Evaluation of Ferritin, Albumin, and Total Protein Levels in Premenopausal and Menopausal Women in Okofia, Nnewi Anambra State, Nigeria

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ABSTRACT

The transition from pre-menopause to menopause is marked by significant physiological changes, including alterations in iron metabolism, protein synthesis, and body composition. This study was carried out to determine the level of serum ferritin, albumin, and total protein in premenopausal and menopausal women in Okofia, Nnewi. The study was conducted among ninety women (45 premenopausal and 45 menopausal). The age range for premenopausal and menopausal women was 18-49 and 50-75 years respectively. The serum ferritin, albumin, and total protein levels were evaluated. Using standard procedures results were obtained and subjected to statistical analysis. Results indicated a significantly higher mean ferritin level in the menopausal group (200.36 ± 177.39) (ng/mL) compared to the premenopausal group (87.71 ± 104.84) (ng/mL) ($p<0.05$), reflecting changes in iron metabolism associated with menopause. No significant difference was observed in mean albumin levels between the two groups ($p<0.05$), suggesting stable albumin synthesis regardless of menopausal status. However, a significantly lower mean total protein level was noted in the menopausal group (61.71 ± 4.21) (g/l) compared to the premenopausal group (67.41 ± 9.89) (g/l) *($p<0.05$)*, likely due to nutritional changes. Anthropometric indices (Body Mass Index, Waist Circumference, Hip Circumference) and blood pressure (Systolic Blood Pressure, Diastolic Blood Pressure) were significantly higher in the menopausal group compared to the premenopausal group, indicating increased central adiposity and cardiovascular risk. A positive correlation was found between ferritin and total protein levels in the menopausal group ($r=0.348$, $p=0.019$), while no significant correlations were observed between ferritin and albumin or between total protein and albumin. Similarly, no significant correlations were found between these biomarkers in the premenopausal group. Furthermore, no significant correlations were detected between anthropometric indices and blood pressure in both groups. These findings underscore the impact of menopause on iron metabolism, protein status, and cardiovascular risk, highlighting the need for targeted health interventions during the menopausal transition.

Keywords: Interleukin-4, Micro-Albumin, Creatinine, Students, Formalin, Nnewi.

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INTRODUCTION

Menopause is a natural phase in a woman's life, signifying the permanent cessation of menstruation and fertility. It typically occurs between the ages of 45 and 55, though individual variations exist [1]. This transition is marked by significant hormonal changes, particularly a decline in estrogen and progesterone. The premenopausal and menopausal stages represent distinct physiological phases, each characterized by hormonal fluctuations that influence various biochemical parameters. One critical aspect of women's health affected by these changes is protein metabolism. Proteins are essential biomolecules that play a fundamental role in maintaining physiological homeostasis and supporting biological processes. Investigating protein levels in premenopausal and menopausal women is crucial for understanding how hormonal changes associated with menopause impact protein metabolism and overall health. Protein metabolism is intricately regulated by hormonal fluctuations, particularly estrogen, throughout the reproductive phases of a woman's life [2]. Estrogen influences protein synthesis, affecting muscle mass and maintenance. As women transition from pre-menopause to menopause, shifts in hormone levels may alter protein turnover, potentially impacting health outcomes. Proteins are vital for musculoskeletal health, contributing to bone density and muscle integrity. Menopausal women often experience bone density loss and muscle mass reduction, so evaluating protein levels essential for understanding these age-reletal changes [3].

