

THE IMPACT OF EXERCISE ON GLYCEMIC CONTROL, CARDIORESPIRATORY, BMI AND QUALITY OF LIFE IN POSTMENOPAUSAL DIABETIC WOMEN: A COMPREHENSIVE REVIEW

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Abstract

Postmenopausal women diagnosed with diabetes face specific challenges when it comes to maintaining optimal glycemic control, which significantly affects their overall health and quality of life. The incorporation of physical activity has emerged as a crucial lifestyle approach in the management of glycemic control among persons. The primary objective of this literature review is to conduct an analysis of prior research to enhance our understanding of the effects of exercise on glycemic management, cardiorespiratory fitness, BMI and Quality of life with a specific focus on postmenopausal women diagnosed with diabetes. A systematic exploration of electronic databases, such as PubMed, Scopus, and Web of Science, was undertaken to locate pertinent papers pertaining to exercise therapies in women with postmenopausal diabetes. Exercise is recognized as a crucial strategy that provides benefits that go beyond the initial lowering of glucose levels. Exercise has a crucial role in managing glycemic control by improving insulin sensitivity, facilitating glucose utilization, and impacting body composition. The psychological advantages associated with physical exercise additionally have a role in enhancing adherence to techniques for managing diabetes. Exercise serves as a catalyst for positive transformation across all dimensions of well-being, encompassing physical, emotional, psychological, and social aspects. In our pursuit of strengthening the management of diabetes and improving the well-being of postmenopausal women, it is crucial to acknowledge the significant impact that exercise may have on improving quality of life.

Keywords: *Postmenopausal women, diabetes, exercise, glycemic control, cardiorespiratory fitness, BMI and Quality of Life*

1. Introduction

The co-occurrence of post-menopause and diabetes poses an intricate and diverse difficulty that has a substantial impact on the well-being and overall quality of life of women (Dalal & Agarwal, 2015). Postmenopausal women, commonly characterized as individuals who have surpassed a duration of twelve consecutive months without experiencing a monthly cycle, undergo a sequence of physiological alterations that arise from the termination of ovarian activity and a reduction in the synthesis of estrogen (Scottish Government, 2023). In contrast, diabetes is a



persistent metabolic condition that is distinguished by elevated blood glucose levels resulting from impairments in the secretion of insulin, its action, or both (Paschou et al., 2019). When the convergence of these two circumstances occurs, it gives rise to a distinct clinical scenario that requires a more elaborative comprehension of the physiological, metabolic, and psychosocial ramifications (Yazdkhasti et al., 2019). There has been a significant increase in the global prevalence of diabetes, with a notable share of those affected by this chronic ailment being postmenopausal women (Animaw & Seyoum, 2017). This specific population is particularly susceptible to various risks as a result of the intrinsic physiological alterations associated with both post-menopause and diabetes. During the menopausal transition, women undergo changes in body composition, hormonal profiles, and insulin sensitivity, which can together lead to difficulties in regulating blood sugar levels (Olshansky, 2018). The intricate management of blood glucose levels in individuals experiencing the menopausal transition is further complicated by the hormonal swings and metabolic disruptions associated with diabetes (Ko & Kim, 2020).

The health considerations specific to postmenopausal women with diabetes encompass more than just the regulation of blood sugar levels (CDC, 2018). The relationship between these illnesses is reciprocal in nature—diabetes amplifies the intrinsic cardiovascular risk associated with menopause, while hormonal fluctuations during menopause can affect glucose metabolism (Stachowiak et al., 2015; Michael-dansinger, 2022). The complex interaction between these factors highlights the significance of adopting a healthcare approach that considers the combined impacts of these circumstances. The care of women with diabetes who have reached menopause necessitates the implementation of a comprehensive and individualized approach that effectively addresses the multifaceted nature of their health condition (Paschou et al., 2019; Xing et al., 2022). The objectives of such treatment extend beyond the regulation of blood sugar levels to include the reduction of cardiovascular risk, maintenance of bone health, and improvement of overall well-being (Mayo Clinic, 2021). In addition, it is imperative to broaden the scope of considerations beyond the physiological dimensions and incorporate psychosocial elements (Eiroa-Orosa, 2020). This is because the emotional and psychological burden associated with simultaneously treating diabetes and menopause can significantly influence adherence to treatment protocols and ultimately affect treatment outcomes (Escobar Florez et al., 2021).

