Relationship between obesity and blood pressure among employees in the Vhembe district municipality of Limpopo Province, South Africa

Takalani Clearance Muluvhu, Makama Andries Monyeki, Gert Lukas Strydom, Abel Lamina Toriola

Abstract

Objective: The aim of this study was to investigate the relationship between obesity and blood pressure among employees of the Vhembe district municipality of Limpopo province.

Methods: A cross-sectional study was conducted among 452 local government employees (207 males, 245 females) aged 24–65 years. Body mass index (BMI), blood pressure (BP) and waist circumference (WC) measurements, and waist-to-height ratio (WHtR) were assessed. Data were analysed using Statistical Package for Social Sciences (SPSS) statistics, version 21.

Results: The results showed that 27% of the participants were classified as overweight and 34% as obese, with females being more overweight and obese (29 and 48%, respectively) compared to males (24 and 17%, respectively). Twenty-five per cent of the participants were hypertensive, with females (27%) showing a higher prevalence compared to males (22%). Based on BMI categories, the obese group (35%) had a higher prevalence of hypertension in contrast to groups that were of normal weight (18%) and overweight (22%). The results also showed that systolic blood pressure (SBP) was positively \( (p \leq 0.05) \) correlated with BMI \( (r = 0.15) \), WC \( (r = 0.26) \) and WHtR \( (r = 0.29) \) in the normal and overweight groups (WC, \( r = 0.23 \) and WHtR, \( r = 0.26 \)), and WHtR correlated with SBP \( (r = 0.26) \) and diastolic blood pressure (DBP) \( (r = 0.19) \).

Conclusion: The study showed a high prevalence of overweight, obesity and hypertension, with females more affected than their male counterparts. BMI, WC and WHtR were positively correlated with SBP in the normal and overweight groups, with WHtR positively correlated with both SBP and DBP in the overweight group. Therefore, it is recommended that intervention regimes designed to address obesity and hypertension should consider risk awareness for cardiovascular diseases, impaired quality of life and productivity among local government employees.

Keywords: obesity, hypertension, employees, blood pressure, body mass index

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Obesity is one of the most important public health problems worldwide.\(^1\) It is a major independent risk factor for chronic diseases, such as cardiovascular disease and diabetes mellitus, and is associated with high morbidity and mortality rates.\(^2\) According to the World Health Organisation (WHO), up to 20% of the population in developed countries may suffer from obesity-associated hypertension, which may account for 78 and 65% of essential hypertension in males and females, respectively.\(^3,4\) The WHO\(^4\) reported that one in six adults is obese and one in three has elevated blood pressure (BP), with the highest prevalence recorded in Africa. Obesity and hypertension are among the preventable risk factors for cardiovascular disease that impose a considerable economic burden, particularly in developing countries.\(^5\)

Hypertension is one of the 10 leading contributors to the global burden of disease and the most important risk factor for mortality worldwide;\(^6,7\) and has been described as a silent killer due to its asymptomatic nature among sufferers.\(^8\) Studies have reported that about nine million people die from hypertension annually.\(^8\) The prevalence of hypertension in Africa has been reported in several previous studies.\(^8,11,12\) Hypertension was once considered a disease of affluence but is now prevalent among the poor.\(^13\) South Africa is facing a serious burden of hypertension.\(^14\) More than 6.2 million South Africans are hypertensive, with 3.2 million having a BP of > 160 mmHg.\(^15\)

Several studies have shown a clear association with BP increase and weight gain.\(^5,16,17\) It has been reported that obese subjects have a 3.5 times increased likelihood of hypertension and that 60% of hypertension is attributable to an increase in adipose tissue stores.\(^2\) Data from the National Health and Nutrition Examination Survey in 2004 indicated that the prevalence of hypertension among obese individuals with a

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body mass index (BMI) > 30 kg/m² was 42.5%, compared with 15.3% in lean individuals. Visceral fat distribution is another genetic factor that contributes to the increase in BP levels among obese individuals. In addition, environmental and behavioural factors, such as alcohol intake, cigarette smoking, timing of onset of childhood obesity, change in daily lifestyle habits and alteration in lipid profile may be implicated in visceral fat distribution and increased BP values. Most studies suggest that centrally located body fat is a stronger determinant of BP elevation than peripheral body fat in both men and women.

