

# Cross-sectional study of the association between abdominal volume index and some anthropometric and cardiometabolic variables in perimenopausal Nigerian women

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**Background:** The abdominal volume index (AVI) is a marker of visceral obesity and is known to correlate with glucose intolerance and type 2 diabetes mellitus. In a population of 46 perimenopausal Nigerian women (45-55 years) resident in a suburb of the Ilorin metropolis, we studied the association between AVI and related anthropometric measures of central and general obesity; as well as how AVI correlates with some cardiovascular risk factors.

**Methods:** In this population, we measured standing height, body weight, waist circumference (WC), and hip circumference (HC) using standard protocols. From these, the AVI, body mass index (BMI), waist to hip ratio (WHR), and waist to height ratio (WHtR) were calculated. Further, we measured blood pressure, blood glucose and fasting serum lipids.

**Results:** Using Pearson's correlation coefficient, AVI shows the strongest and significant ( $p < 0.05$ ) association with WC ( $r = 0.99$ ), followed by WHtR ( $r = 0.94$ ), HC ( $r = 0.88$ ), and BMI ( $r = 0.73$ ). Moreover, AVI has positive though weak association with blood pressure, blood glucose and serum lipids, except HDL-c, where the association is negative ( $r = -0.04$ ).

**Conclusion:** In the perimenopausal Nigerian women, AVI has the strongest correlation with WC, and both anthropometric indices are valuable predictors of metabolic and cardiovascular risks. Similar future studies that enlist larger numbers of perimenopausal women are however recommended. Such studies are especially helpful in sub-Saharan Africa, where, due to resource limitation, large percentages of individuals are unable to afford regular cardiometabolic assessments at the health centres.

**Keywords:** *perimenopausal, abdominal volume index, metabolic syndrome, anthropometry, Nigerian women*

## Introduction

Reproductive ageing and menopause transition are associated with physical and biochemical changes in women. The perimenopausal and postmenopausal periods are characterized by decreasing circulating oestrogens, especially

oestradiol, and decreased energy expenditure that predispose to increased visceral adiposity, cardiovascular perturbations and insulin resistance, among others (Banack et al., 2023; Wang et al., 2023). As chronological age advances, the prevalence of the insulin resistance syndrome (syndrome X or cardiometabolic syndrome), classically characterized by fasting hyperglycaemia, dyslipidaemia, and hypertension, is known to rise in both sexes (Marlatt, et al., 2022; Sirisena et al., 2022; Zhou et al., 2025; Singh et al., 2024). In the female gender, in addition to lowered plasma oestradiol, advancing age is also strongly linked to the occurrence of cardiovascular problem in the perimenopausal and postmenopausal years (Chen et al., 2022; Singh et al., 2024). Moreover, reduced energy expenditure in these female subpopulations promotes insulin resistance and abdominal (visceral) adiposity (Marlatt, et al., 2022; Singh et al., 2024). Consequently, the metabolic syndrome, being a cardiometabolic phenomenon, also has anthropometric correlates that may include increases in waist circumference (WC), hip circumference (HC), body mass index (BMI), waist to hip ratio (WHR), and waist to height ratio (WHtR) (Moreira et al., 2022; Sirisena et al., 2022). In this respect, findings from population-based studies showed that the anthropometric markers of metabolic syndrome are invaluable as proxies for predicting metabolic syndrome; howbeit these indices perform differentially in this context as they are influenced by age categories, ethnicity and gender (Nagayama et al., 2022; Mina et al., 2024). In middle-aged women undergoing menopause transition as evidenced by oligomenorrhoea and related symptoms, changes in serum levels of reproductive hormones and altered metabolic parameters are reported to correlate variably with anthropometric markers of general and central adiposity (Goedecke et al., 2025; Hammer et al., 2022; Marlatt et al., 2022). Meanwhile, in addition to commonly reported indices of visceral adiposity such as the WC, HC, WHR and WHtR, additional markers do exist with different degrees of accuracy in predicting visceral adiposity and metabolic syndrome.

