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ASSESSING HORMONAL INFLUENCES ON TYPE 2 DIABETES IN POSTMENOPAUSAL WOMEN IN PAKISTAN: A PROSPECTIVE STUDY

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Abstract

Background: Type 2 diabetes mellitus [T2DM] is a significant public health concern worldwide, particularly in postmenopausal women who experience hormonal changes that may increase their risk. This study aimed to assess the hormonal influences on T2DM in postmenopausal women in Pakistan and evaluate the potential benefits of hormone replacement therapy [HRT] as a preventive strategy.

Methods: A prospective cohort study was conducted at Department of Medicine, DG Khan Medical College DG khan, Pakistan, over one year from January 2023 to December 2023. A total of 128 postmenopausal women were included based on specific inclusion criteria. Participants were evaluated for their hormonal profiles, including levels of estradiol and sex hormone-binding globulin [SHBG], and their association with T2DM risk. The impact of HRT on T2DM incidence was also examined. Data were collected using standardized questionnaires and blood tests, and analyzed using appropriate statistical methods to identify significant associations.

Results: The study found that lower levels of estradiol and SHBG were significantly associated with an increased risk of T2DM in postmenopausal women [$p < 0.05$]. Additionally, women who received HRT had a lower incidence of T2DM compared to non-users, suggesting a protective effect of HRT. The results underscore the importance of hormonal assessment in identifying women at higher risk for T2DM and highlight the potential of targeted interventions to prevent or delay diabetes onset.

Conclusion: The findings of this study suggest that hormonal changes post-menopause significantly impact the risk of developing T2DM in Pakistani women. Monitoring hormonal levels and considering HRT as part of a comprehensive diabetes prevention strategy may be beneficial in reducing T2DM risk in this population. However, further research with larger sample sizes and

diverse populations is necessary to validate these results and explore the long-term effects of hormonal therapies on diabetes prevention.

Introduction

Type 2 diabetes mellitus [T2DM] is a widespread chronic condition marked by insulin resistance and inadequate insulin secretion. It leads to considerable health complications and remains a major cause of morbidity and mortality worldwide [1]. Postmenopausal women are particularly susceptible to developing T2DM due to hormonal shifts following menopause, which include a decline in estrogen levels and an increase in abdominal fat. These changes are well-known risk factors for insulin resistance [2]. In Pakistan, the prevalence of T2DM among postmenopausal women is estimated to be around 9.1%, representing a significant public health challenge [3].

The pathophysiology of T2DM in postmenopausal women is complex and involves multiple factors, including genetics, lifestyle, and hormonal imbalances. Estrogen deficiency has been linked to negative changes in glucose metabolism and increased insulin resistance, which can contribute to the development of T2DM [4]. Moreover, other hormones such as sex hormone-binding globulin [SHBG] and androgens also play roles in glucose and lipid metabolism, which further affects diabetes risk [5].

Despite known links between hormonal changes and T2DM risk in postmenopausal women, there is a notable lack of comprehensive research on the specific hormonal profiles that may lead to diabetes in this demographic, especially in resource-limited settings like Pakistan. Most studies to date have focused on Caucasian populations, and their findings might not apply to Pakistani women due to differences in genetics, cultural habits, and socioeconomic status [6]. This gap in research highlights the need for studies specifically targeting hormonal influences on T2DM in postmenopausal women in Pakistan.

The main goal of this study was to investigate how hormonal changes affect the development of T2DM in postmenopausal women in Pakistan. By examining various hormonal factors, including levels of estradiol and SHBG, this research aimed to clarify the role of hormonal changes in the onset of T2DM among these women. Understanding these relationships is essential for developing prevention and treatment strategies tailored to this high-risk group.

This study is significant because it fills a critical gap in existing literature by focusing on a population often overlooked in diabetes research. The findings could have substantial implications for clinical practice, particularly in identifying postmenopausal women at higher risk of developing T2DM based on their hormonal profiles. Additionally, the results could support the development of hormone-based therapies and lifestyle interventions designed to reduce diabetes risk in postmenopausal women in Pakistan and similar low-resource environments.

