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The effect of a six-minute walking test on glucose levels among patients with type 2 diabetes

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ABSTRACT

Postprandial glucose is regulated by skeletal muscle movement, and exercise is the cornerstone of T2D therapy as it improves glucose uptake and metabolism in skeletal muscles. The ability to perform functional exercises is determined through (6MWT). To investigate the effect of 6mwt on glucose levels in patients with type 2 diabetes as well as to compare their functional abilities with healthy controls. Using a purposive sampling strategy, this case-control study included 62 subjects: 31 with T2DM and 31 with healthy controls. All the participants were nonsmokers with no pulmonary problems that could have influenced the 6MWT.Age, sex, and BMI were matched to each T2DM and healthy controls. We assessed demographic, anthropometric, biochemical, and physical parameters. The 6MWT was used to assess functional exercise capacity. The maximum amount of oxygen consumed (VO2 max) was calculated. Cardiac parameters and random blood glucose (RBG) were measured pre and post the 6-MWT. Descriptive and inferential statistics were used to analyze the data. p was chosen as the Alpha level < 0.05. There was a decrease in glucose levels post-6MWT in the T2DM group, with a mean and stander deviation pre (260.6±103.9) and post 6MWT (214.3±92.6). Type 2 diabetes patients had a lower functional exercise capacity than healthy controls, with mean and standard deviations of 6MWD and estimated VO2 max of (445.678.7) and (10.91.3) for T2DM and (529.770.1) and (12.31.1) for healthy controls, respectively. Blood glucose control will be enhanced by health education on self-care management, particularly walking. In comparison to matched healthy controls, exercise capacity is reduced in T2DM patients.

1. INTRODUCTION

Diabetes mellitus is a serious and long-term condition that poses a significant social, epidemiological, and economic burden as a concern for public health defined as a lifestyle disease [1]. Diabetes mellitus has increased in prevalence from 108 million in 1980 to 422 million in 2014 [2]. Diabetes has nearly doubled in prevalence among adults over the age of 18 since 1980, rising from 4.7 percent in 1980 to 8.5 percent in 2014. In 2015, diabetes caused an estimated 1.6 million deaths [3]. Almost 425 million people worldwide had diabetes in 2017; by 2045, that figure is anticipated to increase to (629) million, according to the International

Diabetes Federation (IDF). In 2017, DM took the lives of roughly 4 million adults [4]. Diabetes is more common in low- and middle-income countries than it is in high-income ones, a development that has been related to rising obesity rates and population aging. There has been a rise in both the number of deaths and the incidence of hyperglycemia connected to chronic hyperglycemia [5]. Diabetics have a two- to three-fold greater risk of heart attacks and strokes as a result of vascular disorders such angina, stroke, and atherosclerosis of the lower limbs, which are detected earlier and more frequently in diabetes patients [6]. Diabetes is a collection of diseases that lower physical ability and impact pulmonary function [7]. Impaired functional exercise capacity is a significant predictor of heart disease and all-cause death rates in type 2 diabetes patients [8]. Even if they do not have coronary artery disease, people with T2DM are more insulin resistant. They have a poorer functional capacity than comparably active age-and body-weight-matched healthy controls [9]. Despite rigorous cardiovascular (CV) risk factor therapy, patients with T2DM continue to have an excess of cardiovascular (CV) mortality. "Insulin resistance, endothelial dysfunction, poor myocardial perfusion, cerebral blood flow, and oxygenation deficiencies," changes in cardiac and skeletal muscle activity, as well as other factors, may all be linked to people with T2DM having a lower exercise capacity [10]. Functional capacity, exercise performance, and exercise endurance are all terms that refer to an individual's ability to undertake a maximal exercise test while exerting their maximum effort. However, these terms are sometimes used to describe a person's ability to undertake sub-maximal activities based on many tests [11]. In type 2 diabetes, the 6MWT may properly reflect functional exercise capability. Because most activities of daily living are conducted at sub-maximal levels of effort, [12]. The test could be utilized in clinical settings to assess the influence of several co-morbidities on exercise capacity and endurance in older persons, such as cardiovascular disease, lung illness, arthritis, diabetes, cognitive impairment, and depression [13].

