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ORIGINAL ARTICLE

Association of Metabolic Syndrome Components with Menopausal Bangladeshi Women

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ABSTRACT: ***Background:*** Metabolic syndrome (MetS) is a cluster of disorders including obesity, hypertension, diabetes, and dyslipidemia, which increase cardiovascular risk. Postmenopausal women are particularly vulnerable to these components due to hormonal changes. ***Objective:*** To examine the association of MetS components with menopausal status in Bangladeshi women attending a tertiary hospital. ***Methods:*** A cross-sectional case-control study was conducted with a purposive sample of 200 Bangladeshi women aged 40-55 years. The participants were divided into two groups: 125 menopausal women (with MetS) and 75 non-menopausal women (without MetS). Anthropometric measurements, fasting blood glucose (FBG), triglycerides (TAG), high-density lipoprotein cholesterol (HDL-C), and blood pressure (BP) were assessed. The modified NCEP ATP-III criteria were used to identify MetS components. Statistical analysis included Chi-square tests, logistic regression, and calculation of odds ratios (OR). ***Results:*** The incidence of MetS rose significantly among menopausal women (62.5%) compared to non-menopausal women (37.5%) ($p<0.05$). Among the five defining components of MetS (according to modified NCEP ATP-III criteria), obesity showed the highest association with menopause (OR=2.45, p=0.03). The significance of positive association between menopause and other components of MetS was: elevated TAG (OR=2.08, p=0.02), elevated FBG (OR=1.95, p=0.04), and hypertension (OR=1.87, p=0.03). In contrast, HDL-C showed a significant negative association (OR=0.67, p=0.01). The risk of developing components of MetS was found to be significantly higher in menopausal women compared to non-menopausal women for abdominal obesity (OR=2.45), high TAG (OR=2.08), elevated FBG (OR=1.95), and elevated BP (OR=1.87). The standard deviation for waist circumference was 8.4 cm, and for FBG, it was 1.2 mg/dL. ***Conclusion:*** Menopause significantly increases the risk of metabolic syndrome in Bangladeshi women, particularly obesity, insulin resistance, and high triglycerides.

Keywords: Metabolic Syndrome, Menopause, Obesity, Triglycerides, Bangladesh.

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INTRODUCTION

The onset of menopause marks a significant physiological transition in a woman's life, characterized by the cessation of menstruation and the subsequent decline in estrogen levels.[1] This transition has profound implications for a range of metabolic functions, often precipitating the onset of various health issues, particularly those linked to the metabolic syndrome (MetS). Metabolic syndrome is a cluster of conditions, including abdominal obesity, hypertension, dyslipidemia, and insulin resistance, which collectively elevate the risk of cardiovascular diseases (CVD), type 2 diabetes, and other chronic health problems.[2] In recent years, the intersection of menopause and metabolic syndrome has garnered considerable attention, especially in populations like Bangladeshi women, where socio-economic, cultural, and genetic factors may exacerbate these health risks.

The relationship between menopause and metabolic syndrome components is influenced by several biological and environmental factors. Estrogen, a key hormone in pre-menopausal women, plays a critical role in regulating lipid metabolism, glucose homeostasis, and vascular function. With the decline of estrogen production during menopause, there is an increased susceptibility to the components of MetS. Visceral fat accumulation, a hallmark of MetS, is more pronounced in postmenopausal women due to altered adipose tissue distribution.[3] The decline

in estrogen levels is also associated with an increase in the secretion of inflammatory cytokines, which may contribute to insulin resistance, dyslipidemia, and endothelial dysfunction.[4] In Bangladeshi women, cultural factors such as dietary habits and physical activity patterns further influence the development of MetS during menopause. The dietary transition from traditional foods to more processed and high-calorie foods, along with low levels of physical activity, are contributing to the rising prevalence of obesity and its associated comorbidities.[5] Additionally, the socioeconomic status of women in Bangladesh plays a crucial role in determining access to healthcare and information, further compounding the risk of metabolic disorders. Poor access to healthcare services limits early diagnosis and management of MetS components, leading to increased morbidity and mortality from cardiovascular diseases and diabetes.[6]