These include conicity index and abdominal volume index. Previous population-based study showed that the latter is useful in assessing central obesity, glucose tolerance and type 2 diabetes (Sekgala et al., 2024). However, its relevance as proxy for assessing cardiovascular risk factors in the perimenopausal Nigerian women is unclear. Therefore, in this Nigerian female subpopulation, we studied the degree of association between abdominal volume index and certain other indices of general and central obesity; as well as the correlations between this index and some metabolic and cardiovascular variables that include blood pressure, blood glucose and serum lipids in a suburb of the Ilorin metropolis.

## Materials and Methods

This cross-sectional population-based study was conducted between March and May 2026. The participants included forty-six adult Nigerian females aged 45-55 years, who were resident in Oke-Ose, Ilorin, Nigeria. Exclusion criteria included ongoing use of medications that could modulate blood lipids, glucose and blood pressure, as well as obvious physical disabilities. Each participant voluntarily enrolled in the study and completed a consent form. Each also completed a questionnaire on their lifestyle and health status.

### Measurement of anthropometric parameters

Anthropometric parameters were taken in duplicate, and by a single observer to eliminate inter-observer differences. Participants wore light clothing and measurements were taken in the early hours of the day. Body weights were recorded with a Hana mechanical weighing scale (Hana, China). A stadiometer was used to take standing height with the subjects adopting the Frankfurt head position. Using a measuring tape, WC was recorded at a point midway between the iliac crest and the last rib; while HC was taken at the level of the femoral greater trochanter.

Moreover, the following were calculated: WHR (as WC divided by HC), BMI (as body weight in kilogram divided by the square of height in meters); and WHtR (ratio of waist circumference to height). Abdominal volume index (AVI) was calculated as follows:

$$\text{AVI} = 2\text{cm} \times (\text{waist})^2 + 0.7\text{cm} \times (\text{waist} - \text{hip})^2 / 1000 \text{ (Guerrero-Romero \& Rodriguez-Moran, 2003)}$$

### Measurement of blood pressure and biochemical parameters

While the subjects were in the resting and seated position, blood pressure was measured in the left arm using an Omron automatic blood pressure monitor (Omron Health Care Co., Vietnam). Systolic and diastolic pressure were obtained in triplicate and the average recorded. To obtain biochemical parameters, blood samples were collected from the median cubital vein into vacutainer tubes after an overnight fast; the blood was centrifuged at 2000 x g for 10 minutes and store frozen at -20 °C until analyzed. Moreover, random blood glucose concentrations were measured with an On-Call Plus glucometer (ACON Lab, USA).

In the serum, variables analyzed using appropriate kits from Randox Lab, India, included LDL-c, HDL-c, total cholesterol, and triglyceride, according to the manufacturer's directives. Furthermore, the TG:HDL-c, TC:HDL-c and LDL-c:HDL-c were calculated.

## Statistical analysis

The correlations among the anthropometric variables and between these and cardiometabolic parameters were determined using Pearson's correlation coefficient, and with the aid of the SPSS (version 22, BMI Inc., USA). Data on the anthropometric and cardiometabolic variables are presented as mean  $\pm$  SD. P value less than 0.05 was accepted as statistically significant.

## Results

The descriptive statistics in relation to anthropometric and cardiometabolic parameters of the study population is as shown in Table 1.

**Table 1. Some descriptive anthropometric and cardiometabolic variables of perimenopausal Nigerian women aged 45-54 years.**

