REVIEW ARTICLE

Unleashing the Potential of Physical Activity in Type 2 Diabetic Postmenopausal Women: A Review

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ABSTRACT

Background: The prevalence of Type 2 Diabetes Mellitus (T2DM) is escalating in postmenopausal women, necessitating a comprehensive exploration of effective intervention strategies. Understanding the complex interplay between menopause, diabetes, and physical activity is crucial for developing targeted, evidence-based interventions. By exploring the physiological, psychological, and metabolic responses to different forms of exercise, this review aims to delve into the existing research to see the impacts of physical activity on T2DM postmenopausal health.

Methods: A comprehensive search of peer-reviewed articles, clinical trials, and observational studies on physical activity and postmenopausal women with T2DM was conducted from various databases. Relevant literature was identified and analyzed to discern patterns and key findings. Inclusion criteria focused on the latest 10 years of clinical studies published up to the present, ensuring a contemporary understanding of the subject matter.

Results: Out of the identified 10 studies, four reported improved glucose regulation and metabolic health, highlighting exercise's role in managing metabolic parameters in postmenopausal women. Three studies provided benefits in body composition overall, physical performance, and muscle strength. The other three include improved quality of life, hormonal changes, and osteoporosis prevention, showcasing the broad health impacts of exercise.

Conclusion: The collective evidence from this review presents a strong argument for implementing structured exercise programs addressing various health outcomes for postmenopausal women. This review, hence, contributes to establishing the role of physical activity in maintaining a healthy lifestyle in type 2 diabetic postmenopausal women.

Keywords: Exercise regimens; Intervention strategies; Physical activity; Postmenopausal women; and Type 2 Diabetes Mellitus.

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INTRODUCTION

Postmenopausal women represent a demographic subgroup facing a unique intersection of health challenges, among which the T2DM prevalence stands out as a significant concern [1]. Menopause, a natural physiological transition marking the cessation of reproductive function, introduces a cascade of hormonal changes, primarily a decline in estrogen levels [2]. This hormonal shift is intricately linked to alterations in metabolism, body composition, and insulin sensitivity, creating a predisposition for the development of Type 2 Diabetes [3].

The postmenopausal phase, typically occurring around the age of 50, is characterized by a complex interplay of biological, lifestyle, and genetic factors that contribute to an increased susceptibility to metabolic disorders, including T2DM [4]944 ever-married women aged 15-49 yr were used; women of older ages were not included in this survey. Since not all women in this age group had achieved natural menopause at the time of survey, Cox proportional hazard regression models were employed to obtain the median age of women reporting a natural menopause, excluding those who underwent hysterectomy. Hazard ratios (HRs. The reduction in estrogen levels during menopause is connected with variations in adipose tissue distribution, favoring an increase in visceral fat. This redistribution and a decrease in lean muscle mass may contribute to insulin resistance, a hallmark of T2DM [5].

Given the rising global prevalence of postmenopausal conditions and T2DM, understanding the nuanced interconnection between these phenomena is paramount [6]. Furthermore, postmenopausal women often experience other metabolic perturbations, such as alterations in lipid profiles and an increase in inflammatory markers, which further amplify the risk of developing T2DM [3]. Factors such as physical activity and diet patterns play crucial part in this intricate relationship, shaping the metabolic landscape during the postmenopausal years [7].

The interplay between postmenopausal conditions and T2DM holds implications not only for the management and prevention of diabetes in postmenopausal women but also for the broader realms of women's health, public health strategies, and the development of targeted interventions aimed at preserving metabolic health in this population [8]. This literature review aims to unleash the potential of physical activity, workout, training, etc, on different impairments due to the condition type 2 diabetes in postmenopausal women and to identify effective approaches for mitigating this risk and improving overall health outcomes.

METHODS

Database & Search Strategy:

In the last 10 years, data from PEDro, Scopus, and PubMed/Medline databases were comprehensibly searched for studies recently published. This review followed the PRISMA Extension for Scoping Review (PRISMA-ScR) guidelines [9]. Menopause, Postmenopause, diabetes, type 2 diabetes, physiotherapy, exercise, resistance exercise, aerobic exercise, and physical activity were used for the search keywords. "MeSH (Medical Subject Headings) terms," analogous keywords, "Boolean operators ("OR" and "AND") using Advanced search options" were involved in searching through all the databases.

