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Research Article

Relationship Between Selected Metabolic Risk Factors and Waist-to-Height Ratio among Employees in Vhembe District Municipality of Limpopo Province, South Africa

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Abstract

Background and Objective: Relationship between metabolic risk factors and waist-to-height (WHtR) in population studies are well known. The aim of the study was to investigate the relationship between selected metabolic risk factors and waist-to-height ratio among employees in Vhembe District Municipality of Limpopo Province, South Africa. **Materials and Methods:** Using a cross-sectional design, the following anthropometric and metabolic variables were assessed in 535 (Men = 249,Women = 286) local government employees (aged 24-65 years) of the Vhembe district, Limpopo province based on standardized protocols: Body Mass Index (BMI),waist-to-height ratio (WHtR), cholesterol (mmol L^{-1}, TC) and fasting blood glucose (mmol L^{-1}, FG). Data were analyzed using SPSS statistics version 21. **Results:** Majority (84.6%, males: 85.1%, females: 3.5%) of the participants were ground maintenance workers. The participants (65.2%) were classified as overweight (21.3%) and obese (43.9), females (20.6-60.5%) being more overweight and obese as compared to males (22-25%). Twenty-five percent of the total participants had an elevated level of fasting glucose, females (3.8%) being more affected than males (3.2%). Fasting glucose was positively associated with the BMI, Waist circumference (WC) and WHtR, especially in the grounds maintenance workers. **Conclusion:** Female employees were more overweight and obese than their male counterparts. Furthermore, fasting glucose was high among the employees, with female being more affected than the males. Municipality managers had high levels of total cholesterol as compared to the ground maintenance workers. It was evident that fatness was positively associated with elevated fasting glucose. From a public health perspective, the current results indicate the need for urgent strategic health promotion intervention among the employees in the Vhembe Local Municipality.

Key words: Obesity, chronic diseases, fasting glucose, total cholesterol, anthropometry

INTRODUCTION

Obesity is a metabolic disorder resulting inter alia from the imbalance between energy intake and expenditure[1]. In the past four decades, obesity has been recognized as the most common risk factor for a number of chronic diseases such as heart diseases, hypertension, stroke, high cholesterol, adult-onset type two diabetes and certain forms of cancers[2,3]. Current estimates from the International Obesity Task Force suggest that at least 1.1 billion people across the globe are overweight and 312 million of them are obese[4]. In developed countries like the USA, the prevalence of overweight is as high as 36% in adults and 17% in youth[5]. Research has also shown that more than 30% of the population in Latin America, the Caribbean, Middle East and Northern Africa are overweight[2]. In Southern Africa, obesity is a major public health concern along with HIV/Aids and malnutrition, it is also apparent that in developing countries obesity and malnutrition co-exist[6]. The South African National Health and Nutrition Examination Survey (SANHANES-1)[7] reported a high prevalence of overweight and obesity in females than males (25 and 40.1% compared with 19.6 and 11.6% for females and males, respectively)[6]. High prevalence of obesity was also found among South African employees at one of the South African diamond mines[8] in which 25% of adult women were overweight and 40.1% obese, while 19.6% of adult men were overweight and 11.6% obese.

Experimental research has demonstrated that altered levels of metabolites in multiple metabolic pathways were associated with obesity, for example glucose[9,10] and lipid metabolism[11]. However, it has been accepted that the location of excess adiposity is a strong determinant of cardio-metabolic risk[12]. Specifically, the central deposition of excess weight has been proven to be a stronger predictor of risk of morbidity and mortality in comparison with overall obesity as defined by BMI alone[13-17]. Although Waist Circumference (WC) is often advocated as a simple and accurate anthropometric marker of central obesity and associated cardio-metabolic risk, its use has been adopted into clinical guidelines[18]. The application of waist circumference to assess cardio-metabolic risk may even differ between Asians and other racial groups[19,20]. The application of waist circumference to assess cardio-metabolic risk also assumes, albeit erroneously, that risk stratification does not influence patient height. For example, it has been shown that the risk of metabolic syndrome within given waist circumference strata is significantly higher among shorter individuals than taller persons[21].

