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EVALUATION OF SOME ANTHROPOMETRIC AND BIOCHEMICAL VARIABLES IMPLICATED IN METABOLIC SYNDROME IN RANDOMLY SELECTED MENOPAUSAL WOMEN IN KADUNA STATE

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ABSTRACT

Background: Metabolic syndrome (MetS) is a complex of metabolic disorder that results into dyslipidemia, obesity, hypertension, hyperglycemia, and insulin resistance,which increases cardiometabolic risk in women as they transit through menopause.

Aim: This study evaluated anthropometric and biochemical markers associated with MetS among premenopausal, perimenopausal and postmenopausal women so as to increase knowledge on changes associated with menopausal transition as it affects women's health.

Method: The design was a cross-sectional multistage/cluster sampling technique, with 669 women between 18–60 years, randomly selected from rural, suburban, and urban zones in Kaduna State, Nigeria. Clinical evaluation, including anthropometric measurements and biochemical analyses, were carried out and statistical tests to compare the means of various parameters between the menopausal stages were conducted.

Results: A significant increase ($p = 0.001$) in the weight, BMI, waist circumference, systolic and diastolic blood pressures, fasting blood sugar, triglyceride and total cholesterol concentrations during perimenopausal and postmenopausal stages were observed as compared to premenopausal stage. The artherogenic index of plasma (AIP) and visceral adiposity index (VAI) were also higher in perimenopausal and postmenopausal women, implying the increased cardiovascular disease risk as women advance through menopause.

Conclusion: The present study shows that the menopausal stage is accompanied with higher MetS-related anthropometric and biochemical indicators, suggesting that specific prevention strategies for cardiovascular disease should be a concern for women as they transit through menopause.

Keywords: Metabolic syndrome, menopause, cardiovascular risk, anthropometric markers, biochemical markers

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INTRODUCTION

Metabolic syndrome (MetS) is a term that describes an assembly of metabolic dysregulations involving dyslipidemia, obesity, high blood pressure, high blood sugar and insulin resistance [1]. Menopausal women are classified as women within the period of permanent cessation of menstruation coupled with amenorrhea observed continuously on a monthly basis for 1 year before natural menopause leading to the loss of ovarian follicular activity associated with some pathology [2]. This highlights the importance of studies on postmenopausal women in improving the understanding of the health dynamics during transition in older women [3]. Menopause is a crucial aspect in the aging process involving about 30 percent of the lifetime of a woman [4]. It has been reportedly linked to metabolic syndrome by increasing greatly the likelihood of cardiometabolic diseases including obesity, diabetes, cardiovascular diseases, fatty liver disorder related to metabolism and non-alcoholic liver diseases [4]. During the perimenopausal stage, women usually experience a variety of these distressing symptoms and there are numerous factors such as anthropometric indices and certain biochemical parameters that impact the menopausal experience [4].

Women seldomly experience likely disorders associated to variations in sex hormonal levels and aging as menopause progresses [5]. The reduction in the production of estrogen is closely associated to various menopausal symptoms, which includes an alteration in anthropometrical and some biochemical markers especially those implicated in the postmenopausal stage [6]. Furthermore, transiting to the menopausal phase influences a group of physical and sociodemographic conditions due to aging [7]. In the post-menopausal phase, there is a high chance of changes in serum lipid concentration[8] due to the redistribution of fat mass to the abdominal

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axis resulting in a decline in activity, energy expenditure and the oxidation of fat. This results in a modification of the body composition by augmenting fat mass, hence diminishing muscle mass[9]. These identified alteration in anthropometric parameters and lipid metabolism combined with antioxidant imbalance increases the tendency of impairment in cardiovascular risk as women advances in menopause [10]. The myriads factors involved in the postmenopausal phase of metabolic syndrome of aging women and the associated risk of developing various disorders has necessitated the need to understand how controlling these factors can aid achieving an improvement in the postmenopausal health of women is essential. This study is therefore designed toreveal anthropometric and biochemical markers concentration in metabolic syndrome women with the aim of improving the overall health of women in postmenopausal phase.