Lifestyle alterations, including dietary modifications and regular exercise, are crucial in the management of both menopause and diabetes (Galaviz et al., 2018). Nevertheless, it is imperative to meticulously customize the selection and scheduling of exercise based interventions to suit the specific needs of everyone. This entails considering several aspects, including but not limited to age, length of diabetes, menopausal stage, and the existence of any concurrent medical conditions (Meeta et al., 2020). A thorough investigation is important to clarify the mechanisms that underlie the interplay between menopause and diabetes, as well as to ascertain approaches that can enhance glycemic management, cardiovascular well-being, bone health, and general quality of life (Paschou, Marina, et al., 2019). This review provides insights into the factors influencing glycemic control in postmenopausal diabetic women and identifies potential avenues for future research and clinical practice.

2. Methodology

A comprehensive and methodical search was performed across various electronic databases, such as PubMed, Scopus, and Web of Science, in order to locate relevant papers pertaining to exercise therapies in women who are postmenopausal and have diabetes. The publications within the previous decade were specifically emphasized. The chosen studies were assessed in order to obtain full understanding of the various impacts of exercise on glycemic control.

Exercise Modalities and Synergistic Effects Various exercise techniques have unique yet complimentary advantages in terms of glycemic enhancement. Gaining insight into the distinct mechanisms underlying different types of physical activity provides valuable knowledge regarding their respective impacts and the possibility of synergistic outcomes when employing integrated training methods (Syeda et al., 2023).

3.1 Aerobic Training: Aerobic workouts, such as brisk walking, jogging, cycling, and swimming, are widely recognized for their capacity to improve insulin sensitivity and promote glucose utilization. These activities elicit the involvement of major muscle groups, resulting in prolonged elevation of heart rate and oxygen consumption. The heightened energy requirements associated with aerobic exercise elicit a corresponding rise in the absorption of glucose into skeletal muscle cells, thereby facilitating the efficient metabolism of glucose and leading to a decrease in blood glucose levels. Regular aerobic training has been found to have cumulative effects that lead to enhanced insulin sensitivity and improved control of glycemic levels (Kirwan et al., 2018).

3.2 Resistance Training: Resistance training, which encompasses exercises involving the lifting of weights or utilization of resistance equipment, is primarily aimed at augmenting muscle strength and increasing muscle mass. Although resistance training may not induce the same level of heart rate elevation as aerobic exercise, its effect on glycemic improvement is significant. Resistance exercises elicit muscular contractions that promote the absorption of glucose into muscle cells, independent of insulin presence. The observed augmentation in skeletal muscle size not only facilitates improved glucose utilization but also plays a role in long-term glycemic advantages by enhancing insulin sensitivity. In addition, resistance training has been found to facilitate glycogen storage, hence mitigating postprandial hyperglycemia by efficient clearance of glucose from the circulatory system after meals (Hargreaves & Spriet, 2020).

3.3 Combined Training: Recent studies indicate that the integration of aerobic and strength exercise may result in synergistic outcomes with regards to enhancing glycemic control. The hybrid strategy shown in this study effectively encompasses multiple facets of glycemic management (Reddy et al., 2019). The inclusion of the aerobic component in exercise routines contributes to the improvement of cardiovascular fitness by facilitating the effective consumption of glucose during physical activity. Concurrently, the implementation of resistance exercise enhances both muscle mass and insulin sensitivity, hence promoting a persistent decrease in blood

glucose levels even during periods of inactivity. The integration of these two modalities presents a holistic approach that may be particularly beneficial for patients aiming to achieve comprehensive glycemic control (Wang & Wang, 2022).