Physical exercise, in combination with pharmacologic therapy, is a successful technique for treating type 2 diabetes patients, with a direct impact on glucose control. [14], due to its ability to lower blood glucose levels and its anti-inflammatory action over time, with the potential to reduce cardiovascular problems in these patients [15]. When a muscle contracts, it absorbs more glucose due to the two main functions of enhancing insulin sensitivity and transporting GLUT4 to the cell surface. In addition, PE raises intramuscular type 4 glucose transporter (GLUT4) content and lowers inflammation, mostly through the production of anti-inflammatory cytokines and a decrease in total lipid content [16].

2. Methodology

2.1 Participants and study design

Using a purposive sample strategy, this case-control study selected 31 patients diagnosed with type 2 diabetes from the Al-Wafaa Specialized Center for Diabetes and Endocrinology and 31 healthy controls whose age, gender, and BMI were homogeneous. Type 2 diabetes patients between the ages of 35 and 66 who are non-smokers and attend the Al-Wafaa Specialized Center for Diabetes and Endocrinology. There were also apparently healthy controls with no history or diagnosis of self-reported T2D, and they were non-smokers who matched for age, gender, and BMI. The study excluded participants with a history of ischemic heart diseases, such as MI or angina, musculoskeletal disorders, such as acute osteoarthritis of the knee or hip joint, peripheral vascular disease, or neurological conditions, such as peripheral neuropathy.

2.2 Data collection

The goal of the study was explained to participants who met the eligibility requirements prior to the commencement of the study, and informed consent was obtained. The most important data on demographic characteristics (e.g., age and sex) and disease history were collected through interviews with a questionnaire.

Both weight and height measurements were taken on a Tanita BC533 Roman-style scale and a SECA 406 Stadiometer to compute the BMI. A SECA 206 tape was used to measure waist circumferences at the midpoint between the lowest costal margin and the lateral iliac crest.

2.2.1 Biochemical analysis

Participants were said not to eat or drink anything for at least 12 hours before the lipid profile and glycated hemoglobin A1c (HBAIC) measurement the day before the visit. Between the hours of 8 a.m. and 10 a.m., all measurements were obtained. Enzymatic methods and a chemical analyzer were used to determine the lipid profile. Total cholesterol had a coefficient of variation of 4.3 percent, triglycerides had a coefficient of variation of 6%, and high-density lipoprotein cholesterol had a coefficient of variation of 3%. (HDL-C). The Fried Wald formula was used to determine LDL-C (low-density lipoprotein cholesterol).

2.2.2 Functional exercise capacity evaluation

In this study, the six-minute walk test (6MWT) was applied to evaluate functional exercise capacity (6MWT). The 6MWT is one of the most extensively used performance-based tests in the evaluation of functional exercise capacity in a number of populations, including type 2 diabetes patients [17]. According to the American Thoracic Society, the 6-MWT was administered using a standardized protocol [18]. Two cones were placed in a 20-meter section of the Al-Wafaa Specialized Center for Diabetes and Endocrinology for the test. Before the exercise test, each subject was given ten minutes of rest in a seated position. Patients were advised to walk from the beginning to the conclusion at their own pace while striving to cover as much ground as possible in six minutes, as instructed. It was done consistently, with encouragement given every 20 seconds or so. Measure the pulse, blood pressure, oxygen saturation rate, rate of perceived exertion, and random blood glucose (through a glucometer) and then ask the patient to walk for 6 minutes and count the number of cycles to know the distance traveled during this time. At the end of 6 minutes, ask the patient to stand in his place and prepare a chair to sit in. Then measure the pulse, blood pressure, oxygen saturation rate, rate of perceived exertion, random blood glucose (through a glucometer), Functional capacity (maximum oxygen consumption (VO2 max)) was determined using a prediction equation after the entire distance walked in six minutes (6MWD) was measured to the closest meter.