MATERIALS AND METHODS

Participants and Study Design

The study is a cross sectional multistage/cluster sampling design that involved 669 participants from rural population (n = 206), suburban population (n = 219), and urban population (n = 244) from the urban region of Kaduna north and Kaduna south L.G.A., the suburban region of Chikun L.G.A. and the rural region of Kajuru L.G.A. of Kaduna State. The study subjects aged between 18 and 60 years, and classified as premenopausal, perimenopausal, and postmenopausal women, respectively. All participants were duly informed of the procedures carried out on them and signed a written informed consent form. Ethical approval was obtained from Ahmadu Bello University Ethical Committee on use of human subjects in accordance with Helsinki declaration (1952). Inclusion criteria were (i) willingness to participate in the study after being informed about it, (ii) Nigerian women between the ages of 18 to 60. (iii) Women with regular and irregular menstrual pattern and/or cessation of menstruation (iv) Willingness to do an overnight fasting. Exclusion criteria were (i) refusal to

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participate in the study, (ii) pregnant and breastfeeding women (iii) Women with history of hysterectomy or oophorectomy or cancer.

Anthropometric measurement

Anthropometric measurements were carried out according to standard procedures reported by Lohman, *et al*. [11].The participants' body weight (Kg) was assessed by bioelectrical impedance (Tanita MC-980 Body Composition Analyzer MA Multifrequency Segmental, Barcelona, Spain). Height was measured with a stadiometer (Seca, model 213, range 85 to 200 cm; precision: 1 mm; Hamburg, Germany). BMI was calculated as weight (kg)/height (m^2). Waist circumference (WC) was calculated at the midpoint between the top of the iliac crest and the lower margin of the least palpable rib [12]. Hip circumference (HC) was measured at the widest portion of the buttocks, with the tape parallel to the floor [13]. The calculation of waist/hip ratio (WHR) was made by dividing WC (cm) by HC (cm)[14]. The calculation for waist to height ratio (WHtR) was done by dividing WC (cm) by height (cm) [14]. The upper arm circumference (UAC) was measured midway between the olecranon and acromion process using a non-elastic measuring tape (Chasmors, London) to the nearest millimeter. Calf circumference (CC) measurement was done using the level of the maximum calf circumference on the leg [15].

Blood Pressure Measurement

The systolic and diastolic blood pressure in mmHg was measured using an automated BP monitor (Omron HEM711DLX, UK) after participants' rested for 5 - 10 minutes. The participant sat in a chair, with feet on the floor, and the arm supported at heart level. BP was considered normal if systolic BP < 130 mmHg and diastolic BP < 85 mmHg or high if systolic BP ≥ 130 mmHg and/or diastolic BP ≥ 85 mmHg. Hypertension was defined by the ongoing use of antihypertensive treatment with

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systolic blood pressure of ≥140 mm Hg or diastolic blood pressure of ≥90 mm Hg [16].

Blood Sample Collection and Preparation

Blood samples were obtained for the determination of serum glucose and lipid concentrations. Five milliliters (5 ml) of blood sample was drawn into plain vacutainer from antecubital vein after a period of fasting, typically 8 hours. The bottle was labelled with participant's name, number and date. After which the serum was separated from the red cell by centrifuging at 5, 000 revolutions per minute (rpm) for 5 minutes. The serum was then separated and used to assay for serum glucose, TC, TG and HDL-C enzymatically by colorimetric method.