The waist-to-height ratio (WHtR) is an alternative anthropometric index of central obesity that circumvents the limitations of waist circumference[22]. First, due to the inclusion of height into the index, any potential confounding of cardio-metabolic risk by height is avoided, second, studies have found similar WHtR cut-offs for increased cardio metabolic risk among Caucasian[22] and Asians[23]. WHtR cutoffs of 0.5 has been proposed as an indicator of cardio-metabolic risk for both Japanese[24], Korean[25] and British[26] men and women.

WHtR has also been shown to denote cardio-metabolic risk among individuals who are not obese when other anthropometric indices were used[26,27]. For example, as compared to BMI and waist circumference, WHtR is a better discriminator for hypertension, diabetes and dyslipidemia in both sexes[28,29]. An Iranian study has shown that WC and WHtR showed greater correlation with total cholesterol, fasting glucose, LDL, HDL-C level than did BMI[30]. The study carried out in African women has also demonstrated the association of abdominal obesity with TG, LDL and high LDL-C[31]. However, there are limited studies which assessed the relationship between selected metabolic risk profiles and WHtR in employees of South African municipalities. Therefore, the aim of this study was to investigate the relationship between selected risk factors of metabolic disease and waist-to-height ratio among local government employees in Vhembe District Municipality, Limpopo Province of South Africa. This study will advance knowledge because waist-to-height WHtR ratio assessment can be used as a tool to measure obesity rather than using body mass index and waist circumference measurement only.

MATERIALS AND METHODS

Research design: The research was based on a cross-sectional design, on a convenience sample of local government employees in the Vhembe District of the Limpopo Province of South Africa.

Participants: Participants were 535 (Men = 249, Women = 286) local government (i.e., Local government is a form of public administration in South Africa which, in a majority context, exists as the lowest tier of administration within a given state) employees in the Vhembe District, which is one of the five districts of Limpopo Province of South Africa. Vhembe District is located in the Northern part of the country and shares its boarders with Beit Bridge District in Matabele land South, Zimbabwe. According to 2001 Census, 800000 of the Vhembe district residents speak Tshivenda as their mother tongue, while 400000 speak Tsonga and 27000 speak Northern Sotho[32]. Majority of the participants in this study

were employed as ground 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 ranges and deemed apparently healthy.

Height and body mass: Standing height was measured to the nearest 0.1 cm, using a Harpenden Portable Stadiometer (Holtain Limited, Crymych, Dyfed, UK). Body mass was measured using a portable calibrated scale (SECA) and recorded to the nearest 0.5 kg. Body mass index (BMI) was calculated as body mass (kg) divided by height (m) squared ($kg\,m^{-2}$).

Waist circumference: Waist circumference was measured using a standard tape measure and in accordance with procedure recommended by the American College of Sports Medicine[33]. For men, low waist circumference in this classification is defined as less than 94 cm, high as 94-102 cm and very high as greater than 102 cm. For women, low waist circumference is less than 80 cm, high is 80-88 cm and very high is greater than 88 cm[18,19]. The WHtR was determined from waist circumferences (cm) divided by height (cm), Normal, WHtR<0.5 and WHtR>0.5 indicating increased risk for both male and females[23].

Cholesterol and glucose screening: Total blood cholesterol and glucose levels were determined after a fasting period of 10 h from capillary blood samples obtained using a finger prick. The sample was placed on the PTS panels of glucose and lipids test strips and analyzed from the Cardiocheck® PA Analyzer (Polymer technology systems, Inc., USA). The Cardiocheck analyzer was calibrated regularly following the instructions of the manufacturer.

Cut-off points: The American College of Sports Medicine (ACSM) has identified thresholds above which individuals will be at increased risk for cardiovascular disease[33]. The thresholds that were used to describe risk included the following:

- Obesity-BMI<18.5 as underweight, between 18.5-24.9 $kg\,m^{-2}$ as normal weight, between 25-29.9 $kg\,m^{-2}$ as overweight and $\geq$30 $kg\,m^{-2}$ as obese
- Total cholesterol $\geq$5.18 mmol L^{-1} or patient using lipid-lowering drugs
- Impaired fasting glucose $\geq$5.5 mmol L^{-1} or patient using diabetic medication