(VO2 max) = Walking Speed × 0.1 + 3.5 [19].

2.3 Data analysis

IBM SPSS Version 26 was used to analyze the data. To see if the distribution was normal, the Kolmogorov-Smirnov test was applied. To summarize the data, descriptive statistics such as frequency, percentage, mean, and standard deviations were used. To compare type 2 diabetes and healthy controls, an independent t-test was utilized, while a paired t-test was used to find a difference between pre and post random blood sugar and cardiovascular response to the 6MWT. "A P value of less than 0.05 was used to indicate statistical significance."

3. Results

Table 3.1 demonstrates that there were sixty-two research participants, with no statistically significant differences in age, gender, and BMI class, indicating homogeneity between study groups. Table 3.2 shows There were no statistically significant differences in mean ± standard deviation for age (53.1±8.7), (51.9±8.9), height (166.6±8.3), (168.4±7), weight (84.9±15.3), (82.3±13.1), and BMI (30.6±5), (29.1±3.9), but there were highly statistically significant differences in waist circumference (WC) (109.8±14.5) and (97.9±12.8). Table 4.3 shows the results of the analysis. It reveals that among type 2 diabetes patients, there are highly statistically significant differences in glucose levels by age group and sex. The total mean and standard deviation for glucose levels before and after the 6MWT were (260.6103.9) and (214.392.6), respectively. Table 3.4 shows that between type 2 diabetes and healthy controls, there are "highly statistically significant differences" in 6MWD and predicted VO2 MAX for males and females.

Table (1): Descriptive of frequency distribution for type2 diabetic and healthy person.

Variables		Type2 Diabetic		Healthy person		p-value
		F	%	F	%	
Age.	35<45	8	25.8	10	32.3	0.855
	45<55	11	35.5	10	32.3	
	55-66	12	38.7	11	35.5	
TOTAL		31	100	31	100	
Sex.	Male	20	64.5	20	64.5	1
	Female	11	35.5	11	35.5	
TOTAL		31	100	31	100	
BMI.	Normal	3	9.7	4	12.9	0.586
	Overweight	13	41.9	16	51.6	
	Obese	15	48.4	11	35.5	
	TOTAL	31	100	31	100	

N.: Number of Participants; F: Frequency; %: Percent; BMI: body mass index.

Table (2): Descriptive Statistics and t-test for the age, anthropometric for both type2 diabetic and healthy person.

Variables	Type2 Diabetic	Healthy Person	T-test	P-value	Sig.
	Mean± SD	Mean SD			
Age	53.1±8.7	51.9±8.9	0.564	0.575	NS
Weight	84.9±15.3	82.3±13.1	0.732	0.467	NS
Height	166.6±8.3	168.4±7	-0.944	0.349	NS
BMI	30.6±5	29.1±3.9	1.269	0.209	NS
WC	109.8±14.5	97.9±12.8	0.209	0.001**	HS

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Note: ** = Significance at P. < 0.01, SD: standard deviation; BMI, Body Mass Index; WC, Waist Circumference.

Table (3): Random Blood glucose (mmol/L) pre and post 6MWT for type2 diabetic.

Note: ** = Significance at P. < 0.01, SD: standard deviation;6mwt: 6-minute walk test, DF:

Glucose Level			**Type2 Diabetic**					
			Pre 6MWT	**Post 6MWT**				
		N	**Mean ± SD**	**Mean ±SD**	**T-Test**	**DF**	**P-value**	**Sig**
Age group	**35<45**	8	249.13±98.7	209.38±91.98	5.399	7	0.001	HS
	45<55	11	245.1±113.6	187.28±101.2	8.451	10	0.000**	HS
	55-65	12	282.1±103.4	233.3 ±89.4	9.873	11	0.000**	HS
Sex	**Male**	20	275.9±111	228.7±100.9	11.407	19	0.000**	HS
	Female	11	232.7±87.4	188.3±72.3	7.642	10	0.000**	HS
TOTAL		31	260.6±103.9	214.3±92.6	13.901	30	0.000**	HS

degree of freedom, Sig: Significance.

