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EFFECTIVENESS OF A REGULAR EXERCISE PROGRAM IN REDUCING THE RISK OF TYPE 2 DIABETES IN INDIVIDUALS WITH PREDIABETES

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Abstract

Prediabetes is a condition characterized by blood sugar levels that are higher than normal but have not yet reached the threshold for type 2 diabetes. Management of prediabetes through a regular exercise program is claimed to reduce the risk of developing type 2 diabetes. This literature research was carried out by reviewing various published empirical studies in health and medical journals in databases such as PubMed, Scopus, and the Cochrane Library. The studies analyzed were those that evaluated the effectiveness of a regular exercise program with a minimum duration of 12 weeks, and compared Hemoglobin A1c (HbA1c) scores, weight loss, and insulin sensitivity between intervention and control groups among individuals with prediabetes. Findings showed a significant reduction in HbA1c values, improved blood glucose control, and increased insulin sensitivity in individuals who underwent a regular exercise program compared to a control group who did not. It was identified that a combination of aerobic activity and resistance training provided the best benefit in reducing the risk of transition to type 2 diabetes. Regular physical activity plays an important role in combating the global increase in the incidence of type 2 diabetes, especially in individuals with prediabetes. Regularity and intensity of exercise are important factors in determining the success of the intervention. Based on the literature reviewed, a regular exercise program is effective in reducing the risk of type 2 diabetes in individuals with prediabetes. Recommendations for increasing the success of the intervention include creating individualized exercise programs, increasing awareness of the importance of physical activity, and support to maintain patient motivation.

Keywords: Type 2 Diabetes, Prediabetes, Regular Exercise, Intervention, Prevention.

INTRODUCTION

In the modern era filled with technological developments and lifestyle changes, the prevalence of non-communicable diseases such as type 2 diabetes continues to increase. One of the important phases in the

development of type 2 diabetes is the prediabetes stage, where an individual's blood sugar levels are higher than normal but have not yet reached the threshold for a diabetes diagnosis. This phase offers a golden window of opportunity for preventive interventions, considering that the transition from prediabetes to type 2 diabetes can be prevented or delayed with appropriate lifestyle changes (Liu et al., 2023).

Regular exercise is an important pillar in this prevention strategy. Various studies have demonstrated the effectiveness of physical activity in improving glycemic control in individuals with prediabetes. This protective effect arises from the ability of exercise to increase insulin sensitivity and reduce blood sugar levels through efficient mechanisms (Zueger et al., 2022). However, questions remain regarding the most effective form, frequency, and intensity of exercise for preventing the transition to type 2 diabetes.

With the increasing prevalence of prediabetes globally, there is an urgent need to identify and deploy the most effective prevention strategies. A regular exercise program not only has the potential to prevent the transition to type 2 diabetes, but also has broad health benefits, including improved cardiovascular health and reduced risk of obesity (Ghamri, 2023).

Additionally, lifestyle interventions including regular exercise are emerging as a cost-effective solution in addressing the global burden of diabetes. With the costs of diabetes care continuing to rise, prevention through exercise may offer a way to significantly reduce healthcare costs. This adds urgency to understanding and optimizing the effectiveness of exercise programs (Hu et al., 2024).

However, challenges remain in implementing and maintaining participation in sports programs. Personal preferences, availability of resources, health conditions, and socioeconomic factors may influence an individual's ability and willingness to participate in regular exercise. There is a need to develop programs that are adaptable and accessible to diverse populations, especially those at high risk for transition to type 2 diabetes (Fuster-Parra et al., 2023).

Additionally, understanding the biological mechanisms by which regular exercise can delay or prevent the onset of type 2 diabetes is still in its infancy. This insight is critical for designing exercise programs that are not only effective but can also target specific biological processes that contribute to the development of type 2 diabetes (Kohatsu, 2023).

Seeing the great potential and urgent need, the importance of conducting further research on the effectiveness of regular exercise programs

in reducing the risk of type 2 diabetes in individuals with prediabetes is becoming clear. This review is not only important to build a solid evidence base but also to guide the development of practical and effective interventions that can substantially reduce the global burden of type 2 diabetes (Battillo et al., 2023).

