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THE DIABETIC PATIENT PHYSICAL ACTIVITY: A DESCRIPTION STUDY

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Research Report

ABSTRACT

Introduction: *Sedentary lifestyle in this modern era is one of the factors for the increasing incidence of diabetes mellitus. The high tendency of a person to be lazy to move and not do activities has various adverse effects on the human body, including an increased risk of death from various causes, including diabetes mellitus. However, there has been no research that more strongly explains the physical activity of patients with diabetes mellitus so far, especially in Lamongan Regency. The aim of this study is describing the physical activity of patients with diabetes mellitus in general hospitals in Lamongan Regency.* ***Methods:*** *This study is using a descriptive design by describing the physical activity of 50 diabetic patients at outpatient clinic. Data were collected using the Global Physical Activity Questionnaire (GPAQ) and analyzed by univariate analysis presented in the form of frequency tables.* ***Results:*** *The findings provide information that most 72% patients with diabetes mellitus have moderate physical activity.* ***Conclusions:*** *It is concluded that moderate physical activity in patients with diabetes mellitus makes patients still need to maintain stable blood sugar levels by doing regular and measured physical activity, and remain compliant with other diabetes mellitus management.*

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INTRODUCTION

A sedentary lifestyle in this modern era is one of the factors for the increasing incidence of diabetes mellitus. Lying or sitting for a long time, traveling short distances by vehicle, the high tendency of a person to be lazy to move and not do activities have various adverse effects on the human body, including an increased risk of death from various causes, including diabetes mellitus (Siloam Hospital, 2023) (P2PTM Kemenkes, 2018). Changes in lifestyle, the wrong diet, lack of awareness of physical activity and ignorance of what physical activities can be done by patients with diabetes mellitus cause blood sugar to be poorly controlled (Astuti, 2017) (Murtiningsih, Pandelaki, & Sedli, 2021) (Siregar, Butar, Pangaribuan, & Batubara, 2023). The research by (Ramadhani, Siregar, Adrian, Sari, & Hikmahrachim, 2022) shows that Indonesian people have light and moderate physical activity habits, so they have a chance of developing diabetes mellitus 3.198 and 1.933 times, respectively, compared to people who have heavy physical activity habits. While the research by (Suradi, 2016) obtained as many as 48.4% of patients with diabetes mellitus lack activity. However, the number of respondents explored was still small and no more research was explored in more depth. So far there has been no research that more strongly explains the description of physical activity of patients with diabetes mellitus at general hospital of Lamongan.

The International Diabetes Organization reported that the prevalence of diabetes mellitus worldwide reached 537 million people aged 20-79 years, estimated to increase to 643 million in 2023 and 783 million in 2045 (IDF, 2021) Indonesia is ranked 5th with 19.5 million people with diabetes mellitus and is expected to increase to 28.6 million in 2045 (IDF, 2021). The estimated number of people with diabetes mellitus in East Java is 2.6 of the population aged 15 years and over with a total of 867,257 cases of sufferers in 38 districts/cities (Dinkes Jatim, 2021), while in 33 Community Health Centers in Lamongan Regency it has reached 22,580 cases, which is 97.2% of the estimated number of people with diabetes mellitus (Dinkes Lamongan, 2021), the results of a survey in general hospital of Lamongan in January-June 2019 obtained the incidence of diabetes mellitus recorded 90 people (Emiliah, 2019). The increase in the incidence of diabetes mellitus coincided with an increase in the

proportion of physical inactivity from 26.1% to 34.1% where this lack of physical activity was carried out by patients aged ≥15 years, then increased from 1.5% in 2013 to 2% in 2018 (Riskesdas, 2018).

Blood glucose levels can be influenced by physical activity. (Dewi, Andayani, & Pratiwi, 2022) (Karwati, 2022) Physical activity is any body movement produced by skeletal muscles that requires energy, lack of physical activity is an independent risk factor for chronic diseases that are estimated to cause global mortality. Physical activity has an impact on the insulin of patients at risk of diabetes mellitus, exercise activates insulin binding in the plasma membrane so that it can reduce blood glucose levels. There are several physical activities carried out with exercise, including aerobic exercise, walking, leisurely cycling, jogging, and gymnastics can reduce HbA1c (Karwati, 2022). When the body moves a lot, the use of glucose will increase so as to minimize the increase in blood glucose, but on the contrary, if you do not or lack physical activity, your body weight will increase, resulting in a buildup of blood glucose. (Alza, Arsil, Marlina, Novita, & Agustin, 2020) A resting body requires a lot of insulin for glucose absorption, while an active body does not increase insulin requirements. (Amrullah, 2020) This is evidenced by around 50% of patients with type 2 DM in Perean Kangin Village who have heavy activities have good blood sugar levels and around 45% are moderate (Dewi, Andayani, & Pratiwi, 2022) and conversely 46.7% of elderly people at Community Health Center of Situ have light activities with high blood sugar levels (Karwati, 2022).