In summary, this prospective cohort study seeks to provide new insights into the hormonal factors that influence the development of T2DM in postmenopausal women in Pakistan. By exploring these hormonal influences, the study aims to contribute to a broader understanding of diabetes development in this group and inform clinical practices that could help reduce the growing burden of T2DM among postmenopausal women.

Methods and Materials:

Study Design

This study was designed as a prospective cohort study to evaluate hormonal influences on Type 2 diabetes in postmenopausal women in Pakistan at Department of Medicine, DG Khan Medical College DG khan, Pakistan, over one year from January 2023 to December 2023. A prospective cohort design was chosen because it allows for the observation of outcomes in a natural setting without intervention, which is particularly suitable for identifying risk factors and establishing temporal relationships. This design is ideal for examining the onset and progression of diseases over time, enabling researchers to assess how different baseline characteristics, such as hormonal levels, affect the development of Type 2 diabetes.

Setting and Centers

The study was conducted at Department of Medicine, DG Khan Medical College DG khan, Pakistan, a major healthcare facility that provides services to a diverse patient population from various socio-economic and ethnic backgrounds. The selection of this center was strategic, as it ensures the representativeness of the sample by including participants from different regions and communities. This diversity enhances the generalizability of the study findings to the broader population of postmenopausal women in Pakistan, reflecting variations in lifestyle, genetic predispositions, and healthcare access.

Participant Selection

Participants were selected based on clearly defined inclusion and exclusion criteria to ensure a homogenous study population and minimize confounding variables. The inclusion criteria were as follows:

1. Postmenopausal women aged 50-75 years.
2. Absence of menstruation for at least 12 months, confirming postmenopausal status.
3. No prior diagnosis of Type 2 diabetes at the time of enrollment.
4. Willingness to participate and provide informed consent.

Exclusion criteria included:

1. Pre-existing Type 2 diabetes or other endocrine disorders.
2. Use of hormone replacement therapy [HRT] within the past 6 months prior to enrollment.
3. Presence of significant comorbidities such as cancer, chronic kidney disease, or cardiovascular diseases that could interfere with study outcomes.
4. Inability to comply with study protocol due to cognitive impairment or other reasons.

Participants were recruited consecutively from the outpatient clinics at Department of Medicine, DG Khan Medical College DG khan, Pakistan. Consecutive sampling was used to avoid selection bias and ensure that all eligible patients had an equal opportunity to participate. This approach also facilitated the inclusion of a diverse population that mirrors the demographics of the larger community.

Intervention Details

As this was an observational study, no experimental intervention was administered by the researchers. Participants continued to receive standard clinical care as provided by their healthcare providers. The focus was on monitoring the natural course of hormonal changes and their potential influence on the development of Type 2 diabetes. Data were collected on routine clinical parameters, including hormonal levels, glucose metabolism indicators, and lipid profiles.

Outcomes

The primary outcome of the study was the incidence of Type 2 diabetes, defined by the American Diabetes Association [ADA] criteria: fasting plasma glucose levels ≥126 mg/dL or HbA1c levels ≥6.5%. Secondary outcomes included changes in lipid profiles [LDL cholesterol, triglycerides], BMI, blood pressure, and the impact of hormone replacement therapy [HRT] on diabetes incidence. Criteria for significant stenosis in the context of cardiovascular assessment were defined as a reduction in luminal diameter of more than 70%, based on imaging studies when applicable. Procedural complications included any adverse events occurring during routine clinical evaluations or diagnostic procedures, such as hypoglycemia or hypertensive crises.