Procedure: The aim of the study was explained to the participants and their employers, who were also informed

that the data would be treated confidential and will only be used for the research purpose. The participants were requested to complete and sign the informed consent form before participating in the study. The measurements took place during weekdays as per arrangement with the participants. A researcher (a Biokineticist, registered with the Health Professions Council of South Africa: Registration number BK 0016195-HPCSA) conducted the measurements. The anthropometric measurements of height and weight were measured in allocated separate rooms for males and females. An investigator and the well-trained research assistants performed the measurements for cholesterol and glucose. After all the participants had completed all the anthropometric measurements, fasting total cholesterol (TC) and glucose, they were guided by a researcher and well-trained research assistants to complete the questionnaires. Given the high level of illiteracy in the sample, assistance was provided in terms of clarifying questions in the participant's native languages without losing the meaning of each question. The study received ethical approval (NWU-00125-13-S1) from the North-West University's ethics committee.

Statistical analyses: Data were analyzed using SPSS statistics version 21[34]. Descriptive statistics of mean, standard deviation, percentage were calculated for selected metabolic risk profiles (fasting glucose and total cholesterol levels) and waist-to-height ratio (WHtR,<0.5 and WHtR>0.5). Percentages were calculated for several metabolic risk profiles (fasting glucose and total cholesterol) and waist-to-height ratio. The relationship between selected metabolic risk profiles (fasting glucose and total cholesterol levels) and waist-to-height ratio was determined by using Pearson's product moment correlation coefficients. A significant level was set at $p\leq0.05$.

RESULTS

Table 1 indicates that out of the 535 employees, majority of workers work as ground maintenance workers with few in skilled positions. Additionally, majority of employees were in the age group of 45-65 years. The results also showed that the majority of the employees have no formal education and were ground maintenance workers.

Figure 1 presents the WC for the total group and by gender. The results show that female employees in the study are presented with high waist circumference compared to their male counterparts.

Figure 2 provides the percentage of BMI categories for the total group and by gender. The results showed high
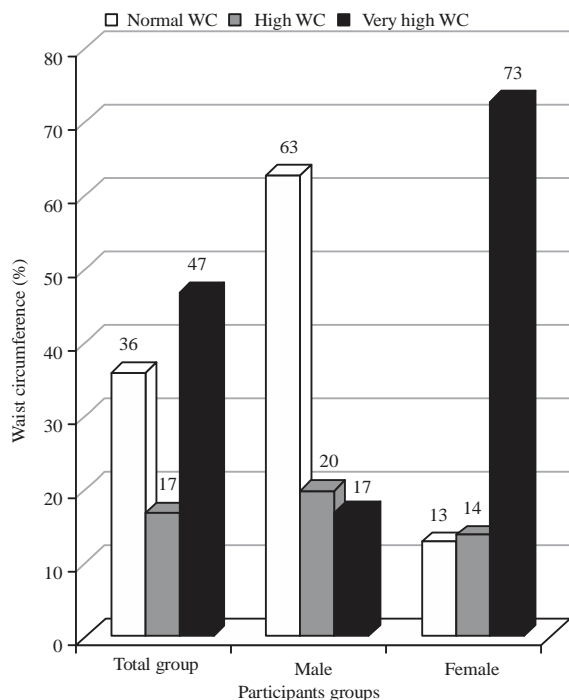
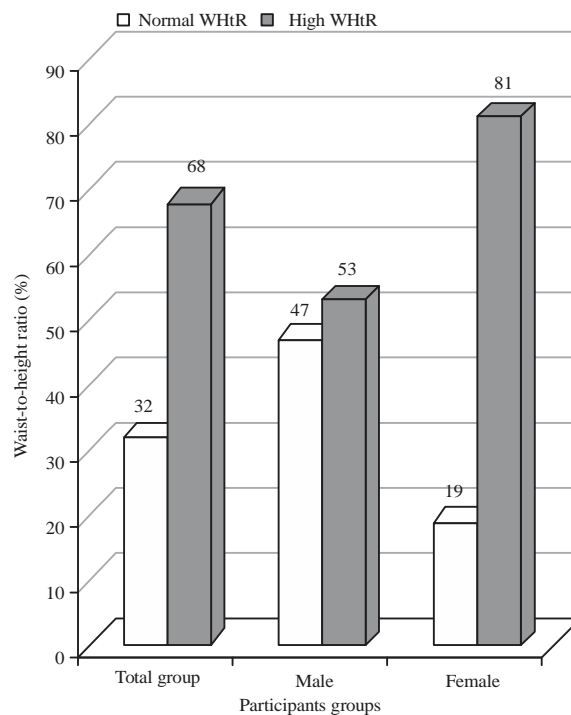Fig. 1: Percentage (%) of WC for the total group and gender