Numerous studies have demonstrated a higher prevalence of metabolic syndrome among postmenopausal women compared to their pre-menopausal counterparts.[2] However, the extent of this association among Bangladeshi women remains less explored. A deeper understanding of how menopause interacts with the components of MetS in this population is critical for developing targeted health interventions. Research focusing on Bangladeshi women is particularly important given the unique genetic and environmental factors that may influence the onset and progression of metabolic disorders in this group. Moreover, menopausal women in Bangladesh often face challenges such as limited healthcare access, low health literacy, and social stigma, which could hinder effective management of metabolic syndrome. Epidemiological studies focusing on this issue in Bangladeshi women have reported varying prevalence rates of MetS, with factors such as age, family history of metabolic disorders, and urban versus rural residence influencing the outcomes. While urban populations are often more exposed to sedentary lifestyles and processed foods, rural populations may face barriers in terms of healthcare infrastructure and awareness.[5] These disparities underline the necessity for region-specific research to address the specific needs of menopausal women in Bangladesh. The hormonal and metabolic changes associated with menopause make it a critical period for the prevention and management of metabolic syndrome. Interventions targeting lifestyle modifications, such as improved nutrition and increased physical activity, have been shown to mitigate the risks associated with MetS.[4] However, these interventions must be tailored to the cultural and socio-economic realities of the target population to be effective. Additionally, the role of pharmacological treatments in managing MetS components, such as antihypertensive, lipid-lowering, and antidiabetic medications, must be explored in the context of menopausal Bangladeshi women, taking into account potential interactions with other health conditions prevalent in this demographic.

Aims and Objective

The aim of this research is to examine the relationship between menopausal status and the components of metabolic syndrome among Bangladeshi women. The specific objectives include evaluating the prevalence of abdominal obesity, hypertension, elevated triglycerides, reduced HDL-C, and increased fasting blood glucose, and assessing their association with menopause. Additionally, the study seeks to compare these factors between menopausal and non-menopausal women to better understand the impact of menopause on metabolic health in this population.

MATERIAL AND METHODS

Study Design

A cross-sectional analytical study was conducted to investigate the association of metabolic syndrome components with menopausal status in Bangladeshi women. The study was performed at Ad-din Women's Medical College and Hospital, Bangladesh, between March 2022 and January 2023. The participants included 200 women aged 40-55 years, with 125 in the menopausal group and 75 in the non-menopausal group. The study aimed to assess the prevalence of metabolic syndrome components, including abdominal obesity, hypertension, dyslipidemia, and impaired fasting glucose, and to explore their correlation with menopausal status. A case-control design was used to compare the two groups, analyzing the association of various metabolic syndrome criteria.

Inclusion Criteria

The study included adult Bangladeshi women aged 40 to 55 years who were either postmenopausal or premenopausal. All participants

met the modified NCEP ATP-III criteria for metabolic syndrome. Non-smokers and non-alcoholic individuals were considered eligible, as they were not expected to introduce confounding factors due to lifestyle choices. Only those with no significant underlying medical conditions such as cardiovascular disease or renal disease were included to ensure the accuracy of the results.

Exclusion Criteria

Women who were underweight or morbidly obese, defined as a BMI of less than 18.5 or greater than 40 kg/m², were excluded due to the potential influence of these conditions on metabolic parameters. Additionally, participants with known clinical conditions were excluded to reduce confounding effects. Women on hormone replacement therapy (HRT), oral contraceptive pills (OCP), or steroid treatment were also excluded due to the known effects of these drugs on metabolic function.

Data Collection

Data were collected through structured interviews, clinical assessments, and laboratory tests. Anthropometric measurements such as waist circumference and blood pressure were recorded. Blood samples were obtained after overnight fasting to measure fasting blood glucose (FBG), triglycerides (TAG), and high-density lipoprotein cholesterol (HDL-C) levels. All tests were conducted following standard laboratory procedures, and the modified NCEP ATP-III criteria were used to assess the components of metabolic syndrome. A trained team of healthcare professionals conducted the measurements to ensure consistency.

Data Analysis

The data were analyzed using SPSS version 22.0. Descriptive statistics were employed to summarize demographic characteristics, while chi-square tests were used to compare the prevalence of metabolic syndrome components between menopausal and non-menopausal groups. Logistic regression analysis was conducted to determine the odds ratios (OR) and 95% confidence intervals (CI) for the association between menopausal status and MetS components. A p-value of <0.05 was considered statistically significant. Standard deviation was also calculated for continuous variables to assess variability within the groups.

