

# Cardiometabolic Risk and its Association with Dietary Diversity, Activity Patterns and the Nutritional Status of Workers in Tertiary Educational Institutions in South-Western Nigeria

Adeomi AA<sup>1</sup>, Akande RO<sup>2</sup>, Olodu MD<sup>1</sup>, Obiajunwa C<sup>1</sup>, Oduntan O<sup>1</sup>, Ogbukwo E<sup>1</sup>

<sup>1</sup>Department of Community Health, Obafemi Awolowo University, Ile-Ife, Osun State, <sup>2</sup>Department of Community Medicine, Bowen University Iwo, Iwo, Nigeria

## ABSTRACT

**Background:** Waist-to-height ratio (WHtR) is increasingly being reported as a simple, but accurate measure of cardiometabolic risk (CMR). Therefore, the objective of this study was to determine the CMR using WHtR, and its association with dietary diversity (DD), activity patterns and the nutritional status of workers in tertiary educational institutions in South-western Nigeria.

**Materials and Methods:** This was a descriptive, cross-sectional study carried out among 400 workers in three randomly selected tertiary educational institutions in Osun State, Nigeria. Only apparently healthy people (18 years and above) were recruited for the study. CMR was assessed using WHtR; DD was assessed using 24-h dietary recall with the 14-food groups, physical activity (PA) patterns using the short form of the International Physical Activity Questionnaire and the nutritional status of the respondents using body mass index (BMI), waist-hip ratio (WHR) and neck circumference. Bivariate and multivariate analyses were used to determine the significant predictors of CMR. The level of significance was set at  $P < 0.05$ .

**Results:** The mean age of the respondents was  $45.8 \pm 10.4$  years, with a male: female ratio of 1:1.1. The mean WHtR among the respondents was  $0.53 \pm 0.08$ , and 63.5% had high CMR. At the bivariate level, there were statistically significant associations between CMR (WHtR) and DD ( $P = 0.027$ ), PA patterns ( $P = 0.030$ ) and the various indicators of nutritional status ( $P < 0.001$ ). After multivariate analysis, DD and PA were no longer significantly associated with CMR (WHtR), whereas BMI (odds ratio [OR] = 1.481; confidence interval [CI] = 1.342–1.635;  $P < 0.001$ ), neck circumference (OR = 1.214; CI = 0.078–1.366;  $P = 0.001$ ) and raised WHR (OR = 1.949; CI = 0.107–3.431;  $P = 0.021$ ) remained significantly associated with CMR (WHtR).

**Conclusion:** The present study found a high prevalence of CMR using WHtR and also found a significant association with BMI, neck circumference and WHR. There is a need for the early screening for CMR using WHtR, and cardiometabolic health education of workers in tertiary educational institutions in Osun state.

**Key words:** Cardiometabolic risk, dietary diversity, nutritional status, tertiary workers

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## INTRODUCTION

Cardiometabolic risk (CMR) is a broad term comprising risk factors for cardiovascular diseases (CVDs) which include obesity, hypertension, diabetes or dyslipidaemia.<sup>1</sup> Globally, CVDs contributed significantly to about 17.6 million deaths in 2016, making it the foremost cause of mortality resulting

from non-communicable diseases.<sup>2</sup> Evidence from American National Survey has revealed that approximately 10% of the youth population exhibits clustering of CMRs.<sup>3</sup> Reports also showed that approximately 114 million Chinese adults had diabetes mellitus and 265 million had hypertension in 2010. Similarly, in Nigeria, different studies have shown that there is an increase in the burden of CVDs across the country.<sup>4,5</sup>

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**Address for correspondence:** Dr. Adeomi AA,  
Department of Community Health, Obafemi Awolowo University, Ile-Ife,  
Osun State, Nigeria.  
E-Mail: [aadeomi@cartafrica.org](mailto:aadeomi@cartafrica.org)

