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Research article

Anthropometric Indices, Blood Pressure and Some Apolipoproteins in older Adults in Nnewi, Southeast Nigeria

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ABSTRACT

Aging is associated with progressive decline in functions which may impact cardiovascular health negatively. This cross-sectional study assessed anthropometric indices, blood pressure and some apolipoproteins in older adults in Nnewi. One hundred and twenty-eight participants (64 older adults and 64 control subjects) were recruited for the study using simple random sampling. Body mass index (BMI), waist circumference (WC), hip circumference (HC), waist-hip ratio (WHR), systolic blood pressure (SBP) and diastolic blood pressure (DBP) were determined using standard methods. Five milliliters (5ml) of venous sample were taken from each participant after 10–12 hours of fasting, minimizing stasis, and placed in plain containers for the determination of apolipoprotein A–I (apoA–I) and apolipoprotein B100 (apoB100) levels using Immunoturbidimetric method. The older persons had significantly ($p<0.05$) lower mean serum apoA-I and higher apoB100 level, apoB100/apoA-1 ratio, BMI, WHR, SBP and DBP values compared to control subjects respectively. Furthermore, the mean serum apoB100 and apoB100/apoA-I ratio, as well as the mean WC, WHR, SBP, and DBP, were all significantly higher while the mean serum apoA-I level was lower in the older males compared to the control males ($p<0.05$). Also, the older females had significantly higher mean SBP, DBP, apoB100 and apoB100/apoA-I ratio with significantly lower apoA-I compared to the female control ($p<0.05$). The findings of this study revealed significant changes in anthropometric measurements, blood pressure, and apolipoprotein levels in older persons, necessitating guidance for Medical Laboratory scientists and Clinicians in their interpretations.

Keywords: *Older adults, anthropometric indices, Blood pressure, Apolipoprotein A-I, Apolipoprotein B100*

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INTRODUCTION

Aging is a universal biological process that leads to a cumulative and permanent loss in physical function across all organ systems and is induced by the buildup of damage in response to a range of stresses (Guo *et al*., 2022). With the population of older people expected to nearly triple by 2050, Nigeria, has the greatest proportion of older people on the African continent and the 19th highest worldwide (Mbam *et al*., 2022). Despite this, and despite the difficulties that come with getting older, the older population in Nigeria seems to be the most ignored. Due to changes in body metabolisms, older age is frequently accompanied by a reduction in physiological and biochemical processes. This is made worse by the fact that chronic non-communicable diseases are becoming more common among older individuals, particularly cardiovascular conditions and malnutrition. This is a result of older people's changing eating habits, sedentary lifestyles, and increased alcohol use, which raises caloric values and predisposes them to obesity, which is a known risk factor for cardiovascular diseases.

Obesity is measured using a variety of techniques, including straightforward anthropometric measurements like body mass index (BMI), waist circumference, waist hip ratio, skinfold thickness, and body density (Reddy and Nambiar, 2018). The preferred indication for determining body size and composition as well as for diagnosing underweight and overweight is body mass index. Body fat distribution, particularly abdominal obesity, and the distinction between lean and fat body mass are not taken into account by BMI (Holanda *et al*., 2006). According to numerous studies an increase in measures of adiposity has been linked to increased cardiovascular risk, increased cardiometabolic risk, increased dependency, and increased frailty (Xu *et al*., 2020; Khosravian *et al*., 2021; Wojzischke *et al*., 2021; Zhang *et al*., 2021). Therefore, it is crucial to assess these anthropometric indicators in older persons.

Apolipoproteins (Apo) are lipid-binding proteins found on the surface of lipoproteins, and they both regulate lipid transit and interact with specific receptors to allow lipid uptake and deposition into tissue, making them important players in cholesterol metabolism (Bartoloni and Zammarchi, 2012). Amongst the apolipoproteins, ApoAs, ApoB, ApoCs, and ApoE are the most studied because of their vital importance for lipid metabolism. According to the findings of several studies, high ApoB concentrations, low ApoA1 concentrations, and the ApoB/ApoA1ratio may be more accurate predictors of CVD risk than LDL, HDL, and the LDL/HDL ratio (Frondelius et *al*., 2017). Apolipoproteins have a significant function in lipoprotein and blood glucose metabolism (Sniderman and Faraj, 2007). Apolipoprotein A1 (ApoA1) and apolipoprotein B (ApoB) are two primary apolipoprotein kinds that have been studied extensively. ApoA1 is the major lipoprotein linked to high-density lipoprotein cholesterol (van der Vorst, 2020). ApoB is a single molecule found in lipoproteins with low, moderate, and extremely low density (Andersen *et al*., 2016). ApoA1 and ApoB regulated fasting blood glucose levels via enhancing insulin levels, according to in vitro and animal studies (Tang *et al*., 2019). A number of studies have demonstrated ApoA, ApoB and ApoB/A1 ratio as better biomarkers for the assessment of cardiovascular disease risk than the conventional lipid profile or panel test [Tian *et al*., 2019; Ogbodo *et al*., 2023). Globally, several studies have shown varying levels of abnormalities in lipid levels in diverse populations (Ezeugwunne *et al*., 2017; González-Rivas *et al*., 2018; Vizentin *et al*., 2019), principally because of sedentary life pattern. Observably most of the previous studies have relied on the use of the conventional lipid profile panel in their assessment of their study participants. The current study, on the other hand, will use nonconventional but current and improved biomarkers to assess cardiovascular function in the current study participants.

