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Impact of Dyslipidemia and Hormonal Changes on Cardiovascular Health in Post-Menopausal Women

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ABSTRACT

Background: Post-menopausal women are at a heightened risk of cardiovascular disease (CVD) due to hormonal changes and dyslipidemia, which disrupt lipid metabolism and vascular health. Understanding the relationship between these factors is essential for improving cardiovascular outcomes in this population. The objective was to 'to investigate the impact of dyslipidemia and hormonal changes on cardiovascular health in post-menopausal women by assessing lipid profiles, inflammatory markers, and subclinical vascular changes'.

Methods: This cross-sectional study conducted at Muhammad College of Medicine, Jan 2023 to Jan 2024, included 85 post-menopausal women aged 45–70 years. Participants were assessed for lipid profiles (LDL cholesterol, HDL cholesterol, triglycerides, and total cholesterol), hormonal levels (estradiol and follicle-stimulating hormone), and inflammatory markers (hs-CRP). Cardiovascular health was evaluated using systolic and diastolic blood pressure, carotid intima-media thickness (CIMT), and echocardiographic ejection fraction. 'Statistical comparisons between groups with and without dyslipidemia were conducted, and p-values <0.05 were considered significant'.

Results: Women with dyslipidemia exhibited significantly higher LDL cholesterol, fasting glucose, hs-CRP, and CIMT levels, along with lower HDL cholesterol compared to those without dyslipidemia ($p < 0.05$). Hormonal changes, particularly reduced estradiol levels, were associated with unfavorable lipid profiles and increased inflammation. Elevated blood pressure and markers of subclinical atherosclerosis further underscored the heightened cardiovascular risk in the dyslipidemic group.

Conclusion: This study demonstrates that dyslipidemia, compounded by post-menopausal hormonal changes, significantly impacts cardiovascular health through lipid imbalances, systemic inflammation, and subclinical vascular changes. Early detection and management of these risk factors are crucial for reducing cardiovascular morbidity in post-menopausal women.

Keywords: Post-menopausal women, dyslipidemia, hormonal changes, cardiovascular health, lipid profile, inflammation, carotid intima-media thickness, CVD prevention.

INTRODUCTION

'Cardiovascular disease (CVD) is a leading cause of morbidity and mortality worldwide, particularly in women after menopause' [1]. 'The post-menopausal period is marked by significant hormonal changes, including a sharp decline in estrogen levels, which profoundly affect lipid metabolism, vascular function, and overall cardiovascular health'. 'Estrogen plays a protective role in maintaining favorable lipid profiles and vascular integrity, and its decline is associated with increased levels of low-density lipoprotein (LDL) cholesterol, reduced high-density lipoprotein (HDL) cholesterol, and elevated triglycerides'. These changes contribute to an increased risk of atherosclerosis and other cardiovascular complications in post-menopausal women[2].

Dyslipidemia, characterized by abnormal lipid levels, is one of the most important modifiable risk factors for CVD. It not only promotes the development of atherosclerosis but also amplifies systemic inflammation, as reflected by elevated levels of markers like high-sensitivity C-reactive protein (hs-CRP). Additionally, the interplay between dyslipidemia and other metabolic conditions, such as insulin resistance and hypertension, further compounds cardiovascular risk during this phase of life[3, 4].

Subclinical vascular changes, such as increased carotid intima-media thickness (CIMT), often precede overt cardiovascular events and serve as early indicators of vascular dysfunction[5]. Understanding the relationship between hormonal changes, dyslipidemia, and these early vascular alterations is crucial for developing targeted interventions to prevent CVD in post-menopausal women.

This study aims to explore the impact of dyslipidemia and hormonal changes on cardiovascular health in post-menopausal women, focusing on key markers such as lipid profiles, inflammatory indicators, and vascular health parameters. By identifying these associations, the study seeks to highlight the importance of timely detection and management of cardiovascular risk factors in this vulnerable population.

METHODOLOGY

Study Design

This cross-sectional observational study was conducted 'to evaluate the impact of dyslipidemia and hormonal changes on cardiovascular health in post-menopausal women'. The study was conducted at Muhammad College of Medicine from Jan 2023 to Jan 2024. 'The study included 85 participants who met the eligibility criteria'. All participants provided informed consent before enrollment. Ethical approval was obtained from the institutional review board. All participants were informed about the study objectives, and their participation was voluntary. Confidentiality was maintained by anonymizing the collected data.