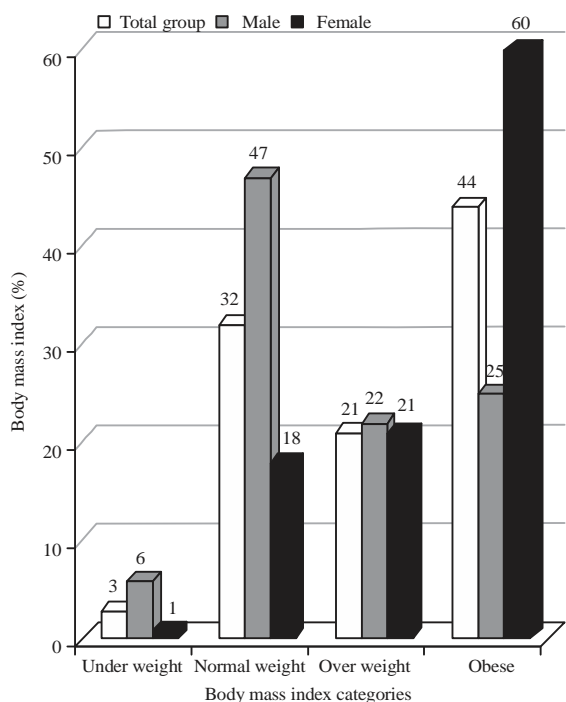Fig. 3: Percentage (%) of WHtR for the total group and gender

Fig. 2: Percentage (%) of BMI categories for the total group and gender

Table 1: Description of age, education and occupation of the participants

	Total (%)	Male (%)	Female (%)
Sex	535	249(46.5)	286(53.5)
Age (years)			
24-29	14 (2.6)	3(1.2)	3.8(3.8)
30-44	58 (10.8)	24(9.6)	11.9(11.9)
45-65	463 (86.5)	222(89.2)	84.3(84.3)
Educational level			
No education	376 (70.3)	177(71.1)	199(69.9)
Std 8	27 (5.0)	17(6.8)	10(3.5)
Matric	50 (9.3)	19(7.6)	31(10.3)
Diploma	48 (9.0)	20(8.0)	28(9.8)
Degree 1	8 (1.5)	5(5.0)	3(1.0)
Degree 2	2 (0.4)	1(0.4)	1(0.3)
Degree 3	12 (2.2)	5(2.0)	7(2.4)
Degree 4	9 (1.7)	4(1.6)	5(1.7)
Certificate	3 (0.6)	1(0.4)	2(0.7)
Occupation			
General clerk	52 (9.6)	28(11.2)	1(0.3)
Accounting clerk	12 (2.2)	2(0.8)	22(7.7)
Ground maintenance workers	460 (84.6)	212(85.1)	10(3.5)
Municipality manager (MM)	12 (2.2)	6(2.4)	240(83.9)
Councillor	8 (1.5)	1(0.4)	6(2.4)

percentages for overweight and obesity for the total group. When analyses were done separately for males and females, females showed high percentages of overweight and obese than the males.