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Waist-to-height ratio (WHtR) is increasingly being reported as a simple, but accurate measure of CMR, even better than body mass index (BMI), waist-hip ratio (WHR) and even waist circumference (WC).<sup>6-9</sup> For several years, BMI has been traditionally used as a predictor for general obesity. Evidence abound that central obesity carries more health risks in comparison with general obesity assessed by BMI.<sup>10-12</sup> Although BMI is correlated with total body fat tissue, it does not take body fat distribution into account.<sup>8,9</sup> More recently, WC, WHR and WHtR have been used as proxies for central obesity.<sup>8</sup> WHtR is increasingly being reported as the best measure of central adiposity and CMR.<sup>6-9</sup>

Understanding the relationship of CMR s with modifiable habits and practices such as diet and physical activity (PA) is important because it holds a great potential for the prevention and control of the CMR s and diseases. There is accumulating evidence that physical exercise may help in improving health through different mechanisms including a decrease in the percentage body fat and improvement in many cardiometabolic risk factor levels obtained during blood assessment.<sup>13</sup> A balanced diet has also been shown to reduce CVD risk factors.<sup>14</sup> It is important to determine these relationships in different contexts and among different populations.

CMRs might not be the same across different regions and population groups due to differences in socio-economic characteristics, culture, ethnicity, geographical location and even occupations. Tertiary educational institution workers may differ from the general population in terms of socio-economic status and their activity patterns. In Nigeria, few studies have focused on the assessment of CMR among apparently healthy population using WHtR, and fewer still among tertiary educational institution workers. Therefore, the study aimed to assess CMR and its association with dietary diversity (DD), activity plans and nutritional status among tertiary educational institution workers in Nigeria and this is necessary and critical to design appropriate cardiometabolic and nutritional intervention programmes for this group.

## MATERIALS AND METHODS

The study was carried out among workers of tertiary educational facilities in Osun State who were adults (18 years and above). Only apparently healthy people were recruited for the study. All those who were acutely ill or had been diagnosed and/or were being managed for chronic illnesses such as sickle cell disease, anaemia, cancers, hypertension and diabetes mellitus were excluded. Others with disabilities that made them unable to stand were also excluded. The sample size was calculated to get an absolute precision of  $\pm 5\%$  using STATCALC on the Epi Info Software (Epi Info™, CDC, Atlanta, GA, USA). The proportion of expected outcome was taken as 38.46% which was the proportion of the adults with abdominal obesity in a similar study carried out in Ekiti State, South-western Nigeria.<sup>15</sup> With an acceptable margin of error of 5%, the calculated sample size was 344, and after correcting

an anticipated non-response of 10%, the sample size came to 400, who were recruited from 3 randomly selected tertiary educational institutions in Osun State using the multistage sampling technique.

A structured questionnaire was used for the data collection. The questionnaire was self-developed after a meticulous review of relevant literature and was pre-tested using 10% (40) of the sample size. DD scores were generated from a scale of 14 food groups, using 24-h dietary recall.<sup>16</sup> Respondents were scored 1 for eating a serving of food in any of the 14 categories and 0 if none was eaten in the 24 h preceding the data collection.

PA patterns were assessed using the International Physical Activity Questionnaire (IPAQ).<sup>17</sup> Respondents were scored for their involvement in different types of physical activities, the number of days in a week they were involved and the average time spent. Respondents were then categorised into low, medium and high depending on their scores.