MATERIALS AND METHODS

Study Design and Population: The cross-sectional study design was used in this investigation. The total number of volunteers employed in this study was 128. The older individuals in the test group and the control group were divided into two equal groups. 32 male and female volunteers between the ages of 45 and 75 who gave written informed consent make up the test group. The control group consists of 64 students, 32 males and 32 females, between the ages of 18 and 30.

Study Area: The study was conducted in Nnewi, one of Anambra State's most significant economic hubs in Nigeria.

Sample size and Sample Size Calculation: The sample size and power of this investigation were computed using the G-Power program, version 3.1.9.2.25. With a 128 participant anticipated sample size, there is a 0.05 error probability and an 80% power to identify responses with differences as small as 0.5 (effect size). 128 consecutive consenting adult participants and control subjects (64 men and 64 women) were chosen using simple random sampling. The test group ranged in age from 45 to 75, whereas the control group was made up of people between the ages of 18 and 30 years.

Inclusion Criteria: The study recruited control subjects (aged 18 to 30 years) and apparently healthy older individuals (aged 45 to 75 years).

Exclusion Criteria: The participants in the present study were not smokers, alcoholics, pregnant women, or those who had diabetes mellitus, kidney disease, cardiovascular diseases, or who were currently lactating.

Approval on ethical grounds: The Nnamdi Azikiwe University Teaching Hospital Ethics Committee granted approval for the study (NAUTH/CS/66/VOL. 16/VER. 3/07/2023/07).

Participants' informed consent: The subjects' signed informed consent was requested and acquired prior to the study's commencement.

Collection of samples and analysis: Five milliliters of venous sample were taken from each participant after 10–12 hours of fasting, minimizing stasis, and placed in plain containers for the determination of apolipoprotein A–I (apoA–I) and apolipoprotein B–100 (apoB–100) levels. After allowing the blood sample enough time to clot and retract, it was spun for ten minutes at 3000 rpm. For the purpose of studying the laboratory analysis, the serum was separated. Unanalyzed serum samples were kept frozen at -20°C until they could be examined.

Laboratory Methods

Estimation of Apolipoprotein A-I (apoA1) and Apolipoprotein B100 (apo B100): The serum apoA-I and apoB100 levels was determined using Immnoturbidimetric method as described by Riepponen *et al*. (1987). The principle is that anti-apolipoprotein A-antibodies and anti-apolipoprotein B-antibodies react with the antigen in the sample to form antigen/antibody complexes which, following aggulutination, can be measured turbidimetrically.

Anthropometric measurements: Body mass index (BMI) was calculated using the following formula: BMI= weight (kg) / height^2 (m^2). A measuring tape was fastened to a piece of wood to determine height, and a manual weighing scale-Peacesky (PH-2015A) made in China was used to determine weight. BMI of 25 and 30 kg/m^2 was used to classify overweight and generalized obesity, respectively.

Waist circumference (WC) was measured with the participant in the standing position, at the midpoint between the upper margin of the iliac crest and the lower margin of the last rib, using a metric tape (cm).

The hip circumference (HC) in turn was determined with the participant in the standing position as the greatest distance between the major trochanters (cm).

The waist/hip ratio (WHR) was calculated by dividing the waist circumference (in cm) by the hip circumference (in cm).

Measurement of Blood pressure: After a 10-minute rest, a cuff of the right size was applied to the left arm while the subject was seated to measure the subject's systemic blood pressure using the Kris-Aaloy Improved Mercurial Sphygmomanometer Desk Type Long Cuff and Dual Head Stethoscope, both made in China. Systolic blood pressure of ≥140 mmHg and/or diastolic blood pressure ≥ 90 mmHg was used to characterize hypertension.

Statistical analysis: The Student's t-test was performed to compare the mean values of the control and test groups using the Statistical Program for Social Sciences (SPSS) (Version 26) software, and Pearson's correlation coefficient was employed to determine correlations between the parameters studied. The results were presented as mean±SD, with a p-value of <0.05 deemed statistically significant.