Figure 3 presents the percentage of WHtR categories for the total group and gender. The results showed that one third of the total group presented with a normal WHtR category, whereas, two third were in high WHtR category. A total of fourth-fifth of the females showed higher percentage of WHtR as compared to half of males.
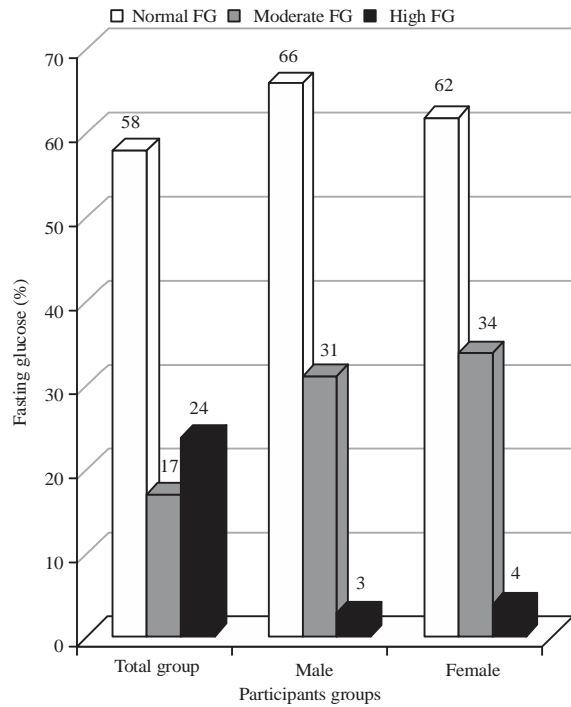
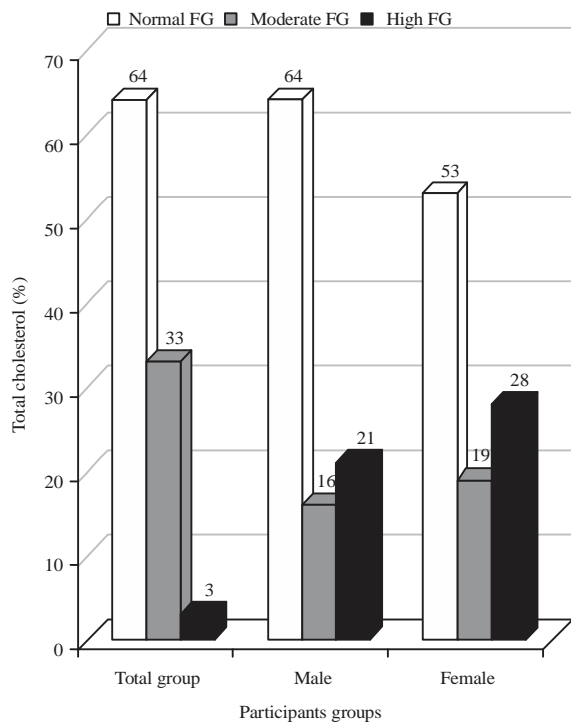Fig. 4: Percentage (%) of fasting glucose levels for the total group and gender

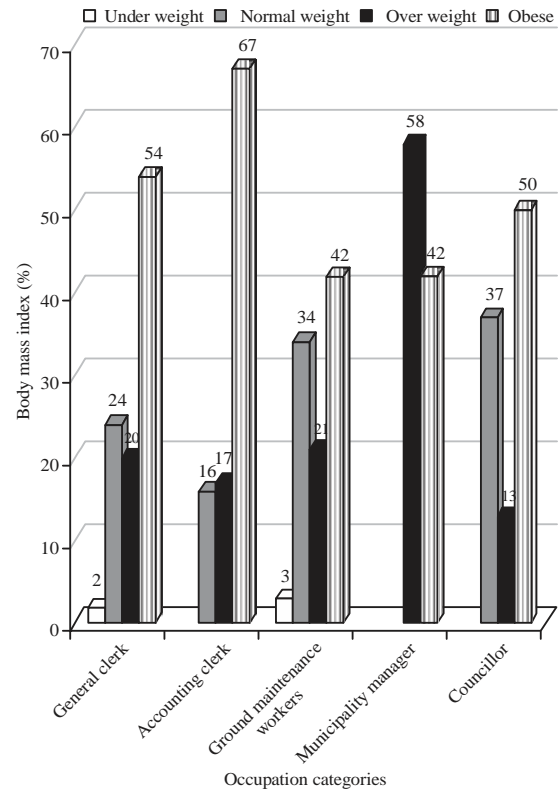Fig. 5: Percentage (%) of Total Cholesterol (TC) for the total group

Fig. 6: Percentage (%) of BMI categories by occupation

almost 60% of the total group respectively had normal with almost a quarter had high fasting glucose levels. Females are presented with high percentages of fasting glucose compared to males.