In response to this challenge, studies have begun to explore key parameters that can improve the effectiveness of exercise programs, including exercise type (aerobic, strength training, or a combination of both), intensity, duration, and frequency. These components are thought to play an important role in the effectiveness of type 2 diabetes risk reduction, with each individual may require a tailored approach based on risk factors, physical abilities, and personal preferences (Via & Mechanick, 2023). This research seeks to translate scientific evidence into practical recommendations that can be applied in individuals' daily lives.

Furthermore, community involvement and social support have proven vital in increasing adherence to exercise programs. Building a support network, whether through community-based programs or exercise groups, can encourage motivation and maintain long-term participation. This suggests that a holistic approach, which does not only focus on the physical aspects of sport but also considers social and psychological factors, could be the key to successful type 2 diabetes prevention programs (Lim et al., 2022).

Overall, while challenges remain, the potential for a regular exercise program in preventing type 2 diabetes in individuals with prediabetes is great. The key to success lies in tailoring programs to meet individual needs and preferences, community support, use of technology, and collaboration between individuals, researchers, health practitioners, and policy makers. Through this joint effort, the vision of reducing the prevalence of type 2 diabetes globally through regular exercise can become a reality (Pathiranage & Suraweera, 2024).

RESEARCH METHOD

The study in this research is qualitative with literature. The literature study research method is a research approach that involves the analysis and synthesis of information from various literature sources that are relevant to a particular research topic. Documents taken from literature research are journals, books and references related to the discussion you want to research (Earley, M.A. 2014; Snyder, H. 2019).

RESULT AND DISCUSSION

Effectiveness of Regular Exercise in Modifying Risk Factors for the Transition from Prediabetes to Type 2 Diabetes

Regular exercise has been consistently proven to be one of the most effective strategies in lifestyle modification to prevent the transition from prediabetes to type 2 diabetes. Physical activity plays an important role in regulating glucose homeostasis and improving insulin sensitivity, both of which are critical components in managing diabetes risk. (Barnard & Kahleova, 2023). Through mechanisms such as increased glucose utilization by muscles and improved lipid metabolism, regular exercise can reduce fasting blood glucose and postprandial blood glucose levels, key risk factors for the development of type 2 diabetes (Colberg et al., 2022).

Research has shown that a combination of aerobic exercise and resistance training offers the greatest benefits in controlling and stabilizing blood sugar levels. Aerobic exercise, such as walking, swimming, or cycling, helps increase the efficiency of the heart and lungs and increases glucose use by muscles, while resistance exercise, such as lifting weights, aims to increase muscle mass and strength (Kawada, 2022). Increasing muscle mass is very important because muscle is the main location where blood glucose is used, so more muscle means more efficient use of glucose (Shi et al., 2022).

In addition to the type of exercise, the frequency, duration, and intensity of physical activity also play a critical role in its effectiveness as a preventive tool. General guidelines suggest at least 150 minutes of moderate to vigorous intensity aerobic activity per week, supplemented with strength training on two or more days per week. Consistency and continuation in regular exercise are key in maintaining blood sugar control and avoiding long-term complications associated with diabetes (Yan et al., 2023).

The importance of regular exercise in modifying risk factors for the transition from prediabetes to type 2 diabetes is not only limited to its effects on weight management and body composition, but also to its role in improving overall well-being. Regular exercise can improve sleep quality, reduce stress and anxiety, and increase self-confidence and mental health. All of these benefits collectively support the adoption and long-term maintenance of an active lifestyle, which is foundational in preventing type 2 diabetes for those diagnosed with prediabetes (Konitz et al., 2024).

Although evidence shows that regular exercise has an important role in preventing type 2 diabetes, there are also challenges in implementing it. One of the main challenges is gaining long-term commitment from individuals with

prediabetes to change their lifestyle and maintain physical activity. This often requires a comprehensive educational approach, support from health professionals, and sometimes, psychological intervention (Gustanar & Fajari, 2023). Long-term behavior change can be achieved through cultivating awareness of the importance of maintaining health, setting realistic goals, and celebrating small achievements on the journey to a healthier lifestyle.