| Variable                 | Minimum | Maximum | Mean $\pm$ SD    |
|--------------------------|---------|---------|------------------|
| Height (m)               | 1.48    | 1.82    | 1.61 $\pm$ 0.07  |
| Weight (kg)              | 49.00   | 107.00  | 74.1 $\pm$ 14.5  |
| WC (cm)                  | 68.00   | 114.00  | 90.1 $\pm$ 11.3  |
| HC (cm)                  | 80.00   | 138.00  | 102.6 $\pm$ 12.0 |
| BMI (kg/m <sup>2</sup> ) | 19.95   | 42.32   | 28.6 $\pm$ 5.2   |
| WHR                      | 0.78    | 1.00    | 0.88 $\pm$ 0.05  |
| WHtR                     | 0.42    | 0.77    | 0.56 $\pm$ 0.07  |
| AVI                      | 9.47    | 26.01   | 16.6 $\pm$ 4.1   |
| RBG (mmol/L)             | 4.00    | 10.70   | 5.4 $\pm$ 1.1    |
| SBP (mmHg)               | 108.00  | 180.00  | 134.3 $\pm$ 16.8 |
| DBP (mmHg)               | 68.00   | 114.00  | 87.7 $\pm$ 12.2  |
| TC (mmol/L)              | 2.80    | 7.10    | 5.0 $\pm$ 1.0    |
| TG (mmol/L)              | 0.30    | 1.80    | 0.90 $\pm$ 0.37  |
| LDL (mmol/L)             | 1.40    | 4.30    | 2.9 $\pm$ 0.8    |
| HDL (mmol/L)             | 0.60    | 2.30    | 1.19 $\pm$ 0.32  |
| TC:HDL                   | 2.00    | 6.75    | 4.35 $\pm$ 0.94  |
| TG:HDL                   | 0.23    | 2.50    | 0.83 $\pm$ 0.47  |
| LDL:HDL                  | 0.61    | 4.38    | 2.56 $\pm$ 0.75  |

**Abbreviations:** WC: waist circumference; HC: hip circumference; BMI: body mass index; WHR: waist hip ratio; WHtR: waist height ratio; AVI: abdominal volume index; RBG: random blood glucose; SBP: systolic blood pressure; DBP: diastolic blood pressure; TC: total cholesterol; TG: triglyceride; LDL: low density lipoprotein cholesterol; HDL: high density lipoprotein cholesterol; TC:HDL: ratio of total cholesterol to high density lipoprotein cholesterol; TG:HDL: ratio of triglyceride to high density lipoprotein cholesterol; LDL:HDL: ratio of low density cholesterol to high density lipoprotein cholesterol

**Table 2. Associations between abdominal volume index and related anthropometric parameters in perimenopausal Nigerian women aged 45-54 years.**

|        | AVI   | Height | Weight | WC    | HC    | BMI   | WHR   | WHtR  |
|--------|-------|--------|--------|-------|-------|-------|-------|-------|
| AVI    | 1.00  | 0.14   | 0.72*  | 0.99* | 0.88* | 0.73* | 0.40* | 0.94* |
| Height | 0.14  | 1.00   | 0.41*  | 0.16  | 0.21  | -0.04 | -0.05 | -0.19 |
| Weight | 0.72* | 0.41*  | 1.00   | 0.71* | 0.83* | 0.89* | -0.06 | 0.57* |
| WC     | 0.99* | 0.16   | 0.71*  | 1.00  | 0.86* | 0.71* | 0.44* | 0.94* |
| HC     | 0.88* | 0.21   | 0.83*  | 0.86* | 1.00  | 0.80* | -0.08 | 0.78* |
| BMI    | 0.73* | -0.04  | 0.89*  | 0.71* | 0.80* | 1.00  | -0.02 | 0.72* |
| WHR    | 0.40* | -0.05  | -0.06  | 0.44* | -0.08 | -0.02 | 1.00  | 0.45* |
| WHtR   | 0.94* | -0.19  | 0.57*  | 0.94* | 0.78* | 0.72* | 0.45* | 1.00  |

**Abbreviations:** AVI: abdominal volume index; WC: waist circumference; HC: hip circumference; BMI: body mass index; WHR: waist to hip ratio; WHtR: waist to height ratio. \*Correlation is significant at the 0.01 level (2-tailed).