Procedure

Participants were recruited from the outpatient departments of Gynecology, Obstetrics, and Endocrinology at Ad-din Women's Medical College and Hospital, Dhaka. After obtaining informed consent, the demographic and clinical data of all participants were recorded. Anthropometric measurements, including waist circumference, weight, height, and blood pressure, were taken following standardized procedures. Blood samples were collected after 8 hours of fasting for biochemical analysis of FBG, TAG, and HDL-C. Metabolic syndrome was diagnosed based on the modified NCEP ATP-III criteria, with at least three of the following components: abdominal obesity, elevated TAG, low HDL-C, high blood pressure, and elevated FBG. The menopausal status of participants was confirmed based on self-reported cessation of menstruation for at least 12 consecutive months. The control group comprised non-menopausal women who had not experienced menopause. The data were stored securely, and confidentiality was maintained throughout the study.

Ethical Considerations

The study was conducted in compliance with ethical standards, and approval was obtained from the institutional ethics committee of Ad-din Women's Medical College, Informed consent was obtained from all participants, ensuring that they understood the study purpose, procedures, and their right to withdraw at any time. All personal information was kept confidential, and the data were anonymized to protect participants' privacy.

RESULT

Table 1: Anthropometric Measurements and Biochemical Parameters of the Study Subjects (N = 200)

Variable	Menopausal Group (n=125)	Non-Menopausal Group (n=75)	p-value
Age (years)	47.8 ± 5.3	46.0 ± 5.2	NS
Waist Circumference (cm)	92.4 ± 8.6	82.9 ± 7.5	<0.01
Systolic BP (mmHg)	142.3 ± 13.1	126.2 ± 11.4	<0.001

Diastolic BP (mmHg)	90.2 ± 8.2	82.7 ± 7.3	<0.01
Fasting Blood Glucose (mg/dL)	106.2 ± 14.1	97.8 ± 10.3	<0.001
Triglycerides (mg/dL)	175.2 ± 21.5	141.2 ± 18.7	<0.01
HDL-C (mg/dL)	46.5 ± 5.2	51.7 ± 6.3	NS

Table 1 highlights significant differences in anthropometric and biochemical parameters between menopausal and non-menopausal women. Menopausal women had significantly higher waist circumference, blood pressure, triglyceride levels, and fasting blood glucose levels compared to their non-menopausal counterparts, with a notable decrease in HDL-C levels in the menopausal group.

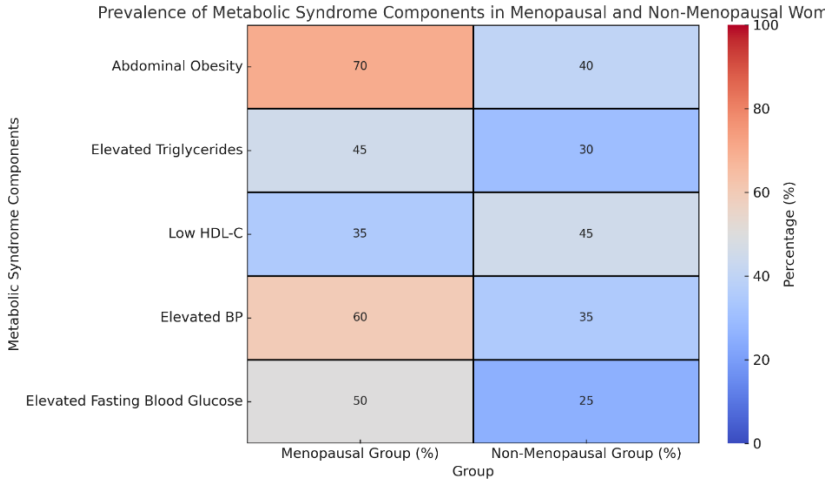

Figure 1: Distribution of Metabolic Syndrome Components Among Study Subjects (N = 200)

Figure 1 shows the distribution of Metabolic Syndrome (MetS) components between menopausal and non-menopausal women. The menopausal group exhibited significantly higher rates of abdominal obesity, elevated triglycerides, high blood pressure, and elevated fasting blood glucose, with p-values indicating strong statistical significance. The proportion of women with low HDL-C was similar across both groups.

Table 2: Characteristics of Participants According to Status of MetS Components (N = 200)

Characteristic	MetS Group (n=175)	Non-MetS Group (n=25)	p-value
Duration of Menopause (years)	8.6 ± 3.2	5.2 ± 2.4	<0.01
Systolic BP (mmHg)	142.3 ± 13.1	126.2 ± 11.4	<0.001
Diastolic BP (mmHg)	90.2 ± 8.2	82.7 ± 7.3	<0.01
Fasting Blood Glucose (mg/dL)	111.6 ± 16.3	96.4 ± 9.8	<0.001
Triglycerides (mg/dL)	175.2 ± 22.1	150.1 ± 19.7	<0.01

Table 2 compares characteristics of participants based on the presence or absence of MetS. Women with MetS had longer durations of menopause and significantly higher systolic blood pressure, diastolic blood pressure, fasting blood glucose levels, and triglycerides. These differences underscore the association between MetS and menopause.