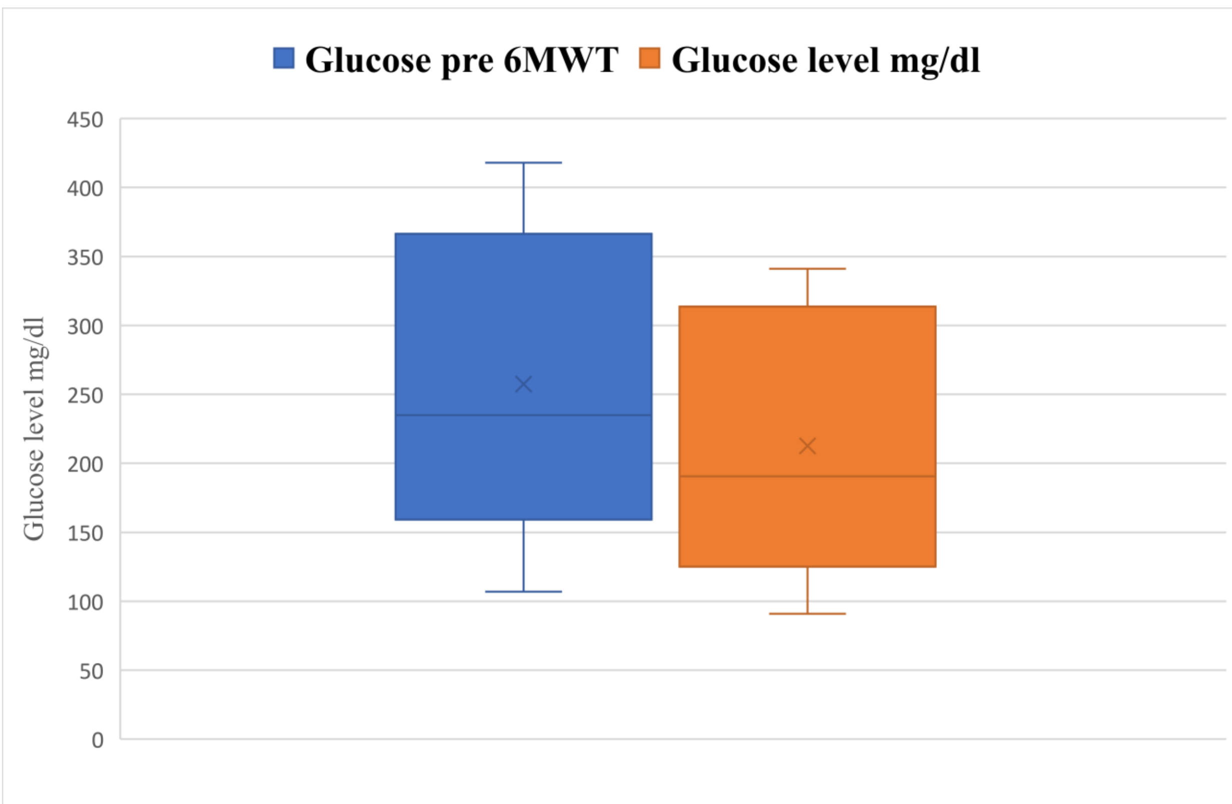

Figure (1-1) Glucose level pre and post 6MWT for Type2 diabetic

Table (4): comparison of functional capacity test between patients with type 2 diabetes and healthy person.