Inclusion Criteria:

All the articles openly elucidation the physical activity role in T2DM postmenopausal women were included. All types of manuscripts identified through the database search were limited to the English language and full-text articles. The references of the systematic reviews within the search period were also identified and included in the study.

Studies not available in full length, published before the search period, published in other languages, and animal studies were excluded.

PROCEDURE

The initial search was confined to keywords within the title and abstract. Then, the abstracts of the articles meeting the restricted search strategy were assessed based on the inclusion criteria, and in cases of uncertainty, full articles were also retrieved. The identified potentially relevant articles were then obtained in full length, and two authors made the final decision regarding their incorporation into the study. All the included articles were then reviewed to extract the key components relevant to the aim of the study. A PRISMA flow diagram shows the number of studies included and eliminated at each stage and the justifications for exclusion (Figure 1).

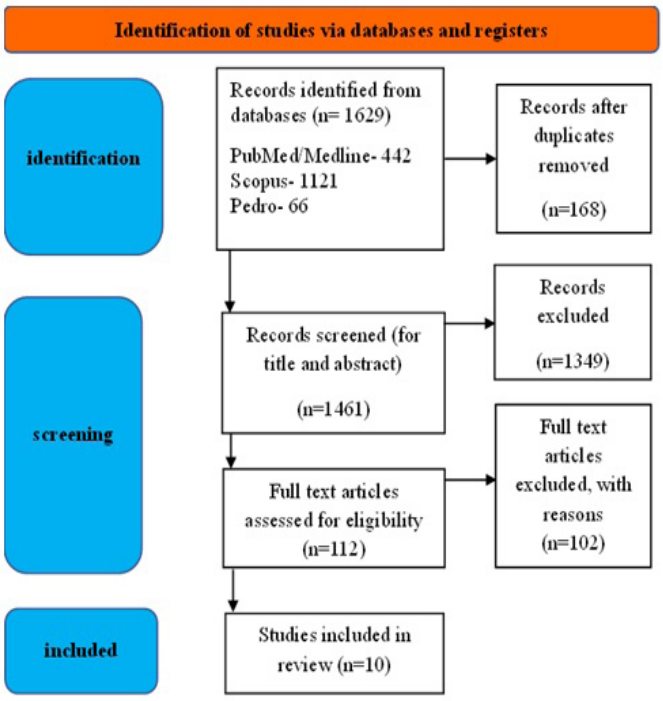

Figure 1: PRISMA flow diagram of the study.

RESULT

One thousand six hundred twenty-nine articles were identified using the aforesaid search strategy. Of these, 1619 articles were excluded, and only 10 were added to the study. Of the excluded articles, 168 were duplicate studies,

1349 were excluded as they included review studies and correlational studies and did not come in the last ten years' criteria, and lastly, 102 studies were excluded due to the unavailability of full-length articles.

The findings of these articles are summarized in (Table 1).