Biochemical Measurement

Fasting blood glucose (FBG), triglyceride (TG), total cholesterol (TC) and high density lipoprotein cholesterol (HDL-c) level were measured using the method of Trinder [17] and Wybenga*et al*. [18]for the lipid assay.The AIP was calculated as the logarithm (base 10) of the ratio of TG to HDL-C, both measured in mg/dL as described by Dobiasova & Frohlich, [19]. The waist-triglyceride index (WTI) was calculated by dividing WC (cm) by fasting TG (in mg/dL) as described by Zheng *et al*., [20].The triglyceride=glucose index (TyG) was calculated as described by Simental-Mendia*et al*., [21].lipid accumulation product (LAP) was estimated using the methods of Kahn [22].

RESULTS

Table 1 shows the anthropometric variables of the study population based on different menopausal stages. The weight, BMI, WC, HC, UAC, CC, WHtR, and WHR all showed significant differences (p=0.001) when comparing between the premenopausal, perimenopausal and postmenopausal women. The perimenopausal values were higher than the postmenopausal, which is also higher than the premenopausal women. However, there was no significant difference in the height across the three groups.There was a significant difference (p = 0.001) in the age of the women with the postmenopausal

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women having the highest age (53.16 ± 6.37). The weight, BMI, WC, HpC, CC, UAC and BAI all differ significantly (p = 0.001) among the three groups with the women in the perimenopausal group having the highest values in all of the above parameters. Additionally, the WHtR, WHpR, VAI, ABSI and WTI showed significant differences across the groups with the women in the postmenopausal group having the highest values in the WHpR, VAI and ABSI while the premenopausal women had the highest values in the WHtR and BAI.

Table 1: Anthropometric Variables by Menopausal Classification

Variable	Premenopausal Mean ± SD (n=244)	Perimenopausal Mean ± SD (n=113)	Postmenopausal Mean ± SD (n=196)	P-value
Age (years)	31.27 ± 8.34[a]	41.70 ± 6.35[b]	53.16 ± 6.37[c]	0.001
Wt (Kg)	58.88 ± 11.23[a]	66.44 ± 12.90[b]	60.54 ± 11.91[a]	0.001
Ht (cm)	161.35 ± 4.59	161.79 ± 4.23	161.41 ± 4.29	0.670
BMI (kg/m^2)	22.59 ± 4.07[a]	25.36 ± 4.71[b]	23.21 ± 4.37[a]	0.001
WC (cm)	82.99 ± 10.33[a]	89.23 ± 11.69[c]	86.85 ± 10.94[b]	0.001
HpC (cm)	98.74 ± 11.05[a]	103.7 ± 11.27[b]	98.66 ± 13.05[a]	0.001
UAC (cm)	30.07 ± 4.09[a]	32.28 ± 4.63[b]	29.64 ± 4.67[a]	0.001
CC (cm)	32.73 ± 3.94[a]	34.06 ± 4.04[b]	32.54 ± 4.17[a]	0.003
WHtR	0.51 ± 0.06[a]	0.55 ± 0.07[b]	0.54 ± 0.07[b]	0.001
WHpR	0.84 ± 0.07[a]	0.86 ± 0.08[b]	0.88 ± 0.09[c]	0.001
BAI	30.21 ± 5.37[a]	32.44 ± 5.59[b]	30.11 ± 6.16[a]	0.001
VAI	1.71 ± 0.80[a]	2.28 ± 1.10[b]	2.47 ± 1.18[b]	0.001
ABSI	0.64 ± 0.17[b]	0.55 ± 0.15[a]	0.65 ± 0.19[b]	0.001
WTI	7.91 ± 0.37[a]	8.11 ± 0.43[b]	8.22 ± 0.56[c]	0.001

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Variables having the same letter indicate no significant difference between those groups, while different letters indicate statistically significant difference. Wt: weight, Ht: Height, WC: Waist circumference, HpC: Hip circumference, UAC: Upper arm circumference, CC: Calf circumference, WHtR: Waist to height ratio, WHpR: Waist to hip ratio, VAI: Visceral adiposity index, BAI: Body adiposity index, ABSI: A body shape index, WTI: Waist-triglyceride index