RESULTS

The mean age of the older adults was significantly higher when compared to the control individuals (59.96±8.47 Vs 23.21±3.41; *P*-value= 0.000), whereas the mean height of the older adults was significantly lower than in the control group (1.61±0.10 Vs 1.70±0.09; *P*-value= 0.000). However, the mean body weight, waist circumference and hip circumference did not differ significantly in the older adults compared to the values observed in the control individuals (*P*-value= 0.932; 0.077; 0.601) respectively. Nevertheless, the mean body mass index (26.05±5.55 Vs 23.37±3.96; *P*-value= 0.002) and waist-hip ratio (0.90±0.05 Vs 0.86±0.05; *P*-value= 0.000) was significantly higher in the older adults compared to the values obtained in the control group. Furthermore, the mean systolic blood pressure (130.50±13.25 Vs 112.96±7.992; *P*-value= 0.000) and diastolic blood pressure (86.43±7.24 Vs 77.68±5.90; *P*-value= 0.000) was significantly higher in the older adults than in the control persons.

Interestingly, the mean serum apolipoprotein A-I (apoA-I) levels was significantly lower in the older adults than in the control individuals (148.72±21.10 Vs 170.85±27.25; *P*-value= 0.000) while the mean serum apolipoprotein B-100 level (apoB-100) (97.96±11.12 Vs 85.01±14.58; *P*-value= 0.000) and apoB-100/apoA-1 ratio (0.67±0.12 Vs 0.50±0.09; *P*-value= 0.000) was significantly higher in the older adults compared to the observed values in the control individuals respectively (Table 1).

The mean age of the older adult males was significantly higher when compared to the control males (62.09±7.87 Vs 23.40±3.16; *P*-value= 0.000), whereas the mean height of the older adult males was significantly lower than in the control male group (1.66±0.07 Vs 1.75±0.06; *P*-value= 0.000). However, the mean body weight, body mass index and hip circumference did not differ significantly in the older adult males compared to the values observed in the control males (*P*-value= 1.000; 0.331; 1.000) respectively.

Table 1:
Mean±SD Serum Levels of Parameters Studied in the older adults and Control Subjects.

Parameters	Older adults (n=64)	Control (n=64)	t-value	*P*-value
Age (years)	59.96 ±8.47	23.21 ±3.41	32.191	0.000*
Height (meter)	1.61 ±0.10	1.70 ±0.09	5.392	0.000*
Weight (Kg)	67.92 ±14.46	68.12 ±12.40	0.085	0.932
BMI (Kg/m^{-2})	26.05 ±5.55	23.37 ±3.96	3.141	0.002*
Waist Circumference (cm)	94.67 ±10.28	89.61 ±20.29	1.780	0.077
Hip circumference (cm)	105.25 ±10.65	103.74 ±20.34	0.525	0.601
Waist-Hip Ratio	0.90 ±0.05	0.86 ±0.05	3.988	0.000*
SBP (mmHg)	130.50± 13.25	112.96 ±7.992	9.061	0.000*
DBP (mmHg)	86.43±7 .24	77.68 ±5.90	7.492	0.000*
APoA1 (mg/dL)	148.72± 21.10	170.85 ±27.25	5.138	0.000*
APoB100 (mg/dL)	97.96 ±11.12	85.01 ±14.58	5.646	0.000*
APoB100/ APoA1 Ratio	0.67 ±0.12	0.50 ±0.09	8.561	0.000*

**P*-value is statistically significant at <0.05.

Table 2:
Mean±SD Serum Levels of Parameters Studied in the older adult Male participants and Male Control Subjects.

Parameters	Older adult Males (n=31)	Male Control (n=32)	*P*-value
Age (years)	62.09±7.87	23.40±3.16	0.000*
Height (meter)	1.66±0.07	1.75±0.06	0.000*
Weight (Kg)	69.87±16.19	69.84±8.96	1.000
BMI (Kg/m^{-2})	25.07±5.52	22.73±2.78	0.331
Waist Circumference(cm)	93.65±10.50	86.57±17.96	0.000*
Hip circumference (cm)	103.89±11.62	103.18±15.54	1.000
Waist-Hip Ratio	0.90±0.04	0.85±0.05	0.005*
SBP (mmHg)	129.87±14.37	112.75±8.49	0.000*
DBP (mmHg)	85.54±6.43	78.25±5.55	0.000*
APoA1 (mg/dL)	146.22±17.82	166.07±26.95	0.009*
APoB100 (mg/dL)	97.05±9.71	80.97±13.53	0.000*
APoB100/ APoA1 Ratio	0.67±0.11	0.49±0.08	0.000*

**P*-value is statistically significant at <0.05.

Nevertheless, the mean waist circumference (93.65±10.50 Vs 86.57±17.96; *P*-value= 0.000) and waist-hip ratio (0.90±0.04 Vs 0.85±0.05; *P*-value= 0.005) was significantly higher in the older adult males compared to the values obtained in the control male group. Furthermore, the mean systolic blood pressure (129.87±14.37 Vs 112.75±8.49; *P*-value= 0.000) and diastolic blood pressure (85.54±6.43 Vs 78.25±5.55; *P*-value= 0.000) was significantly higher in the older adult males than in the control males.