3. Physiological Changes Influencing Glycemic Control

The maintenance of glycemic control, which involves the management of blood glucose levels within a small physiological range, is a fundamental component of metabolic homeostasis that plays a critical role in maintaining overall health.

4.1 Hormonal Fluctuations: Hormonal fluctuations during menopause are crucial, as they decrease ovarian activity and reduce estrogen and progesterone synthesis. Estrogen affects glucose metabolism, insulin sensitivity, adipose tissue distribution, and pancreatic beta-cell activity. Falling estrogen levels lead to decreased insulin sensitivity, poor glucose utilization, and postprandial hyperglycemia. Additionally, fluctuating estrogen levels disrupt adipose tissue depots, causing reduced subcutaneous adipose tissue and increased visceral adiposity. This redistribution leads to increased release of pro-inflammatory cytokines, such as TNF- α and IL-6, from visceral fat, disrupting insulin signalling pathways and causing insulin resistance, making it difficult to manage glycemic control (Eaton & Sethi, 2019; Galicia-Garcia et al., 2020; Alemany, 2021)

4.2 Insulin Resistance: Insulin resistance, a common feature of menopause and diabetes, affects blood sugar regulation in women with diabetes after menopause. This occurs due to disrupted biochemical circuits regulating insulin effects. Insulin resistance leads to dysregulation of intracellular signaling cascades, affecting skeletal muscles and adipose tissue. Adipokines, released by adipose tissue, exacerbate insulin resistance and contribute to chronic low-grade inflammation. Dysregulation of adipokine production in postmenopausal women with diabetes mellitus can exacerbate insulin resistance and hinder glucose utilization (Petersen & Shulman, 2018; Chadt & Al-Hasani, 2020)

4.3 Adipose Tissue Alterations: Diabetes postmenopausal women have insulin resistance, dyslipidemia, and systemic inflammation due to adipose tissue alterations. Adipokines and adipocytokines from adipose tissue regulate insulin signalling and glucose metabolism. Lipotoxicity from adipose tissue dysfunction increases insulin resistance, lipid buildup in non-adipose tissues, and glucose absorption (Marsh et al., 2023).

Thus, the glycemic management of postmenopausal diabetic women is greatly influenced by a complex physiological landscape characterized by the interplay of hormonal oscillations, insulin resistance, and adipose tissue abnormalities. The modifications combined give rise to difficulties in maintaining glucose homeostasis, hence promoting a tendency towards hyperglycemia and an elevated susceptibility to problems associated with diabetes. It is crucial to acknowledge the complex mechanisms involved in order to devise precise interventions that

effectively target the physiological obstacles encountered by this population. This, in turn, can result in increased regulation of blood sugar levels and improved general well-being.

4. Mechanisms of Exercise-Induced Glycemic Improvement

5.1 Insulin Sensitivity and Exercise: The fundamental factor influencing glycemic management is insulin sensitivity, which refers to the degree of responsiveness exhibited by insulin target tissues towards the effects of insulin. Physical activity has a significant impact on the sensitivity of insulin, which is mediated by various interconnected processes (Andrade et al., 2019).

5.2 Aerobic Metabolism and Glucose Uptake: During times of physical activity, the energy requirements of contracting muscles escalate, leading to an increased need for glucose use to support aerobic metabolism. Aerobic exercise, which is distinguished by the performance of continuous activities at a moderate intensity, elicits an increase in glucose absorption into muscle cells in order to fulfil the energy requirements associated with such activities. The elevation in glucose utilization observed during physical activity leads to a decrease in the concentration of glucose in the bloodstream, therefore playing a role in the immediate enhancement of glycemic control (SyLOW et al., 2016).

5. Hormonal and Metabolic Influences

6.1 Impact on Hormones: Physical activity elicits a series of hormonal reactions that have a substantial impact on the regulation of blood sugar levels. Physical activity elicits the secretion of hormones, including adrenaline and glucagon, which subsequently trigger the release of glucose from the liver. The mobilization of glucose serves to provide a consistent provision of energy in order to sustain heightened physical requirements. Following physical activity, these hormones play a crucial role in restoring glycogen reserves in both the liver and muscles, contributing to the regulation of blood sugar levels and facilitating metabolic adaptability (Eaton & Sethi, 2019; Alemany, 2021).