The average age of the subjects was 50.4 $\pm$ 2.8 years, BMI of 28.6 $\pm$ 5.2 kg/m<sup>2</sup>, random serum glucose (RBG) of 5.4 $\pm$ 1.1 mmol/L, and systolic blood pressure (SBP) of 134.3 $\pm$ 16.8 mmHg. When compared to other anthropometric measures of central obesity (Tables 2 and 4), abdominal volume index (AVI) shows a strong and significant linear association ( $p < 0.05$ ) with waist circumference (WC;  $r = 0.99$ ), waist to height ratio (WHtR;  $r = 0.94$ ), hip circumference (HC;  $r = 0.88$ ); and BMI ( $r = 0.73$ ). Waist to hip ratio (WHR) shows the least though significant association ( $r = 0.40$ ) with AVI in this

perimenopausal population. In contrast, AVI has weak positive association with all cardiometabolic variables ( $p > 0.05$ ), including blood pressure, blood glucose and serum lipids, except for high density lipoprotein cholesterol (HDL-c), where the association is negative ( $r = -0.04$ ;  $p > 0.05$ ) (Tables 3 and 4).

**Table 3. Associations between abdominal volume index and some cardiometabolic parameters in perimenopausal Nigerian women**

|         | AVI   | RBG   | SBP   | DBP   | TC     | TG    | LDL   | HDL    | TC:HDL | TG:HDL | LDL:HDL |
|---------|-------|-------|-------|-------|--------|-------|-------|--------|--------|--------|---------|
| AVI     | 1.00  | 0.20  | .046  | 0.21  | 0.07   | 0.15  | 0.16  | -0.04  | 0.22   | 0.16   | 0.20    |
| RBG     | 0.20  | 1.00  | 0.31* | 0.29  | -0.12  | 0.15  | -0.13 | -0.01  | -0.13  | 0.11   | -0.15   |
| SBP     | 0.05  | 0.31* | 1.00  | 0.76* | -0.09  | -0.04 | -0.16 | 0.12   | -0.12  | -0.05  | -0.10   |
| DBP     | 0.21  | 0.29  | 0.76* | 1.00  | -0.05  | 0.04  | -0.13 | 0.12   | -0.11  | 0.02   | -0.11   |
| TC      | 0.07  | -0.12 | -0.09 | -0.05 | 1.00   | -0.11 | 0.81* | 0.53*  | 0.28   | -0.39* | 0.22    |
| TG      | 0.15  | 0.15  | -0.04 | 0.04  | -0.11  | 1.00  | -0.06 | -0.18  | 0.12   | 0.84   | 0.11    |
| LDL     | 0.16  | -0.13 | -0.16 | -0.13 | 0.81*  | -0.06 | 1.00  | 0.22   | 0.40*  | -0.23  | 0.60*   |
| HDL     | -0.04 | -0.01 | 0.12  | 0.12  | 0.53*  | -0.18 | 0.22  | 1.00   | -0.61* | -0.58* | -0.58*  |
| TC:HDL  | 0.22  | -0.13 | -0.12 | -0.11 | 0.28   | 0.12  | 0.40* | -0.61* | 1.00   | 0.36*  | 0.87*   |
| TG:HDL  | 0.16  | 0.11  | -0.05 | 0.02  | -0.39* | 0.84* | -0.23 | -0.58* | 0.36*  | 1.00   | 0.34*   |
| LDL:HDL | 0.20  | -0.15 | -0.10 | -0.11 | 0.22   | 0.11  | 0.60* | -0.58* | 0.87*  | 0.34*  | 1.00    |

**Abbreviations:** AVI: abdominal volume index; RBG: random blood glucose; SBP: systolic blood pressure; DBP: diastolic blood pressure; TC: total cholesterol; TG: triglyceride; LDL: low density lipoprotein cholesterol; HDL: high density lipoprotein cholesterol; TC:HDL: ratio of total cholesterol to high density lipoprotein cholesterol; TG:HDL: ratio of triglyceride to high density lipoprotein cholesterol; LDL:HDL: ratio of low density cholesterol to high density lipoprotein cholesterol. \*Correlation is significant at the 0.05 level (2-tailed).

