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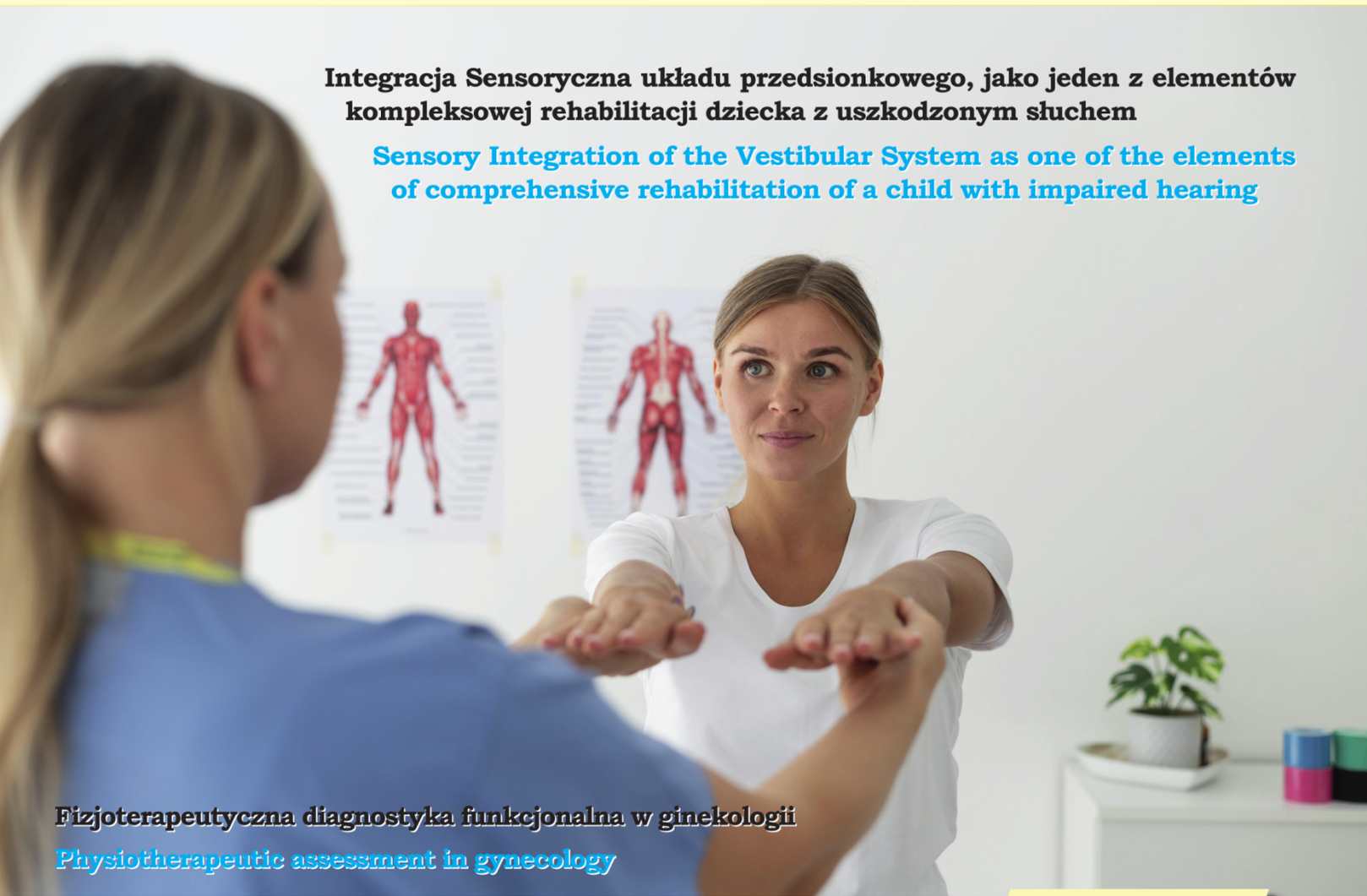

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The effect of moderate and low-intensity aerobic exercise on lowering blood sugar

Efekt umiarkowanych i niskointensywnych ćwiczeń aerobowych na obniżenie poziomu cukru we krwi

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Abstract

Problems and Purpose. The global prevalence of diabetes is on the rise, alongside other diseases related to obesity, including hypertension, heart disease and dyslipidemia. Exercise is recognized as a method to control blood sugar levels. This study aimed to investigate the impact of low and moderate-intensity sports exercises on blood sugar levels in patients.
Materials and Methods. This research was a laboratory experiment following a completely randomized design. Twenty participants were enlisted for the study and divided into two groups: a control group and a moderate-intensity exercise group. The study spanned two months.
Results. The results revealed a significant change in the blood sugar levels of patients who underwent low and moderate-intensity aerobic exercise with a p-value of 0.001.
Conclusion. This research concludes that there are notable differences in the impact of low and moderate-intensity aerobic exercises on body mass index and blood sugar levels in diabetes patients.