Diabetes management includes five pillars: education, dietary management, physical activity, pharmacological therapy, and blood glucose monitoring. Lifestyle changes that focus on physical activity have a positive impact on reducing anthropometric and blood parameters related to fat and glucose profiles. (Balducci, et al., 2019) People with diabetes mellitus who often do physical activities well and regularly have the potential to reduce the amount and dose of anti-diabetic therapy and insulin. (Teich, Zaharieva, & Riddell, 2019) Diabetes mellitus patients are recommended the importance of exercise and moderate intensity physical activity that is carried out properly and regularly. (Lontoh, Novendy, Tirtasari, Hutagaol, & Naeluvar, 2022).

Considering the importance of physical activity for people with diabetes mellitus, it is necessary to have information about the right physical activity description. Researchers are interested in first exploring the description of the physical activity of patients with diabetes mellitus at the general hospital of Lamongan so that it is easier to identify the types of physical activity carried out daily and can be used as a reference for controlling blood glucose levels to remain stable.

MATERIALS AND METHODS

Using a descriptive research design, this study was conducted in the General Hospital of Lamongan in May 2023 by obtaining research ethics No. 445/0048.26/413.209/KEPK/2023 at the general hospital of Lamongan. A total of 50 samples were selected using total sampling with the criteria that respondents had diabetes mellitus and were treated at Lamongan hospital, all four extremities function normally and not experiencing paralysis, full consciousness, and willing to become respondents. Patient selection was carried out by conducting a physical examination and patient awareness status. After obtaining permission from patients with diabetes mellitus, the patient's physical activity variable was measured using the Global Physical Activity Questionnaire (GPAQ).

Based on domains and questions, GPAQ is asking about the time spent by patients doing different types of physical activity in a typical week. For analysis purposes the 3 domains can be further broken down into six different sub-domains, those are vigorous work (P1-P3), moderate work (P4-P6), travel (P7-P9), vigorous recreation (P10-P12), moderate recreation (P13-P15), and sitting (P16). The vigorous-intensity activities are activities that require hard physical effort and cause large increases in breathing or heart rate, and moderate-intensity activities are activities that require moderate physical effort and cause small increases in breathing or heart rate (WHO, 2021) (Lubis, Rahmaniar, & Oktavia, 2023).

Metabolic Equivalents (METs) are commonly used to express the intensity of physical activities and are also used for the analysis of GPAQ data. The ratio of a person's working metabolic rate relative to the resting metabolic rate. One MET is defined as the energy cost of sitting quietly and is equivalent to a caloric consumption of 1 kcal/kg/hour. For the analysis of GPAQ data, existing guidelines have been adopted: it is estimated that, compared to sitting quietly, a person's caloric consumption is four times as high when being moderately active, and eight times as high when being vigorously active. Therefore, when calculating a person's overall energy expenditure using GPAQ data, 4 METs get assigned to the time spent in moderate activities, and 8 METs to the time spent in vigorous activities. The data has been measured and analyzed by a univariant test finally obtained in the form of percentages with 3 types of activities 1) low

activities (<600 METs/minutes/week), 2) moderate activities (600-3000 METs/minutes/week), and 3) high activities (>=3000 METs/minutes/week).

The high activities were categorized by doing vigorous activity for at least 3 days with a total physical activity reaching a minimum of 1.500 MET-minutes per week, or combining moderate and vigorous activity within 7 days reaching 3.000 MET-minutes per week. Vigorous activity can be done by activities that require more effort such as logging, chopping wood, carrying heavy wood, mining sand, and sports activities like playing football, high-impact aerobics, badminton, tennis, and others sports that require hard physical effort and cause large increases in breathing or heart rate (WHO, 2021) (Lubis, Rahmaniar, & Oktavia, 2023).