Table 1: Interventions for the treatment of postmenopausal type 2 diabetic women

Author(Year)	Participants	Aim	Intervention	Outcome	Conclusion
(2023)	30 postmenopausal women.	To test the effect of core stability exercises on physical performance, balance, and QoL after Postmenopause.	Experimental group: Core stability exercises + conventional therapy Control Group: Conventional therapy for four weeks.	Menopause-specific quality of life questionnaire Y balance test Short physical performance battery One-leg stance test	Training sessions for core stabilisation have been shown to be more beneficial for improving dynamic balance in postmenopausal women than traditional workouts alone. However, both effectively improve QoL, physical performance, and static balance.
(2022)	19 inactive postmenopausal women.	Investigating the effect of a T2DM family history on metabolism of exercise and substrate oxidation in postmenopausal women, including metabolism and exercise capacity post-exercise.	Cycle ergometer with peak power of 40-70% .	Resting metabolic rate (RMR) Breath samples vacuumed tube DEXA Maximal aerobic capacity ($V^{\cdot}$ O2 peak) Blood Sampling	Findings indicate that oxidation and metabolism during submaximal exercise remain unchanged in the family history of T2DM postmenopausal women in good health. Thus, the alterations in metabolism and substrate oxidation during exercise do not contribute to the tardy responses observed in the exercise benefits among individuals with a family history of T2DM.
Machado PG et al.(12) (2021)	24 postmenopausal women with type 2 diabetes.	To assess the combined functional training intensity influences post-menopausal women with type 2 diabetes cardiometabolic characteristics.	Functional training: Resistance exercises for large muscle groups and aerobic exercises 3 times a week for eight weeks.	Body Composition Analyzer HDL-C, LDL-C, HR, BP, plasma glucose, and glycated hemoglobin	The results demonstrated that, for postmenopausal women with type 2 diabetes, 8 weeks of functional training, at any intensity, is a valuable method for enhancing glucose regulation and fostering positive health outcomes.
Jeon YK et al.(13) (2020)	45 Type 2 diabetic Postmenopausal women.	This study aimed to evaluate the impact of a combined aerobic and resistance training program on the levels of circulating ApoJ and other cardiometabolic risk factors, which could serve as potential indicators of insulin resistance in T2DM postmenopausal.	Exercise group: aerobic exercise and resistance training The control group did not perform any additional exercise throughout the 12 weeks. The exercise sessions occurred thrice weekly, specifically on Mondays, Wednesdays, and Fridays. Each session had a duration of 20 minutes, which included a 5-minute warm-up at the beginning and a 5-minute cool-down at the end.	Enzyme-linked immunosorbent assay (ELISA) Homeostatic model assessment of insulin resistance (HOMA-IR)	Exercise training directed to a substantial reduction in circulating ApoJ level, and the change in ApoJ level showed an inverse correlation with the change in muscle mass in individuals with T2DM. Additionally, there was an improvement in insulin sensitivity. This suggests that circulating ApoJ could serve as a valuable metabolic marker for assessing the insulin-sensitizing effect of physical exercise in T2DM patients.
Martins F.M. et al.(14) (2018)	16 postmenopausal women.	Test effectiveness of High-intensity bodyweight training (HIBWT) compared to combined training (COMT) as an exercise strategy for postmenopausal women at risk of developing T2DM.	HIBWT group: exercise program (ten sets of 60 seconds, three sessions per week for 12-week) COMT group: 30-minute walk + five resistance exercises (three sets of each exercise).	Six-minute Walk test DEXA International Physical Activity Questionnaire short form (IPAQ-SF) Electrochemoluminescence Automated colorimetric Enzyme-linked immunosorbent assay	Similar effects on metabolic health, physical performance, muscle mass, and inflammatory markers are exhibited by HIBWT and COMT. HIBWT can be considered a time-efficient alternative treatment strategy that is both accessible and safe when compared to COMT. Additionally, a significant increase in muscle strength was observed in the COMT group, indicating a notable interaction between time and the group ($P < 0.05$).