Height was measured to the nearest 0.1 m using the stadiometer (Leicester® Height Measure, Seca, UK), weight was measured using the Seca® electronic bathroom weighing scale (SECA GmbH and Co., Germany) and waist and hip circumferences using the Goldfish brand non-elastic tape measure. The anthropometric measurements were done according to the standard protocols recommended by the International Society for the Advancement of Kinanthropometry.<sup>18</sup>

CMR was assessed using WHtR, which has been shown to be the best predictor of cardiovascular risk and mortality.<sup>19</sup> WHtR was calculated by dividing WC in cm by height in cm and those with  $\geq 0.5$  were classified as high. Other measures of nutritional status were BMI, WC, WHR and neck circumference. BMI was calculated by dividing the weight in kilograms by the height in metre<sup>2</sup>. Those with BMI <18.5, 18.5–24.9, 25.0–29.9 and  $\geq 30$  were classified as underweight, normal, overweight and obese, respectively.<sup>20</sup> WC (in centimetres) was categorised into three groups for males and females into low risk, increased risk ( $\geq 80$  cm for females; 94 cm for males) and substantially increased risk ( $\geq 88$  cm for females and 102 cm for males).<sup>21</sup> WHR was calculated as WC in centimetres (cm) divided by hip circumference in cm. WHR was classified such that males with a ratio equal to or  $> 0.9$  and females with a ratio equal to or  $> 0.85$  had increased risk for cardiometabolic disease.<sup>21</sup> The neck circumference was also used as a measure of nutritional status and was measured in centimetres.

The DD was assessed using 14 food groups<sup>16</sup> and a 24 h dietary recall. Respondents were given a score of 1 if they ate any of the food groups giving a maximum possible score of 14. The respondents were then categorised into those with low ( $\leq 4$ ), medium (5–9) and high ( $> 10$ ). The PA was assessed using the short form of the IPAQ short form which is arguably the most widely used instrument for assessing activity.<sup>17</sup> This was used to classify the activity patterns of the respondents into low, moderate/medium and high. The instruments used

are standardised tools that have been validated and used in Nigeria.<sup>22-24</sup>

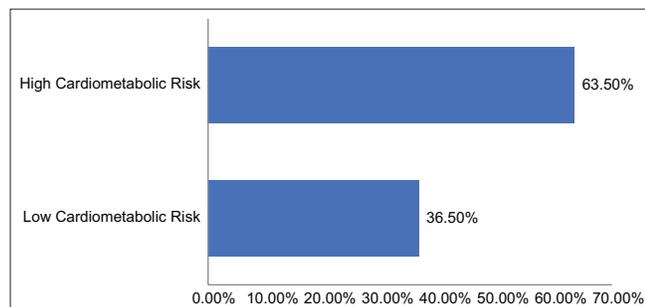
The frequency distribution of all the variables was first done (descriptive analysis) and they were represented using tables and charts. At the bivariate level, Pearson Chi-square test was used to test the association between the categories of the WHtR and the categorical independent variables, whereas independent sample *t*-test was used to compare the means of continuous variables (i.e., age and DD scores) across the categories of WHtR. Correlation and linear regression analyses were also used to determine the relationship between WHtR (as a continuous variable) and other continuous variables. For multivariate analysis, all the variables with significant associations with WHtR at the bivariate level were entered into a binary logistic regression analysis.

Ethical clearance was obtained from the Ethical Review Committee, Institute of Public Health, Obafemi Awolowo University, Ile-Ife. The participants' information sheet and consent were given to them. Important information on the participants' information sheet included that the information volunteered will be kept confidential as all questionnaires were coded without names or addresses of respondents. It also emphasised that participants were free to opt-out if they were not comfortable with the information in the questionnaire. Signed consent forms were then obtained from the respondents before being recruited for the study.

## RESULTS

The mean age of the respondents was  $45.8 \pm 10.4$  years, with a male: female ratio of 1:1.1. Most of the respondents were married (87.7%) and lived in monogamous family settings (92.0%). Expectedly, more than half of them (53.1%) had post-graduate degrees and 53.5% earned 100,000 naira (\$278) dollars or more monthly.