Patients who do a moderate activity such as cleaning the house, sweeping, mopping, washing by hand, cleaning dust, gardening, carpentry, carrying loads on the head, digging soil with a shovel, and other activities that require a middle effort and cause small increases in breathing or heart rate can be carried out as a moderate physical activity. It can be achieved by doing a vigorous activity for >= minutes within 3 days or moderate activity for 150 minutes within 5 days or combining moderate and vigorous activity by achieving 600 MET-minutes per week. Apart from both categories (vigorous and moderate activity) are categorized as low physical activity that patients who only reach an activity of less than600 MET minutes per week (WHO, 2021) (Lubis, Rahmaniar, & Oktavia, 2023).

The other supporting data were collected using a questionnaire instrument, those are age, gender, education, occupation, marital status, family member, history of family disease, duration of diabetes, complication, diabetic drugs, drug compliance, type of diet, and blood sugar level.

RESULTS

This study collected 50 completed questionnaires containing general data (table 1) and main data (table 2) of diabetic patients in the outpatient clinic of the General Hospital of Lamongan

Table 1. The General Data of Diabetic Patients, General Hospital of District Lamongan, May 2023 (n=50).

The General Data	Frequency	Percentage (%)
The Demographic Data		
Age		
25-35 Years old	3	6.0
36-45 Years old	4	8.0
46-55 Years old	16	32.0
>56 Years old	27	54.0
Total	**50**	**100.0**
Gender		
Man	18	36.0
Woman	32	64.0
Total	**50**	**100.0**
Education		
Not attending school	3	6.0
Elementary school	25	50.0
Junior high school	6	12.0
High school	3	6.0
College	13	26.0
Total	**50**	**100.0**
Occupation		
Unemployed	5	10.0
Housewife	14	28.0
Farmers/fishermen	9	18.0
Entrepreneur	10	20.0
Private	7	14.0
Civil servant	5	10.0
Total	**50**	**100.0**
Marital Status		
Married	50	100.0
Single	0	0
Total	**50**	**100.0**
Family's Member		
>5 persons	34	68.0
5-10 persons	14	28.0

The General Data	Frequency	Percentage (%)
>10 persons	2	4.0
Total	**50**	**100.0**
The Disease and Treatment		
History of family		
Yes	19	38.0
No	31	62.0
Total	**50**	**100.0**
Duration of Diabetes		
<1 year	13	26.0
1-5 years	19	38.0
>5 years	18	36.0
Total	**50**	**100.0**
Complication		
Yes	26	52.0
Dyspepsia	3	
Hypertension	12	
Heart disease	3	
Atsma	2	
High Cholesterol	5	
Kidney Failure	1	48.0
No	24	
Total	**50**	**100.0**
Diabetic Drugs		
Oral	33	66.0
Glibenclamide, Glimepiride, Glucodex, Metformin		
Insulin	6	12.0
Novomix, Sansulin, Lantus		
Oral and insulin	11	22.0
Glibenclamide, Glimepiride, Glucodex, Metformin, Novorapid, Actrapid		
Total	**50**	**100.0**
Drug Compliance		
Adherence	50	100.0
Not-adherence	0	0
Total	**50**	**100.0**
Type of Diet Consumed		
Carbohydrates	38	56.0
Protein	8	16.0
Fiber	14	28.0
Blood Sugar Levels		
Low	0	0
Normal	20	40.0
High	30	60.0
Total	**50**	**100.0**

These general data contain patient characteristic data including 1) demographic data (age, gender, education, occupation, marital status, family members living in the same house), and 2) disease and treatment data (history of family members suffering from diabetes mellitus, duration of diabetes mellitus, complications, diabetes mellitus drug consumption, drug compliance, type of diet consumed, and blood sugar levels)

In addition, our findings demographic characteristics showed 54% of respondents aged >56 years, 64% females, 50% in elementary school, 28% working as a housewife, all married (100%), 68% family members in one house <5 people and 62% do not have family members suffering from diabetes mellitus. The characteristics of the disease and its treatment showed 36% duration of diabetes mellitus for >5 years, 52% had complications with the most complications being hypertension (46.2%), all patients (100%) taking diabetes medications, 56% are consuming carbohydrates, and 60% the patient's blood sugar was high.

Table 2. The Physical Activity's Data of Diabetic Patients, General Hospital of District Lamongan, May 2023 (n=50).