A positive correlation between BMI and BP has been reported among Ghanaian adults aged 30 to 50 years old. Certain occupations, especially white-collar jobs, are characterised by sitting for long periods of time, such as employees in financial institutions and administration offices, and this predisposes individuals to a sedentary lifestyle. These individuals tend to spend the majority of their adult working lives less engaged in physical activity outside of working hours, thereby predisposing them to obesity and diseases. A study in India reported a higher prevalence of hypertension, which was more positively correlated to obesity among employees than the general population of the country.

A recent systematic review among workers in West Africa reported a prevalence of hypertension of 12 to 69% among employees. The prevalence of obesity ranged from 2% among automobile garage employees in Kumasi, Ghana, to 42.1% among healthcare workers in Umuahia, Nigeria. The prevalence of hypertension ranged from 27.9 to 79.8% among obese workers compared with 7.3 to 65.4% among non-obese employees in West Africa. Among healthcare workers in a university teaching hospital, there appeared an unusual ratio in the association between obesity and hypertension, which was 2.2 (p = 0.004). In Kaduna, civil servants younger than 40 years old who were overweight or obese were five times as likely to have hypertension compared with healthy-weight workers. Schutte et al. reported a prevalence of 48% overweight and obesity among South African employees from 18 companies participating in health-screening programmes. Cardiovascular risk factors, specifically diabetes and hypertension, were found to be associated with obesity among public service workers in Ondo State, Nigeria.

This study will be first of its kind to study employees in the Vhembe district municipalities of the Limpopo Province to investigate the relationship between obesity and BP.

Methods

The research was based on a cross-sectional design on an available population sample of local government employees in the Vhembe district municipality of the Limpopo Province, South Africa. Participants voluntarily participated in the study.

There were 452 (men = 207; women = 245) participants from local government employees in the Vhembe district, which is one of the five districts of the Limpopo Province of South Africa (local government is a form of public administration in South Africa, which exists as the lowest tier of administration in the provinces). Vhembe district is located in the northern part of the country and shares its borders with the Beitbridge district in Matabeleland south, Zimbabwe. According to the 2001 census, 800 000 Vhembe district residents speak Tshivenda as their mother tongue, while 400 000 speak Tsonga and 27 000 speak Northern Sotho. The majority of the participants in this study were employed as grounds maintenance workers, clerical workers, managers and councillors. The employees were categorised into three age groups as follows: 24–29, 30–44 and 45–65 years. Participants were included in the study if they were within the age categories and deemed healthy.

Standing height was measured to the nearest 0.1 cm, using a Harpenden portable stadiometer (Holtain Ltd, Crymych, Dyfed, UK). Body mass was measured using a portable calibrated scale (SECA) and recorded to the nearest 0.5 kg. BMI was calculated as body mass (kg) divided by height (m) squared (kg/m²).

Waist circumference (WC) was measured using a steel tape measure and in accordance with the procedure recommended by the American College of Sports Medicine. For men, low WC in this classification is defined as less than 94 cm, high is 94 to 102 cm, and very high is greater than 102 cm. For women, low WC is less than 80 cm, high is 80 to 88 cm, and very high is greater than 88 cm. Waist-to-height ratio (WHtR) was determined from waist circumferences (cm) divided by height (cm). The norms for WHtR were as follows: normal is WHtR < 0.5, while WHtR > 0.5 indicates increased risk for both males and females.

BP was measured by using an automated sphygmomanometer (Omron, Health Care, Inc, USA). The participants were seated, and systolic (SBP) and diastolic (DBP) blood pressure measurements were determined according to the protocols suggested by the American College of Sports Medicine (ACSM).

The ACSM has identified thresholds above which individuals may be at an increased risk for cardiovascular disease. The thresholds that were used to describe risk included the following:

- overweight = BMI between 25 and 29.9 kg/m²; obesity = BMI ≥ 30 kg/m²
- hypertension = SBP ≥ 140 mmHg and DBP ≥ 90 mmHg, as well as for participants on hypertension treatment.

