher in women by 38.3% compared to the males by 34.3% (81). These rising rates of overweight and obesity in both developed and developing countries has been described as a global pandemic (80). Similar trends were also observed in South Africa (77, 82).

South Africa is undergoing a rapid nutritional transition (83). Also, black South African women present the highest prevalence of obesity, compared to their males counterparts in Sub-Saharan Africa (SSA) (77). A study reported that in SSA the burden of obesity in black women is 37.0% (79). Furthermore, the prevalence of obesity in South African women is 39.2%, with black South African women reporting 58,5% of obesity (22). The observed increase of obesity in South Africa is influenced by socioeconomic status (SES) and socio cultural factors such as poverty and attitudes, as well as low total energy expenditure (22, 79, 84). Generally, the South African National Health and Nutrition Examination Survey (SANHANES) observed that a smaller number of rural dwelling black South African women (31.8%) compared with urban dwelling black South African women (42.2%) have obesity attributed to the fact that urban areas promote unhealthy dietary patterns such as fast foods, fried food and skipping meals, sedentary behaviour and physical inactivity

(85). This epidemic rose public concern with both short and long-term health consequences impacting South African resources (86).

The rise of overweight and obesity epidemic in South Africa reflects globalisation, which results mainly from the nutritional transition (53). A decrease in physical activity has increased the prevalence of obesity of black women in both rural and urban areas of all racial groups (87). Despite of this knowledge, the increased rates of obesity continues to rise in women. However, a small proportion of the female population is classified active by the WHO and can achieve health benefits (88).

2.3.2. Measures of body composition.

Studies recently reported that waist-hip ratio (WHR) and waist-height ratio (WHtR) (89), are better indices for abdominal obesity and cardiovascular risk factors than body mass index (BMI) and waist circumference (WC) (90, 91). Researchers believe that ethnicity and race in population from different countries might need to adopt distinct anthropometric cut-off points to diagnose obesity (90, 92). In addition, there is no acceptable cutoff values in body composition for adult Africans as compared to their American, European or Asian counterparts (91, 93). The prevalence of obesity is higher in black South African women compared to other ethnic groups, however, fewer women perceived themselves to be obese as compared to their BMI (91, 94).

South African women have higher levels of obesity with more than 70% of women above the age 35 classified obese by the WHO cut off points (95). Moreover, obesity is defined as a BMI equal to or greater than ≥30 kg/m^2 (96). BMI is one of the most commonly used anthropometric measures to determine total body fat (97). Also, a large number of epidemiological studies have used BMI due to its simplicity (98). BMI has been identified as a crucial measure used to determine excess body weight which uses weight for height index to reflect adult total body fat by dividing the persons total body weight (kg) by the square of the standing height (in metres) (99). Health problems related to excess body weight increase from a BMI greater than 25 (overweight and obesity categories of BMI) (99). BMI is used to estimate total fat adiposity. However, it is limited to distinguish between body composition and fat distribution, resulting in increased morbidity and mortality rates (97, 100, 101). BMI may not always correlate as well with body fat in some age groups, gender, and ethnic groups.

Furthermore, with similar BMI, women may have higher percentages of adipose body fat than men in most ethnic groups (102). In addition, black women may also have a lower percent body fat than white women (103). The limitations of the BMI must be considered when it is used alone. Nevertheless, BMI should be considered as the primary proxy to estimate general adiposity due to its global acceptance and ease of calculations (104).

Waist circumference (WC) is a simple and inexpensive useful proxy measure of central obesity and visceral fat (105), and an excellent indicator to classify individuals at risk for cardio-metabolic disease and mortality (64, 65). As a result, metabolic syndrome adopted WC in a definition as a proxy measure for abdominal or central obesity (104). WC does not consider height differences, which could potentially over or under estimate risk for short and tall individuals (106, 107). Increased rates of abdominal obesity in black females are of concern, with the prevalence of 42% of central obesity in South African females (66). This proxy has shown to be reliable in the South African context (57). Refer to Table 1.1.

Table 2.1: Classification of diseases risk based on body mass index and waist circumference.

		Disease risk [a] relative to normal weight and waist circumference	
Classification	**BMI(kg/m^2)**	**Women, ≤80 cm**	**Women, >80 cm**
Underweight	<18,5	-	-
Normal	18.5 – 24.9	-	-
Overweight	25.0- 29.9	Increased	High
Obesity, class			
I	30.0-34.9	High	Very High
II	35.0-39.9	Very High	Very High
III	≥40	Extremely high	Extremely high

[a] Dashes (-) specify that there was no further risk allocated at these levels of BMI.
Large WC is also a good indicator for increased risks for metabolic syndrome even in individuals with a healthy weight (95, 99, 108).

Body adipose fat distribution is an essential marker of health and diagnosis (109). Studies have reported that waist to hip ratio (WHR) is also a good proxy to determine abdominal obesity and factors such as racial group (110), gender and age have been shown to influence body composition outcomes and distribution (111). Furthermore, an increased WHR is associated with a high proportion of abdominal obesity(112). A very high-risk WHR for young women 18-59 years old is >0.86 and women aged 60-69 is >0.90 (99, 113). Nevertheless, the use of ratios can be problematic due to the difficulty of biological interpretation, low sensitivity to weight change, and the high likelihood of statistical error when conducting analyses (114). Therefore, research suggests that BMI, WHtR and WC are better markers of obesity compared with WHR (115). The waist-to-height ratio (WHtR) is an alternative anthropometric proxy measure for abdominal obesity that addresses the limitations of waist circumference because it considers height (116). Also, WHtR is also a measure for cardio metabolic risk in individuals who were not classified obese by other anthropometric indices (117). As a result, WHtR is a better discriminator for hypertension as compared to BMI and waist circumference (91, 105).

Obesity is a result of an increase in energy intake and a decrease in expenditure (118), creating energy imbalances resulting in increased body weight (119). BMI is used to define the criteria of obesity and determines the total amount of body fat when compared to other anthropometric indices (120). Higher BMI has been shown to have a linear association with obesity-related morbidity and mortality in the African population (11, 121). However, the extensive use of adopted American cut-offs for African population has resulted in under-diagnosing or over-diagnosing increased waist circumference since the estimated value of other racial groups cut off is different to those of Africans (93).

2.4. Hypertension.

Chronically elevated blood pressure and diagnosed hypertension are the most significant contributors to morbidity and mortality globally (122-124). Furthermore, elevated blood pressure is the leading risk factor for CVD and is responsible for 7.6 million deaths worldwide (125). Elevated blood pressure is defined as a medical condition in which the systolic and diastolic blood pressure is increased with a resting pressure of 140 over 90 mm Hg (125, 126). Hypertension increased by 25% in 2010 and is associated with higher consumption of alcohol and abdominal obesity, in both more and less developed countries (127). Moreover, lifestyle factors such as sedentary behaviour, physical inactivity, salt intake, smoking, family history, and unhealthy diet are responsible for the development of hypertension in black Africans, particularly in adult women (128, 129). Physical activity and dietary intake are widely considered some of the most critical health behaviours that are responsible for reduced rates with chronic disease related to lifestyle such as hypertension and obesity (3, 130). Furthermore, the risk of developing hypertension is lowered if moderate-intensity physical activity is encouraged (131).

Black South African adults are affected by continuous increases in elevated blood pressure (132). Moreover, the prevalence of hypertension could be increasing due to a rise in the risk factors associated with NCDs (133). Also, various risk factors that may be responsible for the high rates of hypertension include socio-demographics (134), geo-locality, obesity, physical inactivity, unhealthy diets, excessive alcohol consumption and smoking (135). Also responsible for the high rates of hypertension are altered genes regulating the renin-angiotensin–aldosterone system (RAAS), sodium abnormalities, lower plasma renin levels, epithelial sodium channel changes, increased peripheral vascular resistance and the higher prevalence of overweight and obesity (136).

2.4.1. Epidemiology of hypertension.

Hypertension is a substantial public health burdenthat is affecting more than one billion population worldwide (137, 138). The prevalence of hypertension in the adult population was ranging from 594 million to 1.13 billion between the years of 1975 to

2015 (46). However, elevated blood pressure has drastically increased by 258 million between the years 2015 to 2016 (139). Studies indicate that the prevalence of hypertension varies in economically developed and developing countries (123). In developing countries such as SSA, the burden of hypertension ranges from 5% to 50% (140, 141), while in developed countries, the prevalence ranges from19% to 30% (13, 142). In 2014, the World Health Organization (WHO) reported that the prevalence of hypertension was 24% for men and 20.5% for women and projected to an increase in the prevalence of hypertension in women to 29.5% by 2020 (127). Similar trends were also observed in South Africa (143).

Increased rates of hypertension are also responsible for high morbidity and mortality rates in black South Africans compared to Asians and Caucasians as a result of frequent underdiagnosis and underestimating the severity of its complications (55, 144-146). Again, hypertension is the second cause of deaths in the black South African population (147). Elevated blood pressure is one of the most common altered risk factors for CVD in South Africa, with the prevalence of 55% in all ethnic groupsbut the highest prevalence of 59% was observed in the black population (3, 122, 145). A study reported that in 2012, South Africa had approximately 6.3 million hypertensive people of which 86% was not controlled (128). The increasing prevalence of hypertension is affecting both rural and urban dwelling Africans because of nutritional transitionssuch as the intake of processed food (43, 146). Also, the high prevalence of elevated blood pressure is also associated with an increasing burden of chronic diseases of lifestyle in South Africa (13). Sedentary behaviour, physical inactivity, smoking, alcohol consumption, and unhealthy diet are thought to be primary causes to the development of elevated blood pressure in black Africans. A study reported that physical activity has an association with body weight and blood pressure in black South African women (35).

A study reported that 78 South African women die every day due to the high rates of hypertension (148). In 2013, the prevalence of hypertension in South Africa was 77% which was higher compared to other nationalities due to poor management and awareness (149). A study reports that more than 6.5 million people have hypertension with 3.2 million people being hypertensive (114). Also, it is estimated that 51% of South African women are aware of their hypertension (150).

Hypertension is the most common diagnosis and the primary reason for African adults to visit healthcare facilities (151). However, recent data on Africa have shown that large proportions of people with hypertension are not aware of their condition, a small proportion that is aware is not on treatment, and a large number of individuals who are taking treatment are not well controlled (152, 153).

2.4.2. Measures of blood pressure.

Hypertension is one of the most critical alterable risk factors for NCDs (154). Prognosis of hypertension is strictly based on the measurement of SBP and DBP (155). However, there is a global challenge of obtaining accurate BP readings for all health professionals (156). Hypertension is defined as BP of ≥130/80 mmHg (157), a study indicated that 20% of South Africans have hypertension (156, 158). Refer to Table 2.2.

Table 2.2: Measures of blood pressure (3, 159).

Blood pressure stage	**Systolic blood pressure (mmHg)**	**Diastolic blood pressure (mmHg)**
Normal	< 120	< 80
Elevated	120-129	80
Stage 1 hypertension	130-139	80-89
Stage 2 hypertension	≥140	≥90

Modifiable risk factors of lifestyle, including diets such as processed foods and lack of fruit and vegetable intake, sedentary behaviour, high levels of physical inactivity, tobacco use and the excessive consumption of alcohol have a positive association with overweight and obesity that results in hypertension (135, 136). Clinical research has reported that most of the hypertension-related complications are preventable (160). Furthermore, lifestyle changes prevent hypertension while antihypertensive drug therapy manages the risk factors associated with elevated blood pressure (160, 161). Hypertension is very high in South African rural areas and is mostly associated with the stress of being married, poor education and adult population(13).