Interestingly, the mean serum apoA-I levels was significantly lower in the older adult males than in the control male individuals (146.22±17.82 Vs 166.07±26.95; *P*-value= 0.009) while the mean serum apoB-100 levels (97.05±9.71 Vs 80.97±13.53; *P*-value= 0.000) and apoB-100/apoA-1 ratio (0.67±0.11 Vs 0.49±0.08; *P*-value= 0.000) was significantly higher in the older adult males compared to the observed values in the male control individuals respectively (Table 2).
The mean age of the older adult females was significantly higher when compared to the control females (57.96±8.63Vs 23.03±3.69; *P*-value= 0.000), whereas the mean height of the older adult females was significantly lower than in the control male group (1.56±0.10 Vs 1.66±0.09; *P*-value= 0.000). However, the mean body weight (66.09±12.60 Vs 66.40±15.03; *P*-value= 1.000), body mass index (26.97±5.49 Vs 24.01±4.83; *P*-value= 0.085), waist circumference (95.63±10.13 Vs 90.65±22.63; *P*-value= 1.000), hip circumference (106.53±9.66 Vs 104.30±24.47; *P*-value= 1.000) and waist-hip ratio (0.89±0.06 Vs 0.86±0.05; *P*-value= 0.188) did not differ significantly in the older adult females compared to the values observed in the control females respectively. Furthermore, the mean systolic blood pressure (131.09±12.30 Vs 113.18±7.58; *P*-value= 0.000) and diastolic blood pressure (87.27±7.93 Vs 77.12±6.26; *P*-value= 0.000) was significantly higher in the older adult males than in the control males.

Table 3:
Mean±SD Serum Levels of Parameters Studied in the older female participants and female Control Subjects.

Parameters	Older adult females (n=33)	female Control (n=32)	*P*-value
Age (years)	57.96±8.63	23.03±3.69	0.000*
Height (meter)	1.56±0.10	1.66±0.09	0.000*
Weight (Kg)	66.09±12.60	66.40±15.03	1.000
BMI (Kg/m^{-2})	26.97±5.49	24.01±4.83	0.085
Waist Circumference (cm)	95.63±10.13	90.65±22.63	1.000
Hip circumference (cm)	106.53±9.66	104.30±24.47	1.000
Waist-Hip Ratio	0.89±0.06	0.86±0.05	0.188
SBP (mmHg)	131.09±12.30	113.18±7.58	0.000*
DBP (mmHg)	87.27±7.93	77.12±6.26	0.000*
APoA1 (mg/dL)	151.06±23.81	175.64±27.13	0.000*
APoB100 (mg/dL)	98.81±12.39	89.06±14.68	0.015*
APoB100/APoA1 Ratio	0.66±0.13	0.51±0.10	0.000*

**P-value is statistically significant at <0.05.*

There were significant positive relationships observed in Weight Vs BMI (r=0.783, *P*-value= 0.000); Weight Vs WC (r=0.490, *P*-value= 0.000), Weight Vs HC (r=0.565, *P*-value= 0.000), WC Vs BMI (r=0.527, *P*-value= 0.000), WC Vs HC (r=0.962, *P*-value= 0.000),WC Vs WHR (r=0.462, *P*-value= 0.000),HC Vs BMI (r= 0.570, *P*-value= 0.000), SBP Vs BMI (r=0.414, *P*-value= 0.001), SBP Vs DBP (r=0.728, *P*-value= 0.000), DBP Vs Weight (r=0.413, *P*-value= 0.001), DBP Vs BMI (r=0.315, *P*-value= 0.011),DBP Vs WC (r=0.378, *P*-value= 0.002),DBP Vs HC (r=0.386, *P*-value= 0.002) and ApoB100 Vs HC (r=0.253, *P*-value= 0.044) in the control group, (Table 4).

Furthermore, the mean serum apoA-I levels was significantly lower in the older adult females than in the control female individuals (151.06±23.81 Vs 175.64±27.13; *P*-value= 0.000) while the mean serum apoB-100 levels (98.81±12.39 Vs 89.06±14.68; *P*-value= 0.015) and apoB-100/apoA-1 ratio (0.66±0.13 Vs 0.51±0.10; *P*-value= 0.000) was significantly higher in the older adult females compared to the observed values in the female control individuals respectively (Table 3).