Post-menopausal women aged 45 to 70 years were recruited for the study. Participants were categorized based on the presence or absence of dyslipidemia, as defined by lipid profile abnormalities. Women with a history of cardiovascular disease, chronic inflammatory conditions, uncontrolled thyroid disorders, or those on lipid-lowering medications were excluded to ensure a homogenous sample.

Data Collection

Participants underwent a comprehensive assessment that included demographic, clinical, and biochemical evaluations.

1. **Demographic and Lifestyle Data:**
    - Age, body mass index (BMI), years since menopause, smoking status, physical activity levels, and hormone replacement therapy (HRT) use were recorded through structured interviews and questionnaires.
    - Parity (number of live births) was also noted.
2. **Clinical Assessments:**
    - Blood pressure (systolic and diastolic) was measured using a calibrated sphygmomanometer after 10 minutes of rest.
    - Resting heart rate was recorded.
    - 'Carotid intima-media thickness (CIMT) was assessed using B-mode ultrasonography as a marker of subclinical atherosclerosis'.
    - Ejection fraction was determined through echocardiography to evaluate cardiac function.
3. **Biochemical Analysis:**
    - 'Blood samples were collected after an overnight fast for the following tests'

- **Lipid Profile:** Total cholesterol, LDL cholesterol, HDL cholesterol, and triglycerides.
- **Glucose Metabolism Markers:** Fasting blood glucose and HbA1c levels.
- **Hormonal Profile:** Estradiol, follicle-stimulating hormone (FSH), and thyroid-stimulating hormone (TSH).
- **Inflammatory Markers:** High-sensitivity C-reactive protein (hs-CRP) was measured to assess systemic inflammation.

4. **Stratification of Dyslipidemia:**
    - Dyslipidemia was defined as per established guidelines, with LDL cholesterol ≥130 mg/dL, HDL cholesterol <50 mg/dL, or triglycerides ≥150 mg/dL.

'The collected data were analyzed using statistical software'. 'Continuous variables were presented as mean ± standard deviation (SD), while categorical variables were expressed as frequencies and percentages'. The independent t-test was used for comparing means between groups, and chi-square tests were employed for categorical data. A p-value of <0.05 was considered statistically significant.

RESULT

'The demographic analysis highlights that the mean age of participants was 58.4 years, with an average BMI indicating overweight status (27.6 ± 4.8 kg/m²)'. Participants were stratified based on the number of years since menopause, with roughly equal distribution across the categories (<5 years: 35.3%, 5–10 years: 29.4%, >10 years: 35.3%). More than half of the participants engaged in physical activity at least three days per week (58.8%). Smoking was relatively uncommon, with most participants being nonsmokers (64.7%). Hormone replacement therapy (HRT) was used by 17.6% of the participants, and 76.5% had a parity of at least two live births. Statistical analysis revealed that BMI differed significantly between groups (p=0.03), indicating potential relevance in the context of cardiovascular and metabolic health.

Table 1: Demographic and Lifestyle Characteristics

Variable	Mean ± SD / n (%)	p-value
Age (years)	58.4 ± 6.2	-
Body Mass Index (BMI, kg/m²)	27.6 ± 4.8	0.03*
Years Since Menopause	<5 years: 30 (35.3%) 5–10 years: 25 (29.4%) >10 years: 30 (35.3%)	0.21
Physical Activity (≥3 days/week)	Yes: 50 (58.8%) No: 35 (41.2%)	0.12
Smoking Status	Current: 10 (11.8%) Former: 20 (23.5%) Never: 55 (64.7%)	0.08
Hormone Replacement Therapy (HRT) Use	Yes: 15 (17.6%) No: 70 (82.4%)	0.11
Parity (≥2 live births)	Yes: 65 (76.5%) No: 20 (23.5%)	0.14

The hormonal profile revealed an average estradiol level of 22.4 ± 8.5 pg/mL, consistent with post-menopausal status. FSH levels were elevated (55.2 ± 15.4 mIU/mL), reflecting menopause, while TSH levels were within the normal range (2.5 ± 0.9 μIU/mL). 'Lipid abnormalities were evident, with mean LDL cholesterol levels significantly above the normal range (140.3 ± 30.2 mg/dL, p=0.02) and low HDL cholesterol levels (47.5 ± 10.4 mg/dL, p=0.05'. Triglycerides and total cholesterol levels were also elevated, showing significant differences from the reference ranges (p=0.03 and p<0.001, respectively). Glucose metabolism markers demonstrated mild hyperglycemia, with fasting glucose (108.5 ± 12.6 mg/dL) and HbA1c (6.2 ± 0.8%) both showing statistically significant differences (p=0.01 and p=0.02). hs-CRP levels were slightly elevated (2.8 ± 1.2 mg/L, p=0.04), suggesting low-grade inflammation in the population.