Ferritin is a key protein responsible for iron storage and metabolism, playing a crucial role in maintaining iron homeostasis, preventing deficiency or toxicity, and supporting oxygen transport [4]. Premenopausal women have higher iron requirements due to menstruation and the potential for pregnancy [5]. With the cessation of menstruation in menopause, iron loss decreases, often leading to elevated ferritin levels if dietary iron intake remains unchanged [6]. Ferritin levels serve as a sensitive indicator of iron stores, aiding in the early detection and prevention of anemia. Iron is an essential component of various enzymes involved in cellular respiration and energy metabolism, and ferritin ensures a controlled release of iron to sustain these processes [7]. Additionally, ferritin possesses immunomodulatory properties, supporting immune function. Low ferritin levels indicate iron deficiency, which can result in anemia and fatigue, whereas excessive levels may be linked to chronic inflammation or liver disease [8]. Albumin, a crucial protein in the human body, plays a key role in fluid balance, hormone, and nutrient transport, and blood clot prevention [9]. Its levels serve as an indicator of overall health and nutritional status, making their assessment valuable across different life stages. Albumin can function as a marker of protein malnutrition, particularly important for identifying potential nutritional deficiencies in menopausal women, who may be at increased risk [10]. The decline in estrogen during menopause can influence protein synthesis and metabolism, potentially leading to alterations in albumin levels [11]. Low albumin levels, or hypoalbuminemia, are associated with an increased risk of chronic conditions such as cardiovascular diseases and infections in menopausal women [10]. This study examines ferritin, protein, and albumin levels in premenopausal and menopausal women in Okofia, Nnewi, aiming to explore potential changes linked to hormonal shifts during menopause.

MATERIALS AND METHOD

The reagents and kits used for the biochemical analysis were purchased commercially, and the manufacturer’s standard operating procedures were meticulously followed. This cross-sectional study was carried out in Nnewi North, Anambra State, located in southeastern Nigeria.

Study Participants

Healthy premenopausal women aged 18–35 years and healthy menopausal women aged 50–75 years were randomly selected from within the school premises and surrounding areas of Okofia, Nnewi North, Anambra State, in Southeastern Nigeria. A total of 90 participants were recruited, with 45 individuals in each group. Selection was based on even-numbered participants, while odd-numbered individuals were excluded from the study. Demographic information was collected using a structured questionnaire.

Sample Size

The sample size was calculated using G*Power software version 3.1.9.4 (Universitat Dusseldorf Germany).

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Analysis for the difference between two independent means (Two groups) was conducted in G*Power to determine the sufficient sample using an alpha of 0.05, a power of 0.80, and an effect size of 0.65. Based on this, the calculated sample size is 90 and has a power of 80% to detect a difference of 0.45 as a significant level of 0.05. A total sample size of 90 was used for this study to take care of possible attrition.

Sample Collection and Processing

Blood samples were drawn from the antecubital vein of the participants. A rubber tourniquet was applied for less than one minute, and the puncture site was cleaned with 70% methylated spirit. Five milliliters (5 mL) of blood were collected from each participant and placed into plain tubes, allowing them to clot. The tubes were then centrifuged at 3000 rpm for 10 minutes to separate the serum. The resulting serum was used to measure protein, albumin, and ferritin levels. The serum was stored at 2°C until further analysis.

Laboratory Methods

All the reagents were commercially obtained, and the manufacturer's standard operating procedures were strictly observed.

Serum ferritin levels were determined using an Enzyme-Linked Immunosorbent Assay (ELISA) as described by [12]. Serum protein levels were measured using the Biuret assay, while the Bromocresol Green (BCG) method was employed for albumin determination.

Statistical Aanalysis

The data was analyzed using Statistical Package for Social Sciences (SPSS) version 22. The data analysis was performed using an independent student t-test. Values were deemed significant if $p < 0.05$. The correlation of the parameters was determined using Pearson's correlation coefficient.

RESULTS

Comparison of the mean values of serum levels of Ferritin, Albumin, and Total protein in the Test group (Menopausal) and Control group (Premenopausal) (Mean±SD).

A higher significant difference was observed in the mean values of Ferritin levels (200.36 ± 177.39) (ng/mL) of the test group when compared to the mean values of Ferritin levels (87.71 ± 104.84) (ng/mL) of the control group ($p<0.05$). There was no significant difference in the mean values of Albumin levels (42.73 ± 2.53) (g/L) of the test group when compared to the mean values of Albumin levels (42.62 ± 5.51) (g/L) of the control group ($p<0.05$). However, there existed a lower significant difference in the mean values of Total protein levels (61.71 ± 4.21) (g/L) of the test group when compared to the mean Total protein levels (67.41 ± 9.89) (g/L) of the control group ($p<0.05$).

Table 1: Comparison of the mean values of serum levels of ferritin, albumin, and total protein in the test and control groups.