Table 4:
Levels of Associations between parameters studied in control group (n=64)

Parameters	Pearson r coefficient	*P*-value
Weight Vs BMI	0.783**	0.000*
Weight Vs WC	0.490	0.000*
Weight Vs HC	0.565	0.000*
WC Vs BMI	0.527	0.000*
WC Vs HC	0.962**	0.000*
WC Vs WHR	0.462	0.000*
HC Vs BMI	0.570	0.000*
SBP Vs BMI	0.414	0.001*
SBP Vs DBP	0.728**	0.000*
DBP Vs Weight	0.413	0.001*
DBP Vs BMI	0.315	0.011*
DBP Vs WC	0.378	0.002*
DBP Vs HC	0.386	0.002*
ApoB100 Vs HC	0.253	0.044*

**P*-value is statistically significant at <0.05; ** = strong correlation

Table 5:
Levels of Associations between parameters studied in test group (n=64)

Parameters	Pearson r coefficient	*P*-value
Weight Vs BMI	0.799**	0.000*
Weight Vs WC	0.725**	0.000*
Weight Vs HC	0.831**	0.000*
BMI Vs WC	0.768**	0.000*
BMI Vs HC	0.804**	0.003*
BMI Vs SBP	0.360	0.000*
BMI Vs DBP	0.489	0.000*
HC Vs WC	0.830**	0.000*
HC Vs DBP	0.385	0.002*
WHR Vs WC	0.395	0.001*
WHR Vs SBP	0.285	0.022*
SBP Vs WC	0.378	0.002*
SBP Vs DBP	0.887**	0.000*
DBP Vs WC	0.426	0.000*
ApoA1 Vs ApoB100/ ApoA1 Ratio	-0.742**	0.000*
ApoB100 Vs Age	0.304	0.015*

**P*-value is statistically significant at <0.05; ** = strong correlation

However, there were positive associations observed in Weight Vs BMI (r=0.799, *P*-value= 0.000), Weight Vs WC (r=0.725, *P*-value= 0.000), Weight Vs HC (r=0.831, *P*-value= 0.000), BMI Vs WC (r=0.768, *P*-value= 0.000), BMI Vs HC (r=0.804, *P*-value= 0.003), BMI Vs SBP (r=0.360, *P*-value= 0.000), BMI Vs DBP (r=0.489, *P*-value= 0.000), HC Vs WC (r=0.830, *P*-value= 0.000), HC Vs DBP (r=0.385, *P*-value= 0.002), WHR Vs WC (r=0.395, *P*-value= 0.001), WHR Vs SBP (r=0.285, *P*-value= 0.022),SBP Vs WC (r=0.378, *P*-value= 0.002), SBP Vs DBP (r=0.887, *P*-value= 0.000), DBP Vs WC (r=0.426, *P*-value= 0.000), and ApoB100 Vs Age (r=0.304, *P*-value= 0.015), whereas ApoA1 Vs ApoB100/ ApoA1 Ratio (r= -0.742, *P*-value= 0.000), showed a significant negative correlation in the test group (Table 5).

DISCUSSION

The older adults in this study had a significantly higher mean age (59.96±8.47) than the control group (23.21±3.41). According to gender, the older adult males and females in the current study had mean ages of (62.09±7.87 years) and (57.96±8.63 years), respectively. This mean age matches that reported in the study by Nzeagwu *et al*. (2021) on the nutritional risks and anthropometric status of older adults in Umuahia metropolis, Abia State, Nigeria, where they found that a sizable portion (44.3%) of the older people in their study area were between 60 and 64 years old. The mean age of older persons was higher in certain other research (Emmanuel *et al*., 2022; López-Solís *et al*., 2022). The mean age in the current study is lower than those found in the Gómez-Sánchez *et al*. (2022) study, Relationship of Different Anthropometric Indices with Vascular Ageing in an Adult Population without Cardiovascular Disease—EVA Study, which found that the mean age of older adults, was 55.9 ±14.24years.