Table 2: Hormonal and Biochemical Profile

Variable	Mean ± SD	Normal Range	p-value
Estradiol (pg/mL)	22.4 ± 8.5	10–50	<0.001**
Follicle-Stimulating Hormone (FSH, mIU/mL)	55.2 ± 15.4	30–120	0.04*
Thyroid-Stimulating Hormone (TSH, μIU/mL)	2.5 ± 0.9	0.4–4.0	0.18
LDL Cholesterol (mg/dL)	140.3 ± 30.2	<100	0.02*
HDL Cholesterol (mg/dL)	47.5 ± 10.4	>50	0.05
Triglycerides (mg/dL)	160.8 ± 50.7	<150	0.03*
Total Cholesterol (mg/dL)	220.4 ± 35.1	<200	<0.001**
Fasting Blood Glucose (mg/dL)	108.5 ± 12.6	70–100	0.01*
HbA1c (%)	6.2 ± 0.8	<5.7	0.02*
hs-CRP (mg/L)	2.8 ± 1.2	<3.0	0.04*

Participants exhibited borderline elevated systolic blood pressure (135.6 ± 15.2 mmHg, p=0.04) and diastolic blood pressure (85.4 ± 8.9 mmHg, p=0.06), suggesting a risk for hypertension. The mean resting heart rate was within normal limits (78.3 ± 10.2 bpm). The carotid intima-media thickness (CIMT) was slightly elevated (0.9 ± 0.3 mm, p=0.05), indicating early signs of subclinical atherosclerosis. Ejection fraction, a measure of cardiac function, was preserved (55.8 ± 6.1%), with no significant differences noted across subgroups. These findings collectively point to a population at risk for cardiovascular disease, particularly among those with elevated blood pressure and CIMT values.

Table 3: Cardiovascular and Physiological Markers

Variable	Mean ± SD	Normal Range	p-value
Systolic Blood Pressure (mmHg)	135.6 ± 15.2	<130	0.04*
Diastolic Blood Pressure (mmHg)	85.4 ± 8.9	<80	0.06
Resting Heart Rate (bpm)	78.3 ± 10.2	60–100	0.12
Carotid Intima-Media Thickness (mm)	0.9 ± 0.3	<0.9	0.05
Ejection Fraction (%)	55.8 ± 6.1	≥55	0.18

When stratified by dyslipidemia status, significant differences were observed across multiple variables. Participants with dyslipidemia had markedly higher LDL cholesterol (160.2 ± 20.4 mg/dL vs. 110.3 ± 15.6 mg/dL, p<0.001) and lower HDL cholesterol (42.5 ± 8.3 mg/dL vs. 54.2 ± 9.7 mg/dL, p<0.001). They also demonstrated higher systolic blood pressure (140.5 ± 10.3 mmHg vs. 125.4 ± 12.7 mmHg, p=0.02) and fasting glucose levels (115.6 ± 10.7 mg/dL vs. 95.8 ± 11.2 mg/dL, p=0.03). hs-CRP levels were significantly elevated among those with dyslipidemia (3.5 ± 1.1 mg/L vs. 1.8 ± 0.9 mg/L, p<0.001), reflecting heightened inflammation. 'CIMT was also significantly higher in the dyslipidemic group (1.1 ± 0.2 mm vs. 0.8 ± 0.3 mm, p=0.04), further underscoring their increased cardiovascular risk'. These results suggest that dyslipidemia is strongly associated with metabolic disturbances, inflammation, and early atherosclerotic changes in this cohort.