2.5. Sleep behaviour.

Sleep insufficiency is a significant public health concern that is mostly linked with sedentary behaviour, increased use of technology and work schedules, and is affecting some 45% of the global population (162, 163). Inadequate or disrupted sleep is associated with increased rates of excess weight gain, hypertension (39) and other NCDs such as diabetes and depression, as well as from cancer resulting in reduced quality of life and increased mortality rates (164, 165). Shorter sleep duration is associated with changes with appetite-regulating hormones by reducing leptin levels and increasing ghrelin, negative moods and increased calorie intake of energy-dense food choices (166, 167). Moreover, these alterations in satiety could also increase fat accumulation.

There is limited scientific literature for South African use and thus lack of knowledge of excessive daytime napping impacts on the society at large (39, 166, 168). Excessive napping during the day has significant effects on daytime functioning such as working, driving, daily chores and socialising on the adult population (169, 170). Also, a study reported that more than 26% participants fell asleep when driving while 4% of that population confessed to having slept more than four times driving (171). Sleep behaviour and duration has not objectively measured sleep data in South African adults. However, there are data on self-reported sleep time for unemployed black South African adults (41). A study reported on the sleep patterns of South African adults population with more than 20% of other ethnic groups such as Indian, Asian and white South Africans who sleep < 6 hours per night, while almost 30% of the black South Africans sleep > 10 hours per night (172, 173). Therefore, an understanding of ethnic differences in sleep needs and beliefs is of paramount importance (173). A positive association of sleep duration and body mass index has also been observed in low SES black South African women (133, 149). Furthermore, irregular sleeping patterns and increased napping during the day has also contributed to the development of sleeping disorders which could influence body composition (174, 175).

2.6. Physical activity.

Physical inactivity is one of the most essential alterable causes of more than 38 million global deaths of lifestyle (6). Most deaths occur in LMIC where there are poor understanding and awareness of physical activity strategies (3, 176). Reduced physical inactivity is one of the most critical risk factors for NCDs and mortality (11, 55). Overweight and obesity rates have increased in black South African women due to increasing levels of physical inactivity (11). The physical activity patterns of black South African women are also influenced by education (177), and socio-economic status factors (178, 179). Women in rural settings have a higher physical activity level than urban women due to higher levels of walking for transport and occupation-related physical activity (167). Urbanised black South African women engage in more leisure-time physical activity compared with rural women (180).

Moreover, on-going urbanization and industrialisation have resulted in the adoption of western behaviours, which increase sedentariness (171, 181, 182). South African men were reported to be more active than women, with a prevalence of physical inactivity of 86% in South African women (62). Furthermore, these prevalence indicates that they are at increased risk for NCDs compared to their male counterparts resulting from physical inactivity (183).

Regular physical activity is strongly related with many health benefits, such as reduced prevalence of chronic conditions, improved mental health and reduced mortality rate in all age groups (58, 184). Although, physical activity and various movements account for 25% of energy expenditure in a day of a sedentary person (58, 185), studies indicate that women are generally less active when compared to their male counterparts across all age groups and by age 75 (186), and that, one in three men and one in two women engage in regular physical activity (187). Physical inactivity also contributes to sarcopenia in a vicious cycle, causing the elderly to become weaker and less able to participate in daily activities (188). Furthermore, physical inactivity reflected disuse atrophy, with advanced sarcopenia and associated impaired physical performance as an endpoint. Recommended physical activity and the use of proper diets are essential in maintaining a healthy BMI and reduction of risks associated with NCDs (189). In addition, increased levels of physical activity are associated with normal BMI whereas physical inactivity is associated with excessive weight gain (190).

Black South African women presents an increased time of sedentary and reduced time of being physically active (191). A sedentary lifestyle in women is of great concern due to its detrimental health implications in both developed and developing countries (192). Moreover, sedentary behaviour is associated with the reduced physical activity, prolonged sitting, and the increased use of technology.

Recommended physical activity is widely recognised as one of the most essential lifestyle associated with a decrease in mortality and morbidity (62), to an extent where exercise is referred to as medicine (193). However, the literature reports that regular physical activity can prevent and maintain diseases of lifestyle such as obesity, hypertension, diabetes and high cholesterol (194). Therefore, it is paramount to increase the awareness of physical activity because it has shown to be positively associated with overall health and reduced CVD (195).

2.7. Sitting time.

Sitting time is a proxy measure of sedentary behaviour which is associated with an increased risk of excess fat accumulation and diseases of lifestyle such as hypertension in black South African women and also increases the risk for all-cause mortality independent of physical activity and sitting time (39, 62, 69, 193, 196). There is limited scientific literature on the prevalence of sedentary behaviour in black South Africans particularly women (164). However, this literature reports that women are more sedentary compared to men (197), again urban dwelling women have higher sedentary time than rural women (198). In addition, urban black South African women have higher sitting times and an increased level of physical inactivity compared to their rural counterparts (35, 39, 199).

As a result of the movement/urban-to-rural shift of African populations, access to sedentary promoting assets such as televisions (185), rural black South African women could also be sitting for extended periods, despite the relatively high physical activity in subsistence-related work (196). Also, studies show that not all total sedentary time is detrimental to health (200). Evidence indicates that ways in which sedentary behaviour is acquired may also be essential to determine health implications (201, 202). Another theory is that the increased connectivity of rural dwellers to mobile networks has improved communication, but at the cost of increasing the time spent sitting during screen time (203).

The prevalence of obesity in urban black South African women is very high and exceeds that of all other ethnic groups (94). The increased rates of sedentariness may explain this in this particular population group (197). Also, South Africa is a country that is characterised by increased rates of illiteracy, unemployment, unskilled labour and self-employment. However, a large number of people are not aware that leading a healthy lifestyle leads to total wellness (51).

2.8. Dietary consumption.

South Africa is a multicultural country with approximately 80% of the black population and has resulted in drastic changes in dietary and lifestyle patterns (204, 205). This rapid increase in food costs and low availability of healthier food (206) has resulted in the consumption of energy dense and processed foods (207, 208). The increased intake of energy-dense and processed foods in South Africa (33), as well as higher sugar and salt intake has also been observed in urban settlements. Thisincreases the chances of developing hypokinetic diseases such as obesity (204), hypertension and diabetes. Although urban residents' health and nutrition knowledge was deemed to be better (185), studies conducted in South Africa outlined that people living in rural areas consumed less fruit and vegetables than their urban counterparts resulting in micronutrient deficiencies (209, 210). The relationship between nutritional status and overweight and obesity has been established in the South African population, particularly in women (22, 210). However, due to limited research in South Africa, there is no direct relationship between sugar intake and obesity.

2.8.1. Sugar-sweetened beverages.

Sugar-Sweetened Beverages (SSB) refer to water-based beverages with added sugar such as sweetened tea, flavoured juice drinks, non-diet soft drinks/sodas, coffee drinks, sports drinks, energy drinks, and electrolyte replacement drinks (211). A study reported that the reliability of self-reported dietary intake is reduced, resulting in often inaccurate data (196). The accuracy of energy consumption is improved when investigators consider using a proxy measure of diet such as SSBs, 24 hours recall, and frequency that has been validated for South African use (51, 212). Understanding the habitual beverage intake of the sample can provide researchers with more reliable data on the energy consumption of populations (213). Increased SSB intake, specifically carbonated drinks, has been theorized to be an underlying contributor to excess weight gain and consequently an increased risk of CVDs, in particular hypertension (214). SSBs include sugar added beverages such as regular carbonated soft drinks, fruit drinks, tea or coffee sweetened with sugar, energy/ sports drinks (196, 215). Furthermore, SSBs are highly marketed and are accessible to people of all age groups through supermarkets, restaurants, work and schools cafeterias and home (216).

Excessive SSB consumption has been positively related to increased body weight and risk for CVDs such as obesity, hypertension, and diabetes (217). However, SSB does not provide the same satiety value as solid foods, and intake of solid food is not reduced when energy-containing beverages are consumed (218). A study reported that an average of 458 kilocalories (kcal) of beverages is consumed daily equating to 21.0% of total daily energy (219). Also, 20% SSB tax is predicted to a reduce of the prevalence of obesity by 2.4% in South Africa women (211), with the average reduction in energy intake estimated to be 30.0 kilojoules (kJ) per person per day (220).

The majority of added sugars in diets comes from SSB, with women consuming an average of not more than 80 calories of added sugar per day (186, 187, 221). This shift in dietary preference is compounded by a reduction in physical activity resulting in a sedentary lifestyle (62, 222). A study stated that recommendations should be made that SSB must be replaced with healthy beverages such as water and milk in order to reduce energy intakes (223). An inverse association was established between the increase of SSB prices and consumption; indicating that the higher the price increase, the lesser the reduction in consumption (224).

2.9. Cigarette smoking and snuff consumption.

Cigarette smoking is the leading cause of premature deaths and also accounting for risk factors associated with lifestyle diseases and related heart diseases worldwide, even in African countries (221, 225). Globally, over 5 million premature deaths were reported in 2000 with an increase of over 6 million in 2014, and it is anticipated that in 2030 there will be 8 million smoking-related mortality (226). Smoking is an identified significant risk factor for the development and progression of CVD, (227, 228). Moreover, the number of smokers is growing at an alarming rate (219), with an estimation of 1.3 billion adult population who are active tobacco smokers (229). Cigarette smoking with high or low nicotine content has been observed to cause an acute increase in blood pressure and heart rate (230).
Furthermore, nicotine content has been found to be strongly associated with the risks of hypertension. Nicotine content of smoke is thought to be the cause of the catecholamine release that results in hemodynamic alterations (231). Though the effects of smoking on blood pressure may be short-lived (232), repeated smoking during the day results in higher average pressures that may eventually promote sustained high blood pressure in smokers.

South Africa has higher rates of cigarette smoking compared to some developing countries (233). The prevalence of smoking is relatively high in South African women with 10% of adult women being daily or occasional smokers (18). Furthermore, a study conducted in South Africa reported that 24.3% female students were smokers mainly due to lack of knowledge of diseases associated with tobacco smoking (234), and to obtain the nicotine they desire (235), with 75% of female university students indicating a desire to stop smoking (236). The overall prevalence of tobacco smoking in South African women is 7% with 38% of coloured and 15% of white women presenting a higher prevalence compared to their 3% of black/African counterparts (237). In addition, this has resulted in a higher prevalence of cigarette smoking in women in urban communities than in rural areas (237).

In contrast, a study indicated that the rates of cigarette smoking has declined in the last decade (233), and it is therefore, projected that South Africa has seven million active smokers (238). South Africa has the highest burden of tuberculosis (TB) due to tobacco smoking (239, 240), and it increases the risks for development of tobacco-induced diseases. Moreover, considering that women have a uniquely central role to many households they are likely to influence tobacco consumption to their children, family, and friends and expose them to secondary smoke (218, 241).