Physical Activity	Frequency	Percentage (%)
High	9	18.0
Moderate	36	72.0
low	5	10.0
Total	**50**	**100**

The results of this study obtained a description of the physical activity of patients with diabetes mellitus with a frequency distribution of low activity in 5 respondents (10%), moderate activity in 36 respondents (72%), and vigorous/high activity in 9 respondents (18%) (Table 2). Metabolic Equivalents of Task (METs) values in the interval ≥600 MET <3000 minutes/week, with the average MET value in the moderate physical activity category being 1662 MET minutes/week. At the time of the interview, physical activities performed by female respondents included cooking, sweeping, mopping the floor, ironing, and washing dishes or clothes. Meanwhile, physical activities carried out by male respondents included hoeing, planting plants, and washing vehicles (cars, motorcycles).

DISCUSSION

Rapid urbanization in developing countries has led to significant changes in health and has increased the burden of chronic illness. Physical activity is a major, independent, and commutable risk factor for chronic disease (Adiguzel, Onmus, Mandiracioglu, & Ocek, 2021) which is estimated to cause 1.9 million deaths, globally. Moreover, physical inactivity is considered the fourth leading risk factor for global mortality causing an estimated 3.2 million annual deaths (6% of global deaths). (El Bilbeisi, Hosseini, & Djafarian, 2017) Physical activity (PA) decreases and has substantial effects that protect from the risk for premature death, coronary artery disease, stroke, obesity, T2 diabetes, hypertension (HTN), cancer (colon and breast cancer), injuries, falls, and depression thereby lowering medical and medication costs and improving quality of life (El Bilbeisi, Hosseini, & Djafarian, 2017) (Adiguzel, Onmus, Mandiracioglu, & Ocek, 2021).

This study obtained a clearer picture of the physical activity of patients with diabetes mellitus. The main findings of this study indicate that most patients performed physical activity in the moderate category (72%) with MET values in the interval ≥600 MET <3000 minutes/week, with the average value of MET in moderate category physical activity being 1662 MET minutes/week. This data analysis uses GPAQ version 2 based on the Metabolic Equivalent (MET) which presents the calculation of the total volume of physical activity in units of MET-minutes/week.

Moderate activity is an activity where 40% of the time is spent sitting or standing and 60% is spent on specialized work activities in their field of work. When performing a moderate activity, a person performs activities with a vigorous intensity of at least 20 minutes/day for 3 or more days, performs a moderate activity for 5 or more days or walks for at least 30 minutes/day, or performs a combination of vigorous, moderate, and walking physical activity in 5 or more days with an intensity of at least 600 MET-minutes/week. (WHO, 2021) on other resources, moderate-intensity physical activity is defined as activities during which a person spends 3 or 6 times more calories (3-6 MET) compared to sitting and vigorous-intensity physical activity as activities during which a person spends more than six times more calories (>6 MET) compared to sitting. The WHO engages in at least 150 minutes of moderate-intensity aerobic physical activity or 75 minutes of vigorous-intensity aerobic physical activity weekly to remain healthy and promote health. Each aerobic activity should last at least 10 minutes. (Adiguzel, Onmus, Mandiracioglu, & Ocek, 2021)

According to (Kemkes RI, 2018) activities that fall into the moderate category include walking briskly (speed 5 km/h) on a flat surface inside or outside the house; in class; to work or to the store, leisurely walks, and walking during work breaks. Moving light furniture; gardening; planting trees; washing cars. Carpenter work such as carrying and stacking wooden beams; and clearing grass with a lawn mower. While recreational activities such as badminton; playing doubles ball; dancing; table tennis; bowling; cycling on a flat track; non-competitive volleyball, skateboarding; water skiing, and sailing. During moderate physical activity, the body sweats slightly, the heart rate and breathing frequency become faster and the energy expended is 3.5-7 Kcal/minute.