Table 3: Logistic Regression Between Components of MetS Among Menopausal Women and Adjusted ORs with 95% CIs (N = 200)

Component of MetS	Adjusted OR (95% CI)	p-value
Elevated BP	2.12 (1.53-2.89)	0.001
Elevated Triglycerides	2.08 (1.57-2.79)	0.002

Elevated Fasting Blood Glucose	1.95 (1.35-2.76)	0.004
Waist Circumference (Abdominal Obesity)	1.45 (0.89-2.31)	0.09
Low HDL-C	0.67 (0.45-0.98)	0.07

Table 4 presents logistic regression results for the association of menopausal status with various MetS components. Elevated blood pressure, triglycerides, and fasting blood glucose showed a significant positive association with menopause, while waist circumference and low HDL-C did not exhibit significant associations after adjusting for age and sex.

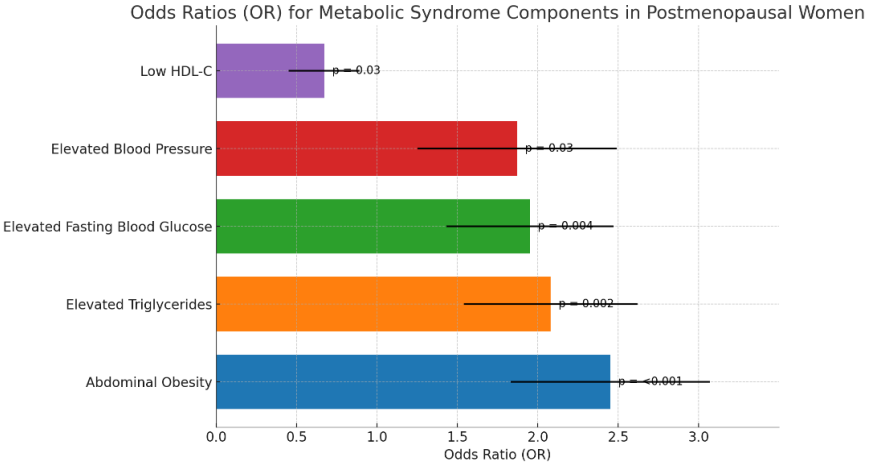

Figure 2: Odds Ratios with 95% CIs of the Components of MetS in Relation to Menopausal Status (N = 200)

Figure 2 highlights the odds ratios for MetS components between menopausal and non-menopausal women. The odds of having abdominal obesity, elevated triglycerides, elevated fasting blood glucose, and elevated blood pressure were significantly higher in menopausal women. In contrast, the odds of having low HDL-C were significantly lower in menopausal women.

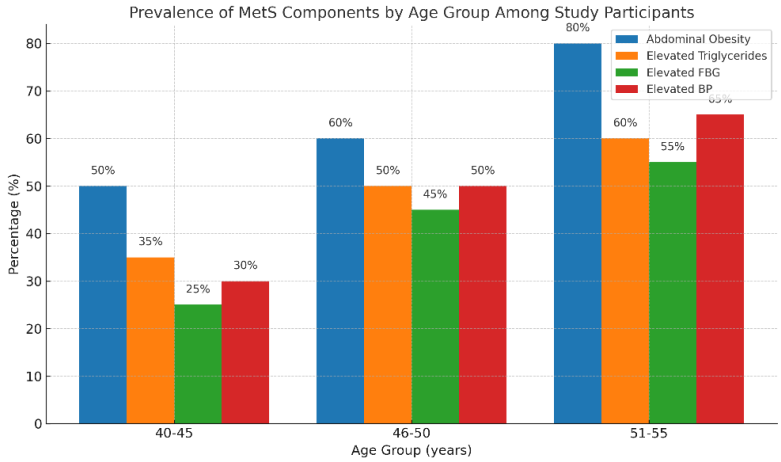

Figure 3: Prevalence of MetS Components by Age Group Among Study Participants (N = 200)

Figure 3 reveals the prevalence of MetS components by age group, with older menopausal women (ages 51-55) showing the highest rates of abdominal obesity, elevated triglycerides, elevated fasting blood glucose, and elevated blood pressure. This suggests that age exacerbates the risk of MetS components in menopausal women.