The older people had a significantly lower mean height than the group serving as a control. This shows that mean height declines with ageing. The current study discovered that height declined with age, which is consistent with results of previous studies (Iwasaki *et al*., 2023). With advancing age, the skeletal system experiences structural changes such demineralization, which narrows the vertebral bodies and distorts the long bones of the inferior extremities. Height loss is caused by osteoporosis, vertebral fractures, disc reduction, postural changes, and kyphosis (Iwasaki *et al*., 2023). Marked long-term height loss is reportedly associated with cardiovascular disease and mortality in the elderly (Iwasaki *et al*., 2023). Several previous studies involving observation for several years have reported that marked height loss in the long term is associated with mortality (Klingberg *et al*., 2021) and cardiovascular diseases in the elderly (Klingberg *et al*., 2021; Choi *et al*., 2022). The mean height of older adults in this study was 1.61± 0.10 m, which is comparable to the mean heights reported by Gómez-Sánchez *et al*. (2022) and Reddy and Nambiar, (2018), respectively, of 165.11± 9.68 cm and 163.8 ±9.12 cm. However, it is lower than the values (156.5± 9.12 cm) published by Lopez-Solis *et al*. (2022). In addition, older adult males and females in the current study had significantly lower mean heights than the control male and female groups (1.66±0.70 and 1.56±0.10). This would suggest that, regardless of gender, mean height gradually decreases with age. The mean height found in this study for older male and female adults is comparable to that found in studies by Canaan Rezende *et al*. (2015) and Lopez-Solis *et al*. (2022), which found that older adult males and females had respective mean heights of 165.5±0.40/152.4±0.35 cm and 162.7±6.74/151.4±7.41 cm. The aforementioned figures, however, were lower than those reported by Gómez-Sánchez *et al*. (2022) who found that older adult males and females had mean heights of 171.60±7.46 and 158.70±6.98, respectively. Height loss ≥ 0.5 cm has been shown to be correlated significantly with an increased risk of mortality compared to height loss < 0.5 cm in both men and women (Iwasaki *et al*., 2023).

Surprisingly, there was no statistically significant difference between the mean body weights of the study's older persons and the controls. The mean body weight of the older adult male and female participants in this study did not differ statistically significantly from that of the corresponding male and female control participants. This might be an indication that aging had no effect on mean weight. The mean weight of the older individuals in the current study (67.92±14.46 kg) was lower than the mean weights of the older adults in other recent studies (Reddy and Nambiar, 2018; Gómez-Sánchez *et al*., 2022; Lopez-Solis *et al*., 2022), that reported different mean weights (62.79±12.78, 69.4±14.01, 72.41±13.61 kg). Additionally, this study recorded mean weight of 69.87±16.19kg in the older adult male individuals in this study, which was lower than those documented in older adult males (73.7±11.58, 79.22±11.75, 84.4±14.1 kg) in some previous studies (Reddy and Nambiar, 2018; Gómez-Sánchez *et al*., 2022; Lopez-Solis *et al*., 2022). However, the mean weight of the older adult females in this study (66.09±12.09 kg) was comparable to the values reported in other earlier investigations, which found mean weights of 65.7±14.84 kg (Lopez-Solis *et al*., 2022) and 65.67±11.87 kg (Gómez-Sánchez *et al*., 2022).

Nevertheless, the mean body mass index was significantly higher in the older adults (26.05±5.55 kg/m^2) compared to the values obtained in the control group (23.37±3.96 kg/m^2). This suggests that body mass index (generalized body fats) increases with advancing age. According to WHO guidelines, BMI is divided into four categories: underweight (18.5 kg/m^2), normal (18.5-24.9 kg/m^2), overweight (25–29.9 kg/m^2), and obese (>30 kg/m^2) (WHO, 2000). The present result shows that the older adults in this study were overweight. Overweight and obesity are primarily caused by an imbalance in energy between calories consumed and calories burned. Globally, there has been a rise in the consumption of calorie-dense foods that are high in fat and sugar, as well as a rise in physical inactivity as a result of the sedentary nature of many occupations, evolving transportation options, and escalating urbanization (WHO, 2021). As a result, these individuals may be more susceptible to developing chronic noncommunicable diseases including diabetes mellitus, cardiovascular conditions, etc. The mean BMI reported in this study is comparable to those reported in earlier investigations. The older adult population in Spain had a mean BMI of 26.52±4.23 kg/m^2, according to Gomez-Sanchez *et al*. (2022). Additionally; Oztürk *et al*. (2023) found that the mean BMI of the older adult population in Turkey was 26.6±4.9 kg/m^2, which is close to the value reported in this study. However, they also found that the mean BMI of the older adult population in Portugal was 29.2±4.7 kg/m^2, which is higher than the number found in this study. Lopez-Solis *et al*. (2022) found that older Mexican individuals had a mean BMI of 28.1±3.98 kg/m^2, which is also higher than in the present study. Canaan-Rezende *et al.* (2015) noted mean BMI of 25.8±0.27 kg/m^2 in older adult males but higher mean BMI of 28.2±0.32 kg/m^2 in older adult females, which is partly consistent with the current findings. Spanish older adult male and female populations were found to have mean BMI values of 26.90±3.54 kg/m2 and 26.14±4.79 kg/m2, respectively, according to Gomez-Sanchez *et al*. (2022). Additionally, Oztürk *et al*. (2023) found that the mean BMI of the older adult population in Turkey was 26.6±4.9 kg/m^2, which is close to the value reported in this study. However, they also found that the mean BMI of the older adult population in Portugal was 29.2±4.7 kg/m^2, which is higher than the number found in this study. In postmenopausal females, Vázquez-Lorente *et al*. (2023) discovered a mean BMI of 27.0±4.60 kg/m^2, while Ogbodo *et al*. (2018) discovered a mean BMI of 25.15±5.81 kg/m^2. However, BMI does not account for weight that is related to increased muscle mass or the unequal distribution of excessive extra fat throughout the body, both of which have a significant impact on the health risks associated with being overweight or obese. BMI serves as an excellent but not ideal substitute for body fatness. For this reason, it is preferable to employ a measure of obesity and overweight that accounts for the increased risk of obesity-related morbidity caused by the buildup of abdominal and visceral fat. Waist-hip ratio (WHR) and waist circumference (WC) are easy measurements that provide a more accurate assessment of visceral and abdominal fat.