Keywords

low and moderate aerobic exercises, blood sugar, patients

Streszczenie

Problemy i cel. Globalna częstość występowania cukrzycy rośnie, równolegle z innymi chorobami związanymi z otyłością, takimi jak nadciśnienie, choroby serca i dyslipidemia. Wiadomo, że ćwiczenia pomagają kontrolować poziom cukru we krwi. Celem tego badania było zbadanie wpływu ćwiczeń sportowych o niskiej i umiarkowanej intensywności na poziom cukru we krwi u pacjentów.
Materiały i metody. Badanie to miało formę eksperymentu laboratoryjnego z całkowicie losowym układem. W badaniu wzięło udział 20 uczestników, podzielonych na dwie grupy: grupę kontrolną i grupę ćwiczeń o umiarkowanej intensywności. Badanie trwało dwa miesiące.
Wyniki. Wyniki wykazały znaczącą zmianę w poziomie cukru we krwi pacjentów, którzy przeszli ćwiczenia aerobowe o niskiej i umiarkowanej intensywności, z wartością p = 0,001.
Wnioski. Na podstawie tych badań można stwierdzić, że istnieją zauważalne różnice w wpływie ćwiczeń aerobowych o niskiej i umiarkowanej intensywności na wskaźnik masy ciała i poziom cukru we krwi u pacjentów z cukrzycą.

Słowa kluczowe

ćwiczenia aerobowe o niskiej i umiarkowanej intensywności, cukier we krwi, pacjenci

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Introduction

Throughout an individual's life, they are continually faced with various activities that can impact physical and physiological conditions [1]. These two factors are intertwined and cannot be separated [2]. Activities undertaken by individuals are not exclusive to the realm of sports; they can also encompass chores such as household cleaning, cooking, water collection, and more [3]. The more frequently a person engages in these activities, the more likely they are to become habits that influence their health [4]. In sports, there are three intensities of activity: high, medium, and low [5]. While everyone can participate in activities of high, medium, or low intensity, it's essential to match the activity to the individual's capability; otherwise, it may strain or harm certain body organs, potentially leading to degenerative changes [6].

Degeneration is a health concern arising from modern societal lifestyle changes [7]. This ailment reflects a health state where specific tissues or organs degrade over time [8]. Several factors predispose an individual to degenerative diseases, including a diet rich in energy and fat that's affordable [9]. In Indonesia, prevalent degenerative diseases include diabetes mellitus, hypertension, stroke, and cancer, contributing to high mortality rates [10]. Diabetes mellitus, for instance, is a chronic condition that impairs pancreatic function, leading to insufficient insulin production necessary for blood sugar regulation [11]. This condition arises when the body can't effectively utilize its produced insulin. As a pressing health issue, diabetes affects not only Indonesians but also the global population and ranks among the top four non-communicable diseases targeted for prevention [12]. It's noteworthy that diabetes cases have been on the rise in recent decades [13].

Some studies suggest that an excessive buildup of body fat can precipitate type 2 diabetes [14]. The risk of developing this type of diabetes grows with an increasing body mass index. Pearson-Stuttard asserts that effective diabetes prevention hinges on weight loss through a balanced diet, ample sleep, a healthy lifestyle, and regular exercise, ideally three times weekly [15]. Dennison et al. emphasize that while overweight individuals are at higher risk of diabetes, the onset can be forestalled with awareness, exercise, and a healthy lifestyle geared towards weight loss and blood sugar reduction. However, in this fast-paced era, many people indulge in unhealthy habits, such as consuming sugary or unhealthy foods, smoking, drinking alcohol, and avoiding exercise, as preliminary research indicates [16]. Neglecting these habits may have dire consequences, hastening the onset of severe complications [17].

While individuals have the agency to prioritize their health, many often succumb to temptations that prioritize transient pleasures over long-term well-being [18]. Today, maintaining health is a daunting task, given its invaluable significance [19]. Addressing health concerns is achievable with the primary solution being self-awareness to abstain from detrimental habits like overeating, frequent consumption of fried foods and sugary drinks, inadequate water intake, and sedentariness [20]. Embracing an unhealthy lifestyle correlates with weight gain and diabetes mellitus, typified by elevated blood glucose levels, overweightness, and increased mortality [20]. It's prudent for individuals to engage in activities promoting health and alleviating disease symptoms. Adopting a healthful lifestyle and exercising, coupled with a commitment to hygiene and healthful living (PHBS), is paramount for present and future health [21]. Moreover, a healthy lifestyle is a bulwark against various chronic diseases, communicable or not [22].