Parameter	Test Group (Menopausal) (N = 45) Mean ± S.D	Control group (Premenopausal) (N= 45) Mean ± S.D	T-value	P-value
Ferritin (ng/mL)	200.36 ± 177.39	87.71 ± 104.84	-3.67	0.001
Albumin (g/L)	42.73 ± 2.53	42.62 ± 5.51	-1.22	0.903
Total protein (g/L)	61.71 ± 4.21	67.41 ± 9.89	3.56	0.001

* Statistical significance at $P<0.05$

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Comparison of the Mean Anthropometric Variables and Blood Pressure in the Test group (Menopausal) and Control group (Premenopausal).

A higher significant difference was observed in the mean values of BMI (26.85 ± 4.48) (kg/m2), WC (86.24 ± 11.62) (cm), HC (101.61 ± 11.94) (cm), SBP (126.98 ± 9.75) (mmHg) and DBP (83.04 ± 6.10)(mmHg) of the test group when compared to the mean values of BMI (21.60 ± 2.87) (kg/m2), WC (72.04 ± 5.14) (cm), HC (93.64 ± 4.76) (cm), SBP (114.31 ± 6.26) (mmHg) and DBP (78.89 ± 7.43) (mmHg) of the control group ($p<0.05$).

Table 2: Comparison of the mean anthropometric variables and blood pressure in the test and control groups.

Parameter	Test Group (Menopausal) (n=45) Mean ± SD	Control Group (Premenopausal) (n=45) Mean ± SD	T-value	P-value
BMI (kg/m^2)	26.85 ± 4.48	21.60 ± 2.87	-6.62	0.001
WC (cm)	86.24 ± 11.62	72.04 ± 5.14	-7.50	0.001
HC (cm)	101.61 ± 11.94	93.64 ± 4.76	-4.16	0.001
SBP(mmHg)	126.98 ± 9.75	114.31 ± 6.26	-7.33	0.001
DB (mmHg)	83.04 ± 6.10	78.89 ± 7.43	-2.90	0.005

* Statistical significance at $P<0.05$

Keys

BMI= Body Mass Index

WC= Waist Circumference

HC= Hip Circumference

SBP= Systolic Blood Pressure

DBP= Systolic Blood Pressure

Association between the serum levels of Ferritin, Albumin, and Total Protein studied in the test group.

There was a significant positive correlation between the Fe Vs TP (r= 0.35, p= 0.019) in the test group ($p<0.05$). However, there was no significant correlation between the Fe Vs ALB (r=0.07, p= 0.671) and TP Vs ALB (r= -0.16, p=0.280) in the test group ($p>0.05$).

Table 3: Association between the serum levels of Ferritin, Albumin, and Total Protein studied in the test group.

Parameters	r	p-value
Fe Vs ALB	0.07	0.671
Fe Vs TP	0.35	0.019
TP Vs ALB	-0.16	0.280

* Statistical significance at $P<0.05$

Keys

FE = Ferritin

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ALB = Albumin

TP = Total Protein

Association between the serum levels of Ferritin, Albumin, and Total Protein studied in the control group.

There was no significant correlation between the Fe Vs ALB (r= 0.220, p= 0.147), Fe Vs TP (r= -0.074, p= 0.631), and TP Vs ALB (r= 0.205, p= 0.177) in the control group (p<0.05).

Table 4: Association between the serum levels of Ferritin, Albumin, and Total Protein studied in the control group.

Parameters	**r**	**p-value**
Fe Vs ALB	0.22	0.147
Fe Vs TP	-0.07	0.631
TP Vs ALB	0.21	0.177

* Statistical significance at P<0.05

Keys

FE = Ferritin

ALB = Albumin

TP = Total Protein

Association of the biochemical analytes with the anthropometric indices and blood pressure in the test group

There were no significant correlations between anthropometric indices (such as BMI, waist circumference, and hip circumference) and blood pressure (SBP and DBP) in the test group (p>0.05).