Besides that, in each individual there may be variability in response to regular exercise which is influenced by genetic factors, age, gender, and existing health conditions. Therefore, an individualized exercise program is a key component in designing an effective intervention plan. These adjustments allow individuals to engage in the type, intensity, and duration of physical activity that best suits their needs, their abilities, and their preferences (Belsky et al., 2023).

To promote long-term success, it is critical to build an infrastructure that supports an active lifestyle. This can include the development of supportive environments, such as public parks, walking and cycling paths, and affordable fitness facilities. Creating public policies that support physical activity and equitable health education can provide strong incentives to keep people active (Devesa et al., 2023).

Ultimately, overcoming the transition from prediabetes to type 2 diabetes requires a multifaceted approach that involves not only regular exercise but also dietary changes, stress reduction, and appropriate medical interventions. Ongoing education and community-led prevention programs, supported by the latest research, will help increase awareness and adopt effective measures to reduce the incidence of type 2 diabetes globally (Griadil et al., 2023).

Sports Program Characteristics (Frequency, Intensity, and Duration) Influence the Results

Exercise frequency is one of the main components of a successful exercise program. Frequency refers to how often a person exercises in a given time period, usually measured in sessions per week. Higher frequencies strengthen exercise habits and support increased cardiorespiratory fitness and muscle strength. However, frequency must also be adjusted to individual fitness levels, exercise goals and the type of exercise performed (Amin et al., 2024). For example, for beginners, a lower frequency such as 2-3 times a week is a good place to start to avoid injury and get the body used to a new activity,

while experienced athletes may want to work out 5-6 times a week for maintenance or improvement of their performance.

Exercise intensity refers to how hard the body works during physical activity. Intensity can be categorized as low, moderate, or high, and has a direct influence on the number of calories burned, as well as the changes that occur in the body (Shehu & Haberlandt, 2022). Low intensity is suitable for individuals just starting out or for recovery, medium for maintaining general fitness, and high for improving fitness and athletic performance. High intensity is often integrated into exercise programs as interval sessions or circuit training, and has been shown to be effective in improving cardiovascular fitness as well as in burning fat (Kumar & Chakraborty, 2024). However, high intensity may not be suitable for everyone, especially for those with certain health conditions, so it is important to consult a health professional before starting this type of exercise.

Exercise duration, which refers to the length of training time in each session, also plays an important role. General health guidelines often recommend at least 150 minutes of moderate-intensity aerobic activity or 75 minutes of vigorous-intensity aerobic activity per week, often divided into multiple sessions. Longer exercise durations are associated with more health benefits, but very long workouts can be risky if done without gradual build-up or without paying attention to one's fitness and health condition. Duration should be chosen based on individual goals, tolerance for physical activity, and time availability (Vinnarasi & DNYA, 2022). The best exercise program is one that consistently adjusts these three factors frequency, intensity, and duration to create an optimal balance for the user, maximize health benefits, and avoid the risk of injury (Rahlin, 2024).

Implementation of appropriate exercise program characteristics is essential in achieving optimal results. The balance between frequency, intensity, and duration must be carefully adjusted based on physical condition, fitness goals, and time and resource availability (Misra & Johnson, 2024). For example, increasing exercise frequency without considering appropriate intensity and duration may lead to fatigue or injury, while high intensity not accompanied by adequate exercise duration may not be sufficient to achieve certain fitness goals. Likewise, long duration workouts can be ineffective if the intensity is too low. Therefore, making regular adjustments to the program taking into account the body's progress and response to training is an important step to ensure that the desired benefits can be achieved safely and efficiently.

Ongoing monitoring and evaluation will assist in identifying whether changes to one or more aspects of frequency, intensity, or duration are necessary. For example, if progress stalls or desired results are not achieved, it may be necessary to increase intensity or frequency. On the other hand, if recovery feels slower or there are signs of overtraining, such as chronic fatigue, it is necessary to reduce the intensity or frequency. Involving a coach or specialist can be very helpful in customizing an exercise program, especially for individuals who require a more structured and scientific approach (Kirchengast & Molnar, 2022).

Ultimately, a holistic approach to an exercise program that takes into account not only frequency, intensity, and duration but also nutrition, hydration, adequate sleep, and other recovery strategies will maximize results and aid in achieving long-term fitness. Maintaining motivation and consistency is key, while always respecting the body's limits and modifying the training plan according to individual needs (Wang et al., 2023). Thus, an exercise program is not just about short-term gains, but also maintaining a healthy lifestyle and sustainable fitness.