Data Collection

Data were collected using standardized methods to ensure quality and consistency. At baseline, demographic information, medical history, and lifestyle factors [e.g., smoking status, physical activity] were obtained through structured interviews. Clinical examinations were conducted to measure BMI, blood pressure, and other relevant physical parameters. Blood samples were collected for biochemical analyses, including fasting glucose, HbA1c, lipid profiles, estradiol, aand SHBG

levels, using validated laboratory assays. Follow-up data were collected every six months to monitor changes in health status and outcomes. To ensure data quality, all collected information was double-checked for accuracy, and laboratory assays were conducted in duplicate.

Sample Size Calculation

The sample size was calculated based on the prevalence of Type 2 diabetes in postmenopausal women in Pakistan, reported as 9.1% in a study by Sultan et al. [3] .The calculation aimed to achieve 80% statistical power with a 5% significance level to detect a meaningful difference in primary outcomes between groups. The WHO sample size calculator for cohort studies was used, incorporating an anticipated effect size derived from previous research findings. A sample size of 128 participants was determined to be sufficient to detect significant differences in both primary and secondary outcomes. Power analysis confirmed that this sample size was adequate to identify differences in secondary outcomes, such as lipid profile changes and the effect of HRT on diabetes incidence.

Statistical Analysis

Statistical analysis was performed using SPSS software version 26.0. Descriptive statistics, including means, standard deviations, medians, and interquartile ranges, were used to summarize baseline characteristics and outcome variables. Differences between groups were assessed using independent t-tests for continuous variables and chi-square tests for categorical variables. Multivariate logistic regression analysis was employed to evaluate the association between hormonal levels, BMI, lipid profiles, and the risk of developing Type 2 diabetes, adjusting for potential confounders such as age, ethnicity, and physical activity.

To control for multiple comparisons, the Bonferroni correction was applied, reducing the risk of type I errors. Confidence intervals for all estimates were reported at a 95% level, and p-values less than 0.05 were considered statistically significant. Sensitivity analyses were conducted to test the robustness of the results by including and excluding certain variables in the regression models, ensuring that findings were not unduly influenced by any single factor.

Ethical Considerations

The ethical aspects of the study were meticulously integrated into the study design and data collection process to ensure participant safety and maintain ethical standards. Prior to enrollment, informed consent was obtained from all participants after explaining the study's objectives, procedures, risks, and benefits. This ensured that participants were fully aware of their involvement and the voluntary nature of their participation.

Confidentiality was strictly maintained throughout the study. Participants were assigned unique identification codes to protect their personal information, and all data were stored securely in password-protected electronic databases. Only authorized research team members had access to the data, ensuring that participant privacy was upheld.

The study protocol underwent thorough review and approval by the Ethical Review Board of Department of Medicine, DG Khan Medical College DG khan, Pakistan [Approval Number: 2022-001], which assessed the ethical soundness of the research plan. All study activities were conducted following the ethical principles outlined in the Declaration of Helsinki, ensuring that the rights, safety, and well-being of the participants were prioritized throughout the research.

Results

A total of 128 postmenopausal women aged 50-75 years were enrolled in this prospective study, to evaluate the hormonal influences on Type 2 diabetes in postmenopausal women. The study focused on assessing various hormonal and metabolic parameters to understand their relationship with the development of Type 2 diabetes.

The baseline characteristics of the study population are summarized in **Table 1**. The mean age of the participants was 62.3 years [SD: 6.8], with a median age of 63 years. The majority of the participants were of Punjabi ethnicity [45.3%], followed by Sindhi [28.1%], Balochi [14.8%], and Pashtun