Functional capacity		**N**	**Type2Diabetic Mean ± SD**	**Healthy Person Mean ±SD**	**T-Test**	**P-value**	**Sig**
6MWD(m)	**Male**	20	490.2±78.9	546.1±79.1	-3.437	0.001**	HS
	Female	11	419.1±72.8	499.9±36.5	-3.293	0.004**	HS
TOTAL		31	445.6±78.7	529.7±70.1	-4.459	0.000**	HS

VO2 MAX ml/kg/min	**Male**	20	11.2±1.3	12.6±1.3	-3.437	0.001**	HS
	Female	11	10.5±1.2	11.9±0.5	-3.557	0.002**	HS
TOTAL		31	10.9±1.3	12.3±1.1	-4.588	0.000**	HS

Note: ** = Significance at P. < 0.01, SD: standard deviation; 6MWD: 6-Minute Walk Distance; VO2MAX: maximum of oxygen consumption.

4. Discussion

Type 2 diabetes mellitus and the 6MWT

The goal of this study was to see how a six-minute walk test(6MWT) affected glucose levels and to evaluate functional exercise capacity between diabetic patients and healthy controls. In patients with chronic obstructive pulmonary disease (COPD), pulmonary hypertension, and congestive heart failure, the 6MWT is commonly used to determine functional exercise capacity and prognosis. This test can also be used to see how different interventions, such as rehabilitation, treatment regimen adjustments, and oxygen supplementation, affect patients' walking capacity. There are only a few studies in the literature that look at the use of the 6MWT in people with diabetes. Diabetes is one of a group of disorders that have a regular impact on one's physical exercise.

In our study Table (3-1): shows no significant differences between patients with type 2 diabetes and the healthy control group concerning “age, gender, and body mass index,” which indicates matching or homogeneity among type 2 diabetes and healthy controls, and these variables do not affect the results of the study. The current study shows that most of the study participants were aged between (55-66) years, and this represents 38.7% of type 2 diabetes cases. A study conducted by [20], agree with our study when they found that Diabetes is predicted to affect fewer than 2% of those aged 16–34 years, compared to 5.1 percent of those aged 35–54 years, 14.3 percent of those aged 55–74 years, and 16.5 percent of those aged over 75 years. This result can be explained as there is a definite link between growing age and the prevalence of type 2 diabetes. A report from the Centers for Disease Control and Prevention says that adults between the ages of 45 and 64 are the most likely to be diagnosed with diabetes. Most of the study participants were obese (48.4%). A study conducted by [21], agrees with our study. This result can be explained as being Obesity is the most preventable cause of type 2 diabetes. Individuals who are obese are five times more likely to be diagnosed with diabetes than adults who are of normal weight. Obesity affects 90 percent of persons with type 2 diabetes.

Table (3-2): shows no statistically significant differences in age, height, weight, and BMI between type 2 diabetic patients and a healthy person, which indicates homogeneity and there are highly statistically significant differences in waist circumference. A study conducted by [22] agree with our study when finding they that patients with T2D and controls were similar in age and sex (p>0.05). This can be explained by the fact that overall obesity (BMI) is more strongly related to hypertension, whereas central obesity (WC) is more strongly connected with T2DM, according to several research. The theory behind these links is that central obesity is the result of a specific buildup of visceral adipose tissue. Due to the generation of free fatty acids and inflammatory mediators, excess visceral adipose tissue is metabolically unfavorable. Obesity, on the other hand, causes a greater overall physiological strain and has a greater impact on vascular and cardiac parameters.

Table (3-3): It demonstrates that there are highly statistically significant differences in glucose level for age group and sex among type 2 diabetic patients. The total mean and standard deviation for glucose level pre 6MWT was (260.6±103.9) and post 6MWT was (214.3±92.6). A study conducted by [23] agree with our study when find they After 12 weeks, the intervention group's HbA1c level dropped dramatically (p=0.02).

and agree with [24] when finding they On days 1, 3, and 8, there were significant differences in blood glucose levels before and after walking (p0.001). This result can be explained as Muscle contractions increase when walking, triggering metabolic events that result in increased glucose uptake by the muscle. This is due to two essential mechanisms: an increase in insulin sensitivity and the independent translocation of the type 4 glucose transporter (GLUT4) to the cell surface, resulting in glucose entry into the cells.