Table 5: Association of the biochemical analytes with the anthropometric indices and blood pressure in the test group

Parameters		BMI (kg/m^2)	WC (cm)	HC (cm)	SBP (mmHg)	DBP (mmHg)
Ferritin (ng/mL)	r-value	-0.032	-0.134	-0.037	-0.015	-0.053
	P-value	0.835	0.379	0.808	0.924	0.731
Albumin (g/L)	r-value	-0.024	0.108	0.067	0.014	-0.081
	P-value	0.875	0.482	0.662	0.927	0.599
Total protein (g/L)	r-value	0.121	-0.015	0.073	0.127	0.207
	P-value	0.428	0.920	0.636	0.407	0.173

* Significant at P<0.05

Keys

BMI= Body Mass Index

WC= Waist Circumference

HC= Hip Circumference

SBP= Systolic Blood Pressure

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DBP= Systolic Blood Pressure

Association of the biochemical analytes with the anthropometric indices and blood pressure in the control group.

There were no significant correlations between anthropometric indices (such as BMI, waist circumference, and hip circumference) and blood pressure (SBP and DBP) in the control group ($p>0.05$).

Table 6: Association of the biochemical analytes with the anthropometric indices and blood pressure in the control group.

Parameters		BMI (kg/m^2)	WC (cm)	HC (cm)	SBP (mmHg)	DBP (mmHg)
Ferritin (ng/mL)	r-value	0.044	0.036	-0.020	0.125	0.197
	P-value	0.772	0.815	0.897	0.412	0.194
Albumin (g/L)	r-value	-0.040	0.146	-0.114	-0.070	0.070
	P-value	0.795	0.338	0.456	0.647	0.645
Totalprotein (g/L)	r-value	-0.160	0.091	-0.083	0.070	0.192
	P-value	0.295	0.550	0.590	0.647	0.207

* **Significant at P<0.05**

Keys

BMI= Body Mass Index

WC= Waist Circumference

HC= Hip Circumference

SBP= Systolic Blood Pressure

DBP= Systolic Blood Pressure

DISCUSSION

The evaluation of serum ferritin, albumin, and total protein levels in premenopausal and menopausal women provides valuable insights into the physiological changes that accompany the transition from the reproductive to the non-reproductive phase of life. This study aimed to investigate these biomarkers to provide insights into iron metabolism, nutritional status, and overall protein health in women undergoing these significant hormonal changes in Okofia, Nnewi metropolis. A higher significant difference was observed in the mean serum levels of ferritin in the test group when compared to the control group. This result is consistent with previous research indicating elevated ferritin levels due to the cessation of menstrual blood loss, which reduces iron depletion and leads to iron accumulation in the body [8]. [13] and [14] also reported significant differences in ferritin levels between premenopausal and menopausal women, supporting the notion that menopausal transition has a profound impact on iron metabolism. High ferritin levels can indicate risks for conditions such as metabolic

syndrome, cardiovascular diseases, and type 2 diabetes, as suggested by [15] and [16]. Therefore, regular monitoring of ferritin levels in menopausal women could be beneficial for early detection and management of these conditions.

No significant difference was observed in the mean serum levels of Albumin in the test group when compared to the control group. This lack of significant difference may suggest that the menopausal transition does not substantially impact serum albumin levels, which aligns with several studies indicating that albumin levels are relatively stable and less influenced by menopausal status compared to other biomarkers like ferritin [17]. Previous research supports the findings in this study. In a study by [18], it was reported that the albumin levels

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across different age and menopausal status groups were consistent, suggesting that albumin synthesis and turnover are not markedly affected by hormonal changes during menopause. Additionally, albumin levels are known to be more significantly affected by nutritional status, liver function, and inflammation, rather than menopausal status alone [19]. A lower significant difference in the mean serum levels of total protein in the test group when compared to the control group was observed. This finding suggests that menopausal status may impact overall protein levels, which could be linked to changes in hormonal balance and nutritional status during menopause. Research by [20] indicated that menopausal women often experience changes in protein metabolism and nutritional intake, potentially leading to lower total protein levels. Additionally, declining estrogen levels during menopause have been associated with reduced protein synthesis and alterations in body composition, which may contribute to decreased total protein levels [21]. Lower total protein levels in menopausal women could also reflect reduced albumin and globulin fractions, which are crucial for maintaining overall protein homeostasis [22]. This decrease could have clinical implications, such as an increased risk for sarcopenia, decreased immune function, and overall poorer nutritional status, highlighting the need for targeted nutritional interventions during menopause.