The mean WHtR among the respondents was  $0.53 \pm 0.08$  and 36.5% had values  $<0.5$  (low cardio-metabolic risk) while 63.5% had values up to or above 0.5 (high metabolic risk) [Figure 1]. The mean DD score was  $6.95 \pm 1.50$ , with 4.8%, 91.2% and 4.0% having low, medium and high DD, respectively. One hundred and forty-four (35.9%) had low activity patterns, whereas 45.3% and 18.8% had moderate



**Figure 1:** Distribution of respondents according to their cardiometabolic risk using waist-to-height ratio ( $n = 400$ )

and high activity patterns, respectively. The prevalence of overweight and obesity was 44.0% and 25.8%, respectively using the BMI categories. Using the WC categories, 54.6% had increased or substantially increased risk for cardio-metabolic disease, while 60.2% had high cardio-metabolic risk using the WHR [Table I].

At bivariate level, there were statistically significant associations between CMR (as measured by WHtR) and age ( $P < 0.001$ ), gender ( $P = 0.002$ ), educational level ( $P = 0.046$ ), marital status ( $P = 0.022$ ), DD ( $P = 0.027$ ) and activity patterns ( $P = 0.030$ ). These relationships were such that, older people, females, those with higher educational levels, married/widowed, those with higher DD and those with low activity patterns were more likely to have high CMR [Table II]. The WHtR had a positive statistically significant correlation with DD scores, PA scores and all the measures of nutritional status including WC, BMI and neck circumference. The strongest relationship was with BMI (coefficient = 0.711,  $P < 0.01$ ), neck circumference (coefficient = 0.434,  $P < 0.01$ ) and WHR (coefficient = 0.417,  $P < 0.01$ ), PA scores (coefficient =  $-0.136$ ,  $P = 0.007$ ) and DD score (coefficient = 0.111,  $P = 0.027$ ) [Table III]. Linear regression analysis also showed that all the other measures of nutritional status could predict the WHtR, except the WHR. Similarly, the strongest predictors were BMI (beta coefficient = 0.247) and neck circumference (beta coefficient =  $-0.188$ ) [Table III].

When all significant variables at the bivariate level were entered into a binary logistic regression model (multivariate analysis), female gender (odd ratio [OR] = 2.126; confidence interval [CI]

**Table I: Dietary diversity, activity patterns and the nutritional status of respondents ( $n=400$ )**

Variables	Frequency (%)
DD	
Low	19 (4.8)
Medium	365 (91.2)
High	16 (4.0)
Activity patterns	
Low	144 (35.9)
Medium	181 (45.3)
High	75 (18.8)
BMI	
Underweight	9 (2.2)
Normal	112 (28.0)
Overweight	176 (44.0)
Obese	103 (25.8)
WHR	
Low risk for CMD	159 (39.8)
Increased risk for CMD	241 (60.2)
WC	
Low risk for CMD	182 (45.4)
Increased risk for CMD	87 (21.8)
Substantially increased risk for CMD	131 (32.8)

CMD: Cardiometabolic disease, DD: Dietary diversity, BMI: Body mass index, WHR: Waist-hip ratio, WC: Waist circumference

**Table II: Factors associated with cardiometabolic risk (using waist-to-height ratio) among the respondents (n=400)**

Variable	CMR (WHtR)		Statistics
	Less than low risk (n=146), n (%)	High risk (n=254), n (%)	
Age (years)	43.0±9.7	47.4±10.4	$P<0.001^{*a}$
Gender			
Male	86 (44.3)	108 (55.7)	$\chi^2=9.964$
Female	60 (29.1)	146 (70.9)	df=1 $P=0.002^*$
Highest level of education			
Secondary	27 (35.1)	50 (64.9)	$\chi^2=9.668$
Bachelor's	16 (37.2)	27 (62.8)	df=4
Master's	34 (50.0)	34 (50.0)	$P=0.046^*$
Doctorate	27 (26.7)	74 (73.3)	
Others	42 (37.8)	69 (62.2)	
Marital status			
Single	17 (47.2)	19 (52.8)	LR=7.593
Married	128 (36.5)	223 (63.5)	df=2
Widowed	1 (7.7)	12 (92.3)	$P=0.022^*$
Monthly income (₦)			
<50,000	40 (36.4)	70 (63.6)	$\chi^2=8.334$
50,000-99,000	29 (38.2)	47 (61.8)	df=4
100,000-249,000	52 (42.6)	70 (57.4)	$P=0.080$
250,000-500,000	19 (33.9)	37 (66.1)	
>500,000	6 (16.7)	30 (83.3)	
Dietary diversity	6.73±1.48	7.07±1.50	$P=0.027^{*a}$
Activity patterns			
Low	43 (29.9)	101 (70.1)	$\chi^2=7.039$
Medium	67 (37.0)	114 (63.0)	df=2
High	36 (48.0)	39 (52.0)	$P=0.030^*$