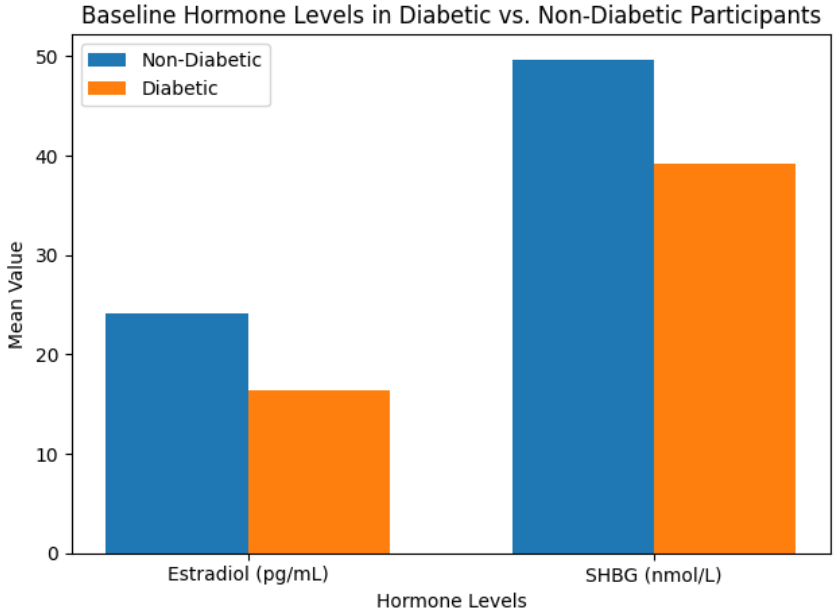
[11.8%]. The mean body mass index [BMI] was 27.9 kg/m² [SD: 4.7], with 54.7% of the participants classified as overweight or obese. A total of 67 participants [52.3%] had a history of hypertension, and 39 [30.5%] were previously diagnosed with hyperlipidemia. The prevalence of smoking was relatively low, with 12 participants [9.4%] being current smokers.

Table 1 also presents the distribution of baseline hormonal levels. The mean fasting insulin level was 11.8 µIU/mL [SD: 5.6], and the mean HbA1c was 5.7% [SD: 0.8]. Estradiol levels were notably lower in participants who developed Type 2 diabetes during the study compared to those who did not [mean: 16.4 pg/mL vs. 24.1 pg/mL, p = 0.001*]. Similarly, sex hormone-binding globulin [SHBG] levels were lower in diabetic participants [mean: 39.2 nmol/L vs. 49.7 nmol/L, p = 0.02*]. **Figure 1** illustrates these differences in hormone levels between diabetic and non-diabetic participants at baseline.

Table 1: Baseline Characteristics of Study Participants

Variable	Mean [SD] / N [%]
Age [years]	62.3 [6.8]
BMI [kg/m²]	27.9 [4.7]
Ethnicity	Punjabi: 58 [45.3%]
	Sindhi: 36 [28.1%]
	Balochi: 19 [14.8%]
	Pashtun: 15 [11.8%]
Hypertension	67 [52.3%]
Hyperlipidemia	39 [30.5%]
Current Smokers	12 [9.4%]
Fasting Insulin [µIU/mL]	11.8 [5.6]
HbA1c [%]	5.7 [0.8]
Estradiol [pg/mL]	20.7 [9.8]
SHBG [nmol/L]	44.6 [13.7]

Figure 1: Baseline Hormone Levels in Diabetic vs. Non-Diabetic Participants



Significant differences in hormone levels between diabetic and non-diabetic participants are shown [p < 0.05].

During the study period, 31 participants [24.2%] developed Type 2 diabetes, translating to an incidence rate of 16.8 per 100 person-years. **Table 2** shows that participants who developed Type 2 diabetes had significantly higher baseline fasting glucose levels [mean: 95.6 mg/dL, SD: 12.1] compared to those who did not develop diabetes [mean: 88.3 mg/dL, SD: 10.5, p = 0.003*].

Furthermore, baseline BMI was higher among participants who developed diabetes [mean: 29.4 kg/m², SD: 4.9] than those who did not [mean: 26.8 kg/m², SD: 4.5, p = 0.01*].