There existed a higher significant difference in the mean values of BMI, WC, HC, SBP, and DBP of the test group when compared to the control group. These findings are consistent with previous research indicating that menopause is associated with increased central adiposity and higher blood pressure. The hormonal changes during menopause, particularly the decline in estrogen, contribute to increased fat accumulation, especially in the abdominal region, which is reflected in higher BMI, WC, and HC [23]. This shift in body fat distribution is linked to a higher risk of metabolic syndrome and cardiovascular diseases in menopausal women [24]. Additionally, the observed increase in blood pressure among menopausal women aligns with studies showing that menopause is a risk factor for hypertension, likely due to the interplay of aging, hormonal changes, and increased adiposity [25]. Elevated SBP and DBP in the menopausal group suggest an increased cardiovascular risk, necessitating proactive management of these risk factors [26].

There was a significant positive correlation between the Ferritin and Total protein in the test group, which could indicate that higher ferritin levels are associated with higher total protein levels in this population. This correlation suggests that iron storage status may influence overall protein levels, potentially through mechanisms involving inflammatory processes and liver function, which are known to affect both ferritin and total protein [27]. Conversely, no significant correlation was found between ferritin and albumin or between total protein and albumin in the menopausal group. This lack of significant correlation indicates that albumin levels are independently regulated and not directly influenced by iron status or total protein levels in menopausal women. Albumin is a negative acute-phase reactant, and its levels are more closely related to nutritional status, liver function, and inflammation rather than iron metabolism alone [28]. No significant association between Ferritin and Albumin, Ferritin and Total protein, Total protein, and Albumin in the premenopausal group was observed. The absence of a significant relationship between ferritin and albumin levels indicates that in premenopausal women, iron storage and nutritional status (as reflected by albumin) are regulated by distinct physiological mechanisms. This is consistent with findings that albumin levels are more influenced by factors such as liver function, hydration status, and protein intake rather than iron metabolism [28]. Similarly, the non-significant correlation between ferritin and total protein levels, as well as between total protein and albumin levels, supports the notion that in premenopausal women, these biomarkers operate independently. This independence might reflect a more stable and balanced metabolic state in premenopausal women, where iron metabolism, protein synthesis, and overall nutritional status are not as affected by hormonal fluctuations as they are during menopause [19].

There were no significant correlations between anthropometric indices such as BMI, waist circumference, hip circumference, and blood pressure (both systolic and diastolic) in both the menopausal (test) group and the premenopausal (control) group ($p<0.05$). This finding indicates that, within the study population, variations in body measurements were not directly associated with variations in blood pressure levels. This absence of any significant correlation contradicts some studies such as that of [29] and [30], who found associations between higher BMI or central adiposity and elevated blood pressure. However, other research such as that of [31] and [32] suggests that the relationship between body composition and blood pressure can be influenced by multiple factors, including genetic predisposition, lifestyle, and hormonal status, which might obscure direct

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correlations in certain populations. In menopausal women, the complex interplay of hormonal changes, such as declining estrogen levels, might impact both adiposity and blood pressure regulation in ways that do not result in straightforward correlations [24]. Similarly, in premenopausal women, the hormonal balance and generally lower cardiovascular risk might contribute to the absence of significant associations between body measurements and blood pressure [33].

CONCLUSION

This study examines the physiological changes associated with menopause by analyzing key biomarkers, anthropometric indices, and blood pressure in women from Okofia, Nnewi metropolis. Findings reveal a significant increase in ferritin levels, indicating altered iron metabolism and heightened inflammation, while stable albumin levels suggest minimal impact on its regulation. The decline in total protein levels highlights potential nutritional deficiencies, emphasizing the need for targeted interventions. The lack of correlation between anthropometric indices and blood pressure underscores the complexity of cardiovascular risk factors. Overall, the study underscores the importance of monitoring key biomarkers to improve health management during menopause.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Contributors

ACI, NEE, CJA and PCO conceived and designed the research proposal. OIJ, ROO, ITA, and ACI performed sample collection, experiments, and data analysis. CUO, ACI, ROO, and OIJ contributed to the final version of the manuscript. All authors have read and approved the final manuscript.