The older adults' mean waist and hip circumferences, however, did not significantly differ from those seen in the control group of people. In this study, older persons had mean waist and hip circumferences of 94.67±10.28 cm and 105.25±10.65 cm, respectively. This is consistent with the reported waist circumference (93.33±12.00 cm) and hip circumference (103.13±9.14 cm) recorded by Gomez-Sanchez *et al*. (2022). Additionally, Lopez-Solis *et al*. (2022) showed mean waist circumference (96.4±11.10 cm) and hip circumference (103.3±9.98 cm) in older female Mexican individuals, which is consistent with the most recent data. Additionally, the older adult males were found to have considerably higher mean waist circumference (93.65±10.50 cm) compared to the values found in control individuals, whereas their mean hip circumference (103.89±11.62 cm) did not differ significantly from the observed values in control group. Despite reporting comparable mean hip circumference (102.71±9.13cm) in older adult males, the current documented results for waist circumference were lower than those (98.76±9.65 cm) observed by Gomez-Sanchez *et al*. (2022), Compared to the results of this investigation, Emmanuel *et al.* (2022) reported that the mean waist circumference was 85.05±21.75 cm. This study also discovered that the mean hip circumference (106.53±9.66) and waist circumference (95.63±10.13) in older adult females did not differ significantly from the values found in the control females, respectively. In a research by Vázquez-Lorente *et al.* (2023) involving postmenopausal women, the mean hip and waist circumference measurements were 105.8±10.5 cm and 89.0±12.6 cm, respectively, which is consistent with the current data. Additionally, Gomez-Sanchez *et al*. (2022) discovered mean waist circumference of 87.95±11.68 cm and hip circumference of 103.55±9.34 cm, both of which are lower than the results of the current study.

On the other hand, compared to the control group, the older adult participants had a significantly higher mean waist-hip ratio (WHR). This study found that the older participants' mean WHR was 0.90±0.05 and the control group's was 0.86±0.05, both of which were lower than the values of 0.92±0.06 reported by Emmanuel *et al*. (2022). Additionally, Lopez-Solis *et al*. (2022) found that the mean WHR was 0.93±0.09; little higher than in the current study. Additionally, the older adult males and females in the current study had mean WHR of 0.90±0.04 and 0.89±0.06, respectively. In contrast to the current finding, Canaan Rezende *et al*. (2015) reported mean WHR of 0.98±0.004 and 0.94±0.003 in older adult males and females, respectively. According to WHO guidelines, central obesity is classified as: WC ≥ 94 cm for males and 80 cm for women, or waist-to-hip ratio (WHR) ≥ 0.90 in men and ≥ 0.85 in women (Ashwell and Gibson, 2009; WHO, 2011). The current data indicate that the older persons in this study are at risk for visceral and central obesity. This could increase the likelihood that these people would develop chronic, non-communicable diseases like diabetes and cardiovascular disease.

In the present study, there was a significantly higher mean systolic blood pressure and diastolic blood pressure levels in the older adults compared to the control participants. A rise in blood pressure (BP) has traditionally been viewed as an unavoidable byproduct of aging in industrialized countries, resulting in hypertension in an important number of elderly individuals (Pinto, 2007). This increase in BP among the older adults may be due to changes in diet especially as regards dietary sodium chloride (salt) intake, physical inactivity and perhaps greater exposure to stress. High-sodium diet can cause vascular smooth muscle cells to alter, leading to collagen buildup in the walls of major arteries and a corresponding increase in arterial stiffness (Safar, 2005). Age-related increases in blood pressure are most likely brought on by an intricate combination of variables that are shaped and impacted by each person's environment and way of life. Okwara *et al*. (2021) in their study on assessment of cardiovascular disease awareness and risk factors in a market population in Nnewi, Nigeria, documented mean diastolic blood pressure and systolic blood pressure of 90.92±28.23 mmHg and 141.85±29.62 mmHg which is higher than the values recorded in the current study. Therefore incorporating dietary sources that have been shown to lower blood pressures may be beneficial for the older adults (Maduka *et al*., 2021).