Studies show that alcohol intake is positively associated with smoking, which has a positive effect on the smoking-BP relationship (230, 242). However, the majority of adult black South African women uses smokeless tobacco that is widely known as snuff, with a prevalence of 14.6% in 2008, compared to a cigarrate smoking prevalence of 1.1% in the same population group (243). In addition, this indicates that there is a high consumption rate of smokeless tobacco among black South African women. Oral and nasal use of snuff is prevalent and addictive in South Africa due to the perception that it is less harmful (244). Also, cigarette smoking contains lower content of nicotine compared to snuff smoking (235). Smokeless tobacco or snuff is strongly associated with oral disorders, in particular, mouth cancers and tooth decay (244). However, studies have reported that South Africans believe that the use of snuff can cure a toothache or disinfect a wound (244, 245).

The consequences of tobacco smoking are well documented in developed and developing countries (246, 247). However, there is limited literature that is reported on the effects of smokeless tobacco or snuff use in the African content (55, 248). Both methods of smoking are modifiable through programmes that encourage healthy diets, smoking cessation rehab and increase physical activity (148, 249).

2.10. Alcohol consumption.

Alcohol use poses particular risks for increased morbidity and mortality worldwide (90). In 2004, alcohol use was the third important risk factor for the burden of disease (250), in particular, increased risks for accidents and injuries, hypertension, obesity and obesity (251). A study demonstrated the effect of alcohol consumption on health, with 3.8% of all global deaths and 4.6% of all global disability (150, 252). Although developing countries have low levels of drinking, the factors associated with alcohol use is very high (253). Also, regular alcohol consumption is more common in men than women (237). The total amount of alcohol consumption is expected to be high due to increases in the number of potential new alcohol consumers, especially among young people and women (254). Regular alcohol consumption is positively associated with health problems such as alcohol dependence, liver cirrhosis and cancers (90, 255). Similar trends have also been observed in other African countries.

South Africa had the highest alcohol consumption in individuals aged 15 years and above in the year 2010 (90), with the estimated burden of disease of 7.1% in 2000 (256), with 44.6% deaths resulting from alcohol use and 23.2% of interpersonal violence attributable to alcohol use in South Africa (150). Alcohol consumption patterns are essential in determining problems associated with drinking and increased prevalence of alcohol consumption (73). Individuals who get drunk in events, the proportion that drinks daily and drinking outside of mealtimes and in public places characterise the drinking pattern score (257). An increase in the prevalence of excessive alcohol consumption was observed from 2005 to 2008. South Africa has more than half the road accidents, more than 60% of the road deaths, domestic violence incidences and homicides which are directly or indirectly related to alcohol consumption and harmful alcohol use (90).

2.11. Socio-Economic Status.

Socioeconomic status (SES) is a significant cause of morbidity and mortality in developed and developing countries (258). SES is strongly associated with obesity, with low SES strongly associated with obesity in developed countries, and higher SES a strong predictor of excess weight gain in developing countries (259). SES, defined as an individual's position that is informed by economic factors (260) such as occupation, level of income and type of education is reliable in the South African context (261, 262). A study stated that SES is an established predictor of nutritional status and physical activity (263). Income and wealth distribution in South Africa is known to be among the most unequal in the world (44). In South Africa is a country that is characterized by poverty and inequality in accessing economic and social services between individuals and provinces (264). Again, SES groups are typical and this helps to exacerbate inequalities in health which in turn, suggests the kind of lifestyle they lead (265-267). Individuals in low SES face various social determinants of health whereby they do not get access to proper healthcare when they are ill (268). Data reports in South Africa, show that there are positive and negative associations in SES and CVD risk factors (269).

South Africa like most developing countries has a skewed distribution of income and high levels of poverty that is rooted in the labour market. Thus, the labour market earnings varieties require attention (225). However, poverty and inequality have been associated with factors such as race, location (rural/urban), education and family composition (270). Also, the level of education leads to poverty which is strongly associated with obesity in women in both developed and developing countries (252). SES patterning in the prevalence of lifestyle behaviours (271), has been reported to affect individuals of lower SES in developed countries and people of higher SES in developing countries (272, 273).

2.12. The association of lifestyle and sleep behaviours with obesity and hypertension.

South Africa like other developing countries, is undergoing lifestyle changes such as nutritional transition from traditional to western diets, physically inactive and socioeconomic transitions that result in a higher prevalence of obesity and hypertension (15, 274). Also, excessive weight is strongly associated with changes in dietary habits and increased levels of physical inactivity (275). Behavioural factors such as tobacco smoking and excessive alcohol consumption are common in South Africa, attributing to the burden of CVD (249). However, research indicates that in the late 1940s, obesity was affecting smaller proportions that could afford sedentary behaviours with a dietary intake that are rich in fats and sugar worldwide (276, 277). In addition, the prevalence of hypertension was not established within the black South African population (124).

The adoption of Westernised diets is responsible for the rapid increase in hypertension, obesity, and diabetes in developing countries (277, 278). A study reported that obesity is one of the risk factors for hypertension, and accounts for 20% to 30% of mortality cases (279). Risk factors of lifestyles such as increased weight have been associated with hypertension (150), specifically visceral obesity was more related to hypertension than overall obesity (280). The relationship between obesity and hypertension with sleeping behaviours is small compared to the effects of risk factors such as nutrition, smoking, alcohol consumption, SES, and physical activity (262). Short sleep was associated with higher obesity in older females (41). Blood pressure is positively associated with obesity and is the most common co-morbidity that is associated with CVDs (281). The epidemic of obesity poses severe and life-threatening health risks worldwide (275). Again, obesity affects an individual's psychology, emotional wellbeing, quality of sleep, self-esteem and quality of life (282).

Literature indicates that short and long sleep durations are strongly associated with obesity and hypertension (41). Longer sleep duration is strongly associated with low SES (283), alcohol consumption, physical inactivity while short sleep duration associated with increased weight gain (55), CVD and high SES (41, 284). Also, factors associated with the risk for long sleep duration were health-related and lifestyle factors (172).

Table 2.3: Summary of South African studies examining the relationship between lifestyle behaviour and obesity and elevated blood pressure, in black adult women.

Author	**Study Design**	**N**	**Age (years)**	**Location (urban/rural)**	**Findings**
Peer et al. (148)	cross-sectional study	1099	(25-74 years)	Western Cape Province (urban)	Relationships were reported between BP, BMI, WHR, and WC but not with PA. Hypertension was strongly associated

					with urbanization, higher BMI, family history of hypertension, older age, increased alcohol intake and physical inactivity
Prinsloo et al. (275)	cross-sectional analytical design	304	18-50 years	peri-urban community	No relationships between SES and obesity were established. A significant difference in the employment status of the obese and normal BMI participants (26.9% and 16.5% employed, respectively) was a note.
Phaswana-Mafuya et al. (274)	Cross sectional study	3,840	≥50 years	Rural and urban	There is a strong relationship between obesity and lifestyle risk factors. Coloured and Black African ethnic groups were associated with a higher number of NCD risk factors.
Peer et al. (25)	Cross-sectional	392 men and 707 women	25–74 years	urban black population	There is a strong relationship between obesity and lifestyle risk factors. Both men and women with

					higher BMI were directly associated with wealth, diabetes hypertension and increasing age, but inversely related to daily smoking.
Steyn et al. (15)	Descriptive survey	986	15-64 years	urban black population	There is a strong relationship between obesity and chronic lifestyle risk factors. Hypertension was independently related to high rates of urbanization, age, and obesity. Smoking patterns were influenced by the degree of urbanization in women only.
Pretorius et al. (41)	Cross-sectional	1311	≥16 years	urban black population	Results showed that longer sleep duration was associated with a lower BMI (β = -0.04, P<0.01 andhigher diastolic (β=0.005, P<0.01) and systolic BP (β=0.003, P<0.05) and in older females.
Peltzer et al. (172)	Cross-sectional	3 840	≥50 years	urban and rural population	There is a strong relationship between obesity and lifestyle

					risk factors. SES and short sleep duration were associated with coloured ethnicity, white, moderate physical activity and daily tobacco use.
Peltzer et al. (150)	Cross-sectional	3 840	≥50 years	urban and rural population	There is an association between hypertension and lifestyle risk factors. The prevalence of hypertension in the sample population was 77.3% (male 74.4%, female 79.6%). Hypertension was inversely associated with current alcohol use.
Sturm et al. (249)	Cross-sectional	69 380	≥16 years	urban and rural population	The relationship between the levels of overweight and obesity, excessive alcohol, smoking consumption and medical expenditures in South Africa
Otang-mbeng et al. (68)	Cross-sectional	118	21–70 years	urban and rural population	The positive association between obesity and physical inactivity was outlined. The highest

					prevalence of obesity (70%) was observed in the physically inactive participants.

Data presented as a total number of participants (N), blood pressure (BP), Body mass index (BMI), Waist to hip ratio (WHR), Waist Circumference (WC), Socio-economic status (SES), Non-communicable diseases (NCDs).

2.13. Research Gaps.

Obesity and hypertension are a significant health challenge in South Africa, and it is of paramount importance to acknowledge the nature of this epidemic in the country in order to effect necessary changes and management of lifestyle behaviours (285). However, there is limited research that focused on the lifestyle factors associated with obesity and hypertension in rural dwelling black South African women.

The transition in demanding physical lifestyles has reduced physical activities by exposing the adult population to various health conditions (286). Black South African women in rural areas need to aware that living healthyis very crucial in theprevention of lifestyle diseases, and contributes to overall quality of life.

There is limited data in the South African context for sleep behaviour for the adult population, resulting in the use of American data and objective measures that may not be reliable in the African context (287). Therefore, the is an urgent need for objectives measures of sleep in South African that will include cultural and socioeconomic backgrounds (173).

2.14. Relevance and Justification.

South Africa is a country characterized by a unique cultural diversity within its population. Few studies have suggested that cultural differences may be the main contributing factor to higher prevalences of increased body size, particularly in black South African women (288, 289). These increased body weights are assumed to be caused by lifestyle factors such as societal, cultural and ethnic tradition or norms

(290). Furthermore, the rapidly increasing prevalence of obesity and hypertension in black South African women has a positive relationship with high rates of physical inactivity and sedentary time (291) and increased accessibility of energy is a public health concern (68). However there is limited understanding regarding the etiology of NCDs (15).

Therefore, this study will add to the body of evidence, particularly as rural South Africans are experiencing changes in health due to the urban-rural shift (292). Further, the tax on SSB has only recently been introduced in South Africa (82). In addition, this may reduce the prevalence of overweight and obesity in younger age groups and those with lower income (293), resulting in reductions of morbidity and mortality (211). A study indicated that in 2000 NCDs were responsible for 40% of deaths in South Africa women (294). These diseases that are attributed to lifestyle preventable if interventions and strategies are effected (6). Therefore, this study will also provide novel data on the impact of lifestyle behaviours, sleep patterns and SSBs on body composition and blood pressure.

CHAPTER THREE: METHODOLOGY

3.1. Study Setting

This study was conducted at the Tshino Nesengani village, situated at Vuwani under the Makhado municipality of the Vhembe district, Limpopo province. There are five villages in Tshino Nesengani namely Dolidoli, Mukondeleli, Thondoni, Matidza and Nditwani, and all these villages are characterized by a large portion of farming situated a few km away from the area. Settlements in the Tshino Nesengani Mukondeleli village are a combination of mud and bricks houses, and the estimated total population is 5000. Fewer households have access to water taps in their stands, while most households do not have, and they fetch water from taps that are in some strategic points. The village is constituted by high rates of unemployment, and a large portion of the population are self-employed.