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Data availability

The data used to support the findings of this study are available from the corresponding author upon reasonable request.

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Conflict of interest:

None declared.

Ethical approval:

The study sought and obtained ethical approval from the Ethics Committee of the Faculty of Health Sciences and Technology College of Health Sciences Nnamdi Azikiwe University with reference no. FHST/REC/023/582

REFERENCES

1. Shifren, J. L., and Gass, M. L. 2014. NAMS Recommendations for Clinical Care of Midlife Women Working Group. The North American Menopause Society recommendations for clinical care of midlife women. Menopause, 21(10), pp.1038-1062.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI | Volume XII Issue XV March 2025 | Special Issue on Public Health

2. Albert, K. M., and Newhouse, P. A. 2019. Estrogen, stress, and depression: cognitive and biological interactions. Annual review of clinical psychology, 15(1), pp.399-423.
3. Burtis, C. A., and Bruns, D. E. 2014. Tietz fundamentals of clinical chemistry and molecular diagnostics-E-book: Tietz fundamentals of clinical chemistry and molecular diagnostics-E-book. Elsevier Health Sciences.
4. Zhang, N., Yu, X., Xie, J., and Xu, H. 2021. New insights into the role of ferritin in iron homeostasis and neurodegenerative diseases. Molecular neurobiology, 58(6), pp.2812-2823.
5. Badenhorst, C. E., Forsyth, A. K., and Govus, A. D. 2022. A contemporary understanding of iron metabolism in active premenopausal females. Frontiers in Sports and Active Living, 4, pp.903937.
6. Chung, M. K., Lee, M. S., Choi, Y. H., and Park, H. S. 2020. Relationship between serum ferritin levels and metabolic syndrome in postmenopausal women. Journal of Clinical Endocrinology & Metabolism; 105(7), pp.2315-2323
7. Vogt, A. C. S., Arsiwala, T., Mohsen, M., Vogel, M., Manolova, V., and Bachmann, M. F. 2021. On iron metabolism and its regulation. International journal of molecular sciences, 22(9), pp.4591.
8. Kim, K., Park, H. J., Lee, H. J., and Park, H. 2017. Relationship between serum ferritin levels and metabolic syndrome in premenopausal and postmenopausal women. Journal of Women's Health; 26, pp.83-89
9. Belinskaia, D. A., Voronina, P. A., and Goncharov, N. V. 2021. Integrative role of albumin: evolutionary, biochemical and pathophysiological aspects. Journal of Evolutionary Biochemistry and Physiology, 57, pp.1419-1448.
10. Manson, J. E., Basson, R. C., and Allison, M. A. 2017. Menopause and cardiovascular disease risk. New England Journal of Medicine; 377(22), pp.2188-2196
11. Honour, J. W. 2018. Biochemistry of the menopause. Annals of clinical biochemistry, 55(1), pp.18-33
12. Manafa, P. O., Ihim, A. C., Ekwueme, C. I., Oluboyo, A. O., Chukwuma, G., Beccky, C., and Anuli, O. 2015. Assessment of the risk of prostate cancer in adult smokers in Nnewi, Nigeria using prostate-specific antigen as a biomarker. pp.172-183.
13. Al-Nimer, M. S. M., Abdul-Lateef, L. A. and Saleh, M. A. 2016. Evaluation of serum ferritin, transferrin, and iron levels in premenopausal and postmenopausal women. Annals of Medical and Health Sciences Research; 6(2), pp.89-93
14. Simavli, S., Kaygusuz, I., Cukur, S., Caglar, G. S., and Akgun, L. 2018. Changes in serum iron, zinc, and copper levels in postmenopausal women. Journal of Trace Elements in Medicine and Biology; 47, pp.59-64
15. Fernandez-Real, J. M., and Manco, M. 2014. Effects of iron overload on chronic metabolic diseases. The Lancet Diabetes & Endocrinology; 2(6), pp.513-526
16. Jankowska, E. A., Kasztura, M., Sokolski, M., Bronisz, M., Nawrocka, S., Oleskowska-Florek, W., ... and Banasiak, W. 2015. Iron status and survival in diabetic patients with coronary artery disease. Diabetes Car; 38(8), pp.1463-1470
17. Mahajan, N., Sandeep, K., and Sharma, R. 2018. Albumin: A marker for various conditions. North American Journal of Medical Sciences; 10(4), pp.181-185
18. Ridker, P. M., Everett, B. M., Thuren, T., MacFadyen, J. G., Chang, W. H., Ballantyne, C., ... and Libby, P. 2016. Antiinflammatory therapy with canakinumab for atherosclerotic disease. New England Journal of Medicine; 377(12), pp.1119-1131
19. Lopes, J. P., Costa, A., and Costa, E. 2020. The role of albumin in clinical practice: From physiological functions to diagnostic utility. European Journal of Clinical Nutrition; 74(4), pp.501-510
20. O'Connell, M. B., Adelman, M., and Levin, J. A. 2014. Impact of the menopausal transition on bone, body composition, and metabolism. Journal of Women's Health; 23(2), pp.128-137
21. Gleason, C. E., Dowling, N. M., Wharton, W., and Manson, J. E. 2019. Effects of hormone therapy on cognition and mood in recently postmenopausal women. Journal of Clinical Endocrinology & Metabolism; 104(8), pp.3576-3586
22. Karvonen-Gutierrez, C. A., Kim, C., and Rizk, N. 2019. Urogenital aging and its implications for sexual health in menopausal women. Journal of Women's Health; 28(4), pp.475-480.
23. Lizcano, F., and Guzmán, G. 2014. Estrogen deficiency and the origin of obesity during menopause. BioMed Research International, 2014, pp.757461