Table (3-4): shows highly Statistically significant differences in 6MWDand estimated VO2max for both males and females between type2 diabetic and healthy controls. Participants with Type 2

Diabetes (T2D) showed reduced exercise capacity, as measured by the Six-Minute Walk Distance (6MWD) and maximum oxygen consumption (VO2MAX) than healthy controls.; and this was significantly lower in females than males. A study conducted by [25] agree with our study when find they There were significant differences between patients with T2D and healthy controls in “6- MWD: 237.13±4.8 m vs. 361.03±5.1 m (t=-15.39, P=0.001) and VO2max: 7.6±0.6 mL/kg/min vs.

9.6±0.6 mL/kg/min (t=-16.16, P=0.001)”. and agree with [26] when finding they The walking distance in the T2D group was 109 meters lower than in the healthy controls group (P> 0.001). This result can be explained as the reduction in exercise capacity of patients with T2D may be linked to poor glucose metabolism. The transporter protein GLUT4 expression at the plasma membrane is related to fiber volume in human skeletal muscle fibers. Poor glycemic control in patients with T2D has been associated with increased stiffness of large conduit vessels. The compliance of the aorta plays a significant role in modulating coronary artery blood flow which has important consequences for myocardial work capacity and, therefore, leading to reduced exercise capacity we found that females compared to males have a lower 6MWD and estimated VO2max. One plausible explanation is that muscle mass and therefore maximum leg-muscle force is lower for females than males.

5. References

[1] Oberoi S, Kansra P. Economic menace of diabetes in India: a systematic review. International Journal of Diabetes in Developing Countries. 2020:1-12.

[2] Grzybowski A, Brona P. Artificial Intelligence in Diabetic Retinopathy. Artificial Intelligence in Ophthalmology: Springer; 2021. p. 139-59.

[3] Chivese T. Type 2 diabetes, cardiovascular risk factors and offspring overweight and obesity 5 to 6 years after hyperglycaemia first detected in pregnancy in Cape Town, South Africa. 2021.

[4] Cho NH, Shaw JE, Karuranga S, Huang Y, da Rocha Fernandes JD, Ohlrogge AW, et al. IDF Diabetes Atlas: Global estimates of diabetes prevalence for 2017 and projections for 2045. Diabetes Res Clin Pract. 2018;138:271-81.

[5] Miranda JJ, Barrientos-Gutiérrez T, Corvalan C, Hyder AA, Lazo-Porras M, Oni T, et al. Understanding the rise of cardiometabolic diseases in low-and middle-income countries. Nature medicine. 2019;25(11):1667-79.

[6] Einarson TR, Acs A, Ludwig C, Panton UH. Prevalence of cardiovascular disease in type 2 diabetes: a systematic literature review of scientific evidence from across the world in 2007–2017. Cardiovascular diabetology. 2018;17(1):1-19.

[7] Werfalli M, Kassanjee R, Kalula S, Kowal P, Phaswana-Mafuya N, Levitt NS. Diabetes in south African older adults: prevalence and impact on quality of life and functional disability–as assessed using SAGE wave 1 data. Global health action. 2018;11(1):1449924.

[8] Tadic M, Grassi G, Cuspidi C. Cardiorespiratory fitness in patients with type 2 diabetes: A missing piece of the puzzle. Heart Failure Reviews. 2021;26(2):301-8.

[9] Bastien M, Poirier P, Brassard P, Arsenault BJ, Bertrand OF, Després J-P, et al. Effect of PPARγ agonist on aerobic exercise capacity in relation to body fat distribution in men with type 2 diabetes mellitus and coronary artery disease: a 1-yr randomized study. American Journal of Physiology-Endocrinology and Metabolism. 2019;317(1):E65-E73.