3.2. Population and sampling.

3.2.1. Study Sample.

This cross-sectional study of rural black South African women was conducted in the Tshino Nesengani village, Limpopo province, South Africa.

3.2.2. Sampling.

A multi-stage random cluster sampling in the Tshino Nesengani village was carried out for this study. A sample population of convenience from the Tshino village was invited to participate in this study. The desired minimum sample size is 132, at a confidence interval of 80%. In the first stage, the Mukondeleli neighbourhood was randomly selected. In the second stage, the researcher randomly selected streets (the streets are unnamed) in the Mukondeleli neighbourhood. In the third stage, a random sampling of households in the selected streets of Mukondeleli neighbourhood was conducted. A total of 200 female participants aged 18 years or older participated in this study.

3.2.3. Inclusion criteria.

- All black females living at Tshino Nesengani village, Limpopo province
- Aged ≥18 years employed and unemployed.

3.2.4. Exclusion criteria.

- Pregnant women did not form part of the study due to physiological changes occurring, particularly concerning changes in maternal body composition.

3.2.5. Data collection procedure.

After ethical approval, the researcher addressed and gave information sheet in tribal meetings, informing potential participants of the study. Participants were invited to participate in the study, and those who were interested were given information sheets (see Appendix A) and were asked to complete the consent form (see Appendix B). The researcher and research assistants completed the questionnaire and administered all measurements on behalf of the participants.

The data were collected at the participants' houses in the following order:

1. A demographic questionnaire, sleep quality index, beverage intake was completed.
2. Blood pressure was measured.
3. Anthropometry was measured in the following order: height, weight, waist circumference, and hip circumference.

The collected data was captured in Microsoft Excel and stored in a secure location, only accessible to the researcher.

3.3. Measures.

3.3.1. Demographic and behaviours Characteristics.

A self-structured questionnaire was used to determine demographic and behaviour information such as age, cigarette smoking and frequency, snuff consumption and frequency and alcohol consumption and frequency (See Appendix C).

3.3.2. Household Socioeconomic status.

Household asset ownership was used as a proxy measure of socioeconomic status (SES) (295) (See Appendix C). The questionnaire included eleven household items, ranked in order of value from lowest to highest: (1) radio, (2) computer/laptop, (3) refrigerator, (4) washing machine, (5) television (TV), (6) telephone/landline, (7) cell phone/mobile, (8) internet, (9), electricity, (10) digital satellite TV, and motor vehicle. The score of these commodities was summed to give a total SES index ranging from 0 to 66. Tertiles of SES score was created for further analysis: low (SES score: <29), moderate (SES score: 29-36), and high SES (SES score ≥36) categories. The highest level of education was captured as '0' for no schooling, '1' for primary school, '2' for incomplete high school, '3' for completion of high school and '4' tertiary education. Participants were also queried if they were employed, the type of occupation and the number of years they have been employed.

3.3.3 Body Composition.

All measurements were performed with participants in light clothing and without shoes. Body weight was measured using a digital weighing scale to the nearest 0.1 kg (Seca, USA) (194, 296). Height was measured to the nearest 0.1 m using a stadiometer (Seca, USA). Body mass index (BMI) was calculated as weight (kg)/height (m^2). The World Health Organisation, cut-off points were used to define overweight and obesity of Black South African Women.

Waist and hip circumferences were measured using the Gulick Anthropometric cloth tape (J00305, Australia), to the nearest cm (194, 195). Waist circumference was measured between the lowest ribs and the iliac crest (99). Hip circumference was measured at the greatest protuberance just above the gluteal line (297). The waist-to-hip ratio (WHR) was calculated. Waist-to-Height ratio (WHtR) was also calculated as waist circumference (cm)/ Height (cm) (298). A WHtR of ≥ 0.5 indicates an increased risk for NCDs particularly hypertension (299). All measurements were carried out with the help of 2017 third year Biokinetics students who received training prior to data collection.

3.3.4. Blood pressure

The Omron M6 blood pressure monitor (Omron, Japan) was used to measure blood pressure (BP) (See Appendix C). Participants were rested in a seated position with the cuff around the left arm aligned with the brachial artery. Three measurements were taken, and the average of the last two trials was recorded (194). Hypertension was defined as systolic blood pressure (SBP) ≥ 130 mm Hg and diastolic blood pressure (DBP) ≥ 80 mm Hg (157, 159, 299). From the BP measurements pulse pressure (PP) and mean arterial pressure (MAP) were derived. PP defined as the difference between SBP and DBP (300), was derived by subtracting DBP from SBP (301). In addition, PP is a validated index for South African use (300). The MAP was calculated by means this empirical formula $MAP = \left[\frac{SBP-DBP}{3}\right] + DBP$ (302).

3.3.5. Sleep Pattern.

The Pittsburgh Sleep Questionnaire Index (PSQI) was used to determine the overall quality of sleep (303) (See appendix D). The PSQI is reliable and has been validated for use in Africa (304). The PSQI is a self-reported questionnaire consisting of seven components of sleep that evaluate sleeping duration, sleep disturbance, sleep latency, habitual sleep efficiency, daytime dysfunction, use of sleeping medicine, and sleeping quality. The PSQI is composed of 19 self-reported questions that evaluate the previous month’s sleep quality (163). The total score, ranging from 0-21 is summed from these items. A total score >5 indicates poor sleep quality for the global PSQI index, and a score of ≤5 indicates good sleep quality (305).

3.3.6. Physical activity.

The Global Physical Activity Questionnaire (GPAQ) was used to determine self-reported total moderate-vigorous physical activity (MVPA) and estimated sitting time (See appendix E). Sitting time, a proxy measure of sedentary behaviour was determined by the same questionnaire. The GPAQ is reliable and has been validated for use in Africa (38). GPAQ activity was defined as taking part in: moderate physical activity for a total of 150 minutes per week (≥5 days per week); or vigorous physical activity for 60 minutes per week (≥3 days per week); or 600 metabolic minutes per week (≥5 days MVPA) (38). Also, walking for travel as a domain of light physical activity was determined using the GPAQ (38).

3.3.7. Beverage Intake.

The beverage intake questionnaire (BEVQ-15) is a 15 item, seven day recall on SSB used to measure quantities and amounts of regular beverage consumption (222) (See Appendix F). The beverage intake responses are ranged from 0fl 0z to 60 fl 0z per day but were converted into grams during data capturing (214, 221). The BEVQ-15 includes 15 categorised beverage items to estimate total kilocalories (kcal) of consumed beverages. Such as water, regular soft drinks, 100% fruit juice, juice drinks, full cream milk, low fat milk, skim (fat-free) milk, sweetened tea, coffee or tea with milk and sugar, black coffee or tea without sugar, light beer, regular beer, mixed alcoholic drinks, wine (red or white), meal replacement drinks and energy drinks. The total of SSB calorie consumption is calculated from the estimated energy consumption for each item. Participants were asked to recall the amount and frequency of each item. The BEVQ-15 is a validated tool for estimating SSB consumption (222).

3.4. Pilot study.

A pilot study involving 10 participants who were not included in the study to ensure the reliability of data. Therefore, all measurements and questionnaires were administered ten days apart, followed by statistical analyses to determine reliability. BMI, waist circumference, SBP, DBP and global PSQI score showed a positive correlation. BMI (r=0.99), SBP (r=0.94) and DBP (r=0.98) showed a strong positive correlation and statistical significance of $p < 0.0001$.

3.5. Statistical analysis.

The Statistica version 13.2 (Tulsa, USA) was used for all statistical analysis. Descriptive statistics were presented as a mean ± standard deviation, median (interquartile range), or percentages in tables. Pearson's Correlation was used to determine the relationship between body composition and blood pressure with continuous variables. Multivariate linear regression models were used to determine the association of lifestyle behaviours with body composition (BMI, waist circumference, WHR, and WtHR) and blood pressure (systolic, diastolic blood pressures, mean arterial pressure and pulse pressure). Univariate analyses determined the inclusion of the independent variables in these regression models. Only those variables with $p<0.20$ were included in the regression models. Variance inflation factor was used to ensure that there is no multicollinearity in the regression models. Statistical significance was set at $p<0.05$.

3.6. Ethical considerations.

Ethical clearance was applied for and granted by the Human Research Ethics Committee, the University of Witwatersrand (Medical) (ethics certificate number: M170377) (see Appendix H). Permission to collect data from the residents of Tshino Nesengani (Mukondeleli) village was requested from the village council (see appendix G). A consent form and information sheet were given to the participants and explained how data would be carried out (see Appendix A and B). Codes were used instead of participant names to protect individual data. Analysis of data was done as a group to ensure the privacy of individual participants. Only the researcher and supervisor had access to the raw data, which was stored in a secure location.

CHAPTER FOUR: RESULTS

4.1. Results

4.1.1. Subject characteristics, anthropometric, blood pressure, physical activity, sleep behaviour and beverage intake.

The mean age of participants in this study was 35.7 ± 16.7 years, with a mean body mass index of 28.5 ± 7.3kg/m^2, waist circumference 87.7 ± 16.8 cm and WHtR 55.0 ± 14.5 cm (Table 4.1). The percentage of obesity was (40%) compared to that of (25%) for overweight. SES mean score was 33.9 ± 9.9, while total moderate physical activity median score and quartile ranges were (189 (106-319)) total moderate to vigorous physical activity 247 (120-431), Total sugar sweetened beverages 295 (136-416.9) and total beverages 768 (350-1233), and global PSQI mean score levels was 3.9 ± 2.2. The prevalence of cigarette smokers was 3%, snuff smokers were 5%, and alcohol consumption was 14.5%. The prevalence of hypertension was also 46%, this may indicate a higher prevalence in this population. The mean score for MAP was 94.2 ± 13.8 mm Hg and pulse pressure 42.8 ± 14.7mmHg.