Aerobic exercise, also known as endurance training, involves the entire physical condition of a human being. Its intensity varies—low, medium, or high—depending on an individual's capability [28]. Regular aerobic exercise for someone with diabetes can increase insulin sensitivity, thereby reducing cardiovascular risk and potentially curbing the progression of the disease [29]. Suitable aerobic exercises for diabetics include walking, cycling, running, and swimming. Diabetic individuals can participate in these activities for extended durations [30]. It's recommended that they exercise 3-4 times per week, beginning with low intensity [31].

The Chronic Disease Management Program (PROLANIS) is implemented by BPJS. PROLANIS is a proactive health service system conducted in an integrated manner involving participants with chronic diseases, health facilities, and BPJS. The primary objective of PROLANIS is to assist participants with chronic conditions in achieving an optimal quality of life. A significant target is that 75% of registered participants who visit primary health facilities should show positive results in managing type 2 diabetes and hypertension to prevent disease progression [32].

PROLANIS activities aim for participants to attain the best quality of life through efficient and effective health services. Activities within PROLANIS encompass medical consultations accompanied by a one-month medication provision, group education, reminders via SMS gateways, home visits, club activities, and health status monitoring [33]. Data from the Banyumas District Health Office in 2016 indicated that there were 1,939 people with diabetes mellitus, 9,281 with hypertension, and 417 who suffered from strokes. Observations from the PROLANIS at the Technical Implementation Unit (UPT) of the Purwokerto Health Center Timur 1 and Twin Health Centers 1 show an uptick in chronic disease patients participating in the health program: 20 people in March, 35 in April, and 48 in May.

The management approach adopted by PROLANIS combines pharmacological therapies, such as oral hypoglycemic agents, and non-pharmacological methods, including aerobic exercises [34]. At the UPT Purwokerto Timur 1 Health Center and Twin Health Center 1, PROLANIS activities occur four times monthly. The initial activity involves measuring blood pressure, taking fasting blood samples, and gauging body weight and height. The secondary activity focuses on aerobics, which are organized four times monthly on Saturday mornings. The tertiary activity entails administering Oral Hypoglycemic Drugs (OHO). Preliminary monitoring reveals that, even after receiving OHO and aerobic exercise, some participants exhibit fluctuating blood sugar levels. Both the Purwokerto Timur 1 and Twin 1 Health Centers are community health establishments under the Banyumas District Health Office. PROLANIS is divided into two classes: hypertension and diabetes. The activities are scheduled as per the PROLANIS calendar and involve six distinct exercises. PROLANIS sessions are held

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monthly and reported to BPJS. The PROLANIS initiatives at Purwokerto Timur 1 and Kembaran 1 Health Centers haven't been previously evaluated, prompting the authors to investigate the effects of low and moderate-intensity aerobic exercises on blood sugar levels in patients with chronic diseases.

Method

This study adopted an experimental approach, employing a two-group pre-test post-test design [35]. A population defines the entire set of subjects sharing specific characteristics that are of interest to the researcher [36]. For this study, the population comprised members of the chronic disease program at the Purwokerto Timur 1 and Twin 1 community health centers, totaling 40.

The study was bifurcated into two groups. Group one engaged in low-intensity aerobic exercises (HRT of 60%-70%), while group two was subjected to moderate-intensity exercises (HRT of 70%-80%). This research scrutinized both dependent and independent variables. Dependent variables included body mass index, blood glucose, and hemoglobin A1c, measured across 20 samples – 10 each from Purwokerto Timur 1 and Twin 1 health centers.

The sampling technique was purposive, ensuring the sample met specific criteria aligning with the study's objectives. The study sample comprised 20 members – 6 men and 14 women. Data analysis involved:

a. Normality tests using the Kolmogorov-Smirnov test [criteria: $p > 0.05$ for normal distribution].

b. Homogeneity tests, leveraging Levene's test and the F-test [criteria: if F count < F table and $p > 0.05$, variables are homogeneous].

c. Hypothesis testing, utilizing the t-test on SPSS, determining the impact of exercise on health markers [criterion: significance level of 5% or 0.05].

Results

The data presented were collected from pre-test data conducted on January 1, 2019, and post-test data carried out on March 4, 2019. The statistical results of the pre-test and post-test data on Blood Glucose are detailed in Table 1.