Figure 5 indicates the percentage of total cholesterol levels for the total group and by gender. The results showed that more than half of the combined sample had normal total cholesterol levels, whereas, one-third had moderate cholesterol levels and small number of the participants had high total cholesterol levels. When data were analyzed separately by gender, the results show that females are presented with high percentages in both moderate and high cholesterol than the males.

Figure 6 presents the percentage of BMI categories by occupation. The results show that employees in the skilled positions were obese as compared to the ground maintenance workers.

Figure 7 presents the percentage of WC categories by occupations. Overall, employees in the study are presented with high percentages of very high WC. Additionally, the results show that ground maintenance workers had low percentages of high WC compared to the other groups.

Figure 8 presents the percentage of WHtR categories by occupation. The results indicated that clerks had high
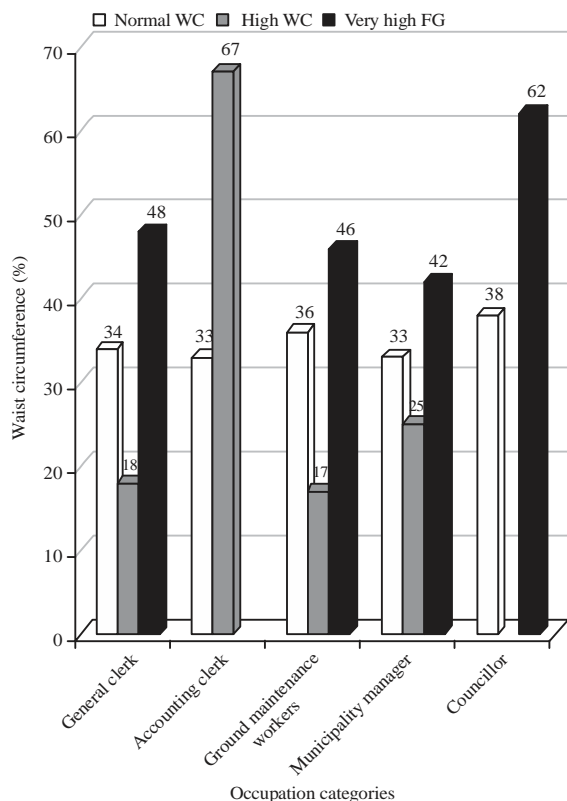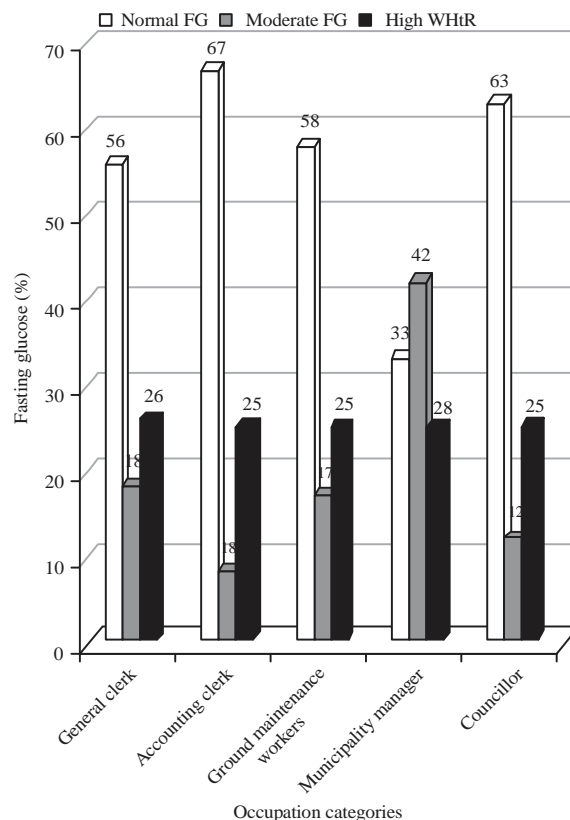
Figure 4 shows the percentage of fasting glucose levels for the total group and by gender. The results showed that