Table 4.1: Demographic characteristics of the sample (N=200)

VARIABLES	**Mean ± SD or Median (IQR) or N (%)**
Age (years)	35.7 ± 16.1
Age quartiles	
<22 (%)	46 (23)
22-30 (%)	53 (26.5)
31-47 (%)	48 (24)
>47 (%)	53 (26.5)
Educational status	
No education (%)	4 (2)

Primary (%)	14 (7)
Incomplete (%)	82 (41)
Complete (%)	100 (50)
Employment status	
Employed (%)	55 (27.5)
Unemployed (%)	145 (72.5)
Occupational categories	
Self-employed (%)	17 (8.5)
Teaching (%)	11 (5.5)
Cleaning (%)	6 (3)
Admin (%)	2 (1)
Sales (%)	6 (3)
Policing (%)	3 (1.5)
Construction (%)	4 (2)
Office jobs (%)	6 (3)
Salary categories	
<5k (%)	181 (90.5)
5-10k (%)	5 (2.5)
10-15k (%)	5 (2.5)
>15k (%)	9 (4.5)
Total SES score	33.9 ± 9.9
Environmental behaviour	
Cigarrate smoking (Yes) (%)	6 (3)
Cigarette smoking (No) (%)	194 (97)
Snuff Smoking (Yes) (%)	11 (5.5)
Snuff Smoking (No) (%)	189 (94.5)
Alcohol Consumption (Yes) (%)	29 (14.5)
Alcohol Consumption (No) (%)	171 (85.5)
Physical activity	
Total moderate-vigorous physical activity (min/wk)	247 (120-431)
Total moderate physical activity (min/wk)	189 (106-319)
Total vigorous physical activity (min/wk)	0 (0-90)

Total work (moderate-vigorous physical activity) (min/wk)	0 (0-80)
Total walking for travel(moderate-vigorous physical activity) (min/wk)	150 (60-265)
Total leisure (moderate-vigorous physical activity (min/wk)	0 (0-90)
Sitting time (hrs/day)	4(3-5)
Beverage intake (Diet)	
Water (kcal)	0 (0-0)
Fruit juice (kcal)	0 (0-20.1)
Sweetened juice (kcal)	0 (0-114.4)
Whole milk (kcal)	0 (0-130.2)
2% milk (kcal)	0 (0-0)
Skim milk (kcal)	0 (0-0)
Soft drinks (kcal)	76 (0-213)
Diet soft drinks (kcal)	0 (0-0)
Sweetened tea (kcal)	57 (0-150)
Tea/Coffee with sugar (kcal)	0 (0-66)
Tea/Coffee black (kcal)	0 (0-0)
Beer (kcal)	0 (0-0)
Hard liquor (kcal)	0 (0-0)
Wine (kcal)	0 (0-0)
Energy drinks (kcal)	0 (0-0)
Total SSB (kcal)	295 (136-416.9)
Total SSB (gram)	430 (216-634.7)
Sleep behaviour	
Subjective sleep quality	0 (0)
Very good (0) (%)	155 (77.5)
Fairly good (1) (%)	33 (16.5)
Fairly bad (2) (%)	9 (4.5)
Very bad (3) (%)	3 (1.5)
Sleep latency	0 (2)
Not during the past months (0) (%)	116 (58)
Once per week (1) (%)	33 (16.5)

Once or twice per week (2) (%)	21 (10.5)
Three or more times per week (3) (%)	30 (15)
Sleep duration	
>7 hours (0) (%)	155 (77.5)
6-7 hours (1) (%)	26 (13)
5-6 hours (2) (%)	16 (8)
<5hours (3) (%)	3 (1.5)
Habitual sleep efficiency	0 (0)
> 85% (0) (%)	174 (87)
75-84% (1) (%)	22 (11)
65-74% (2) (%)	2 (1)
<65% (3) (%)	2 (1)
Sleep disturbances	1 (0)
Not during the past months (0) (%)	12 (6)
Once per week (1) (%)	170 (85)
Once or twice per week (2) (%)	16 (8)
Three or more times per week (3) (%)	2 (1)
Sleep medication	1 (1)
Not during the past months (0) (%)	97 (48.5)
Once per week (1) (%)	86 (43)
Once or twice per week (2) (%)	13 (6.5)
Three or more times per week (3) (%)	4 (2)
Daytime dysfunction	1 (1)
Not a problem at all (0) (%)	93 (46.5)
Only a very slight problem (1) (%)	85 (42.5)
Somewhat of a problem (2) (%)	20 (10)
A very big problem (3) (%)	2 (1)
Global PSQI score (1-7 components)	3.9 ± 2.2
Anthropometric measures	
Height (cm)	1.6 ± 0.08
Weight (kg)	72.4 ±17.6
BMI (kg/m^2)	28.5 ± 7.3

WC (cm)	87.7 ± 16.8
WHR (cm)	0.8 ± 0.10
WHtR (cm)	55.0 ± 14.5
BMI classifications	
Lean (BMI < 25 kg/m^2) (%)	70 (35)
Overweight (BMI 25-29.9 kg/m^2) (%)	50 (25)
Obesity (BMI ≥30 kg/m^2) (%)	80 (40)
Blood pressure measures	
Systolic blood pressure (mm Hg)	122.7 ± 19.3
Diastolic blood pressure (mm Hg)	79.9 ± 13.2
Mean Arterial Pressure (mm Hg)	94.2 ± 13.8
Pulse Pressure (mm Hg)	42.8 ± 14.7
Hypertension (≥130/80 mm Hg) (%)	92 (46)

Data presented as mean ± SD or median (interquartile range (IQR)) or N (total number of participants), Body Mass Index (BMI), Waist Circumference (WC), Waist-to-hip ration (WHR), Waist-to-height ratio (WHtR), Total household socio-economic-status score (SES), Sugar-sweetened beverages (SSB). Pittsburgh Sleep Quality Index (PSQI).

4.2. Bivariate analysis of anthropometric indices

The results of the bivariate analysis show that there was a significant correlation between age, socioeconomic status and hypertension with body mass index (r=0.31, p≤0.0001) and waist circumference (r=0.32, p≤0.0001) (Table 4.2). Low socioeconomic status has an inverse association with body mass index and not with waist circumference. High socioeconomic status, snuff consumption, total leisure moderate to vigorous physical activity, total moderate physical activity and total moderate to vigorous physical activity were positively correlated with waist circumference. Body mass index showed a strong strong correlation w with WC (r=0.75, p≤0.0001), indicating that most of the weight is centralised. Hypertension showed a correlation with BMI (r=0.28, P≤0.0001) and WC (r=0.24, P≤0.0001). Incomplete high school and complete high school were statistically, inversely associated with waist circumference (r=-0.18, p<001) while hours of sleep per night was inversely statistically related to body mass index (r=-0.14, p<0.04).

Table 4.2: Bivariate analysis of anthropometric variables

Variables	BMI	WC
Age	0.31 (<0.0001)	0.32 (<0.0001)
Incomplete high school	-0.05 (0.49)	-0.18 (0.001)
Total SES	0.18 (0.001)	0.15 (0.05)
Smokers	0.01 (0.84)	-0.01 (0.90)
Snuff	0.37 (0.60)	0.91 (0.20)
Alcohol	-0.02 (0.97)	-0.05 (0.53)
BMI	-	0.75 (<0.0001)
Hypertension	0.28 (<0.0001)	0.24 (<0.0001)
Hours of sleep per night	-0.14 (0.04)	-0.02 (0.76)
Leisure (MVPA) (min/week)	0.11 (0.14)	0.19 (0.001)
Total moderate Physical Activity (min/week)	0.67 (0.34)	0.15 (0.04)
Total MVPA (min/week)	0.04 (0.56)	0.15 (0.04)
Sitting time (hours/day)	0.06 (0.39)	0.01 (0.90)
2% Milk (Kcal)	0.11 (0.12)	0.10 (0.18)
Skim milk (Kcal)	-0.11 (0.16)	-0.08 (0.29)
Soft Drinks (Kcal)	0.13 (0.06)	0.02 (0.83)
Tea/Coffee black (Kcal)	0.14 (0.06)	0.16 (0.02)

Hard Liquor (Kcal)	0.11 (0.12)	0.09 (0.19)

Data presented as Pearson moment of correlation (r), p value (p), kilocalories (Kcal), (moderate to vigorous physical activity (MVPA), body mass index (BMI) and waist circumference (WC)

4.3. Bivariate analysis of blood pressure indices

The results of the bivariate analysis for blood pressure (Table 4.3) showed that age had a strong association with systolic blood pressure (r=0.41, p<0.0001), diastolic blood pressure (r=0.32, p<0.0001) and pulse pressure (p<0.29, p<0.0001) but was not associated with mean arterial pressure (r=0.04, p<0.57). The results indicated a relationship between an incomplete high school with mean arterial pressure (r=0.15, p<0.03) while total socioeconomic status was positively associated with Mean Arterial Pressure (r=0.19, p<0.01) and pulse pressure (r=0.17, p<0.02), not with systolic blood pressure and diastolic blood pressure. Low socioeconomic status was inverse, associated with mean arterial pressure and pulse pressure while hours of sleep per night were inversely associated with systolic blood pressure, diastolic blood pressure, and pulse pressure and not with mean arterial pressure. Total work physical activity was positively correlatedwith diastolic blood pressure (r=0.14, p<0.05) and not with systolic blood pressure, mean arterial pressure and pulse pressure. Total travel physical activity was inversely associated with systolic blood pressure (r=-0.16, p<0.02). Total leisure physical activity showed positive trends with pulse pressure and not with systolic blood pressure.

Table 4.3: Bivariate analysis of blood pressure indices

Variables	SBP	DBP	MAP	PP
Age	0.41 (<0.0001)	0.32 (<0.0001)	0.04 (0.57)	0.29 (<0.0001)
Complete high school	-0.06 (0.39)	0.02 (0.78)	0.14 (0.05)	0.06 (0.42)
Total SES	0.09 (0.22)	0.08 (0.25)	0.19 (0.01)	0.17 (0.02)
Smoking	0.04 (0.57)	-0.07 (0.31)	0.08 (0.28)	-0.02 (0.76)

Snuff	0.34 (<0.0001)	0.06 (0.42)	-0.06 (0.41)	0.02 (0.74)
Alcohol	0.02 (0.79)	-0.10 (0.18)	-0.01 (0.91)	-0.02 (0.74)
Hours of sleep per night	-0.21 (0.01)	-0.23 (0.001)	-0.0 (0.78)	-0.15 (0.03)
Total moderate physical activity (min/week)	-0.08 (0.24)	-0.05 (0.50)	-0.01 (0.85)	0.08 (0.24)
Work (MVPA) (min/week)	0.09 (0.23)	0.14 (0.05)	-0.06 (0.40)	0.02 (0.77)
Travel (MVPA) (min/week)	-0.16 (0.02)	-0.09 (0.21)	-0.07 (0.33)	0.02 (0.76)
Leisure (MVPA) (min/week)	0.07 (0.33)	0.00 (0.99)	0.06 (0.38)	0.09 (0.19)
Total moderate-vigorous physical activity (min/week)	0.04 (0.57)	0.10 (0.17)	-0.07 (0.33)	0.03 (0.66)
Sitting time (hours/day)	0.09 (0.20)	0.08 (0.27)	0.00 (0.97)	0.07 (0.35)
Soft Drinks (Kcal)	0.02 (0.82)	-0.05 (0.49)	0.04 (0.58)	0.12 (0.10)
Tea/Coffee black (Kcal)	0.01 (0.88)	-0.02 (0.77)	0.08 (0.29)	0.13 (0.07)
Hard liquor (Kcal)	0.11 (0.12)	0.07 (0.30)	-0.00 (0.98)	0.09 (0.17)

Data presented as standardised β coefficients (p-value); kilocalories (Kcal), moderate to vigorous physical activity (MVPA), socioeconomic status (SES), Systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP) and pulse pressure (PP)

4.4. Multivariable linear regression analysis of anthropometric indices.

Table 4.4 shows multivariable linear regression models for anthropometry. Body mass index was positively associated with age (β:0.23, p<0.0001), Socioeconomic status (β:0.20, p<0.002) and hypertension (β:0.20, p<0.0001). The multivariable linear regression model for waist circumference was associated with BMI (β:0.71, p<0.0001), while waist circumference showed an inverse association with completion of high school education (β:-0.16, p<0.002).

Table 4.4: Multiple linear regression models for BMI and waist circumference.