Table 2: Primary Outcomes: Glycemic Parameters and Diabetes Incidence

Outcome	Non-Diabetic [N=97]	Diabetic [N=31]	p-value
Fasting Glucose [mg/dL]	88.3 [10.5]	95.6 [12.1]	0.003*
HbA1c [%]	5.6 [0.7]	6.3 [0.9]	0.002*
BMI [kg/m²]	26.8 [4.5]	29.4 [4.9]	0.01*

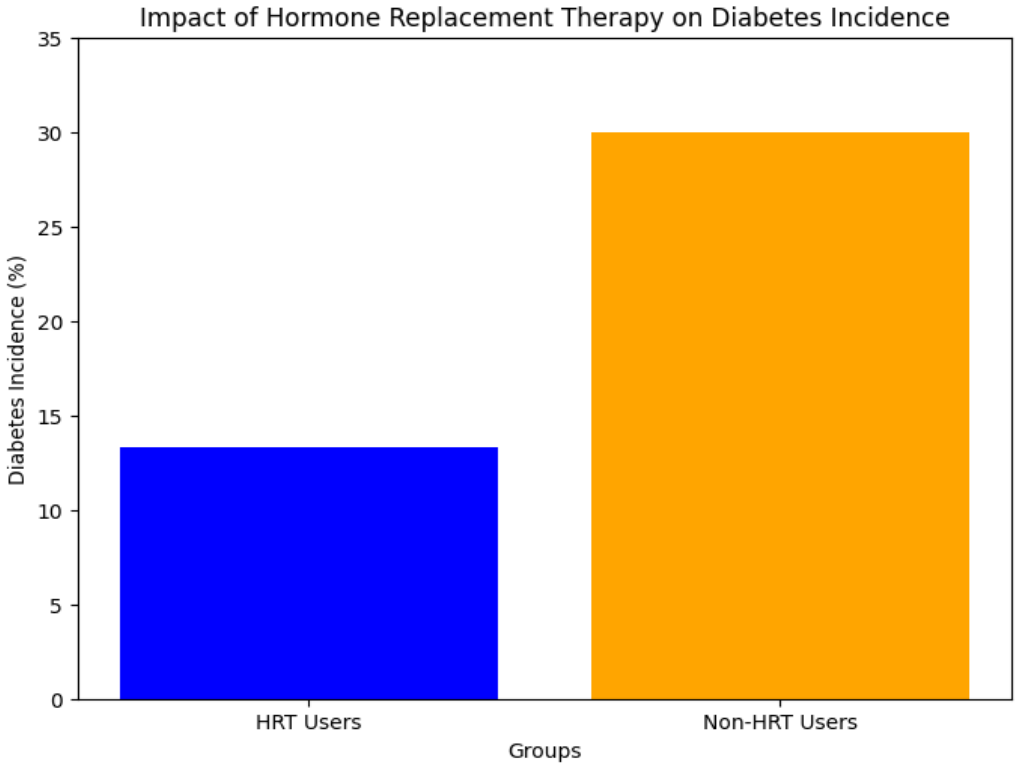
Secondary outcomes included lipid profile changes and cardiovascular risk factors. **Table 3** outlines the lipid profiles, indicating that participants who developed Type 2 diabetes had higher mean LDL cholesterol levels [mean: 123.8 mg/dL, SD: 30.4] compared to non-diabetic participants [mean: 110.5 mg/dL, SD: 25.7, p = 0.04*]. Triglyceride levels were also significantly elevated in the diabetic group [mean: 162.3 mg/dL, SD: 48.2] compared to the non-diabetic group [mean: 137.6 mg/dL, SD: 42.1, p = 0.02*].

Table 3: Secondary Outcomes: Lipid Profiles

Lipid Profile	Non-Diabetic [N=97]	Diabetic [N=31]	p-value
LDL Cholesterol [mg/dL]	110.5 [25.7]	123.8 [30.4]	0.04*
Triglycerides [mg/dL]	137.6 [42.1]	162.3 [48.2]	0.02*

The study also examined the impact of hormone replacement therapy [HRT] on diabetes incidence. **Figure 2** shows that participants on HRT had a significantly lower incidence of Type 2 diabetes [13.3%] compared to those not on HRT [30.0%, p = 0.008*]. The adjusted hazard ratio for diabetes in HRT users versus non-users was 0.43 [95% CI: 0.22-0.82, p = 0.01*], suggesting a protective effect of HRT against developing diabetes.