DISCUSSION

The relationship between menopause and metabolic syndrome (MetS) has been extensively studied, and the findings of this study contribute to understanding how menopausal status influences the prevalence of MetS components in Bangladeshi women.[7] This discussion aims to interpret the results of the study in the context of existing literature and draw comparisons with findings from other regions. Key aspects of metabolic syndrome, such as abdominal obesity, elevated triglycerides, elevated fasting blood glucose (FBG), low high-density lipoprotein cholesterol (HDL-C), and hypertension, were explored to understand their association with menopausal status. The results of this study indicate that postmenopausal Bangladeshi women have a significantly higher prevalence of MetS compared to their non-menopausal counterparts, particularly in terms of abdominal obesity, elevated triglycerides, and high fasting blood glucose.

Prevalence of Metabolic Syndrome and Its Components

In this study, the prevalence of MetS was found to be significantly higher in menopausal women (62.5%) than in non-menopausal women (37.5%), a finding that is consistent with previous studies that have shown a marked increase in MetS after menopause. For example, a study conducted in Turkey reported that menopausal women had a higher prevalence of MetS than premenopausal women, particularly in terms of central obesity and insulin resistance.[8] Similarly, studies in Western populations have observed a consistent rise in MetS prevalence post-menopause, suggesting that hormonal changes related to menopause, including decreased estrogen levels, play a significant role in the development of metabolic disorders.[9] Estrogen is known to influence fat distribution, lipid metabolism, and insulin sensitivity, and its decline during menopause has been linked to the accumulation of visceral fat, which is a key factor in the development of MetS components.[10] The higher incidence of abdominal obesity in postmenopausal women in our study (70%) is particularly notable. Studies have consistently found that postmenopausal women experience a redistribution of fat from peripheral areas to the abdominal region, a phenomenon largely attributed to the decline in estrogen levels.[11] This pattern is also seen in studies from various Asian countries, including India and China, where postmenopausal women exhibit higher levels of central obesity compared to premenopausal women.[12] Our findings align with these studies, reinforcing the importance of abdominal obesity as a key risk factor for the development of MetS in postmenopausal women.

The results of this study showed that 45% of menopausal women had elevated triglyceride levels, which is consistent with findings from other studies. For instance, a study conducted in Saudi Arabia found that menopausal women had higher levels of triglycerides compared to non-menopausal women, further supporting the role of hormonal changes in lipid metabolism.[13] Elevated triglycerides are a critical component of MetS and have been shown to increase the risk of cardiovascular disease and diabetes, which are highly prevalent in menopausal women. Hormonal fluctuations during menopause can lead to an imbalance in lipid metabolism, characterized by higher triglyceride levels and lower HDL-C levels, both of which are risk factors for cardiovascular diseases.[14] In this study, the prevalence of elevated fasting blood glucose (50%) was also significantly higher in menopausal women compared to non-menopausal women (25%). These findings align with studies from other regions, where postmenopausal women show an increased risk of insulin resistance and hyperglycemia.[15] A study conducted in the United States found that the prevalence of impaired fasting glucose was higher among postmenopausal women than premenopausal women, even after adjusting for factors such as age and body mass index.[16] The increase in FBG levels post-menopause is likely due to changes in insulin sensitivity and glucose metabolism, which are exacerbated by abdominal obesity and reduced estrogen levels.[17]

Blood Pressure and Menopause

The findings of this study indicate that postmenopausal women had significantly higher systolic and diastolic blood pressure compared to non-menopausal women. This result is in agreement with several studies that have reported an increase in blood pressure following menopause. For example, a study from Japan found that systolic blood pressure increases with age, and this effect is more pronounced in postmenopausal women.[18] Similarly, a study in South Korea observed that blood pressure increased significantly in women after menopause, with elevated blood pressure being one of the most

common cardiovascular risk factors in this population.[19] The rise in blood pressure post-menopause has been attributed to several factors, including the loss of estrogen's vasodilatory effect, which leads to increased arterial stiffness and higher systemic vascular resistance.[20] Additionally, hormonal changes during menopause can affect the renin-angiotensin-aldosterone system and the sympathetic nervous system, both of which play crucial roles in regulating blood pressure.[21] The findings of this study suggest that menopause may serve as a critical period for the onset of hypertension, underscoring the need for regular blood pressure monitoring and early intervention in menopausal women.