Biological Mechanisms Behind the Benefits of Exercise

Exercise produces significant benefits for the human body through various biological mechanisms. One of the main impacts of physical activity is increased blood circulation. When exercising, the heart pumps more blood to meet the increased oxygen demand of the entire body. This increase in blood flow helps in transporting vital nutrients to cells and carrying metabolic waste, such as carbon dioxide, for excretion (Webb, 2023). This not only improves organ function and efficiency but also helps in faster recovery from stress and injury.

At the cellular level, exercise stimulates the production of various substances in the body that support health and therapy. For example, exercise stimulates the release of endorphins, which are natural chemicals that function as pain relievers and provide feelings of happiness. In addition, physical activity also increases the production of a protein known as brain-derived neurotrophic factor (BDNF), which plays a key role in the growth and differentiation of neurons as well as the survival of brain cells (Ridings, 2024). This shows that exercise is not only good for physical fitness but also mental health.

Furthermore, regular exercise activates the immune system by stimulating more effective regeneration of immune cells, which helps the

body fight infection and disease. Regular physical activity increases the redistribution of leukocyte cells which helps the body identify and fight pathogens (Shastry et al., 2023). In addition, exercise is known to reduce inflammation in the body by reducing TNF (tumor necrosis factor) and other inflammatory interleukins. In short, through stimulation of the cardiovascular, neuroendocrine, and immune systems, exercise helps slow the aging process and increases the body's resistance to various health conditions (Herzog et al., 2022).

In addition to these immediate impacts, exercise also contributes to long-term adaptation mechanisms that improve the body's resilience and function. One of the main benefits is improved insulin sensitivity and regulation of glucose metabolism, which helps in the management and prevention of type 2 diabetes. Regular physical activity can improve the ability of muscle cells to absorb glucose from the bloodstream, which reduces the risk of hyperglycemia. Exercise also increases lipolysis, namely the breakdown of fat in adipose cells, which helps in reducing fat mass and improving the blood lipid profile, thereby protecting against cardiovascular disease (Nici, 2024).

Furthermore, the musculoskeletal system also benefits from continuous exercise. Weight training and physical activities that emphasize strength and flexibility help in building and maintaining muscle and bone mass. The mechanical stimulus of muscle contraction and pressure on bones triggers muscle protein synthesis and new bone formation, processes that are very important for preventing sarcopenia (decreased muscle mass) and osteoporosis (Karami et al., 2022). This indicates that exercise plays an important role in maintaining bone density and strength, as well as supporting body mobility and balance.

When exercising, the body also experiences beneficial hormonal changes. For example, exercise can raise levels of growth hormone and testosterone which play a vital role in muscle growth and recovery. These hormones also influence metabolic processes, reproductive health, and even mental conditions (Zhou et al., 2022). Better hormonal balance through physical activity can help in managing stress, easing symptoms of depression or anxiety, and overall improving a person's psychological well-being. Thus, the benefits of exercise manifest not only in physical features but also complement better emotional and psychological conditions (Valera-Calero et al., 2022).

CONCLUSION

A regular exercise program shows significant effectiveness in reducing the risk of transition from prediabetes to type 2 diabetes. Through regular aerobic activity, strength training, and a combination of both, individuals with prediabetes can experience weight loss, improvements in insulin sensitivity, and better regulation of blood sugar levels. These positive effects contribute directly to reducing the risk of developing type 2 diabetes. Complemented by healthy lifestyle changes, including proper nutrition and reducing calorie intake, regular exercise plays a key role in preventing type 2 diabetes. Consistency and regularity in exercising are factors is important in achieving optimal results, with recommendations for physical activity of at least 150 minutes per week at moderate intensity, or 75 minutes per week at vigorous intensity. Overall, the integration of a regular exercise program in the lifestyle of individuals with prediabetes is not only effective in reducing the risk of type 2 diabetes but also improves general quality of life through physical strengthening, increased energy, and mental well-being. Thus, researchers and health practitioners strongly encourage the adoption of exercise routines as an essential prevention strategy.

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