\*Statistically significant<sup>a</sup> t-test for two independent test used, Others represent other post-secondary school degrees apart from bachelors, e.g., NCE, OND, other diplomas, etc.,  $\chi^2$ : Chi-square test used, LR: Likelihood ratio used, WHtR: Waist-to-height ratio, CMR: Cardiometabolic risk

= 1.183–3.820;  $P = 0.012$ ), master's degree (OR = 0.370; CI = 0.144–0.948;  $P = 0.038$ ), BMI (OR = 1.481; CI = 1.342–1.635;  $P < 0.001$ ), neck circumference (OR = 1.214; CI = 0.078–1.366;  $P = 0.001$ ) and raised WHR (OR = 1.949; CI = 0.107–3.431;  $P = 0.021$ ) remained the only statistically significant explanatory variables for CMR using WHtR [Table IV and Figure 2].

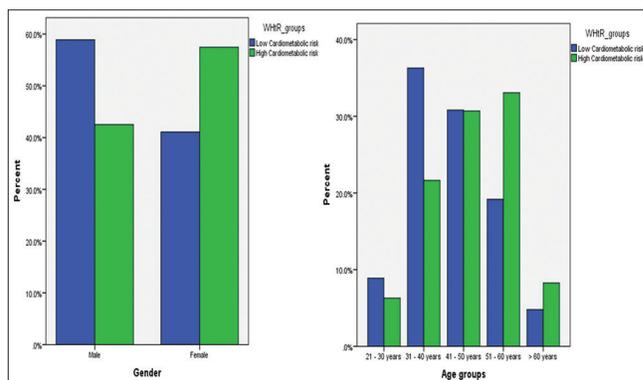
## DISCUSSION

Previous studies have found that WHtR and WC were more significant predictors of cardio-metabolic outcomes than BMI,<sup>4,25</sup> and others have even reported that WHtR is the best predictor.<sup>6,8,9</sup> Therefore, the use of BMI alone could lead to an underestimation of the at-risk population. Over the last several decades, efforts to prevent or treat CVDs have resulted in the identification of certain CMRs. By targeting lifestyle behaviours associated with CMR, it may be possible to prevent and manage risk for cardio-metabolic disease and adverse outcomes of these disease processes at the early stages of development.

**Table III: Waist-to-height ratio and its association with other measures of nutritional status using correlation and regression analyses (n=400)**

Variables	Correlation analysis <sup>a</sup>	
	Coefficient	P
BMI	0.711	<0.001*
Neck circumference	0.434	<0.001*
WHR	0.417	<0.001*
Physical activity scores	-0.136	0.007*
Dietary diversity scores	0.111	0.027*
Variables	Regression analysis	
	Beta coefficient	P
BMI	0.247	<0.001*
Neck circumference	-0.188	<0.001*
Physical activity scores	-0.127	0.011*
Dietary diversity scores	0.098	0.049*
WHR	-0.030	<0.085

<sup>a</sup>Statistically significant, <sup>a</sup>Pearson correlation used. BMI: Body mass index, WHR: Waist-hip ratio