The aim of the study was explained to the participants and their employers, who were also informed that the data would be treated confidentially and would only be used for the purposes of research. The participants were requested to complete and sign an informed consent form before participating in the study. The measurements took place during weekdays, as arranged with the participants. The researcher (a biokineticist registered with the Health Professions Council of South Africa: registration number BK 0016195-HPCSA) was assisted by well-trained research assistants conducting the measurements. The anthropometric measurements of height, weight, WC and BP were taken in allocated separate rooms for males and females. The study received ethical approval (Ref: NWU-00125-13-S1) from the ethics committee of North West University, Potchefstroom, South Africa.

Statistical analysis

Descriptive statistics were calculated for all variables according to gender. Numerical data are expressed as mean and standard deviation (mean ± SD) and categorical data are expressed as percentages. A t-test was used to determined differences in the means of variables (age, height, weight, BMI, WC, WHtR, and SBP and DBP between the study groups), and the chi-squared test was used to compare the prevalence of general obesity and central/abdominal obesity in men and women. The differences in BMI and WC across age groups were described by gender,
and the chi-squared test was used to compare the prevalence of obesity between the various age groups. To determine the differences between the BMI categories/groups, an analysis of variance (ANOVA) was calculated for all variables. Descriptive characteristics of the hypertensive and normotensive groups were determined and compared. Pearson correlation coefficients were used to determine the relationship between obesity and BP among employees. All statistical analyses were performed with the SPSS, version 21. The statistical level of the $p$-values was set at $p \leq 0.05$.

**Results**

Fig. 1 presents the percentage for BMI categories for the total group and by gender. The results show that of the total group, 39% had normal weight, 27% were overweight and 34% were obese. The findings also indicate that 29% of women were overweight compared to 24% of men. Similarly 48% of women were obese in comparison to 17% of men.

Fig. 2 presents the percentage of hypertension for the total group by gender and BMI categories. In the total group, the results show that 25% of the employees presented with hypertension in which the women (27%) were more affected than men (22%). When the data were analysed according to BMI categories, the results showed a significantly higher percentage of hypertension in both the overweight and obese groups.

Table 1 presents the percentages regarding the subjects' characteristics for the total, non-obese and obese groups. The women in the age group of 45 to 65 years had a higher prevalence of overweight (84.7%) and obesity (87.3%) compared to 76.6 and 82.9% of the men (Table 1). The results also show that participants with no education tended to be more overweight (71.1%) compared to those with qualifications, where women were 76.4% overweight and 66.1% obese, in contrast to men who were 63.3% overweight and 65.7% obese. The findings

<table>
<thead>
<tr>
<th>Variables</th>
<th>Non-obese group, n (%)</th>
<th>Obese group, n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total participants</td>
<td></td>
</tr>
<tr>
<td>Age group (years)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24–29</td>
<td>17 (9.6)</td>
<td>4 (3.3)</td>
</tr>
<tr>
<td>30–44</td>
<td>14 (7.9)</td>
<td>8 (6.5)</td>
</tr>
<tr>
<td>45–65</td>
<td>147 (82.6)</td>
<td>111 (90.2)</td>
</tr>
<tr>
<td>Qualification</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No formal education</td>
<td>124 (69.7)</td>
<td>92 (74.8)</td>
</tr>
<tr>
<td>Std 8</td>
<td>8 (4.5)</td>
<td>8 (6.5)</td>
</tr>
<tr>
<td>Matric</td>
<td>20 (11.2)</td>
<td>12 (9.8)</td>
</tr>
<tr>
<td>Diploma</td>
<td>17 (9.6)</td>
<td>7 (5.7)</td>
</tr>
<tr>
<td>Degree 1</td>
<td>2 (1.1)</td>
<td>1 (0.8)</td>
</tr>
<tr>
<td>Degree 2</td>
<td>1 (0.6)</td>
<td>1 (0.8)</td>
</tr>
<tr>
<td>Degree 3</td>
<td>3 (1.7)</td>
<td>1 (0.8)</td>
</tr>
<tr>
<td>Certificate</td>
<td>2 (1.1)</td>
<td>1 (0.8)</td>
</tr>
<tr>
<td>Occupation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>General clerk</td>
<td>12 (6.7)</td>
<td>11 (8.9)</td>
</tr>
<tr>
<td>Accounting clerk</td>
<td>3 (1.7)</td>
<td>1 (0.8)</td>
</tr>
<tr>
<td>Grounds maintenance workers</td>
<td>160 (89.9)</td>
<td>111 (90.2)</td>
</tr>
<tr>
<td>Municipality manager (MM)</td>
<td>1 (0.6)</td>
<td>-</td>
</tr>
<tr>
<td>Councillors</td>
<td>2 (1.1)</td>
<td>-</td>
</tr>
</tbody>
</table>