Fig. 7: Percentage (%) of WC by occupation

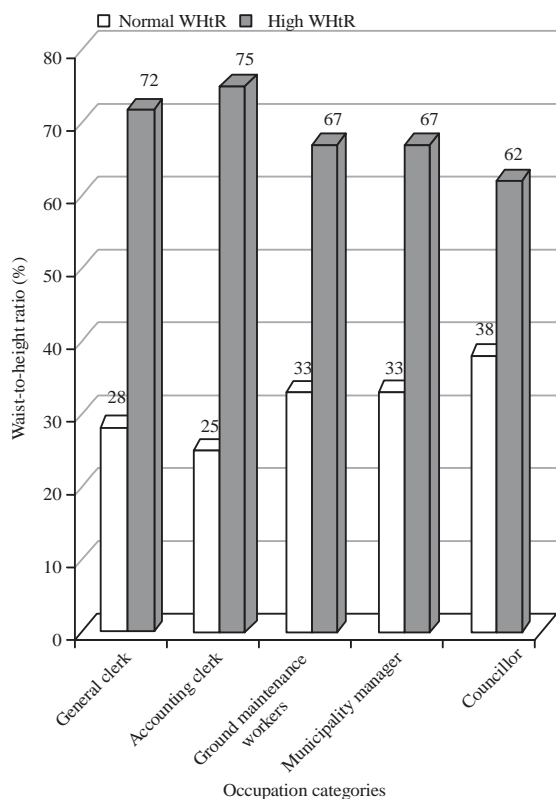Fig. 8: Percentage (%) of WHtR by occupation

Fig. 9: Percentage (%) Fasting Glucose (FG) by occupation

WHtR. Municipal managers and ground maintenance workers are presented with high WHtR compared to the councilors.

Figure 9 presents the percentage of fasting glucose levels by occupation. The results showed that a quarter of general and accounting clerks had high fasting glucose levels as compared to accounting clerks respectively, a quarter of municipality managers, councillors and ground maintenance workers also had high fasting glucose levels.

Figure 10 presents the percentage of total cholesterol levels by occupation. The results showed that municipality managers had high levels of total cholesterol as the ground maintenance workers.

The results showed significant ($p \leq 0.01$) positive correlations between fasting glucose and BMI and WHtR for the total group. Table 2 showed that, when the data were analyzed based on employment position, fasting glucose was positively associated with BMI and WHtR in the ground maintenance workers. No significant relationships were found for total cholesterol and anthropometric measures.
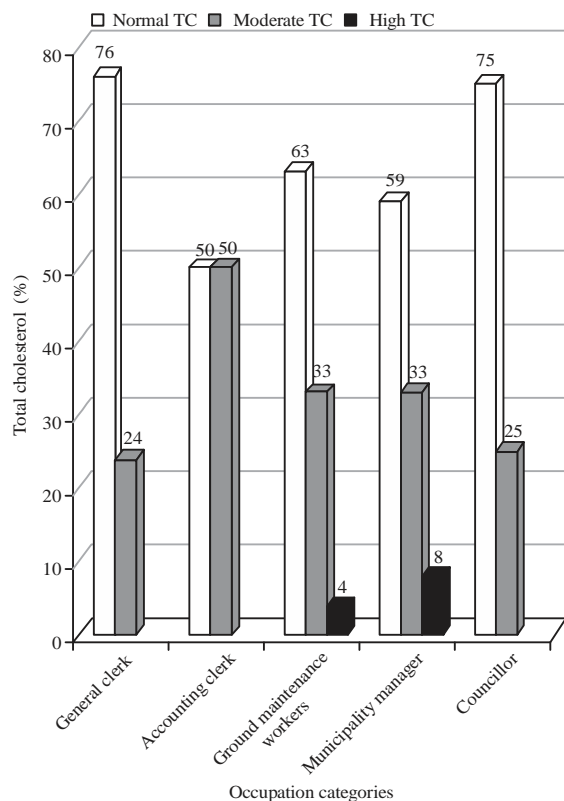
Fig. 10: Percentage (%) of Total Cholesterol (TC) by occupation