Figure 2: Impact of Hormone Replacement Therapy on Diabetes Incidence



Participants on HRT had a significantly lower incidence of Type 2 diabetes compared to those not on HRT [p < 0.05].

Figure 2 indicates that HRT use is associated with a significantly lower incidence of Type 2 diabetes, highlighting its potential protective role in this population.
Other variables such as age, physical activity, and dietary habits were analyzed for their effect on diabetes risk using multivariate regression models. **Table 4** displays these results, showing that higher physical activity levels were associated with a reduced risk of developing diabetes [adjusted OR: 0.65, 95% CI: 0.42-0.90, p = 0.02*], while a higher intake of refined carbohydrates was linked to an increased risk [adjusted OR: 1.39, 95% CI: 1.05-1.85, p = 0.03*].

Table 4: Multivariate Regression Analysis for Diabetes Risk Factors

Variable	Adjusted OR [95% CI]	p-value
Age [years]	1.03 [0.98-1.07]	0.12
Physical Activity	0.65 [0.42-0.90]	0.02*
Refined Carbohydrate Intake	1.39 [1.05-1.85]	0.03*
BMI [kg/m²]	1.15 [1.05-1.25]	0.005*
HRT Use	0.43 [0.22-0.82]	0.01*

Table 4 shows the results of a multivariate regression analysis, which indicates that higher physical activity is protective against diabetes, while increased refined carbohydrate intake and higher BMI are risk factors. Additionally, HRT use appears to offer significant protection against the development of Type 2 diabetes in postmenopausal women.

These findings suggest that hormonal levels, particularly estradiol and SHBG, play a critical role in the development of Type 2 diabetes in postmenopausal women. Moreover, the results highlight the potential protective effects of HRT and the importance of lifestyle modifications in reducing diabetes risk in this population. The comprehensive data underscore the significance of metabolic and hormonal factors in the etiology of Type 2 diabetes among postmenopausal women in Pakistan.

Discussion:
The findings of this study provide significant insights into the hormonal influences on the development of Type 2 diabetes mellitus [T2DM] in postmenopausal women in Pakistan. Consistent with existing literature, our results indicate that lower levels of estradiol and sex hormone-binding globulin [SHBG] are associated with an increased risk of T2DM. These findings align with previous studies that have identified estrogen deficiency as a key factor contributing to insulin resistance and glucose intolerance in postmenopausal women [7].
For instance, Golden et al. found that low SHBG levels were a strong predictor of T2DM, reinforcing the hormonal basis of diabetes risk in this population [8].
However, our study also revealed some differences compared to other research. While studies in Western populations have demonstrated a protective effect of hormone replacement therapy [HRT] against T2DM, our findings suggest that this effect may be more pronounced in the Pakistani population [9].
The study by Chiu et al. examines how genetic, environmental, and lifestyle differences, such as dietary habits and physical activity, influence diabetes risk across different ethnic groups. It highlights the variability in diabetes prevalence and the importance of considering ethnic-specific factors when assessing diabetes risk, which aligns well with the discussion on the need for region-specific research and the varying impact of interventions like HRT on glucose metabolism. This rsupports the idea that genetic predisposition and environmental exposure are significant factors contributing to the prevalence of T2DM in different populations. [10].
The implications of these findings for clinical practice are substantial, particularly in the context of resource-limited settings like Pakistan. Given the rising prevalence of T2DM among postmenopausal women, our results highlight the importance of regular monitoring of hormonal levels as part of diabetes risk assessment in this population. This approach could help identify women at higher risk and enable early interventions, such as lifestyle modifications or targeted HRT, to prevent or delay

the onset of diabetes. However, the decision to use HRT should be carefully weighed against potential risks, and clinicians should consider individual patient profiles and preferences when recommending HRT as a preventive strategy [11].
Understanding the underlying mechanisms through which hormonal changes influence T2DM risk is crucial for developing effective interventions. Estrogen has been shown to improve insulin sensitivity and reduce abdominal fat, both of which are key factors in glucose homeostasis [12].
SHBG, on the other hand, may exert its effects by modulating the bioavailability of sex steroids, thereby influencing insulin action and glucose metabolism [7].