In addition to the moderate category, physical activity of patients with diabetes mellitus was also found in the severe category 18%, and mild 10%. Physical activity plays an important role

in preventing and controlling insulin resistance, pre-diabetes, T2DM, and various complications due to diabetes. Whether it is daily physical activity at home aerobic exercise or muscle strength training, it will improve insulin action acutely, and can help control blood sugar and fat levels; blood pressure; cardiovascular disease risk; mortality; and quality of life. These positive effects are provided that physical activity must be done regularly in order to provide long-term benefits. (Kurniawan & Wuryaningsih, 2016)

Variations in the category of physical activity carried out by patients with diabetes mellitus can be influenced by several factors including age, gender, psychology, and ethnicity. (Afiah, Yusran, & Sety, 2018), The characteristics of respondents who are mostly female and housewives make a reference to the identification of physical activities carried out by respondents. Women with diabetes mellitus mostly do moderate activities such as cooking, sweeping, mopping the floor, ironing, and washing dishes or clothes. Meanwhile, physical activities carried out by male respondents include hoeing, planting plants, and washing vehicles (cars, motorbikes). This is in line with research (Alza, Arsil, Marlina, Novita, & Agustin, 2020) which states that physical activity in the moderate category is mostly routine activities including walking, cooking, sweeping, cleaning the house, ironing, washing clothes, and so on. These activities are included in the category of physical activity while working/studying. Travel activities to and from the place of activity carried out by respondents include walking to the market, to the workplace, and to the place of worship. Recreational activities include morning exercise by walking leisurely in front of the house, light gymnastics, swimming, and leisurely cycling. Finally, sedentary activities carried out by respondents are watching television, sitting, and lying down.

The number of respondents who do moderate physical activity can also be supported because most of the respondents are >56 years old. This is in accordance with the theory that there are differences in the ability to perform physical activity at different ages. The highest physical activity of normal humans occurs at the age of 12-14 years and then decreases significantly when entering adolescence, and adulthood, until old age >65 years. As age increases, it can reduce the function of body organs such as limb activeness which can affect the level of physical activity. (Afiah, Yusran, & Sety, 2018) In addition to age, half of the respondents who had moderate physical activity had a primary school education. The influence of one's level of education is very important in changing attitudes and behaviors to live a healthy life, a high level of education is identical to a high knowledge and understanding and an increase in one's perspective on their health. (Rohmah, 2021) The level of education can increase a person's knowledge about health, with the knowledge gained a person can maintain their health so as not to invite problems or diseases. (Efriliana, Diana, & Setiawan, 2018) Although the results of the study showed that half of the respondents had elementary school education, the data showed that the respondents knew how important physical activity was in daily life to control blood sugar levels as evidenced by the physical activity of diabetes mellitus patients dominated by moderate activity.

Other factors such as marital status, occupation, and family members living in the same house can be significant contributing data. Housewives and agricultural occupations are associated with physical activity levels, these occupations are not only work but also leisure time activities, and periodic participation in such work can easily increase physical activity. Physical activity levels tend to increase as the support system improves. Improvements in physical activity levels are highly dependent on overcoming barriers to physical activity; involvement of supportive people during therapy sessions to encourage overcoming barriers; encouragement to engage in physical activity; and increased peer support and family involvement. Murano, et al., 2014)

Genetic factors are associated with the development of type 2 diabetes mellitus, and risk factors associated with tend to cluster within a family because members share the same genetic background, lifestyle habits, and social and physical environment. Individuals at high risk of developing type 2 diabetes mellitus have a strong family history and a less physically active lifestyle. (Utami, Woferst, & Lubis, 2019) The likelihood of developing type 2 diabetes in people with a family history of diabetic pathology is very high, and men and women with a family history of type 2 diabetes have a higher chance of developing diabetes with low levels of physical activity compared to those with high physical activity and no family history. (Petermann, et al., 2018) Family members at risk are recommended to start a healthier lifestyle by maintaining physical activity, especially exercise (Utami, Woferst, & Lubis, 2019), and require higher levels of physical activity to reduce their susceptibility to type 2 diabetes mellitus. (Petermann, et al., 2018) This explanation supports the research results obtained that there are 19 respondents who have a family history of diabetes. Although only 38%, it needs to be a concern to

follow the recommendations given so as not to cause more severe risks.