**Table 4. Correlations among some anthropometric and cardiometabolic variables in perimenopausal Nigerian women.**

|        | HEIGHT | WEIGHT | WC    | HC    | BMI   | WHR   | WHtR  | AVI   | RBG   | SBP   | DBP   | TC     | TG    | LDL   | HDL    | TC:HDL | TG:HDL | LDL:HDL |
|--------|--------|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--------|-------|-------|--------|--------|--------|---------|
| HEIGHT | 1.00   | 0.41*  | 0.16  | 0.21  | -0.04 | -0.05 | -0.19 | 0.14  | -0.01 | -0.05 | 0.15  | 0.24   | 0.27  | 0.22  | 0.12   | 0.10   | 0.16   | 0.08    |
| WEIGHT | 0.41*  | 1.00   | 0.71* | 0.83* | 0.89* | -0.06 | 0.57* | 0.72* | 0.14  | 0.06  | 0.15  | -0.03  | 0.34* | 0.12  | -0.07  | 0.13   | 0.27   | 0.12    |
| WC     | 0.16   | 0.71*  | 1.00  | 0.86* | 0.71* | 0.44* | 0.94* | 0.99* | 0.20  | 0.05  | 0.21  | 0.08   | 0.17  | 0.16  | -0.05  | 0.23   | 0.18   | 0.20    |
| HC     | 0.21   | 0.83*  | 0.86* | 1.00  | 0.80* | -0.08 | 0.78* | 0.88* | 0.09  | -0.07 | 0.08  | 0.06   | 0.21  | 0.20  | -0.09  | 0.22   | 0.21   | 0.24    |
| BMI    | -0.04  | 0.89*  | 0.71* | 0.80* | 1.00  | -0.02 | 0.72* | 0.73* | 0.17  | 0.10  | 0.09  | -0.15  | 0.23  | 0.02  | -0.13  | 0.08   | 0.21   | 0.09    |
| WHR    | -0.05  | -0.06  | 0.44* | -0.08 | -0.02 | 1.00  | 0.45* | 0.40* | 0.23  | 0.24  | 0.29  | 0.07   | -0.05 | -0.02 | 0.08   | 0.09   | -0.02  | -0.01   |
| WHtR   | -0.19  | 0.57*  | 0.94* | 0.78* | 0.72* | 0.45* | 1.00  | 0.94* | 0.21  | 0.07  | 0.17  | 0.00   | 0.07  | 0.08  | -0.08  | 0.19   | 0.12   | 0.16    |
| CI     | 0.01   | 0.01   | 0.69* | 0.38* | 0.01  | 0.67* | 0.68* | 0.67* | 0.12  | -0.02 | 0.18  | 0.22   | -0.08 | 0.18  | 0.06   | 0.22   | -0.01  | 0.18    |
| AVI    | 0.14   | 0.72*  | 0.99* | 0.88* | 0.73* | 0.40* | 0.94* | 1.00  | 0.20  | 0.05  | 0.21  | 0.07   | 0.15  | 0.16  | -0.04  | 0.22   | 0.16   | 0.20    |
| RBG    | -0.01  | 0.14   | 0.20  | 0.09  | 0.17  | 0.23  | 0.21  | 0.20  | 1.00  | 0.31* | 0.29  | -0.12  | 0.15  | -0.13 | -0.01  | -0.13  | 0.11   | -0.15   |
| SBP    | -0.05  | 0.06   | 0.05  | -0.07 | 0.10  | 0.24  | 0.07  | 0.05  | 0.31* | 1.00  | 0.76* | -0.09  | -0.04 | -0.16 | 0.12   | -0.12  | -0.05  | -0.10   |
| DBP    | 0.15   | 0.15   | 0.21  | 0.08  | 0.09  | 0.29  | 0.17  | 0.21  | 0.29  | 0.76* | 1.00  | -0.05  | 0.04  | -0.13 | 0.12   | -0.11  | 0.02   | -0.11   |
| TC     | 0.24   | -0.03  | 0.08  | 0.06  | -0.15 | 0.07  | 0.00  | 0.07  | -0.12 | -0.09 | -0.05 | 1.00   | -0.11 | 0.81* | 0.53*  | 0.28   | -0.39* | 0.22    |
| TG     | 0.27   | 0.34*  | 0.17  | 0.21  | 0.23  | -0.05 | 0.07  | 0.15  | 0.15  | -0.04 | 0.04  | -0.11  | 1.00  | -0.06 | -0.18  | 0.12   | 0.84*  | 0.11    |
| LDL    | 0.22   | 0.12   | 0.16  | 0.20  | 0.02  | -0.02 | 0.08  | 0.16  | -0.13 | -0.16 | -0.13 | 0.81*  | -0.06 | 1.00  | 0.22   | 0.40*  | -0.23  | 0.60*   |
| HDL    | 0.12   | -0.07  | -0.05 | -0.09 | -0.13 | 0.08  | -0.08 | -0.04 | -0.01 | 0.12  | 0.12  | 0.53*  | -0.18 | 0.22  | 1.00   | -0.61* | -0.58* | -0.58*  |
| TCHDL  | 0.10   | 0.13   | 0.23  | 0.22  | 0.08  | 0.09  | 0.19  | 0.22  | -0.13 | -0.12 | -0.11 | 0.28   | 0.12  | 0.40* | -0.61* | 1.00   | 0.36*  | 0.87*   |
| TGHDL  | 0.16   | 0.27   | 0.18  | 0.21  | 0.21  | -0.02 | 0.12  | 0.16  | 0.11  | -0.05 | 0.02  | -0.39* | 0.84* | -0.23 | -0.58* | 0.36*  | 1.00   | 0.34*   |
| LDLHDL | 0.08   | 0.12   | 0.20  | 0.24  | 0.09  | -0.01 | 0.16  | 0.20  | -0.15 | -0.10 | -0.11 | 0.22   | 0.11  | 0.60* | -0.58* | 0.87*  | 0.34*  | 1.00    |