HDL-C Levels and Metabolic Syndrome

In this study, low HDL-C was found to be more prevalent in menopausal women (35%) compared to non-menopausal women (45%), though the difference was not statistically significant. Several studies have reported a decrease in HDL-C levels after menopause, and this decline is often considered one of the hallmark features of MetS in postmenopausal women. For example, a study from Brazil found that HDL-C levels were significantly lower in postmenopausal women compared to premenopausal women, even after adjusting for lifestyle factors such as diet and physical activity.[22] Estrogen is known to increase the synthesis of HDL-C and enhance its clearance, so its decline during menopause may contribute to the lower levels of this beneficial cholesterol in postmenopausal women.[23] However, while HDL-C is a critical component of lipid metabolism, the findings from this study suggest that other factors, such as triglycerides and blood glucose, may play a more prominent role in determining the risk of MetS in Bangladeshi women. This highlights the importance of a comprehensive approach to the diagnosis and management of MetS, where all components, including HDL-C, should be monitored and addressed.

Logistic Regression and Risk Factors for Metabolic Syndrome

The results of the logistic regression analysis showed a significant positive association between menopause and elevated blood pressure, elevated triglycerides, and elevated fasting blood glucose, while no significant association was found for waist circumference and HDL-C. These findings are consistent with those from other studies that have used similar regression models to assess the risk factors for MetS in postmenopausal women. A study in Canada found that menopause significantly increased the odds of developing hypertension and insulin resistance, with age and obesity being the primary risk factors for MetS in this population.[24] Similarly, a study in Egypt found that menopausal women had a higher risk of developing hypertension and dyslipidemia, and the odds of having MetS increased with the duration of menopause.[25] Interestingly, the findings from this study suggest that waist circumference, which is often considered the key indicator of abdominal obesity, did not show a significant association with MetS in menopausal women after adjusting for age and other factors. This could be due to the fact that central obesity is already prevalent in this population, and other factors such as insulin resistance or inflammation may play a more significant role in the development of MetS. A study from the United Kingdom found that visceral fat, rather than overall body weight or waist circumference, is a better predictor of MetS in postmenopausal women.[26]

Age and the Prevalence of Metabolic Syndrome

This study also found that the prevalence of MetS components increased with age, particularly in the 50–55-year age group. Similar trends have been reported in other studies, where the incidence of MetS and its components rises significantly in older menopausal women. For instance, a study from India observed that women aged 50-55 years were more likely to have multiple components of MetS, including abdominal obesity, high triglycerides, and elevated blood pressure, compared to younger postmenopausal women.[27] The increased risk of MetS with age can be attributed to several factors, including the cumulative effects of hormonal changes, lifestyle factors, and the natural aging process. The decline in estrogen during menopause accelerates the risk of developing chronic conditions such as hypertension, diabetes, and dyslipidemia, which become more pronounced as women age.[28]

Implications for Public Health and Clinical Practice

The findings of this study have important implications for public health policies and clinical practices in Bangladesh. The higher prevalence of MetS components in postmenopausal women underscores the need for targeted health interventions

aimed at preventing and managing MetS in this population. Lifestyle modifications, including weight management, regular physical activity, and dietary changes, should be emphasized, as these have been shown to reduce the risk of developing MetS and its components.[29] Additionally, regular screening for blood pressure, fasting blood glucose, and lipid profiles is essential for early detection and management of MetS in menopausal women. Furthermore, healthcare providers should be aware of the increased cardiovascular risks in menopausal women and consider pharmacological interventions when necessary. For instance, statins may be used to manage elevated cholesterol levels, while antihypertensive medications may be prescribed for women with elevated blood pressure. Hormone replacement therapy (HRT) has also been shown to mitigate some of the metabolic changes associated with menopause, although its use must be carefully considered based on individual risk factors, particularly for women at risk for breast cancer or cardiovascular disease.[30]

CONCLUSION

This study highlights the significant association between menopause and the increased prevalence of metabolic syndrome (MetS) components, such as abdominal obesity, elevated triglycerides, and fasting blood glucose levels, in Bangladeshi women. The results underscore the importance of monitoring menopausal women for MetS and related cardiovascular risks. As menopause accelerates the development of MetS, early intervention strategies are crucial. Future research should explore the underlying mechanisms and the efficacy of personalized interventions in mitigating MetS risks among postmenopausal women.

Recommendations

Implement regular screening for MetS components in menopausal women.

Promote lifestyle interventions, including physical activity and dietary modifications.

Investigate the role of hormone replacement therapy in preventing MetS in menopausal women.

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