Table 1. Statistical description of pre-test and post-test data on blood sugar test results

Treatment	Statistics	Pre-Test results	Post-Test results	Decline
Low Intensity	Amount	163.3	114.5	21.8
	Average	136.3	114.5	
	SD	22.82	10.82	
Moderate Intensity	Amount	118.4	94.9	23.5
	Average	118.4	94.9	
	SD	7.648	10.50	

In Table 1 it is explained as follows: (1) the low-intensity exercise group, before exercise, had an average of 136.4. After being given treatment, the average decreased to 114.5. This means the fasting blood sugar in the low-intensity aerobics group decreased by 21.8, or 15.99%. (2) The moderate-intensity exercise group, before exercise, had an average of 118.4. After treatment, the average decreased to 94.9, resulting in a decrease in fasting blood sugar in the moderate-intensity aerobic exercise group of 23.5 or 19.85%. The statistical results of the HbA1c pre-test and post-test data are as follows:

Table 2. Independent tests

Variable	Means	Difference	t counts	Sig	Description
Low Intensity	114.5	21.80	4.109	0.001	significant
High Intensity	94.90	23.50			

Based on the t-test results in Table 2, blood sugar with a significant p-value of 0.001 is a variable with a significance value of $p < 0.05$. The results show significant differences in changes due to low and medium-intensity aerobic exercise in the blood sugar variable. Conversely, for variables with a significance value of $p > 0.05$, the results show no significant difference in changes due to low and medium-intensity aerobic exercise.

Discussion

According to Irianto, low-intensity training (60%-70%) results in an increase of up to 38.50% and can raise the heart rate up to 77.6% HR Max [37]. This intensity zone is recommended for cardiac endurance. Specifically, low and moderate-intensity training stimulates the cardiorespiratory system, impacting increased blood circulation, heart rate frequency, stroke volume, and cardiac output [38]. It also enhances the muscles' ability to

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produce energy aerobically and shifts metabolism from carbohydrates to fats. This allows muscles to burn fat more efficiently, producing health effects like reduced fat stores, blood fat levels, the risk of cardiorespiratory disease, improved insulin sensitivity, and reduced risk of diabetes. This aligns with the statements of Galih and Widiyanto, asserting that appropriate exercise, according to exercise dose, can positively affect a person's physiology [39].

Joint movement exercises in aerobic exercise are isotonic exercises that mobilize all joints through their full range of motion. They are also part of nursing interventions for patients with impaired physical mobility [40]. Isotonic exercises, such as active aerobic exercises, can enhance muscle tone, mass, and strength, and maintain joint flexibility and circulation. During isotonic exercise, the heart rate and cardiac output increase, promoting blood flow throughout the body. Continuous physical exercise for diabetic patients can prevent future complications. Movement exercises for the lower and upper extremities are similar to diabetic foot exercises, which can impact the vascularization of the lower extremities and maintain normal values [41].

With regular physical exercise, cells become trained and more sensitive to insulin, increasing glucose intake by glucose transporters into the cells. This activity then lowers fasting glucose levels [42]. The glucose resulting from the breakdown of carbohydrates from food, once absorbed by the digestive tract, is then taken to target cells to be used for energy metabolism. The protein component responsible for transporting glucose to target cells is the glucose transporter (GLUT). There are different types of GLUT to transport glucose, adapted to the target cell. GLUT 4, specifically, transports glucose to muscle tissue and is affected by insulin [43].

Regular moderate physical activity is associated with a 45-70% reduction in mortality in the type 2 diabetes mellitus population [44]. Physical activity of at least 150 minutes per week, consisting of aerobic exercise, resistance training, or a combination of both, correlates with decreased HbA1c levels in individuals with type 2 diabetes mellitus [45]. Other study results align with multiple studies on physical exercise in patients with type 2 DM. Physical exercise has been shown to enhance blood circulation to the lower extremities. For instance, a study by Gibbs et al. on 140 patients with type 2 diabetes without complications, who were given an intervention in the form of aerobic exercise, demonstrated significant change. The exercise resulted in a decrease in HbA1c and was proven to improve endothelial function, ensuring better peripheral blood flow [46]. Smooth blood circulation will inhibit capillary membrane thickening and an increase in size and number of capillary endothelial cells, ensuring that blood vessel lumens remain adequate. The results of a systematic review and meta-analysis of clinical research regarding the effects of physical exercise interventions with structured HIIT programs for ≥ 8 weeks can change HDL levels [47]. Moreover, the HIIT program can bring HbA1c levels closer to normal values [48].

Conclusion

Based on the findings of this study, the researchers can conclude that there is a significant effect of low and medium-intensity aerobic exercise on blood sugar, with a significance value of 0.001. This proves that low and moderate-intensity exercise has a noteworthy impact, beneficial for those with high blood sugar. Thus, moderate-intensity aerobic exercise is more suitable for controlling blood sugar levels.

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