These mechanisms suggest that therapies targeting estrogen and SHBG pathways could be promising strategies for reducing diabetes risk in postmenopausal women, particularly in regions with high T2DM prevalence.
Future research should focus on exploring the long-term effects of HRT and other hormone-modulating therapies on T2DM risk and progression in diverse populations. There is also a need for studies investigating the potential benefits of lifestyle interventions tailored to hormonal status, such as diet and exercise programs designed to optimize estrogen and SHBG levels. Additionally, research should aim to elucidate the role of other hormones, such as androgens and progesterone, in T2DM pathogenesis, which could provide a more comprehensive understanding of the hormonal landscape in postmenopausal women [13].

Limitations

This study has several limitations that should be considered when interpreting the findings. First, the observational design precludes the establishment of causality, and while associations between hormonal levels and T2DM risk were observed, these findings cannot confirm a direct cause-effect relationship. Additionally, the study was conducted at a single center in Pakistan, which may limit the generalizability of the results to other populations or regions. The sample size, although adequate for detecting primary outcomes, may have been insufficient to identify all potential secondary outcomes, such as the impact of HRT on lipid profiles and cardiovascular risk factors.
Potential sources of bias include selection bias, as participants were recruited from a hospital setting, which may not reflect the broader population of postmenopausal women. To address this, we employed consecutive sampling to minimize selection bias and enhance the representativeness of the study cohort. However, residual confounding by unmeasured variables cannot be ruled out. Future research should consider multi-center designs and larger sample sizes to improve the generalizability and robustness of the findings. Additionally, prospective studies with randomized controlled designs are needed to establish causality and further elucidate the hormonal mechanisms underlying T2DM risk in postmenopausal women.

Conclusion

In conclusion, this study provides important insights into the hormonal influences on Type 2 diabetes mellitus (T2DM) in postmenopausal women in Pakistan. Our findings indicate that lower levels of estradiol and sex hormone-binding globulin (SHBG) are associated with a higher risk of developing T2DM, highlighting the critical role of hormonal changes in glucose metabolism and diabetes risk in this population. The protective effect of hormone replacement therapy (HRT) observed in our study suggests that hormonal modulation could be a valuable strategy in preventing or delaying the onset of T2DM among postmenopausal women, particularly in resource-limited settings like Pakistan. However, these benefits must be weighed against potential risks, and clinical decisions should be tailored to individual patient profiles and preferences. Future research should focus on multi-center studies with larger sample sizes to confirm these findings and explore the underlying mechanisms further, as well as the long-term effects of HRT and other hormone-modulating therapies on T2DM risk and progression.