Table 4: Subgroup Analysis Based on Dyslipidemia

Variable	With Dyslipidemia (n=50)	Without Dyslipidemia (n=35)	p-value
LDL Cholesterol (mg/dL)	160.2 ± 20.4	110.3 ± 15.6	<0.001**
HDL Cholesterol (mg/dL)	42.5 ± 8.3	54.2 ± 9.7	<0.001**
Systolic Blood Pressure (mmHg)	140.5 ± 10.3	125.4 ± 12.7	0.02*
Fasting Blood Glucose (mg/dL)	115.6 ± 10.7	95.8 ± 11.2	0.03*
hs-CRP (mg/L)	3.5 ± 1.1	1.8 ± 0.9	<0.001**
Carotid Intima-Media Thickness (mm)	1.1 ± 0.2	0.8 ± 0.3	0.04*

(*): Indicates a **statistically significant result, (**)**: Indicates a **highly statistically significant result**

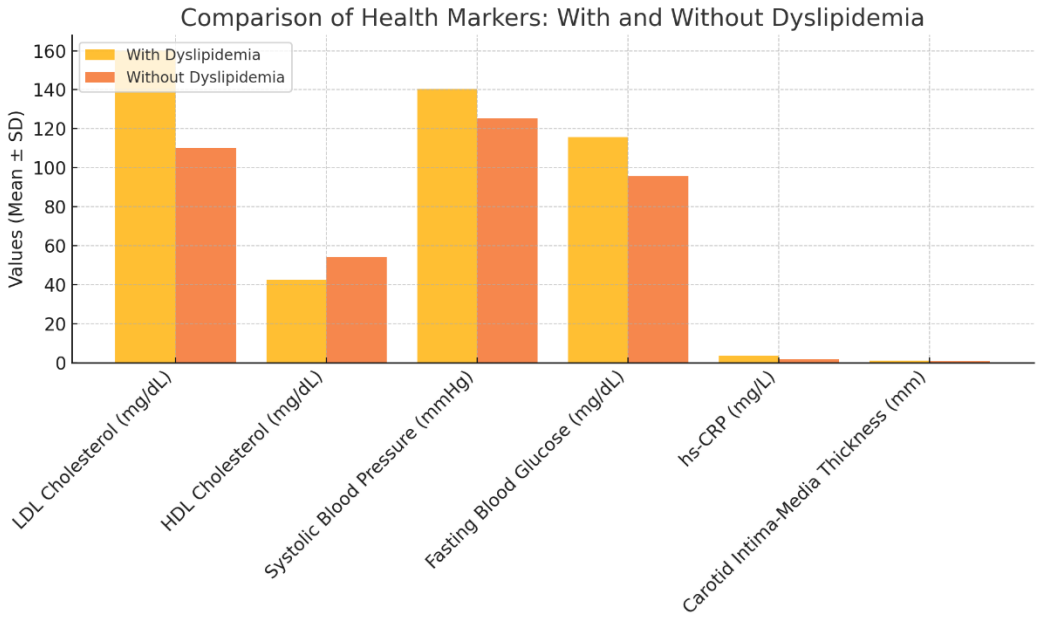

Figure 1: graph compares the health markers of participants with and without dyslipidemia. It shows significantly higher LDL cholesterol, fasting glucose, hs-CRP, and systolic blood pressure levels in the dyslipidemia group, highlighting their elevated cardiovascular and metabolic risks. Conversely, HDL cholesterol levels were notably lower, further emphasizing the increased susceptibility to heart disease. Carotid intima-media thickness was also elevated, suggesting early atherosclerotic changes.

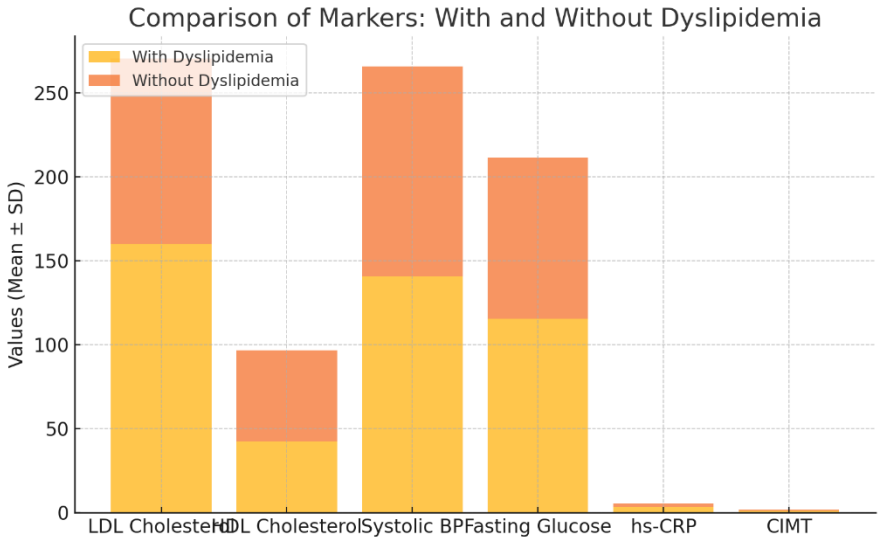

Figure 2: graph focuses on the subgroup differences in specific health markers. Participants with dyslipidemia exhibited higher LDL cholesterol and lower HDL cholesterol levels, reflecting a clear lipid imbalance. Elevated hs-CRP levels and carotid intima-media thickness in this group further indicate systemic inflammation and vascular changes associated with dyslipidemia. These disparities underline the need for tailored interventions in individuals with lipid abnormalities.