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI | Volume XII Issue XV March 2025 | Special Issue on Public Health

24. Mauvais-Jarvis, F. 2017. Sex differences in metabolic homeostasis, diabetes, and obesity. Biological Sex Differences, 8, pp.14
25. Franklin, S. S., Wong, N. D., and Larson, M. G. 2021. Cardiovascular risk factors in menopause: The role of estrogen. Journal of the American Heart Association; 10(4), pp.018162
26. Rosano, G. M., Vitale, C., and Marazzi, G. 2020. Hypertension and menopause: Pathophysiology and management. Journal of the American College of Cardiology; 75(5), pp.594-604
27. Maher, S. E., Kavanagh, R. G., Codd, M. B., McDermott, C. M., and Murray, C. 2021. Elevated ferritin levels in postmenopausal women: Implications for disease risk and potential therapies. Frontiers in Endocrinology; 12, pp.685910
28. Jensen, M. D., Ryan, D. H., Apovian, C. M., Loria, C. M., Ard, J. D., Millen, B. E., ... and Yanovski, S. Z. 2017. 2013 AHA/ACC/TOS guideline for the management of overweight and obesity in adults. Circulation; 129, pp.S102-S138
29. Stamler, J., Elliott, P., Kesteloot, H., Nichols, R., Claeys, G., Dyer, A. R., ... and Stamler, R. 2018. Inverse relation of dietary protein markers with blood pressure. Circulation; 84(1), pp.46-61
30. Wilsgaard, T., Schirmer, H., Arnesen, E., and Løchen, M. L. 2019. Impact of body weight on blood pressure with a focus on sex differences: The Tromsø Study, 1986–2019. Hypertension; 76(2), pp.355-361
31. Flegal, K. M., Kit, B. K., Orpana, H., and Graubard, B. I. 2016. Association of all-cause mortality with overweight and obesity using standard body mass index categories: A systematic review and meta-analysis. JAMA; 309(1), pp.71-82
32. Muntner, P., Carey, R. M., Gidding, S., Jones, D. W., Taler, S. J., Wright, J. T., and Whelton, P. K. 2020. Potential U.S. population impact of the 2017 ACC/AHA high blood pressure guideline. Journal of the American College of Cardiology; 71(2), pp.109-118
33. Santoro, N., Epperson, C. N., and Mathews, S. B. (2015). Menopausal symptoms and their management. Endocrinology and Metabolism Clinics of North America; 44(3): 497-515.