OV = overweight; OB = obese; Std 8 = Standard eight (grade 10).
also indicate that 83.5% of grounds maintenance employees were overweight and 79.7% were obese in comparison to participants in other occupations, where women showed a higher preponderance of overweight (90.3%) and obesity (77.1%) compared to men who were 73.5% overweight. Accounting clerks showed a higher percentage of obesity (88.6%) within the obese category.

Presented in Table 2 are the means and standard deviations for overweight and obesity for the total group and by gender. As shown in the results, the mean height for the non-obese group was 167.94 ± 8.80 cm (from the total group of 178 participants). Men were taller on average (170.71 ± 7.19 cm) than women (161.76 ± 9.27 cm). The mean weight was 64.90 ± 7.97 kg for the total group, in which men were heavier (66.75 ± 7.93 kg) than women (60.75 ± 6.38 kg). Regarding BMI, the mean value for the total group was 22.99 ± 2.05 kg/m²; however, specific values were 22.89 ± 2.13 kg/m² for men and 23.23 ± 1.83 kg/m² for women.

Mean BP data for the total group were as follows: SBP 130.31 ± 11.26 and 84.90 ± 12.49 mmHg, respectively. However, the mean BMI for overweight and obese participants, respectively, was 167.94 ± 9.27 cm (73.5% overweight) and women (60.75 ± 6.38 kg), with a mean WC of 98.06 ± 11.96 and 99.41 ± 15.04 cm obtained for men and women, respectively. In the obese group the mean SBP was 140.44 ± 20.21 mmHg for men, and 143.61 ± 24.61 mmHg for women. However, the mean DBP was 80.23 ± 12.93 and 82.79 ± 12.93 mmHg for the men and women, respectively. The results also show that there was a significant difference (p ≤ 0.05) in height, BMI and WHtR among men and women.

Table 5 presents the correlation coefficients for the normal, overweight and obese groups. In all three BMI groups, BW, WC, BMI and WHtR were significantly and positively related to each other. In the normal group, SBP was positively correlated (p ≤ 0.05) with BMI (r = 0.150), WC (r = 0.26) and WHtR (r = 0.29). In the overweight category, WC was significantly correlated (p ≤ 0.05) with BMI and WHtR and positively correlated with SBP (r = 0.23), and WHtR was positively associated with both SBP (r = 0.26) and DBP (r = 0.19).

Discussion

The purpose of this study was to investigate the relationship between obesity and BP among employees in the Vhembe district municipality of the Limpopo Province, South Africa. The study showed that 27 and 35% of the total participants were overweight and obese, respectively. These findings were higher in comparison to a study by Lategan, et al., which found that half of the participants from the black urban population of the Free State community had a BMI above normal (23% overweight and 32% obese). The results of this study concur with the findings of WHO,* which estimated that 45.1% of the South African population were overweight and obese. Schutte, et al.** reported a prevalence of 48% overweight and obesity among South African employees from 18 companies participating in health-screening programmes.