6.2 Regulation of Lipid Profile: The treatment of diabetes, particularly in postmenopausal women, places significant emphasis on the crucial role of cardiovascular health. The reduction in oestrogen levels that occurs during menopause, along with the presence of diabetes, exacerbates the risk factors associated with cardiovascular disease. Cardiorespiratory fitness, which is an indicator of cardiovascular well-being, functions as a prognosticator for cardiovascular disease (CVD) outcomes. Physical activity serves as a powerful means to improve cardiorespiratory fitness, effectively connecting the relationship between glucose regulation and cardiovascular well-being (El Khoudary et al., 2020). Aerobic exercise and high-intensity interval training (HIIT) have played a crucial role in augmenting cardiorespiratory fitness, as indicated by elevated maximal oxygen consumption (VO₂ max) and enhanced endurance capacity. Resistance training, while its primary focus is on enhancing muscle strength, has the potential to generate small improvements in cardiovascular fitness as well. The integration of training modalities frequently

results in synergistic outcomes, yielding comprehensive benefits (Ito, 2019). Physical activity not only influences the metabolism of glucose but also exerts a beneficial influence on the lipid profile, which is closely associated with insulin sensitivity and cardiovascular well-being. The observed improvement in lipid composition has been found to enhance insulin sensitivity and reduce the likelihood of cardiovascular problems commonly linked with diabetes (Lin et al., 2022).

Aerobic exercises, which are defined by prolonged activities that increase heart rate and oxygen consumption, play a crucial role in improving cardiorespiratory fitness. Consistent participation in aerobic exercises, such as brisk walking, cycling, or swimming, leads to physiological changes in the cardiovascular system. These changes encompass heightened stroke volume, cardiac output, and capillary density, ultimately resulting in enhanced oxygen transportation to muscles and improve cardiovascular fitness (Nystoriak & Bhatnagar, 2018).

6.3 Influence of Exercise on BMI: The body mass index (BMI) is a metric used to assess body weight in relation to height, and functions as an indicator of body composition and obesity. The correlation between obesity and diabetes has been well documented, with postmenopausal women exhibiting heightened vulnerability to weight gain as a result of hormonal fluctuations and metabolic alterations. An increased body mass index (BMI) contributes to the worsening of insulin resistance and the risk of cardiovascular disease (CVD), highlighting the need for therapies that focus on managing weight. Engaging in physical activity is an effective approach for controlling body mass index (BMI) in women who have reached menopause and are living with diabetes. Both aerobic and weight training are essential components in this particular environment. Aerobic exercise facilitates the expenditure of calories, hence playing a role in the maintenance of energy balance and the management of body weight. In contrast, resistance exercise promotes the growth of lean muscle mass, leading to an elevation in resting metabolic rate, hence facilitating the maintenance of body weight. The collective impact of various exercise modalities plays a role in moderating BMI and reducing the potential dangers linked to obesity in individuals with diabetes (Powell-Wiley et al., 2021).

6. Quality of Life

The concept of quality of life (QoL) is intricate and multifaceted; it includes aspects of physical, emotional, social, and psychological well-being. The difficulties brought on by the co-occurrence of diabetes and menopausal hormonal changes might have a major negative influence on quality of life (QoL) for postmenopausal diabetic women. A decreased sense of wellbeing can be caused by a combination of factors, including the difficulty of managing the disease, the risk of complications, and the psychological toll of living with a chronic condition. Additionally, menopausal symptoms including hot flashes, mood swings, and sleep issues can make QoL challenges much worse. The development of therapies that comprehensively address the needs and concerns of postmenopausal diabetes women depends on understanding the complex character of QoL (Velasco-Téllez et al., 2020).