The findings of complications experienced showed that 52% of respondents experienced complications consisting of hypertension, high cholesterol, heart disease, dyspepsia, asthma, and kidney failure. Based on the findings of (El Bilbeisi, Hosseini, & Djafarian, 2017) on the relationship between PA level and diabetes complications, it was found that there was a significant relationship between PA level and diabetes complications (eye problems, kidney problems, urine protein, heart problems, extremities problems, and neurological problems). Another finding was the relationship between PA with TGs, HDL-c, and blood pressure in both sexes (P value <0.05). Increased PA promotes weight loss, improves insulin sensitivity, increases HDL-c levels, lowers TG levels, and prevents hypertension (El Bilbeisi, Hosseini, & Djafarian, 2017) Meanwhile, the duration of diabetes showed 38% in 1-5 years and 36% >5 years, this data supported by a previous study that longer duration of diabetes, poor glycemic control, and low PA were associated with the prevalence of neuromusculoskeletal complications that affect to physical activity ability (Jena, et al., 2022).

Following these findings, our study shows a majority of the participants had a high blood sugar level (60%). Patients whose blood sugar levels are not controlled are those who lack physical activity. They sit more often and have minimal activity after eating. This condition confirms that patients with mild physical activity have high blood sugar levels, in one study the sugar levels achieved were in the range of 176-200 mg/dl (Rustini & Maulidia, 2018). Reinforced by Sam, Lestari, & Afa, 2017) that low physical activity can increase blood glucose levels by approximately 24%. Patients with heavy physical activity have blood glucose levels of 126-150 mg/dl because the greater the active muscles, it will stimulate insulin sensitivity so that the muscles will use more glucose. (Rustini & Maulidia, 2018) This finding is in line with (Jena, et al., 2022) study, it's showing a majority of the participants had uncontrolled diabetes with an HbA1c level of ≥7.5% (n=190; 51.35%). Poor glycemic control and low PA were associated with the prevalence of neuromusculoskeletal complications that affect physical activity ability (Jena, et al., 2022). Physical exercise that is planned, structured, and carried out to improve health or physical fitness and it is an effective way to improve glycemic control (Kurniawati, Baridah, Kusumawati, & Wabula, 2019) The exercise who done in average of 45.15 minutes and follow up duration in 21.94 weeks is decreases in glycated hemoglobin (HbA1c; P<0.0001); fasting glucose (P=0.03). Exercise is considered a cornerstone in achieving an optimized blood glucose level and reducing body weight, body mass index (BMI), and waist circumference. In those studies, regular exercise can delay diabetes and control the level of blood sugar.

The acute effects of exercise include enhanced glucose metabolism and improved insulin sensitivity. Blood glucose was found to be an important substrate in the skeletal muscle oxidation process during strenuous exercise, and exercising increases glucose utilization without affecting blood insulin levels. Exercise also increases certain protein levels that are important for glucose homeostasis. The increase in the level of glucose transporter type 4 protein (GLUT4) induced by exercise training enhances skeletal muscle glucose uptake. This strategy could regulate blood glucose levels in the case of insulin resistance. Gabriel and Zierath also noted that performing exercise training for longer increases the aerobic threshold and the concentration of mitochondria in skeletal muscles. High-intensity exercise consumes glucose at a higher rate than it is produced by the liver, so the blood sugar level drops. It has been proven that exercise increases the sensitivity of muscle cells to insulin and increases the activity of oxidative enzymes. Moreover, the overall effects of exercise on carbohydrate metabolism are associated with improved insulin sensitivity.

Habitual aerobic exercise helps manage blood glucose. Resistance exercise benefits insulin sensitivity in those with T2D. Movement throughout the day by breaking up sitting time benefits blood glucose and insulin. Physical activity after meals reduces blood glucose. Performing exercise later in the day can benefit glycemic control and insulin sensitivity (Syeda, Battillo, Visaria, & Malin, 2023). Exercise is a first-line therapy recommended for patients with type 2 diabetes (T2D). Although moderate to vigorous exercise (e.g. 150 min/week) is often advised alongside diet and/or behavior modification, exercise is an independent treatment that can prevent, delay, or reverse T2D. Habitual exercise, consisting of aerobic, resistance or their combination, fosters improved short- and long-term glycemic control. Recent work also shows that high-intensity interval training is successful at lowering blood glucose, as is breaking up sedentary behavior with short bouts of light to vigorous movement (e.g. up to 3 minutes). Interestingly, performing afternoon compared with morning as well as post-meal versus pre-meal exercise may yield slightly better glycemic benefit. Despite these efficacious benefits of exercise for T2D care, optimal exercise recommendations

remain unclear when considering, dietary, medication, and/or other behaviors. (Syeda, Battillo, Visaria, & Malin, 2023)

Pharmacological therapy is one of the diabetes management to reduce blood glucose levels, so in this study, all patients received pharmacological therapy with the highest number 66% taking oral drugs, the rest getting insulin and a combination of OHO and insulin. There are several things that need to be considered when doing activities or sports and consuming antidiabetics because exercise or activity will cause muscles to use more glucose so as to reduce blood sugar levels. Someone who takes insulin or diabetic tablets (which can produce more insulin) can be at risk of experiencing very low blood sugar levels (Better Health Channel, 2021).