**Figure 2: Distribution of cardiometabolic risk according to gender and age groups**

The prevalence of CMR, using WHtR was high among the respondents, with nearly two-thirds of them having high cardiometabolic risks. A study among workers in a District Municipality in South Africa similarly reported about two-thirds of the workers having high WHtR.<sup>26</sup> With different studies reporting WHtR as a predictor for cardiometabolic diseases,<sup>6-9</sup> this finding should be a cause of worry to stakeholders in cardiovascular health, economics, labour and productivity. This is because workers form the productive group in any society and their health should be of importance, not only to them, but the nation at large.

The other anthropometric measures of the nutritional status of the respondents further underscore the level of CMR among the respondents. Nearly 7 out of 10 of the workers were overweight or obese using the BMI categories and about three-fifths had raised WHR and WC. This prevalence is in tandem with that reported by previous studies among workers in Ireland<sup>27</sup> and South Africa.<sup>26</sup> Thabit *et al.*<sup>27</sup> in Ireland opined that this may

**Table IV: Predictors of cardiometabolic risk (waist-to-height ratio) using binary logistic regression (n=400)**

Variables	P	OR	CI	
			Lower	Upper
Age (years)	0.920	0.998	0.965	1.032
Gender				
Male (reference value)				
Female	0.012*	2.126	1.183	3.820
Marital status				
Single (reference value)				
Ever married	0.496	0.696	0.245	1.976
Highest level of education				
Secondary (reference value)				
Bachelor's	0.395	0.633	0.221	1.816
Master's	0.038*	0.370	0.144	0.948
Doctorate	0.321	0.618	0.239	1.598
Others	0.961	0.980	0.429	2.235
Dietary diversity	0.214	1.132	0.931	1.376
Activity patterns				
Low (reference value)				
Medium	0.900	0.959	0.500	1.839
High	0.962	0.979	0.416	2.305
BMI	<0.001*	1.481	1.342	1.635
Neck circumference	0.001*	1.214	1.078	1.366
WHR				
Low risk (reference value)				
Increased risk	0.021*	1.949	0.107	3.431

\*Statistically significant. OR: Odds ratio, CI: Confidence interval, WHR: Waist-hip ratio, BMI: Body mass index

be related to long hours of sedentary and highly stressful work-related activities, compounded by poor health choices such as excessive alcohol consumption, smoking and lack of healthy dietary options within the work environment.

After controlling for confounders using logistic regression analysis female gender, having a master's degree, BMI, neck circumference and WHR were the only variables that were still significantly associated with CMR using WHtR. Females and those with raised WHR were two times more likely than males and those with low WHR to have raised WHtR, respectively while those with a master's degree were 63% less likely than those with secondary education to have raised WHtR. In addition, one unit increase in the BMI and neck circumference increased the likelihood of raised WHtR by 48% and 21%, respectively.

Raimi *et al.* in South-western Nigeria similarly found that females were more likely to have raised WHtR than others,<sup>28</sup> and other studies from outside Nigeria have reported similar findings.<sup>26,29</sup> Similarly, other studies have reported associations between WHtR and other measures of nutritional status including BMI and WHR.<sup>6,8,9,13,14,30</sup> Neck circumference as an indicator of CMR has also been reported,<sup>31-33</sup> but it is relatively recent and an emerging topic which should be better explored.

A major limitation of this study is its cross-sectional nature, which makes it impossible to establish causality. Another limitation is that other measures of CMR such as blood pressure, blood sugar and the lipid profile were not assessed.

## CONCLUSION

There was a high prevalence of CMR, using WHtR among the respondents. The CMR (using WHtR) was significantly associated female gender, educational level, BMI, WHR and neck circumference. Therefore, there is a need for early screening for CMR using WHtR and cardio-metabolic health education of workers in tertiary educational institutions in Osun State.

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## Conflicts of interest

There are no conflicts of interest.

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