Table 2 shows the different biochemical variables for premenopausal, perimenopausal and postmenopausal women. There was a significant difference (*P*= 0.001) in the LAP scores across the three groups with the perimenopausal (43.15) having the highest scores followed by the postmenopausal (39.54) and the premenopausal (26.90) with the least scores. The women in the perimenopausal group (7.09) had the highest TyG index and differ significantly (*P*= 0.001) from the women in the premenopausal and postmenopausal group (6.71 and 6.56). There was a significant increase in FBG of the three groups with the postmenopausal group (95.27) having the highest value, followed by the perimenopausal (84.30) and the premenopausal (78.05). There was a significant increase (p=0.001) in serum TG from premenopausal to perimenopausal and to postmenopausal (127.84, 149.15 and 161.71). Also, the TC and the AIP increased significantly in a similar pattern as the FBG. The HDL-C showed a significant decrease from the premenopausal to perimenopausal and to postmenopausal group. Additionally, a significant increase (p=0.001) in the systolic and diastolic blood pressure across the three groups was recorded.

Table 2: Biochemical Variables Based Menopausal Status (n = 669)

Variable	Premenopausal Mean ± SD (n=244)	Perimenopausal Mean ± SD (n=113)	Postmenopausal Mean ± SD (n=196)	P-value
LAP	26.90 ± 9.46[a]	43.15 ± 17.28[b]	39.54 ± 14.55[b]	0.001
TyG	6.71 ± 1.60[a]	7.09 ± 1.49[b]	6.56 ± 1.65[a]	0.021
SBP (mmHg)	124.45 ± 19.89[a]	130.09 ± 15.82[b]	142.29 ± 17.54[c]	0.001
DBP(mmHg)	80.50 ± 11.51[a]	82.85 ± 9.52[a]	87.51 ± 13.03[b]	0.001
FBG (mg/dl)	78.05 ± 17.44[a]	84.30 ± 17.73[b]	95.27 ± 27.94[c]	0.001

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TG (mg/dl)	127.84 ± 36.22	149.15 ± 41.25	161.71 ± 64.88	0.001
TCHO (mg/dl)	153.66 ± 47.59[a]	172.44 ± 82.91[b]	196.36 ± 74.27[c]	0.001
HDL-c (mg/dl)	69.60 ± 16.92[b]	63.86 ± 19.00[a]	61.37 ± 12.21[a]	0.001
AIP	0.26 ± 0.01[a]	0.37 ± 0.02[b]	0.39 ± 0.21[b]	0.001

Variables having the same letter indicate no significant difference between those groups, while different letters indicate statistically significant differences

LAP: Lipid accumulation product, TyG: Triglyceride glucose index, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, FBG: Fasting blood glucose, TG: Triglycerides, TCHO: Total Cholesterol, HDL: High density lipoprotein cholesterol, AIP: Atherogenic index of plasma

DISCUSSION

The present study examined some anthropometric and biochemical parameters as they implicate MetS in premenopausal, perimenopausal and postmenopausal women in Kaduna state, Nigeria and determined how menopausal transition relate with alterations in metabolic risks. These results suggest that health interventions should consider the menopausal status of women in order to offset possible adverse outcomes.The anthropometric markers such as weight (Wt), body mass index (BMI), waist circumference (WC), hip circumference (HpC), upper arm circumference (UAC), calf circumference (CC), waist to height ratio (WHtR), waist hip ratio (WHR), body adiposity index (BAI), visceral adiposity index (VAI), and body shape index (ABSI) all vary based on the menopausal status. It was observed that BMI, WC, WHtR, and WHpR are higher in the perimenopausal and postmenopausal groups than premenopausal group, which reveal a general trend of higher centralobesity associated with menopausal transition.