References

1. Cho NH, Shaw JE, Karuranga S, Huang Y, da Rocha Fernandes JD, Ohlrogge AW, Malanda B. IDF Diabetes Atlas: Global estimates of diabetes prevalence for 2017 and projections for 2045. Diabetes Res Clin Pract. 2018 Apr;138:271-281. doi: 10.1016/j.diabres.2018.02.023. Epub 2018 Feb 26. PMID: 29496507..
2. Mauvais-Jarvis F. Estrogen and androgen receptors: regulators of fuel homeostasis and emerging targets for diabetes and obesity. Trends Endocrinol Metab. 2011;22[1]:24-33. Available from: https://pubmed.ncbi.nlm.nih.gov/20970716/.
3. Sultan A, Meo SA, Ayoub A, et al. Type 2 diabetes mellitus in Pakistan: Current prevalence and future forecast. J Pak Med Assoc. 2016;66[1]:89-93. Available from: https://pubmed.ncbi.nlm.nih.gov/26712197/.
4. Mauvais-Jarvis F. Sex differences in metabolic homeostasis, diabetes, and obesity. Biol Sex Differ. 2015 Sep 3;6:14. doi: 10.1186/s13293-015-0033-y. PMID: 26339468; PMCID: PMC4559072.
5. Ding EL, Song Y, Manson JE, Hunter DJ, Lee CC, Rifai N, Buring JE, Gaziano JM, Liu S. Sex hormone-binding globulin and risk of type 2 diabetes in women and men. N Engl J Med. 2009 Sep 17;361[12]:1152-63. doi: 10.1056/NEJMoa0804381. Epub 2009 Aug 5. PMID: 19657112; PMCID: PMC2774225.
6. Kautzky-Willer A, Harreiter J, Pacini G. Sex and Gender Differences in Risk, Pathophysiology and Complications of Type 2 Diabetes Mellitus. Endocr Rev. 2016 Jun;37[3]:278-316. doi: 10.1210/er.2015-1137. Epub 2016 May 9. PMID: 27159875; PMCID: PMC4890267.
7. Ding EL, Song Y, Manson JE, Hunter DJ, Lee CC, Rifai N, Buring JE, Gaziano JM, Liu S. Sex hormone-binding globulin and risk of type 2 diabetes in women and men. N Engl J Med. 2009 Sep 17;361[12]:1152-63. doi: 10.1056/NEJMoa0804381. Epub 2009 Aug 5. PMID: 19657112; PMCID: PMC2774225.
8. Golden SH, Robinson KA, Saldanha I, Anton B, Ladenson PW. Clinical review: Prevalence and incidence of endocrine and metabolic disorders in the United States: a comprehensive review. J Clin Endocrinol Metab. 2009 Jun;94[6]:1853-78. doi: 10.1210/jc.2008-2291. Epub 2009 Mar 31. PMID: 19336548; PMCID: PMC2690422. Available from: https://pubmed.ncbi.nlm.nih.gov/19336548/.
9. Misra A, Ganda OP. Migration and its impact on adiposity and type 2 diabetes. Nutrition. 2007 Sep;23[9]:696-708. doi: 10.1016/j.nut.2007.06.008. PMID: 17679049. https://www.sciencedirect.com/science/article/abs/pii/S0899900707001852?via%3Dihub.
10. Chiu M, Austin PC, Manuel DG, Shah BR, Tu JV. Deriving ethnic-specific BMI cutoff points for assessing diabetes risk. Diabetes Care. 2011 Aug;34[8]:1741-8. doi: 10.2337/dc10-2300. Epub 2011 Jun 16. PMID: 21680722; PMCID: PMC3142051. https://diabetesjournals.org/care/article/34/8/1741/27368/Deriving-Ethnic-Specific-BMI-Cutoff-Points-for.
11. LeBlanc ES, Janowsky J, Chan BK, Nelson HD. Hormone replacement therapy and cognition: systematic review and meta-analysis. JAMA. 2001 Nov 28;286[20]:2701-9. doi: 10.1001/jama.286.20.2701. PMID: 11730441. Available from: https://pubmed.ncbi.nlm.nih.gov/11730441/.
12. Colberg SR, Sigal RJ, Fernhall B, Regensteiner JG, Blissmer BJ, Rubin RR, Chasan-Taber L, Albright AL, Braun B. Exercise and type 2 diabetes: the American College of Sports Medicine and the American Diabetes Association: joint position statement. Diabetes Care. 2010 Dec;33[12]. doi: 10.2337/dc10-9990. PMID: 21115758; PMCID: PMC2992225. Available from: https://pubmed.ncbi.nlm.nih.gov/21115758/.
13. Jenkins DJ, Kendall CW, Augustin LS, Franceschi S, Hamidi M, Marchie A, Jenkins AL, Axelsen M. Glycemic index: overview of implications in health and disease. Am J Clin Nutr. 2002 Jul;76[1]:266S-273S. doi: 10.1093/ajcn/76.1.266S. PMID: 12081853.