[10] Paneni F, Diaz Cañestro C, Libby P, Lüscher TF, Camici GG. The aging cardiovascular system: understanding it at the cellular and clinical levels. Journal of the American College of Cardiology. 2017;69(15):1952-67.

[11] Vukomanovic V, Suzic-Lazic J, Celic V, Cuspidi C, Petrovic T, Ilic S, et al. Association between functional capacity and heart rate variability in patients with uncomplicated type 2 diabetes. Blood pressure. 2019;28(3):184-90.

[12] Vancampfort D, Vandael H, Hallgren M, Van Damme T. Test–retest reliability and correlates of the 6-min walk test in people with alcohol use disorders. Physiotherapy Research International. 2021:e1900.

[13] Giannitsi S, Bougiakli M, Bechlioulis A, Kotsia A, Michalis LK, Naka KK. 6-minute walking test: a useful tool in the management of heart failure patients. Therapeutic advances in cardiovascular disease. 2019;13:1753944719870084.

[14] AJ SJ, Gomes L. Effects of an educational program focused on self-care and concurrent physical training on glycemia and drug treatment of patients with diabetes mellitus. Diabetes. 2019;5:1-7.

[15] Taylor R, Al-Mrabeh A, Sattar N. Understanding the mechanisms of reversal of type 2 diabetes. The lancet Diabetes & endocrinology. 2019;7(9):726-36.

[16] Ferrari F, Bock PM, Motta MT, Helal L. Biochemical and molecular mechanisms of glucose uptake stimulated by physical exercise in insulin resistance state: role of inflammation. Arquivos Brasileiros de Cardiologia. 2019;113:1139-48.

[17] Fell B, Hanekom S, Heine M. A modified six-minute walk test (6MWT) for low-resource settings- a cross-sectional study. Heart & Lung. 2022;52:117-22.

[18] Society AT. ATS statement: guidelines for the six-minute walk test. Am J Respir Crit Care Med. 2002;166:111-7.

[19] Awotidebe TO, Adedoyin RA, Oke KI, Ativie RN, Opiyo R, Ikujeyisi EO, et al. Relationship between functional capacity and health-related quality of life of patients with type—2 diabetes. Diabetes & Metabolic Syndrome: Clinical Research & Reviews. 2017;11(1):1-5.

[20] Mihaylova D, Popova A, Alexieva I, Krastanov A, Lante A. Polyphenols as suitable control for obesity and diabetes. The Open Biotechnology Journal. 2018;12(1).

[21] Goff LM. Ethnicity and type 2 diabetes in the UK. Diabetic Medicine. 2019;36(8):927-38.

[22] Awotidebe TO, Adedoyin RA, Yusuf AO, Mbada CE, Opiyo R, Maseko FC. Comparative functional exercise capacity of patients with type 2-diabetes and healthy controls: a case control study. The Pan African Medical Journal. 2014;19.

[23] Şavkın R, Büker N, Bayrak G, Oğuz G, Topsakal Ş. Effect of Walking Exercise on Blood Parameters in Patients with Type 2 Diabetes Mellitus. Istanbul Medical Journal. 2021;22(4).

[24] Yuliastuti C, Setiadi NMA, Rinarto ND. Walking as Simple Exercise to Reduce Blood Glucose Level in Type 2 Diabetes.

[25] Awotidebe TO, Ativie RN, Oke KI, Akindele MO, Adedoyin RA, Olaogun MO, et al. Relationships among exercise capacity, dynamic balance and gait characteristics of Nigerian patients with type-2 diabetes: an indication for fall prevention. Journal of exercise rehabilitation. 2016;12(6):581.

[26] Kuziemski K, Słomiński W, Jassem E. Impact of diabetes mellitus on functional exercise capacity and pulmonary functions in patients with diabetes and healthy persons. BMC endocrine disorders. 2019;19(1):1-8.