7.1 Exercise and Enhanced QoL: Physical activity is a potent intervention that has the potential

to enhance the quality of life (QoL) for women with diabetes who have reached menopause. The activity provides physiological advantages such as enhanced glucose control and cardiovascular fitness, hence contributing to an augmented sensation of overall well-being. Engaging in consistent physical activity has been shown to decrease the likelihood of experiencing issues associated with diabetes, hence alleviating feelings of anxiety and uncertainty over future health outcomes. This phenomenon results in a decrease in the overall prevalence of diseases, so contributing to enhanced mental well-being and fostering a more optimistic perspective on life. Exercise has been found to have a physical impact on the body by triggering the production of endorphins. These endorphins play a role in promoting happy mood states, reducing stress levels, and functioning as natural mood enhancers. Regular exercise may potentially lead to a decrease in anxiety and depression symptoms in postmenopausal women with diabetes. Participating in health management practises can promote feelings of empowerment, self-assurance, and self-worth, so contributing to an overall improvement in quality of life (Thomas & Daley, 2020).

7. Future directions

Post-menopause and diabetes in women are complex hormonal fluctuations that impact blood sugar regulation. Postmenopausal women experience reduced estrogen levels and metabolic disruptions, making it difficult to maintain glucose homeostasis. Exercise is a versatile intervention that addresses the intricate interplay of factors affecting glycemic control. Research shows that consistent physical activity has a beneficial effect on multiple facets of glycemic management in women with diabetes who have reached the postmenopausal stage. Exercise improves insulin sensitivity, promoting efficient absorption of glucose into muscle cells and reducing blood glucose levels. This is crucial for diabetic women in the postmenopausal stage, as they often experience insulin resistance due to hormonal changes during menopause and metabolic modifications associated with diabetes. Physical activity plays a crucial role in glucose consumption and metabolic adaptations. Aerobic workouts, such as walking, jogging, and swimming, increase glucose use for energy over prolonged periods of physical exertion, leading to an upregulation of mitochondrial biogenesis and enhanced oxidative capability in skeletal muscle tissue. Postmenopausal women with diabetes are at risk of experiencing reductions in muscle mass and functional capacity, making it essential to participate in exercise that facilitates glucose consumption and promotes muscle adaptations to effectively manage blood sugar levels. Physical activity can also induce alterations in body composition that have a beneficial impact on glucose management. Aerobic exercises, with their sustained energy expenditure, facilitate fat reduction and enhance body composition. Decreases in body fat percentage and waist circumference not only enhance physical appearance but also play a significant role in mitigating insulin resistance and improving glycemic outcomes.

8. Conclusion

Within the complex relationship between post-menopause and diabetes, wherein hormonal changes and disruptions in metabolism intersect, the influence of physical activity on the

regulation of blood sugar levels appears as a promising and empowering factor. The present review has comprehensively explored the intricate physiological intricacies and mechanistic understandings to shed light on the transforming capacity of exercise in the context of postmenopausal women with diabetes. Exercise surpasses its function as a simple physical activity and takes on the responsibility of a comprehensive intervention, involving several systems that encompass physiological, metabolic, and psychological aspects. One notable indication of the impact of exercise is its ability to improve insulin sensitivity. In a domain characterized by the exacerbation of insulin resistance resulting from hormonal oscillations and complex metabolic processes, physical exercise appears as a potent and influential ally. Enhancing the sensitivity of insulin target tissues and promoting the uptake of glucose, effectively mitigates the obstacles to glycemic control commonly experienced by postmenopausal women with diabetes. In conclusion, physical activity serves as a fundamental intervention for maximizing glycemic regulation in women with diabetes who have reached the postmenopausal stage. The diverse impacts of this phenomenon on insulin sensitivity, glucose utilization, body composition, and psychological well-being cumulatively contribute to enhanced glycemic outcomes. Given the increasing incidence of diabetes, it is imperative to acquire a thorough comprehension of the effects of exercise on glycemic management in postmenopausal women. This understanding is crucial for the development of customized and efficient strategies aimed at improving their overall health and quality of life.

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