The findings of this study, according to gender, showed that females were more overweight and obese (29, 48%) compared to males (24, 17%). This is higher when compared to findings by the South African Demographic and Health Survey, reporting that 18.7% of urban black men were overweight and 8.1% were obese, with 27.1% of urban black women being overweight and 33.8% obese. Our findings confirmed the trend that black South

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Table 2. Descriptive statistics (mean and standard deviations) of the men, women and total participants in the overweight and obese groups

<table>
<thead>
<tr>
<th></th>
<th>Non-obese group, mean ± SD</th>
<th>Overweight and obese group, mean ± SD (n = 234)</th>
<th>Overweight group (n = 49)</th>
<th>Obese group (n = 185)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total participants (n = 178)</td>
<td>Men (n = 121) Women (n = 55) p-value</td>
<td>Total participants (n = 153)</td>
<td>Men (n = 49) Women (n = 72) p-value</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>167.94 ± 8.80</td>
<td>170.71 ± 7.19 161.76 ± 9.27 &lt; 0.001</td>
<td>169.00 ± 8.39 168.07 ± 10.73 &lt; 0.001</td>
<td>165.60 ± 17.34 159.47 ± 7.31 0.003</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>64.90 ± 7.97</td>
<td>66.75 ± 7.93 60.75 ± 6.38 &lt; 0.001</td>
<td>76.67 ± 7.77 92.85 ± 14.67 &lt; 0.001</td>
<td>85.09 ± 14.77 92.19 ± 14.77 0.31</td>
</tr>
<tr>
<td>BMI</td>
<td>22.99 ± 2.05</td>
<td>22.89 ± 2.13 23.23 ± 1.83 0.30</td>
<td>28.42 ± 1.46 35.92 ± 4.92 28.09 ± 1.42 28.65 ± 1.46 0.04</td>
<td>34.97 ± 5.06 36.20 ± 4.87 0.19</td>
</tr>
<tr>
<td>WC</td>
<td>84.20 ± 11.02</td>
<td>85.24 ± 12.30 81.85 ± 6.92 0.05</td>
<td>93.92 ± 10.76 105.42 ± 14.42 96.53 ± 7.13 92.15 ± 12.39 0.03</td>
<td>105.81 ± 15.70 105.31 ± 14.08 0.86</td>
</tr>
<tr>
<td>SBP</td>
<td>138.53 ± 23.10</td>
<td>142.20 ± 23.05 130.31 ± 21.17 0.001</td>
<td>137.74 ± 21.71 145.76 ± 24.06 138.45 ± 18.07 137.25 ± 23.98 0.77</td>
<td>138.23 ± 21.06 147.99 ± 24.52 0.05</td>
</tr>
<tr>
<td>DBP</td>
<td>77.04 ± 13.62</td>
<td>78.05 ± 14.53 74.80 ± 11.11 0.14</td>
<td>79.26 ± 11.26 84.90 ± 12.49 80.67 ± 10.97 78.31 ± 11.43 0.26</td>
<td>79.57 ± 10.49 86.48 ± 12.63 0.004</td>
</tr>
<tr>
<td>WHtR</td>
<td>0.50 ± 0.07</td>
<td>0.50 ± 0.07 0.51 ± 0.05 0.58</td>
<td>0.57 ± 0.07 0.65 ± 0.08 0.57 ± 0.04 0.58 ± 0.08 0.43</td>
<td>0.62 ± 0.07 0.66 ± 0.08 0.04</td>
</tr>
</tbody>
</table>

OW = overweight; OB = obese.
African women have substantially higher BMIs than their male counterparts. Overweight or obese individuals are at greater risk of developing metabolic (type 2 diabetes and dyslipidaemia) and non-metabolic disorders.44

The study also found a 25% prevalence of hypertension in the total group; this is lower when compared with a study by Maepa et al.,44 which revealed that 49.2% of African adults between the ages of 24 and 65 years in Cape Town. This also corresponds with findings by Owalabi et al.,45 which reported a 40% prevalence of hypertension among employees in the gold mines of Gauteng’s Harmony Gold Mining Company in South Africa. This also corresponds with a study by Ntuli et al.46 which reported a 40% prevalence of hypertension among adults in South African provinces during 2010. Peer et al.47 also reported a lower prevalence of hypertension (38.9%) among black urban South African adults between the ages of 24 and 65 years in Cape Town.