Table 2: Correlation coefficients between glucose, cholesterol levels and selected anthropometric measures for the total group and by employment position (N = 535)

	r		
Total groups	BMI	WC	WhtR
Total cholesterol	0.05	0.02	0.04
Fasting glucose	0.20**	0.24**	0.23**
Ground maintenance worker			
Total cholesterol	0.01	-0.01	0.01
Fasting glucose	0.13**	0.19**	0.16**
Admin clerk			
Total cholesterol	0.16	0.20	-0.06
Fasting glucose	-0.19	-0.07	-0.01
Municipal manager			
Total cholesterol	0.09	0.18	0.27
Fasting glucose	0.03	-0.13	-0.05
Councillors			
Total cholesterol	-0.07	0.23	0.35
Fasting glucose	0.55	0.56	0.60

**p$\leq$0.05, WC: Waist circumference, WhtR: Waist to height ratio

DISCUSSION

The purpose of this study was to investigate the relationship between selected metabolic risk factors of (fasting glucose and total cholesterol levels) among employees in Vhembe District Municipality of Limpopo province, South Africa. The results showed high WHtR of 68% for the total group, in which 80 and 53% were females and males, respectively as indicated in Fig. 3. These rates are higher than those of a study reported by Raimi et al.[35], which showed that more participants were classified more centrally obese when using WHtR than WC (29% Versus 13% in males and 62% versus 57% in females). Ashwell and Hsien[22] suggested that the WHtR is more useful for assessing health risk than BMI, further a cut off value of WHtR$\geq$0.05 indicates increased risk for both males and females across ethnic and population groups.

Additionally, the results showed high prevalence of obesity (44%) for the total group comprising 60% were females as compared to 25% males, as indicated in Fig. 2. These are higher when compared to the results of Puone et al.[6] study, which indicated that 56.6% of women were obese as compared to 29.9% of men. It is generally accepted that obesity as defined by BMI, increases the risk of type 2 diabetes, hypertension, cardiovascular disease and all- cause mortality[35-37]. The present study showed that 3% of the total group had high total cholesterol levels, with 28% of females showing high TC levels as compared to males (21%), as indicated in Fig. 5. The results are lower than those reported by Chehrei[30], in which high TC levels was found in 28% of their sample, with 30% prevalence observed in males compared to 23% in females.

Significant positive relationships between total glucose, BMI, WC and WHtR were found in the present study, which are consistent with results of the study by Saghafi-Asl et al.[38] which showed that WHtR had the strongest correlation with blood lipid profiles (r = 0.37, p = 0.004 for TC) and (r = 0.33, p = 0.011 for LDL-C) compared with BMI and WC. The results of a meta-analysis support the superiority of central obesity, especially WHtR over BMI for detecting cardiovascular risk factor in both males and females[29]. The WHtR and WC are strongly associated with cardiovascular risk factors than WHR[28]. Also in this study, BMI, WC and WHtR significantly (p<0.05) correlated with fasting glucose which showed the highest correlation observed for WHtR than BMI and WC[30].

The present study has several limitations which should be noted when interpreting the results: The cross-sectional design of the study may one way or the other may have confounded the results of metabolic risk factors observed in the study. The Vhembe district municipality employees data which is not representative of all municipalities employees in South Africa also limits the generalisation of the present findings. The strength of the study is that it was, to our knowledge, the first of its kind which assessed the relationship between anthropometric indicators and selected risk factors

of CVD among employees in the Vhembe district of the Limpopo province of South Africa.

CONCLUSION

The study concluded that municipality employees were overweight and obese with females being more affected than males. A similar trend was noted regarding the findings on total cholesterol. Furthermore, it was evident that fatness was more positively associated with fasting glucose, especially in ground maintenance workers than the other categories of employees. A significant proportion of the employees presented with health risks that may decrease productivity. From a public health perspective, the current results implicate the need for urgent strategic intervention targeted at promoting physically healthy lifestyle among the employees in the Vhembe local municipality.

SIGNIFICANCE STATEMENT

The study investigated the relationship between selected metabolic risk factors and waist-to-height ratio, which results to cardio-metabolic risk among employees. This study will help the researcher to uncover that waist-to-height ratio is an alternative index of determining obesity which has a positive relationship with cardio-metabolic risk factors but has not been researched among employees within municipalities of South Africa. Thus, additional evidence in ascertaining WHtR as a practical determinant of fatness and its possible use in larger employee samples may be significant in epidemiological studies.

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