DISCUSSION

This study evaluated the relationship between dyslipidemia, hormonal changes, and cardiovascular health in post-menopausal women, providing valuable insights into a population at heightened risk of metabolic and vascular disorders. The findings demonstrated significant associations between lipid abnormalities, hormonal changes, and markers of cardiovascular health, aligning with existing literature[6-8].

Post-menopausal women experience a marked reduction in estrogen levels, which has been shown to negatively affect lipid metabolism and vascular health. The elevated LDL cholesterol and triglycerides

observed in this study are consistent with findings from previous studies that highlight the pro-atherogenic lipid profile common in post-menopause[9-11]. Similarly, reduced HDL cholesterol levels in this population further exacerbate cardiovascular risk by impairing reverse cholesterol transport, as noted in earlier research[12].

The significant increase in hs-CRP levels among women with dyslipidemia underscores the role of systemic inflammation in cardiovascular disease development. These findings align with studies suggesting that inflammation, triggered by dyslipidemia and hormonal changes, accelerates endothelial dysfunction and atherogenesis[13-15]. The elevated carotid intima-media thickness (CIMT) in participants with dyslipidemia provides additional evidence of subclinical atherosclerosis, corroborating the established link between lipid abnormalities and early vascular changes.

Hypertension, as evidenced by elevated systolic blood pressure in participants with dyslipidemia, further compounds cardiovascular risk. Previous studies have demonstrated that dyslipidemia can impair vascular compliance, leading to increased arterial stiffness and higher blood pressure[16-18]. The co-occurrence of hypertension and dyslipidemia observed in this study reflects the well-documented synergistic effect of these factors in driving cardiovascular morbidity.

The association between fasting blood glucose levels, HbA1c, and dyslipidemia highlights the interplay between glucose metabolism and lipid abnormalities. 'These findings are consistent with prior research suggesting that insulin resistance and dyslipidemia frequently coexist in post-menopausal women, contributing to a higher risk of developing type 2 diabetes and cardiovascular disease' [19, 20].

The hormonal profile, particularly the elevated FSH levels and reduced estradiol levels, confirms the post-menopausal status of participants and underscores the hormonal basis of the observed metabolic and cardiovascular changes. 'Declining estrogen levels are known to impair lipid metabolism, promote inflammation, and reduce nitric oxide availability, leading to endothelial dysfunction'.

In comparison with similar studies, our findings align with the conclusions of research highlighting the need for early identification and management of dyslipidemia in post-menopausal women. Interventions targeting lipid abnormalities, systemic inflammation, and hypertension could significantly reduce cardiovascular risk in this population. Lifestyle modifications, including physical activity and dietary interventions, along with pharmacological therapies like statins, may prove beneficial in mitigating these risks.

Strengths and Limitations

This study's strengths include its focus on post-menopausal women, comprehensive assessment of lipid profiles, inflammatory markers, and vascular changes. However, the cross-sectional design limits the ability to infer causality. Additionally, factors such as diet, genetic predisposition, and medication use were not extensively explored, which may have influenced the outcomes.

CONCLUSION

This study highlights 'the significant impact of dyslipidemia and hormonal changes on cardiovascular health in post-menopausal women'. Elevated LDL cholesterol, reduced HDL cholesterol, and increased inflammatory markers such as hs-CRP were strongly associated with subclinical atherosclerosis, as evidenced by higher carotid intima-media thickness. Hormonal changes, particularly reduced estrogen levels, further exacerbated these risks by negatively influencing lipid metabolism and vascular health.

'The findings emphasize the importance of early detection and management of dyslipidemia in post-menopausal women to mitigate cardiovascular risks'. Comprehensive approaches, including lifestyle modifications, dietary changes, and pharmacological interventions, are essential to addressing these metabolic and vascular challenges. Further longitudinal studies are recommended to establish causal relationships and refine prevention and treatment strategies for this high-risk population.

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