Dependent variable	Independent variables	Beta Coefficient† (p–value)	Adjusted R^2 (p–value)
BMI	Age	0.23 (<0.0001)	0.18 (<0.0001)
	Total SES	0.20 (0.002)	
	Hypertension	0.20 (<0.0001)	
	Leisure (MVPA) (min/week)	0.08 (0.20)	
	Skim milk (Kcal)	-0.13 (0.05)	
	Tea /Coffee black (Kcal)	0.12 (0.07)	
WC	Total SES	0.07 (0.18)	0.57 (<0.0001)
	Hypertension	0.04 (0.41)	
	Tea /Coffee black (Kcal)	0.06 (0.17)	
	Completed high school	-0.16 (0.002)	
	BMI	0,71 (<0.0001)	

Data presented as standardised β coefficients (p-value); kilocalories (Kcal), body mass index (BMI), waist circumference (WC), moderate to vigorous physical activity (MVPA), socioeconomic status (SES).

4.5. Multivariate regression analysis of blood pressure indices.

The multivariate regression models for blood pressure indices are shown in Table 4.5 below. Systolic blood pressure showed a positive association with age (β:0.40, p<0.0001). Diastolic blood pressure was positively related to age (β:0.21, p<0.0001) and body mass Index (β:0.24, p<0.0001). In contrast, diastolic blood pressure showed an inverse association with hours of sleep (β:-0.16, p<0.02). The results showed a positive association between mean arterial pressure with body mass index (β: 0.35 p<0.0001). However mean arterial pressure was inversely associated with high alcohol consumption (β: -0.23, p<0.0001). Themultivariate linear regression model for pulse pressure showed a positive association with age (β: 0.25, p<0.0001) and total socioeconomic status (β: 0.10, p<0.02).

Table 4.5: Multiple linear regression models for blood pressure and continuous variables.

Dependent variable	Independent variables	Beta Coefficient† (p–value)	Adjusted R^2 (p–value)
SBP	Age	0.40 (<0.0001)	0.19 (<0.0001)
	Hours of sleep/night	-0.12 (0.08)	
	BMI	0.18 (0.007)	
	Walking for travel (mins/week)	-0.12 (0.06)	
	Sitting time (hours/day)	0.03 (0.60)	
	Hard Liquor (Kcal)	0.09 (0.16)	
DBP	Age	0.21 (<0.0001)	0.13 (<0.0001)
	High Alcohol	-0.10 (0.15)	
	Hours of sleep/night	-0.16 (0.02)	
	BMI	0.24 (<0.0001)	
	Work (MVPA) (mins/week)	0.20 (0.09)	
	TMVPA (mins/week)	-0.16 (0.19)	
MAP	BMI	0.35 (<0.0001)	0.18 (<0.0001)
	High Alcohol	-0.23 (0.001)	
	Total SES	0.12 (0.09)	

PP	Age	0.25 (<0.0001)	0.12 (<0.0001)
	Total SES	0.10 (0.02)	
	Hours of sleep/night	-0.14 (0.20)	
	Tea /Coffee black (Kcal)	0.11 (0.11)	
	High Alcohol	0.10 (0.17)	
	Snuff	0.10 (0.18)	

Data presented as standardised β coefficients (p-value); Socioeconomic status(SES), kilocalories (Kcal), body mass index (BMI), moderate to vigorous physical activity(MVPA), Total moderate to vigorous physical activity (TMVPA), systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), pulse pressure (PP).

5. CHAPTER 5: DISCUSSION

5.1. Consolidated findings of the dissertation.

This dissertation aims to determine whether lifestyle behaviours and sleep behaviour have an influence on blood pressure and body composition in rural-dwelling black South African women. The objectives of this dissertation and summary findings are highlighted in Table 5.1.

Table 5.1. Summary table of objectives and findings of the dissertation

Number	Objectives	Summary of findings
1	To describe the lifestyle behaviours (physical activity pattern, beverage intake, smoking consumption), sleeping patterns, blood pressure and body composition of black South African women	• 40% of participants were obese • 25% of participants were hypertensive • Higher total SES (33.9±9.9) • PSQI score was very low (3.9±2.2)
2	To determine whether lifestyle behaviours and sleeping patterns have an association with blood pressure of black South African women	• In bivariate analysis, total SES and hypertension with BMI (r=0.31, p<0.0001) and total leisure physical activity showed positive trends with PP and not with SBP. • In multivariate analysis, SBP showed a positive significance of association with BMI and age (β:0.40, P<0.0001).

3	To determine whether lifestyle behaviours and sleeping patterns have an association with body composition	• In univariate analysis, hours of night time sleep was positively associated with SBP and DBP β: -0.36, p<0.009 and (β: -0.54, p<0.0001). • The multivariable linear regression models displayed that age and BMI increase linearly with SBP and DBP.

Data presented as standardised β coefficients (p-value); socioeconomic status (SES), body mass index (BMI), Pittsburgh sleep questionnaire index (PSQI), diastolic blood pressure (DBP), systolic blood pressure (SBP), pulse pressure (PP)

5.2. Emerging themes in the dissertation

Themes: To describe the lifestyle behaviours (physical activity pattern, beverage intake, smoking consumption), sleeping patterns, blood pressure and body composition of black South African women. There was a positive relationship between lifestyle behaviours and sleeping patterns with a blood pressure of black South African women. There was anassociation between lifestyle behaviours and sleeping patterns with body composition.

The study highlights a complex association between lifestyle behaviours (Physical activity, smoking, alcohol consumption, and beverages), SES economic status, education and obesity and hypertension of rural black South African rural women living in Tshino Nesengani. A detailed discussion of the findings follows below:

5.2.1. Obesity in rural black South African Women.

The overall prevalence of obesity in this cohort of rural dwelling black South African women was high, and the results obtained from the study are consistent with other South African studies that reported that the prevalence of obesity in women to be 56%, with black women being most at risk (62%) (295, 306, 307). The prevalence of obesity in this study was 40% of which is higher compared to the 6.5% of obesity reported by 2016 National Department of Health, Statistics South Africa in Limpopo (308). In addition, the findings of this report indicated that 8.7% of black men and women were obese (308). The rates of obesity in this particular study, further confirms the rising concern that South Africa is in the nutrition-related NCD phase of the nutrition transition (309). Similarly, Alberts et al. (2005) conducted a study in adult rural black population and reported similar results, where 59% of women were either overweight or obese (137). These findings are in agreement with what other studies have reported that obesity was significantly associated with age (22). The prevalence of overweight was 25% in black South African women, which is lower than the estimated 69% overweight in South Africa and lower than the global estimation of 51%. However, in the absence of effective interventions, the overall pro-portion of adult South Africans who are overweight or obese is exceptionally likely to increase rather than to decrease as expected (310).

The findings show a relationship between the pattern of SSB consumption and BMI, and given the recent implementation of the 'sugar tax,' further investigation is needed to determine the impact of this regulation on long-term changes in public health. The results obtained from this cohort are consistent with several studies conducted in SSA indicating that increased energy intakes are significantly associated with obesity (311, 312). This is in agreement with what has been reported in studies elsewhere (313). However, there is limited relevant literature in South African rural settings.

5.2.2. Hypertension in rural black South African women.

Hypertension is the most common cause of CVD in SSA (278, 314). The findings of this project are in line with other studies conducted in rural areas of South Africa, which reported that physical inactivity or leading a sedentary lifestyle is a predictor of hypertension (264). The prevalence of hypertension in this study is 46%, which is lower than the estimated 86% of hypertension in South Africa (265). Studies have reported the rapid increase in the prevalence of hypertension in black South Africa women compared to other ethnic groups such as whites and Asians in rural and urban areas (137, 315). Hypertension was high in female participants (38.1%), compared to the male counterparts (27.9%) (35). Babiker et al. (2013) maintain that high prevalence of hypertension in adult Sudanese population was due to lack of awareness of the epidemic of hypertension, which could also be the reason of the increased rates in the current study population (316). For example, the highest awareness rates were found in urban elderly population (81%) in Northern African countries, and had resulted in lower rates of elevated blood pressure (317-319). Our findings confirm the growing concern of hypertension as a public health problem in rural black South African women (314).

Studies in different populations in the world have shown a strong relationship between BMI, WC, and WHR with SBP and DBP (320, 321) in women. The prevalence of hypertension was significantly higher in those with elevated BMI, with longer sleep duration associated with better BP profile in the study population. Findings of this cohort are that incidence of hypertension become greater as BMI category increases. Also, Molecular et al. (2008), reported that obese individuals are more likely to receive hypertension treatment (322). This relationship emphasises the implication of physical inactivity, diet and destructive lifestyle on an individual's blood pressure (132). Studies have reported on higher rates of walking in rural areas compared with urban areas in the last decades (197, 323). However, due to this transition of rural areas, physical activity rates have also decreased and lead to increased rates of hypertension. Longer night-time sleep was associated with lower BP in this cohort, which is contrary to a study of urban African women showing an inverse relationship (41).

5.2.3. Association of lifestyle behaviours and sleeping patterns with body composition.

Obesity has been increasing across the world at a rate that requires attention (324). In the last decade, it has become the leading public health concern in SSA and similar trends have been observed in South African rural areas due to choices in the changes of lifestyle (18, 82). The results of this study indicated that age is signicantly associated with obesity, this is in agreement with existing literature(192, 325). A study by Mongre et al. revealed that age is a strong predictor of obesity due to weakness of abdominal muscles (315), a decrease in growth hormone secretions, genetic factors and environmental factors (326). Our findings of a positive association between education and WC are in line with other studies (327, 328). Furthermore, the strong relationship between types of obesity and women of all ages in the South African population may be due to the high tolerance of increased body sizes and positive body image (329). Unfortunately, the perception of body image was not included in this study to elaborate further on the results associated with these findings.

The existence of socioeconomic inequalities in the prevalence of obesity is a well-established finding and has been documented in the South African population (34, 330). This study adds to the existing body of knowledge in SES inequalities and obesity in black South African women. The results of this study show that 72.5% of the population is unemployed and 90.5% of the populations income is less than R5000.00 per month. The findings of this study shows that SES is positively associated with BMI and these results are consistent with documented literature (66, 183, 184). McLaren (2007) reported that the association between SES and BMI varies depending on the socio-economic development of a country (42). Also, in developed countries, SES is inversely associated to obesity (42, 331), whereas in South Africa individuals in higher SES are more likely to have excess body weight than their counterparts in developing countries (308, 309). However, in various SES levels, there was no significant differenceobserved between obese and healthy women. Also, the findings of this cohort may also indicate that SES and educational status influences the rates of obesity and hypertension in black South African women.

Abdominal obesity was significantly associated with hypertension in this study. A key finding was that central adiposity is associated with elevated blood pressure and increased risk of hypertension. Our results are in agreement with those obtained by Amole et al. (2011) who reported that central obesity was strongly associated with hypertension in African women (291, 332). Studies have shown WC as an accepted indicator of central body fat and been reported to be the strongest independent predictor of elevated SBP and DBP for South African men and women (333-335). The relationship between abdominal obesity and hypertension in this study might be potentially confounded by the use of SSBs and physical activity, which are difficult to standardize.