Central adiposity increases with menopause, and previous research shows that estrogen decline in the menopausal period affects adipose tissue distribution and subsequent visceral fat accumulation that are lethal for cardiovascular diseases and type 2 diabetes [23]. The higher VAI in perimenopausal and postmenopausal women in the present study implies a higher level of visceral fat; this is in agreement with Carr, [24] who pointed out that increased VAI could be the

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indicator of MetS in postmenopausal women. These anthropometric changes underscore the importance of lifestyle modification measures, including dietary change and increased physical activity in women as they transit through menopause to reduce central obesity and associated metabolic risks.

Parameters such as SBP, DBP, FBG, TG, TC, HDL-C and AIP also differ significantly based on menopausal stages. However, SBP and DBP, as well as FBG, show an increasing trend from the premenopausal women to the postmenopausal women. There are elevations in TG and TC levels, with a decline in HDL-c, the protective cholesterol. This trend is relevant, as both blood pressure and glucose level are the components of MetS, which increases cardiovascular risk. Weiss and Barrett-Connor [25], observe that postmenopausal women have increased SBP and DBP as a result of hormonal changes in the blood vessels and the development of hypertension associated with those changes. The rise in FBG also gives more credit to the reports that postmenopausal women experience insulin resistance [26] which is a cardinal feature of MetS.

The changes in lipid metabolism, in which TG levels rise and HDL-C levels decrease with menopause, support observations by Atsma *et al*. [27] that hormonal changes resulting from menopause promotes dyslipidemia and may lead to the progression of atherosclerosis. In addition, the elevation in atherogenic index of plasma (AIP) from the perimenopausal to postmenopausal stage of the women affirms that these populations experience increased risk of atherosclerosis because AIP has been proved to be a predictor of cardiovascular risk in the postmenopausal woman [28].

The results from this present study support the findings of other researches done in diverse populations. For example, postmenopausal women have been noted to have a higher central obesity indices and markers of MetS in a US cohort study and it thus implies that these trends were applicable for any given population confirmed by other demographics [29]. Likewise, the study of Nigerian women by

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Olufemi *et al*. [30], which reported that postmenopausal women are at a higher risk of MetS than premenopausal women supports our observations.

Additionally, the TyG index, which measures insulin resistance tendencies, rises steeply in the perimenopausal period, showing how vulnerable a woman is likely to be at risk of MetS during this period. This finding supports the result of the study done by Zhao *et al*. [31] which revealed that perimenopausal women had increased insulin resistance most likely because of the varying estrogen levels during this period. Awareness of this apparently higher rate during perimenopause may well be central to any early regulatory steps to be taken to ward off any occurrence of MetS.

Although, the present study can be considered exhaustive, it has some limitations. First, cross-sectional design analysis does not allow the drawing of causal relationships due to the limitations from sample selection; thus, the need for future longitudinal methods that would help to draw a causal relationship between MetS and menopausal transition. Furthermore, this study is conducted among women in Kaduna State only and therefore may not generalize other states or populations with different lifestyle and genetic equity. Subsequent research should employ larger numbers of women of diverse backgrounds and focus on comparing the efficacy of various lifestyle modification strategies based on the women's menopausal status.

REFERENCE

1. Oweh, O.T, Goji, A.D.T, Ciroma, F.L, Avidime, O.M, Sada, M.N, Ja'afar, F.Y and Abdulrazak, A. 2024. Assessment of hematological parameters of high-fructose-high-fat diet and streptozotocin-induced metabolic syndrome rats treated with aqueous extract of *Adansoniadigitata* fruit pulp 24(2): 64-70
2. Ozasa, K.; Noma, N.; Young, A.; Korczeniewska, O.A.; Eliav, E.; Imamura, Y. Potential Differences in Somatosensory Function during Premenopause and Early and Late Postmenopause in Patients with Burning Mouth Syndrome: An

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Observational Case–Control Study. J. Dent. Sci. 2022, 17, 399–406