**Abbreviations:** AVI: abdominal volume index; WC: waist circumference; HC: hip circumference; BMI: body mass index; WHR: waist to hip ratio; WHtR: waist to height ratio; RBG: random blood glucose; SBP: systolic blood pressure; DBP: diastolic blood pressure; TC: total cholesterol; TG: triglyceride; LDL: low density lipoprotein cholesterol; HDL: high density lipoprotein cholesterol; TC:HDL: ratio of total cholesterol to high density lipoprotein cholesterol; TG:HDL: ratio of triglyceride to high density lipoprotein cholesterol; LDL:HDL: ratio of low density cholesterol to high density lipoprotein cholesterol. \*Correlation is significant at the 0.05 level (2-tailed).

## Discussion

Abdominal volume index (AVI) is a marker of abdominal adiposity and central obesity. It estimates overall abdominal volume between the sternal xiphoid process and the pubic symphysis, and is presumed to assess the volume of intra-abdominal adiposity, with a strong correlation with glucose intolerance and type 2 diabetes mellitus (Sekgala et al., 2024). In the present study, we first assessed the association between this index and other markers of central adiposity (WC, HC, WHR, and WHtR) and general obesity (BMI) in a population of 46 perimenopausal Nigerian women (45-55 years) resident at Oke-Ose (a suburb of the Ilorin metropolis). We then studied the correlation between the AVI and cardiometabolic variables, including blood pressure, blood glucose and serum lipids. Among the anthropometric variables studied in this perimenopausal population, WC shows the strongest positive association with AVI, while WHR has the weakest though significant positive correlation. This strong association between AVI and WC, as reported in our study, had also been reported in recent studies (Sadeghi et al., 2024; Yamada et al., 2022), and is considered an excellent