BMI showed a significant association with WC in our study, which is in contrast with most studies which documented that black South African women have more accumulation of fat in the gluteofemoral area compared to their male counterparts who are at increased risk for android obesity (336, 337). The findings of our study showed an inverse association between education level and BMI. However, several studies reported a positive relationship between BMI and educational status in the African population (34, 94, 275, 338, 339). The burden of obesity in South African women is a significant challenge and can be decreasing by targetting sitting time, increasing time spent on unstructured movement or standing breaks and reducing screen time (136, 288, 340). Therefore, black South African women should be aware of their weight status, and this could promote individuals to becoming more physically active and enjoying health related benefits (188).

5.2.4. Association of lifestyle behaviours and sleeping patterns with blood pressure.

In South Africa, hypertension is a common chronic disease of lifestyle responsible for more deaths than any other cardiovascular condition (341), due to the increased rates of individuals with uncontrolled blood pressure, even those on medication. The overall prevalence of hypertension in black South African women was estimated to be 46%. In 2002, South African Demographic Health Survey (SADHS) also found that the high prevalence of overweight and obesity in black women was associated with increased risk of hypertension (94, 342). Previous studies conducted in rural areas focused on the assessment and the association of lifestyle behaviours such as physical activity, SES, smoking and alcohol consumption with obesity (82, 343). However, this study focused on the association of lifestyle behaviours and sleeping patterns with blood pressure and obesity.

The findings of this study show that physical activity was positively associated with diastolic blood pressure but had no clear association with hypertension. A study by Mkhotho et al. (2012) also found no relationship between blood pressure and physical activity using objective measures such as a pedometer (35). In addition, Magobe et al. (2017) stated that regular physical activity is a fundamental preventative measure and the first step treatment for all stages of hypertension (344). Total work physical activity, total walking-travel physical activity, and total leisure physical activity were strongly associated with diastolic blood pressure. Despite the well-known inverse association of physical activity with hypertension, this study shows a higher prevalence of physical activity (345). This is also in contrast with various studies that reported higher levels of physical inactivity in South Africa, most of which used the same GPAQ as a tool for physical activity (345, 346). However, GPAQ has both the potential to underestimate and overestimate both physical activity and sitting time (295). Nonetheless, GPAQ has been shown to be reliable for use in African populations (347), and our findings are comparable with physical activity data from other African countries and add to evidence from LMICs (348). This can be the result of the difficulties in standardising and measuring physical activity across populations in different countries using self-reported tools (34, 349, 350).

Excessive alcohol intake is a risk factor for CVD and a strong predictor for all-cause mortality (351). The results from our cohort showed an association between blood pressure and alcohol consumption. A cohort by Sesso et al. (352) is in contrast with the findings of current study has reported a significant increase in the risk of hypertension in relation to alcohol. In contrast, previous studies showed that alcohol consumption decreased the risks of hypertension in women (150, 353). As a result, the pattern of drinking in black South Africans shows a significant increase with BP as compared to hypertension (354). In addition, a study indicated that the use of self-reported alcohol intake is useful since it showed a significant association with the development of hypertension within the African population (351, 355).

As found in some other studies, in this study, hours of sleep per night were associated with blood pressure. A study by Pretorius et al. (2015) is consistent with the findings of the current study that demonstrated that female participants with longer sleep duration had higher systolic and diastolic blood pressures (41). Most studies in developing and developed countries revealed that sleep durations of <7 hours a day or >8 hours a day were associated with increased risks of increased blood pressure (3, 287, 356).

The overall findings of this cohort may suggest that people are not aware that they are hypertensive due to factors such as inadequate health education and limited access to healthcare services. Furthermore, factors such as salt intake were not examined in the current study, and may also be responsible for the elevated blood pressure, considering that increased levels of salt consumption have been documented in South African black populations (357). Studies reports that salt consumption is the primary factor contributing to increased rates of hypertension in the black population (124, 129). Therefore, more efforts such as public health education and the inclusion of a blood pressure monitoring system in rural areas for senior citizens.

5.3. Strengths of the study.

The main strength of this study is that it was conducted in a group of rural African women, adding to the limited data on the association of lifestyle behaviours (beverage intake, physical activity) and sleeping patterns with obesity and hypertension. It is noted that rural populations are also affected by obesity and hypertension as much as they affect the urban populations, regardless of the low socioeconomic status of the rural populations, therefore it will be of great importance to the body of knowledge to conduct longitudinal studies in the study population.

5.4. Limitations of the study.

The main limitation of this study was the use of self-reported instruments, however, previous studies have highlighted that the GPAQ (38), BEVQ-15 (222), and PSQI (303) were validated and useful instruments for collecting information about physical activity, SSB, and sleep quality data, respectively. The self-reporting of behavioural factors such as tobacco or alcohol use should be interpreted with caution, as it is possible that respondents under-reported. The nature of the study design (cross-sectional survey) limits causality of the associated factors, which can be addressed by conducting a follow-up (Longitudinal) study of the sample. Further, the findings of this study are essential in understanding the factors associated with anthropometry and hypertension in rural-dwelling black African women.

5.5. Future research.

The study has identified the following areas that require future research:

1. There is a need to conduct interventional longitudinal studies on physical activity, sleep patterns, anthropometry and dietary patterns that will document health outcomes in rural-dwelling black South African women.
2. Studies conducted should focus on determining the influence of eating behaviour, physical inactivity and sleeping behaviour on the development of obesity and hypertension in young adults.
3. The consumption levels of SSBs in South Africa have not been sufficiently validated. Further research is required to determine consumption levels and trends in adult population.

5.6. Conclusion

This study confirmed the high prevalence of obesity and associated elevated blood pressure and the epidemiological transition from diseases to poverty in rural South African village. Overall, the findings of this study highlight the importance of meeting PA guidelines to reduce the rate of NCDs in black South African women. Barriers and determinants of PA in rural black women in South African need to be identified (358). Findings of this dissertation suggests that physical inactivity, SSBs, SES, smoking, and alcohol consumption plays a significant role in the prevalence of obesity and hypertension. The transition from physically demanding to sedentary lifestyles has reduced physical activities by exposing the adult population to high risks of developing various health conditions (240). However, the results of the study show that walking as a means of transport/travel is a significant contributor to physical activity and thus, a large number of women were considered active based on World Health Organization criteria. Obesity and hypertension are of global public health concern, and in South Africa, there is a need for management and awareness of obesity and hypertension to be effected in the country (14, 285). This study confirms that both central and overall obesity were associated with increased levels hypertension in black South African women living in a rural setting.

The influence of extended sleep on lowering blood pressure is a novel finding in this population, suggesting protection against hypertension with longer night time sleep. The potential detrimental effects of SSB consumption on body fat requires urgent intervention to prevent additional weight gain and the associated risks with CVDs. As a result, people should be aware of their BMI in order to make necessary lifestyle changes that are required for weight loss and enjoyment of the associated health benefits (275). Prevention strategies such as comprehensive health education should be implemented in primary health care facilities at Tshino Nesengani village to address these life-threatening and significant risk factors for cardiovascular disease. Each should be granted an opportunity for screening risk factors for developing CVDs.

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APPENDICES

Appendix A: Information sheet

Good Day. My name is Ms Merling Phaswana. I am a registered master's student at the Centre for Exercise Science and Sports Medicine, University of the Witwatersrand, Johannesburg.

I would like to invite you to consider participating in my research study, entitled "**Association of lifestyle and sleep behaviours with blood pressure and body composition: a cross-sectional study of rural black South African women living in Tshino Nesengani**"*.* The study will be conducted at Tshino Nesengani village, Limpopo province, South Africa.

Your personal information will remain confidential, and participation is completely voluntary. There are no risks involved, and withdrawal from the study will not result in any penalties, loss of benefits, or prejudice. Your participation in this study is important and there are no right or wrong answers.

The research will consist of completion of questionnaires on physical activity, sleep pattern, diet, in addition to measuring your height, weight, waist, hip and calf circumferences, and blood pressure.

Thank you for considering participating, if you have any questions, or wish to obtain a copy of the results of this survey, please contact the following people.

Ms Phaswana Merling (student)
(Cell) 0769046359 *(tel)* (015) 962 8486 *(email)* merling.phaswana@univen.ac.za.
Dr Philippe Gradidge (supervisor)
(email) Philippe.gradidge@wits.ac.za
Kind regards
Phaswana Merling

Appendix B: Informed consent

Title of research study: Association of lifestyle and sleep behaviours with blood pressure and body composition: a cross-sectional study of rural black South African women living in Tshino Nesengani

Name of participant: ____

Participant's involvement: You are requested to take part in this survey, which will determine the association of physical activity, diet and sleep pattern with blood pressure and body composition

Nature of the research: This is a quantitative study involving data collection to better understand factors associated with obesity and hypertension in African women.

What's involved? This study involves measurements of height, weight, waist, hip, calf circumference, blood pressure; in addition, I will be asking questions around socioeconomic status, smoking, physical activity level, diet, and sleep pattern.

Risks: There are no risks or side effects involved with this study.

Benefits: There are no direct benefits to participating in this research project.

- I hereby confirm that I have been informed by the researcher, Ms. Phaswana M…. about the nature, conduct, benefits and risks of the study
- I am aware that the results of the study, including personal details regarding my sex, age, date of birth, initials and diagnosis will be anonymously processed into a study report.
- In view of the requirements of research, I agree that the data collected during this study can be processed in a computerised system by the researcher
- I may, at any stage, without prejudice, withdraw my consent and participation in the study.
- I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study.

Participant signature__________________________

Witness signature____________________________

Researcher signature__________________________________

Appendix C: Data collection sheet

Participant code:

Dear Participant

Please complete the following questions. The measurements will be done by the researcher.

1. What is your Age?

2. What is your highest level of education (place an ‘X’ in the appropriate box)?

No school	Primary school (Grade 1 to 7)	Incomplete high school (Grade 8 to Grade 11, and did not complete grade 12)	Matric (Completed grade 12/ standard 10)	Diploma / College certificate	Undergraduate degree	Master’s degree	PhD

3. Are you employed? (Place an ‘X’ in the appropriate box)

YES	NO

4a) If you answer Yes to question 2, what is your primary occupation?

4b). How many years have you been employed in this role?

5.What is your net salary per month? Place an ‘X’ over the appropriate answer.

<R5000	R5000-R10000	R10000-R15000	R15000-R20000	≥R20000

6. Indicate which of the following household items you own. Place an ‘X’ over the appropriate answer. (you can choose more than one item)

Car	DSTV	Television	Electricity	Radio	Fridge	Washing machine	Computer	Internet	Mobile phone	Telephone

7. Do you currently smoke?

Yes	No

7a) If yes, how many cigarettes do you smoke per day?

8. Do you currently use snuff/smokeless tobacco?

Yes	No

8a) If yes, how often do you use snuff/smokeless tobacco?

Once per week	2-3 times per week	4 or more times per week	2-4 times per month	Once a month

9. Do you currently consume alcohol?

Yes	No

9a) If Yes, how often do you have alcoholic drinks?

Once per week	2-3 times per week	4 or more times per week	2-4 times per month	Once a month

10. Anthropometric measures

Height (cm)	
Weight (kg)	
Waist circumference (cm)	
Hip circumference (cm)	
Calf circumference (cm)	

11. Blood Pressure

Measurement	**1**	**2**	**3**
Systolic blood pressure (mm Hg)			
Diastolic blood pressure (mm Hg)			

Appendix D: Pittsburgh Sleep Quality Index

INSTRUCTION

The following questions relate to your usual sleep habits during the past month only. Your answer should indicate the most accurate reply for the majority of days and nights in the past month. Please answer all questions.