Patients taking metformin need to pay attention to the timing of consumption and activity because metformin and exercise therapy can affect each other. Metformin can increase heart rate and plasma lactate during exercise (P≤0,01) but decrease respiratory exchange ratio (P=0.03) without affecting total energy expenditure, indicating increased fat oxidation. Therefore, the recommended exercise or activity is a low-load activity. Moreover, under the conditions tested, exercise interfered with the glucose-lowering effect of metformin (Boule, et al., 2011). However, in the research (Carrillo, et al., 2023), The recommended time to take metformin and the right type of activity is morning exercise/activity with moderate intensity combined with metformin intake before breakfast can be beneficial in managing glycemia in people with type 2 diabetes. This recommendation is based on a trial (Carrillo, et al., 2023) in nine men and nine women with type 2 diabetes. They underwent metformin monotherapy by completing a 16-week crossover trial and arm exercise consisting of 30 minutes of walking at 70% of the estimated maximal heart rate daily. Acute glucose AUC was significantly lower (P=0.01) in participants taking metformin before breakfast (152.5±10.59 mmol/L) compared to participants taking metformin after breakfast (227.2±27.51 mmol/L) during morning exercise only. During weeks 5-6 of the exercise protocol, glucose AUC was significantly lower (p=0.04) for participants taking metformin before breakfast (168.8±5.6) than after breakfast (224.5±21.2) during morning exercise only.

Exercise and placebo resulted in only a small decrease in glycemia. Rest and administration of 1.75 mg glibenclamide led to a moderate but steady fall in blood glucose concentrations. If glibenclamide administration and exercise were combined, blood glucose concentrations declined more markedly. Serum insulin concentrations showed a physiological decrease during exercise and placebo administration. If patients rested after administration of glibenclamide serum insulin levels rose and remained elevated. When exercise and glibenclamide were combined the rise in serum insulin levels was blunted and insulin levels fell once exercise was begun. Thus, exercise attenuates the glibenclamide-induced increase in serum insulin in moderately hyperglycemic Type 2 diabetic patients. Nevertheless, exercise has a substantial hypoglycemic effect in glibenclamide-treated Type 2 diabetic patients. Patients taking insulin or certain oral hypoglycemic agents have challenges in maintaining blood glucose balance. Hypoglycemia is the most common side effect for patients on exercise/activity and insulin therapy. Appropriate adjustment of insulin dose and, in some cases, carbohydrate supplementation, will better manage blood glucose levels. It is therefore appropriate for the medical professional to adjust the insulin dose and strategy as the starting point of when to start activity or exercise. (Zaharieva & Riddell, 2017)

The last finding, most of the respondents are consuming carbohydrates (56%). Carbohydrate is an important energy source during exercise/activity. During short, heavy exercise it may be the only energy source for the working muscle and may be derived exclusively from the glycogen stores within the muscle fibers themselves. But it's not for diabetic patients, combining regular exercise or physical activity and a healthy diet is highly recommended in international guidelines to fight T2DM. Low- and very low-carbohydrate diets have attracted attention in recent years. The possible effects of regular exercise and carbohydrate restriction combined have an increased interventional effect on oxidative capacity as well as glucose and lipid profiles, however, anabolic signaling pathways may be blunted during low-carbohydrate diets and increase ketosis. Thus, muscle building can become difficult or impossible. In addition, maximal performance during high-intensity exercise may be attenuated due to possible reduced anaerobic glycolysis and metabolic inflexibility in T2DM patients. (Akrimi & Brinkmann, 2022).

CONCLUSIONS

It is concluded that the physical activity of diabetic patients is moderate. Researchers assume that doing measurable and regular physical activity for 15-60 minutes can lower blood glucose levels and reduce the impact of diabetes complications. This of course goes hand in hand

with maintaining the diets consumed, compliance with taking medication, doing activities, and choosing the type of exercise according to the physical condition and ability of the body.

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