The study showed that women (27%) had a higher prevalence of hypertension compared to males (22%). This is lower than the prevalence of hypertension (38.9%) among black urban South African adults between the ages of 24 and 65 years in Cape Town. This also corresponds with findings by Owalabi et al.,45 which revealed that 49.2% of the Buffalo City metropolitan municipality adults had a high prevalence of hypertension. The findings of the study are also lower when compared to a study by Day et al.,48 which reported a 40% prevalence of hypertension among adults in South African provinces during 2010. Peer et al.47 also reported a lower prevalence of hypertension (38.9%) among black urban South African adults between the ages of 24 and 65 years in Cape Town. The study showed that women (27%) had a higher prevalence of hypertension compared to males (22%). This is lower than the study by Ntuli et al.46 in adults in a rural community of Dikgale in the Limpopo Province, which showed that 42% of males and 41% of females were hypertensive.
The findings of our study are also similar to those of the South Africa Demographic and Health Survey (SADHS), which reported that using a cut-off of 140/90 mmHg and gender adjustment, 25% of men and 26% of women had hypertension. Based on BMI categories, our study showed that obese groups (35%) had a high prevalence of hypertension when compared to the normal (18%) and overweight groups (22%). These findings are similar to a study by Dua et al., which found that the prevalence of high BP was greater in those with high BMI. This has also been reported in other studies. The WHO reported that hypertension was globally responsible for 45% of deaths due to cardiovascular disease and 51% of deaths due to stroke. According to Ibrahim and Damasceno, as well as the WHO, an estimated one billion people worldwide are hypertensive, and this number is expected to rise to 1.56 billion by 2025.

These studies also found that all measures of body composition (WC, BMI and WHtR) significantly correlated with WC and WHtR. BMI and WC positively correlated with SBP in the normal group. The same trend was observed in other studies, where a statistically significant association was found between hypertension and BMI among employees working at Port Said University. The results of the study also found that, in the overweight group, WC correlated significantly with SBP, and WHtR correlated positively with both SBP and DBP. These findings correspond with those of Dua et al., who showed a statistically significant positive correlation between all the anthropometric measures and BP parameters (SBP and DBP). These findings are also in agreement with other studies, which found that anthropometric variables such as BMI, WC and WHtR were frequently positively associated with BP among employees in West Africa. Obesity emerged as a strong predictor of hypertension among employees in Ghana.

The high prevalence of overweight/obesity in this study linked to the prevalence of hypertension agrees with the International Study of Salt and Blood Pressure, which reported a strong, significant, independent association between BMI and BP. From the literature, it was revealed that obesity is associated with more pronounced changes in BP during a 24-hour cycle and a higher SBP, DBP and pulse pressure, indicating autonomic dysfunction or hypertension. All these risk factors may contribute to the increase in prevalence of chronic diseases and absenteeism among employees.

The major constraint of the study was the difficulty in collecting data from all the municipalities that participated. Inclusion of all employees from the Vhembe district would have enriched the data collected. In addition, it was not feasible to collect 24-hour BP data from the participants due to logistical challenges. This would have shed more light on the observed relationships between WC and WHtR measures. It would be important in future studies to address these challenges.

Conclusion

Females showed a higher percentage of obesity and hypertension than their male counterparts. The obese group showed a high prevalence of hypertension compared with the other groups. Body composition measures were associated with BP parameters (more especially, BMI, WC and WHtR), which showed a positive significant relationship in both normal and overweight groups. Therefore, this study recommends that intervention regimes designed to address the risk of obesity and hypertension should focus on the awareness of cardiovascular diseases, impaired quality of life, and low productivity associated with obesity and hypertension among local government employees in the Vhembe district of Limpopo Province.

The willingness of the Vhembe local municipality employees to participate in the study is highly appreciated. The University of Venda biokineticist interns: Walter, Precious, Gudani and Merlyn and third-year biokinetics students Tsakani, Fululheko, Pearl, Rixongile, Ruth and Emmanuel are acknowledged for their roles in data collection and capturing. Furthermore, Ms Frazer Maake is thanked for her support in organising satellites within the Vhembe district where the study took place. The financial support by the University of Venda towards the study is acknowledged.

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