proxy for diagnosing metabolic syndrome (Li et al., 2022). Similarly, in a population of perimenopausal and postmenopausal Chinese women (46-65 years) resident in Shenyang Wang et al. (2017) studied the predictive power of several anthropometric variables at assessing the risk of metabolic syndrome. They showed that AVI (compared to several other indices that included WC, BMI, ABSI, BAI, BRI, CI, WHR and VAI) had the strongest discriminatory power at predicting the risk of metabolic syndrome, and that WC had the strongest association with VAI, a finding that is comparable to our data in Nigerian perimenopausal women. These and related findings (Li et al., 2022; Sadeghi et al., 2024) suggest that WC and AVI are superior to BMI, WHR, etc., as proxies for diagnosing metabolic syndrome and cardiovascular risks in women undergoing menopausal transition. Moreover, in a cross-sectional study of 780 Iranian women, Ehrampoush et al. (2017) found that among all indices examined, AVI and WHtR are better able to assess abdominal adiposity, and that AVI showed stronger association with WHtR rather than WC, BMI or any other indices. In our Nigerian subjects however, AVI shows the strongest correlation with WC, followed by WHtR. This makes the three indices (AVI, WC and WHtR) invaluable as markers of abdominal visceral adiposity and metabolic syndrome in (perimenopausal) women relative to other anthropometric indices, with AVI being the most powerful predictor. Furthermore, in the same perimenopausal Nigerian women, we assessed blood pressure, blood glucose and serum lipid profile, and correlated these variables with the anthropometric markers of cardiometabolic status. Like AVI, most anthropometric indices studied (including WC, HC, BMI, WHR, and WHtR) showed positive, though weak association with the cardiometabolic parameters. The exception being HDL-c, which instead has a negative association with the anthropometric variables. The present findings are in consonance with related study in Korean immigrants (Choi, 2011). In this Korean population, WC showed the strongest (negative) association with HDL-c, and also performed better than BMI in this regard. It is noteworthy that in our Nigerian (perimenopausal) population, AVI and WC have comparable negative correlation with HDL-c; suggesting that AVI is a good predictor of dyslipidaemia in perimenopausal women. Meanwhile, one of the limitations in the present study was our inability to measure fasting serum glucose. Instead, random (non-fasting) blood glucose was measured with a glucometer. Nonetheless, AVI correlates positively with blood glucose in these perimenopausal subjects. This presupposes that AVI is a good anthropometric proxy for assessing glucose intolerance. This inference also holds true for BMI, WC, HC, WHR and WHtR in the present study. A previous novel cross-sectional study of non-gravid women from Northern Mexico showed a higher odd ratio between AVI and impaired glucose tolerance (IGT); and between the same (abdominal volume) index and type 2 diabetes mellitus (Sekgala et al., 2024). In this Mexican population, AVI is reportedly excellent at predicting IGT and diabetes mellitus in women. A related study of a postmenopausal American population aged 50-79 years showed a very strong association of WC and WHtR with serum blood glucose (Kabat et al., 2014). The latter report from an American population further lends credence to our findings in the present study, and given that WC and WHtR showed the strongest positive association with AVI in our Nigerian subjects. Further, we studied the association between AVI and the systolic and diastolic blood pressure in perimenopausal Nigerian women. AVI and WC have similar (positive) association with blood pressure; albeit diastolic pressure shows stronger association with the anthropometric parameters than systolic blood pressure. The reason for this is, however, unclear. Findings from a cross-sectional study of 802 Mexican women living in a semi-urban setting showed that AVI was a good predictor of blood pressure and cardiovascular health than WHR and conicity index, and that its usefulness in this regard is comparable with that of WC (Neufied et al., 2008).

## Conclusion

Our anthropometric and cardiometabolic findings in the present study show that among the indices evaluated, AVI has the strongest correlation with WC, and that both are valuable assessors of metabolic and cardiovascular risks in perimenopausal Nigerian women aged 45-55 years. However, the relatively small numerical size of our study population would justify future studies that enlist larger subsets of women undergoing menopausal transition, with a view to assessing the association of anthropometric variables with cardiometabolic risk factors. Such studies are especially helpful in sub-Saharan Africa, where, owing to resource limitation, a large number of the populace are unable to afford regular (laboratory-based) cardiometabolic check-ups at the health facilities.

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## Author's contributions

OBA conceptualized the study; OBA, FPO and STA collected and analysed data; OBA supervised the study and drafted the manuscript; All authors approved the manuscript.

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## Conflict of interest

The authors declare no conflict of interest. The manuscript has not been submitted for publication in other journal.

## Ethics approval

Each anonymized participant voluntarily enrolled in the study and did complete an informed consent form. The study was approved by the University Ethical Review Committee (UERC) of the University of Ilorin, Nigeria (Approval number: UERC/ASN/2023/2517), and also complied with the Helsinki Declaration on studies involving human subjects.

## AI tool usage declaration

The authors not used any AI and related tools to write this manuscript.

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