Maillard F et al.(15) (2016)	17 T2DM postmenopausal women	To assess and compare the impact of High-Intensity Interval Training and Moderate Intensity Continuous Training on the overall body and abdominal fat mass in postmenopausal women with T2DM.	HIIT Group: cycling × 60 repetitions of 8 seconds MICT Group: cycling for 40 minutes. Duration-16 weeks (2 sessions per week).	DEXA CT Scan Diet monitoring IPAQ questionnaire Blood parameter	HIIT program showed greater effectiveness in reducing central obesity compared to MICT. Therefore, HIIT can be considered an alternative exercise training program for this population.
Lesser IA et al.(16) (2016)	75 physically inactive, postmenopausal women .	To investigate whether exercise could reduce Visceral Adipose Tissue (VAT) and related health risks within the South African population.	Group 1: Bhangra dance (BD) Group 2: Standard exercise (SE) program at the gym Group 3: The control group includes no exercises Duration-12 weeks	Visceral Adipose Tissue (VAT)	BD and SE exercise programs did not show effectiveness in reducing VAT compared to a non-exercise control group in postmenopausal South Asian women. Nevertheless, for the women who adhered to these programs, a significant reduction in VAT was observed.
Lesser IA et al.(17) (2016)	49 postmenopausal women.	To analyze the effect of supervised aerobic exercises on cardiometabolic risk factors in inactive, postmenopausal South Asian women.	Both Groups: warm up for 10 minutes, exercise for 40 minutes, and cool down session for 10 minutes Standard Group: The exercise intensity was individually tailored according to participants' maximal heart rate and gradually increased every 3 weeks. Bhangra Group: High-intensity movements Duration-12 weeks	CT scan Fasting blood sample DEXA	The correlation between the change in risk factors of cardio-metabolic and Visceral Adipose Tissue remained significant regardless of the changes observed in Waist Circumference and Subcutaneous Adipose Tissue (SAAT). Thus, a decrease in VAT may serve as a significant indicator of glucose regulation enhancements, even without a reduction in WC.
Kim C et al.(7) (2014)	382 overweight, glucose-intolerant postmenopausal women not using exogenous estrogen.	To investigate the effects of a weight loss intervention on FSH levels in postmenopausal women.	Group 1: 850 mg metformin twice daily Group 2: placebo twice daily Group 3: Intensive Lifestyle Change (ILS) program (includes low-calorie, low-fat diet, moderate physical exercises for 150 minutes per week.	Block food-frequency questionnaire 1-year recall Modifiable Activity Questionnaire Venous blood sample ELISA	Weight loss in overweight, postmenopausal women can result in slight elevations in follicle-stimulating hormone (FSH) levels. This effect may be influenced by pathways involving endogenous estrogen and other mechanisms.
Bello M et al.(18) (2014)	20 pre-diabetes and T2DM postmenopausal women.	To assess the effects of community-based exercises protocol on bone mineral density (BMD) and body composition in postmenopausal women diagnosed with pre-diabetes and T2DM.	Exercise program: Walking, resistance training, and aquatic exercises three times a week for 32 weeks.	DEXA	Results indicate that consistent participation in a comprehensive training program involving multiple components is successful in preventing osteoporosis and sarcopenia in pre-diabetes and T2DM postmenopausal.

DISCUSSION

Scrutinising exercise interventions within postmenopausal women highlights the significant role of physical activity in improving various health parameters. One of the studies reveals that exercises for stabilizing the core improve physical performance, balance, and life quality in this demographic, which is serious as women after menopause are at an amplified fall risk and related complications because of variations in bone density and muscle strength [10]. This aligns with the findings from another study, which emphasize that high-intensity bodyweight training can effectively enhance muscle mass and metabolic health among postmenopausal women. Collectively, these results underscore a compelling need for tailored exercise programs that serve to address specific health challenges faced by this population [14].

Moreover, the investigation by the author in another study of how type 2 diabetic family history influences metabolism during exercise offers further insights into metabolic adaptations in postmenopausal women. Understanding these nuances is essential for designing interventions that promote fitness and mitigate risks associated with metabolic disorders common during this life stage [11]. Similarly, it illustrates the positive changes in glycemia, blood pressure, and body composition with moderate to high-intensity exercises, reinforcing the multifaceted benefits of physical activity beyond mere weight management [12].

The integration of aerobic and resistance training shows promise in reducing insulin resistance in postmenopausal diabetic women, suggesting that combinatory exercise regimens can yield significant health improvements [13]. The importance of HIIT is also supported, with HIIT

effectively reducing abdominal fat in a similar cohort. This accentuates the need for healthcare providers to advocate for diverse exercise routines tailored to individual needs, combining aerobic and resistance elements for comprehensive benefits [15].

Limitations:

Research also indicates that social and community aspects are prime in executing exercise programs. The long-term community-based exercise programs affirm that sustained physical activity can improve bone mineral density, which is particularly vital for osteoporotic postmenopausal women due to decreased estrogen levels [18]. This reveals an avenue for future explorations to incorporate community engagement and support as a fundamental aspect of such interventions.

CONCLUSION

The collective evidence from this review presents a strong argument for implementing structured exercise programs addressing various health outcomes for postmenopausal women. An intersection of core stabilization, strength training, aerobic sessions, and community involvement could serve as a robust strategic model for enhancing well-being in this population, helping mitigate risks associated with age-related health decline.

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