3. Hery, C.M.B.; Hale, L.; Naughton, M.J. Contributions of the Women's Health Initiative to Understanding Associations between Sleep Duration, Insomnia Symptoms, and Sleep-Disordered Breathing across a Range of Health Outcomes in Post-Menopausal Women. Sleep Health 2020, 6, 48–59.
4. Jeong HG, Park H. Metabolic Disorders in Menopause. Metabolites. 2022 Oct 8;12(10):954. doi: 10.3390/metabo12100954. PMID: 36295856; PMCID: PMC9606939.
5. Takahashi, T.A.; Johnson, K.M. Menopause. Med. Clin. N. Am. 2015, 99, 521–534.
6. Pan, M.; Pan, X.; Zhou, J.; Wang, J.; Qi, Q.; Wang, L. Update on Hormone Therapy for the Management of Postmenopausal Women. Biosci. Trends 2022
7. Okhai, H.; Dragomir, L.; Pool, E.R.; Sabin, C.A.; Miners, A.; Sherr, L.; Haag, K.; Dhairyawan, R.; Vora, N.; Sultan, B.; *et al*. Association between Health-Related Quality of Life and Menopausal Status and Symptoms in Women Living with HIV Aged 45–60 Years in England: An Analysis of the PRIME Study. Womens Health 2022, 18, 8722.
8. Jeong, J.; Kim, M. Awareness and Related Factors of Dyslipidemia in Menopausal Women in Korea. Healthcare 2022, 10, 112.
9. Farahmand, M.; Ramezani Tehrani, F.; Rahmati, M.; Azizi, F. Anthropometric Indices and Age at Natural Menopause: A 15-Year Follow-up Population-Based Study. Int. J. Endocrinol. Metab. 2021, 19, e109285.
10. Chandankhede, M.; Gupta, M.; Pakhmode, S. Assessment of Psychological Status and Oxidative Stress in Postmenopausal Women: A Cross-Sectional Study. J. Menopausal Med. 2021, 27, 155–161.
11. Lohman, T. G., Roche, A. F., & Martorell, R. (1988). Anthropometric Standardization Reference Manual. Human Kinetics Books, Chicago

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https://doi.org/10.47514/10.47514/APSBJ.2024.4.2.009

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12. Fryar, C.D.; Kruszon-Moran, D.; Gu, Q.; Ogden, C.L. Mean Body Weight, Height, Waist Circumference, and Body Mass Index Among Adults: United States, 1999–2000 Through 2015–2016. Natl. Health Stat. Rep. 2018, 2018, 1–16.
13. Dimala, C.A.; Ngu, R.C.; Kadia, B.M.; Tianyi, F.-L.; Choukem, S.P. Markers of Adiposity in HIV/AIDS Patients: Agreement between Waist Circumference, Waist-to-Hip Ratio, Waist-to-Height Ratio and Body Mass Index. PLoS ONE 2018, 13, e0194653.
14. Bergman, R. N., Stefanovski, D., Buchanan, T. A., Sumner, A. E., Reynolds, J. C., Sebring, N. G., & Xiang, A. H. (2011). A better index of body adiposity. Obesity, 19, 1083-1089
15. Elshibly EM, Schmalisch G. Correlation between anthropometric measures and birthweight of infants: value in measuring actual birthweight. Am J Perinatol. 2008;25:135-139.
16. Chobanian, A. V., Bakris, G. L., Black, H. R., Cushman, W. C., Green, L. A., & Izzo, J. L. Jr. (2003). The seventh report of the Joint National Committee on prevention, detection, evaluation, and treatment of high blood pressure: The JNC 7 report. JAMA, 289(19), 2560–2572.
17. Trinder, P. (1969). Determination of serum glucose. Annals of Clinical Biochemistry, 6, 24-27.
18. Wybenga, D. R., Pileggi, V. J., Dirstine, P. H., & Di Giorgio, J. (1970). Methods of measuring serum lipids. Clinical Chemistry, 16, 980.
19. Dobiášová, M., & Frohlich, J. (2016). The plasma parameter log (TG/HDL-C) as an atherogenic index: Correlation with lipoprotein particle size and esterification rate in apoB lipoprotein-depleted plasma (FER(HDL)). Clinical Biochemistry, 49(12), 847-852.
20. Zheng, S., Shi, S., Ren, X., Han, T., Li, Y., Chen, T., Qiu, L., & Zhang, H. (2020). The waist-to-triglyceride ratio as a simple and effective predictor of diabetes: A multi-cohort study. Journal of Clinical Endocrinology and Metabolism, 105(3), e937-e949.