In this study, older persons had significantly lower mean serum apolipoprotein A-I levels than were seen in the control group. Additionally, this study found that older adult males and females had significantly lower mean serum apolipoprotein A-I levels than those seen in the corresponding male and female control group. This finding might imply that age-related declines in apolipoprotein A-I levels occur in both sexes. The anti-atherogenic capacity of HDL particles is reflected by ApoA-I (Mehta and Shapiro, 2022), and the higher the value, the better the cardiovascular risk reduction (Feingold, 2021). An important modulator of both cellular and plasma cholesterol homeostasis is apoA-I. Reverse cholesterol transport is effectively accomplished by the unique ability of apoA-I to remove cholesterol from cells, interact with lipids, and increase lecithin: cholesterol acyltransferase (LCAT) activity, and make HDL receptive to particular receptors and proteins (Feingold, 2021; Yaseen *et al*., 2021).

According to the results of the current investigation, older persons had significantly higher mean serum apolipoprotein B100 levels than the control group. Additionally, older men and women had significantly higher mean serum apoB100 levels compared to their respective male and female control groups. This indicates that those who are older may have a higher risk of developing cardiovascular diseases, and this increase may be caused by a variety of causes, including changes in adiposity, sedentary lifestyles, and changes in dietary habits that come with being older. Furthermore, regardless of gender, evidence demonstrates that apoB100 levels rise with advancing age. Cardiovascular disease risk is increased by higher levels of apoB lipoproteins (Yaseen *et al*., 2021; Olsen *et al*., 2017). In a population-based study stratified by age, Ding *et al*. (2021) found that low ApoA-I and high total cholesterol (TC), triglycerides, ApoB, and ApoB/ApoA-I ratio) at ages 39-59 or 60-79 were associated with higher all-cause mortality. According to Richardson *et al*. (2021), increased apob shortens lifespan, raises risks of heart disease and stroke. Furthermore, numerous studies have demonstrated that the number of atherogenic lipoprotein particles, as estimated by apolipoprotein B (apoB), is a more accurate measure of the risk that lipoprotein lipids pose than the concentration of cholesterol that they contain, as estimated by either LDL cholesterol or non-HDL cholesterol (Behbodikhah *et al*., 2021; Sniderman *et al*., 2019). In their previous study on the Evaluation of Apo-lipoproteins and Troponin levels in postmenopausal women in Nnewi Metropolis, Anambra State, Nigeria, Ogbodo *et al*. (2018) found that the mean serum concentrations of Apo B, Apo C-II, and Troponin I were significantly higher in postmenopausal women aged between 50 and 70 years than in the control subjects, who were between 20 and 30 years old, while the mean serum Apo A-I concentration was significantly lower in postmenopausal women. This result is consistent with the current research.

It is interesting to note that the older persons in this study had a higher mean serum apoB100/apoA-I ratio than what was shown in the control group. In addition, the mean serum apoA1/apoB100 ratio was higher in both male and female older persons than it was in the control group. The plasma ApoB100 concentrations significantly represent proatherogenic potentials. On the other hand, ApoA is the main apolipoprotein present in high-density lipoprotein and represents the serum level of ApoA where antiatherogenic potentials are shown. The ApoB100/ApoA1 ratios serve as a representation of the equilibrium between the negative and positive potentials. The ApoB100/ApoA1 ratio rises as the atherogenic potentials get more developed and/or as the antiatherogenic potentials diminish (Song *et al*., 2015) and it has been found to be a more accurate biomarker for the identification of cardiovascular disease risks (Bodde *et al*., 2019; Yaseen *et al*., 2021).

In conclusion, The results of the current investigation revealed that older persons had significantly lower mean serum apoA-I levels than the control group, as well as higher mean BMI, WHR, SBP, and DBP values, as well as mean serum apoB-100 and apoA-I/apoB100 levels. The mean serum apoB100 and apoB100/apoA-I ratio, as well as the mean WC, WHR, SBP, and DBP, were all significantly higher in older male subjects compared to male control subjects, but the mean serum apoA-I level was significantly lower. Additionally, the older adult females had significantly higher mean SBP, DBP, mean serum apoB100, and mean apoB100/apoA-I ratios compared to the female control group, but their mean serum apoA-I levels were significantly lower. In contrast to the test group, where weight Vs BMI, weight Vs WC, weight Vs HC, BMI Vs WC, BMI Vs HC, HC Vs WC, and SBP Vs DBP revealed strong significant connections, there were strong positive relationships between weight and BMI, WC vs HC and SBP vs DBP in the control group. Because of the significant changes in apoA-I, apoB100, apoA-I/ap0B100 ratio, BMI, WHR, SBP, and DBP values with age in older people, this study highlights a public health concern given the present global and Nigerian aging trends.

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