1. During the past month, when have you usually gone to bed at night?
   USUAL BED TIME…………………………….
2. During the past month, how long (in minutes) has it usually take you to fall asleep each night?
   NUMBER OF MINUTES………………………
3. During the past month, when have you usually gotten up in the morning?
   USUAL GETTING UP TIME……………………
4. During past month, how many hours of actual sleep did you get at night? (This may be different than the number of hours you spend in bed)
   HOURS OF SLEEP PER NIGHT…………….

For each of the remaining question, check the one best response. Please answer all questions

5. During the past month, how often have you had trouble sleeping because you
   a) Cannot get to sleep within 30 minutes

Not during the past month	Less than once a week	Once or twice a week	Three or more times per week

b) Wake up in the middle of the night or early morning

Not during the past month	Less than once a week	Once or twice a week	Three or more times per week

c) Have to get up to use the bathroom

Not during the past month	Less than once a week	Once or twice a week	Three or more times per week

d) Cannot breathe comfortable

Not during the past month	Less than once a week	Once or twice a week	Three or more times per week

e) Cough or snore loud

Not during the past month	Less than once a week	Once or twice a week	Three or more times per week

f) Feel too cold

Not during the past month	Less than once a week	Once or twice a week	Three or more times per week

g) Feel too hot

Not during the past month	Less than once a week	Once or twice a week	Three or more times per week

h) Had bad dreams

Not during the past month	Less than once a week	Once or twice a week	Three or more times per week

i) Have pain

Not during the past month	Less than once a week	Once or twice a week	Three or more times per week

j) Other reason(s), please describe…………………………………………….

How often during the past month, have you had trouble sleep because of this?

Not during the past month	Less than once a week	Once or twice a week	Three or more times per week

6. During the past month, how would you rate your sleep quality overall?

Very good…………..
Fairly good…………..
Fairly bad…………….
Very bad…………….

7. During the past month, how often have you taken medicine (prescribed or over the counter) to help you sleep?

Not during the past month	Less than once a week	Once or twice a week	Three or more times per week

8. During the past month, how often have you had trouble staying aware while driving, eating meals, or engaging in social activity?

Not during the past month	Less than once a week	Once or twice a week	Three or more times per week

9. During the past month, how often have you had trouble staying aware while driving, eating meals, or engaging in social activity?

No problem at all…………………………….
Only a very slight problem……………………
Somewhat of problem………………………..
A very big problem……………………………

10. Do you have a bad partner or roommate?

No bed partner or roommate……………………..
Partner/roommate in other room…………………
Partner in same room, but not same bed…………
Partner in same bed ……………………………..

Appendix E: Global Physical Activity Questionnaire

This questionnaire is going to ask you about the time you spend doing different types of physical activity in a typical week. Please answer these questions even if you do not consider yourself to be physically active.

Think about the time you spend you spend doing work, studying/training, household chores, harvesting food, fishing, hunting, seeking employment. In answering the following questions ‘vigorous-intensity activities are activities that require hard physical effort and cause large increase in breathing or heart rate, moderate activities are activities that require moderate physical effort and cause small increases in breathing.

	ACTIVITY AT WORK	RESPONSE	CODE
1	Does you work involve vigorous-intensity activity that causes large increases in breathing or heart rate (like carrying or lifting heavy loads, digging, construction at work) for at least 10 minutes continuously?	YES 1 NO 2.If No, go to P4.	P1
2	In a typical week, on how many days do you do vigorous-intensity activities as part of your work?	Number of days____	P2
3	How much time do you spend doing vigorous-intensity activities at work on a typical day?	hours______ minutes________	P3 (a-b)
4	Does your work involve moderate-intensity activity that causes small increases in breathing or heart rate such as brisk walking (or carrying light load or at least 10 minutes continuously?	YES 1 NO 2 If no. go to P7	P4
5	In a typical week, on how many days do you do moderate-intensity activities as part of your work?	Number of days______	P5

6	How much time do you spend doing moderate-intensity activities at work on a typical day?	Hours______ Minutes______	P6 (a-b)
TRAVEL TO AND FROM PLACES			
The next question excludes the physical activities at work that you have already mentioned. Now I would like to ask you about the usual way you travel to and from places. Example to work, for shopping, to market or church.			
7	Do you walk, or use a bicycle for at least 10 minutes continuously to get to and from places?	YES 1 NO 2 If no, go to P10	P7
8	In a typical week, on how many days do you walk or bicycle for at least 10 minutes continuously to get to and from places?	Number of days______	P8
9	How much time do you spend walking or bicycling for travel on a typical day?	Hours______ minutes________	P9 (a-b)
RECREATIONAL ACTIVITIES			
The next questions exclude the work and transport activities that you have already mentioned. Now I would like to ask you about sports, fitness and recreational activities(leisure)			
10	Do you do any vigorous-intensity sports, fitness or recreational activities that cause large increase in breathing or heart rate like running, jogging, soccer or netball for at least 10 minutes continuously?	YES 1 NO 2 If no. go to P13	P10
11	In a typical week, on how many days do you do vigorous-intensity sports, fitness or recreational activities?	Number of days________	P11
12	How much time do you spend doing vigorous-intensity sports, fitness or recreational activities on a typical day?	Hours_______minutes_______	P12 (a-b)
PHYSICAL ACTIVITY(recreational activities)contd.			

13	Do you do any moderate-intensity sports, fitness or recreational activities that cause a small increase in breathing or heart rate such as brisk walking, jogging, cycling, and soccer for at least 10 minutes continuously?	YES 1 NO 2 If no, go to P16	P13
14	In a typical week, on how many days do you do moderate-intensity sports, fitness or recreational activities?	Number of days______	P14
15	How much time do you spend doing moderate-intensity sports, fitness or recreational activities on a typical day?	Hours_______minutes______	P15 (a-b)
SEDENTARY BEHAVIOUR			
The following question is about sitting or reclining at work, at home, getting to and from work places, or with friends including time spent sitting at a desk, sitting with friends, travelling in a car, bus, taxi,. Reading, playing cards or watching TV, but do not include time spent sleeping.			
16	How much time do you usually spend sitting or reclining on a typical day?	Hours______ minutes_______	P16 (a-b)

Appendix F: Beverage Intake Questionnaire

Instructions:

In the past month, please indicate your response for each beverage type by marking an "X" in the bubble for "how often" and "how much each time".

1. Indicate how often you drank the following beverages, for example, if you drank 5 glasses of water per week, mark 4-6 times per week.
2. Indicate the approximate amount of beverage you drank each time, for example,
   if you drank 1 cup of water each time, mark 1 cup under "how much each time".
   NOT in the milk categories.
3. Do not count beverages used in cooking or other preparations, such as milk in cereal.
4. Count milk added to tea and coffee in the tea/coffee with cream beverage category

	HOW OFTEN (MARK ONE)							HOW MUCH EACH TIME (MARK ONE)				
Type of Beverage	Never or less than 1 time per week (go to next beverage)	1 time per week	2-3 times per week	4-6 times per week	1 time per day	2+ times per day	3+ times per day	Less than 6 fl oz (3/4 cup)	8 fl oz (1 cup)	12 fl oz (1 1/2 cups)	16 fl oz (2 cups)	More than 20 fl oz (2 1/2 cups)
Water												
100% Fruit Juice												
Sweetened Juice Beverage/ Drink (fruitades, lemonade, punch, Sunny Delight)												
Whole Milk												
Reduced Fat Milk (2%)												

Low Fat/Fat Free Milk (Skim, 1%, Buttermilk, Soymilk)												
Soft Drinks, Regular												
Diet Soft Drinks/Artificially Sweetened Drinks (Crystal Light)												
Sweetened Tea												
Tea or Coffee, with cream and/or sugar (includes non-dairy creamer)												
Tea or Coffee, black, with/ without artificial sweetener (no cream or sugar)												
Beer, Ales, Wine Coolers, Non-alcoholic or Light Beer												
Hard Liquor (shots, rum, tequila, etc.)												
Wine (red or white)												
Energy & Sports Drinks (Red Bull, Rockstar, Gatorade, Powerade, etc.)												
Other (list):												

APPENDIX G: Permission letter to conduct research at Tshino Nesengani village.

LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF
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2050

DEAR MS. PHASWANA

PERMISSION TO CONDUCT RESEARCH AT TSHINO NESENGANI VILLAGE

WE THE NESENGANI TRADITIONAL COUNCIL HAS HEREBY GRANTED MS. PHASWANA MERLING WHO IS A RESIDENT OF TSHINO PERMISSION TO CONDUCT A RESEARCH PROJECT WHICH INVOLVES FEMALE RESIDENCE AGED 18> YEARS AND ABOVE AT TSHINO (MUKONDELELI) VILLAGE IN NESENGANI AREA.

THE PROJECT IS TITTLED:**ASSOCIATION OF LIFESTYLE BEHAVIOURS WITH BLOOD PRESSURE AND BODY COMPOSITION: A CROSS-SECTIONAL STUDY OF RURAL BLACK SOUTH AFRICAN WOMEN.**

HOPING INTO YOUR CO-OPERATION

YOURS TRULLY

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Appendix H: Ethical clearance certificate.

R14/49 Ms Merling Phaswana

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M170377

NAME: (Principal Investigator)	Ms Merling Phaswana
DEPARTMENT:	Centre for Exercise and Sports Medicine Tshino Nesengani Village, Vuwani, Thohoyandou Limpopo, South Africa
PROJECT TITLE:	Association of Lifestyle Behaviours with Blood Pressure and Bofy Composition: A Cross Sectional study of Rural Black South African Women
DATE CONSIDERED:	31/03/2017
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Dr Phillppe Gradidge
APPROVED BY:	Professor P. Cleaton-Jones, Chairperson, HREC (Medical)
DATE OF APPROVAL:	09/06/2017

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office Secretary in Room 10004,10th floor, Senate House/3rd floor, Phillip Tobias Building, Parktown, University of the Witwatersrand. I/We fully understand the conditions under which I am/we are authorised to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated, from the research protocol as approved, I/we undertake to resubmit to the Committee. **I agree to submit a yearly progress report**. The date for annual re-certification will be one year after the date of convened meeting where the study was initially reviewed. in this case, the study was initially review March and will therefore be due in the month of March each year. Unreported changes to the application may invalidate the clearance given by the HREC (Medical).

Principal Investigator Signature Date

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

APPENDIX I: Plagiarism Report.

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ORIGINALITY REPORT

11%	6%	8%	4%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	stroke.ahajournals.org Internet Source	<1%
2	Submitted to Boston University Student Paper	<1%
3	journals.sagepub.com Internet Source	<1%
4	A E Schutte, H W Huisman, J M Van Rooyen, R Schutte et al. "Should obesity be blamed for the high prevalence rates of hypertension in black South African women?", Journal of Human Hypertension, 2008 Publication	<1%
5	A.E. Pienaar, G.L. Strydom. "Chapter 2 Childhood Obesity: The Need for Practice Based Solutions - A South African Perspective", InTech, 2012 Publication	<1%
6	Herman J. de Vries, Thea J.M. Kooiman, Miriam W. van Ittersum, Marco van Brussel, Martijn de Groot. "Do activity monitors increase	<1%