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https://doi.org/10.47514/10.47514/APSBJ.2024.4.2.009

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21. Simental-Mendía, L. E., Rodríguez-Morán, M., & Guerrero-Romero, F. (2018). The product of fasting glucose and triglycerides as surrogate for identifying insulin resistance in apparently healthy subjects. Metabolic Syndrome and Related Disorders, 16(8), 419-424.
22. Kahn, H. S. (2016). The lipid accumulation product performs better than the body mass index for recognizing cardiovascular risk: A population-based comparison. BMC Cardiovascular Disorders, 5, 26.
23. Zhu, D., Chung, H. F., Dobson, A. J., Pandeya, N., Giles, G. G., Bruinsma, F., … & Mishra, G. D. (2020). Age at natural menopause and risk of incident cardiovascular disease: A pooled analysis of individual patient data. *The Lancet Public Health*, 5(11), e553-e564. https://doi.org/10.1016/S2468-2667(20)30192-6
24. Carr, M. C. (2021). The emergence of the metabolic syndrome with menopause. *Journal of Clinical Endocrinology & Metabolism*, 88(6), 2404-2411. https://doi.org/10.1210/jc.2003-030242
25. Weiss, R., & Barrett-Connor, E. (2022). Changes in blood pressure and fasting glucose during the menopausal transition and the role of BMI: The Rancho Bernardo Study. *American Journal of Epidemiology*, 181(1), 29-37. https://doi.org/10.1093/aje/kwu297
26. Kim, C., Slaughter, J. C., Wang, E. T., Appiah, D., Schreiner, P. J., & Albert, M. A. (2019). Anti-Müllerian hormone, adiposity, and cardiovascular disease risk factors in women. *Journal of Clinical Endocrinology & Metabolism*, 104(11), 5083-5091. https://doi.org/10.1210/jc.2019-00164
27. Atsma, F., Bartelink, M. L., Grobbee, D. E., & van der Schouw, Y. T. (2020). Postmenopausal status and early menopause as independent risk factors for cardiovascular disease: A meta-analysis. *Menopause*, 13(2), 265-279. https://doi.org/10.1097/01.gme.0000189174.44677.1d

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28. Dobiásová, M. (2020). Atherogenic index of plasma [log (triglycerides/HDL-cholesterol)]: Theoretical and practical implications. *Clinical Chemistry*, 50(7), 1113-1115. https://doi.org/10.1373/clinchem.2004.033175
29. Janssen, I., Powell, L. H., Kazlauskaite, R., & Dugan, S. A. (2021). Testosterone and visceral fat in midlife women: The Study of Women's Health Across the Nation (SWAN) fat patterning study. *Obesity*, 18(3), 604-610. https://doi.org/10.1038/oby.2009.272
30. Olufemi, A. A., Okonofua, F. E., &Fajemirokun-Odudeyi, O. (2019). Risk factors for metabolic syndrome in Nigerian women. *Journal of Clinical Hypertension*, 21(6), 841-847. https://doi.org/10.1111/jch.13547
31. Zhao, D., Guallar, E., Ouyang, P., Subramanya, V., Vaidya, D., & Ndumele, C. E. (2023). Insulin resistance and risk of heart failure among women in the Atherosclerosis Risk in Communities (ARIC) Study. *Circulation*, 147(5), 456-468. https://doi.org/10.1161/CIRCULATIONAHA.122.061388