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Vascular and Cardiorespiratory Factors are Associated with Functional Capacity in Patient with Type 2 Diabetes Mellitus

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ABSTRACT

Background: Diabetes mellitus is a degenerative disease that has globally increased prevalence annually¹. Impaired functional capacity due to poor blood sugar control and presence of cardiovascular autonomic dysfunction. Six minute walk test is a method that is widely used in the assessment of functional capacity in patients with Type 2 Diabetes Mellitus. **Objective:** To evaluate factors that are associated with functional capacity in Type 2 Diabetes Mellitus. **Methods** This is an analytic observational study with a cross sectional design. Fourty patients who had been diagnosed with diabetes mellitus was assessed by six minute walk test. Chi square and logistic regression analysis was perform by using SPSS 25. **Results:** Six minute walk test correlated significantly with Ankle Brachial Index scores ($p = 0.016$) and Body Mass Index ($p = 0.03$) **Conclusion:** Ankle Brachial Index Score and Body Mass Index are factors associated with functional capacity in Type 2 Diabetes Mellitus

1. Introduction

Diabetes mellitus is a degenerative disease that has globally increased prevalence annually¹. Complications of diabetic can affect various organs including cardiorespiratory function. The six minute walk test (6MWT) is a method that is widely used in the assessment of functional capacity including in patients with Type 2 Diabetes Mellitus (T2DM)^{2,3,4}. Chronic complications of diabetes result from a variety of biological changes in the vascular system⁵. Impaired functional capacity due to poor blood sugar control and the presence of cardiovascular autonomic dysfunction which is assessed based on variations in pulse rate and blood pressure⁶.

Decreased exercise capacity in diabetic patients is an early sign of deterioration in physical health status and affects the prognosis. Recent literature study

shows the hypothesized pathophysiological mechanism consisting of interrelated factors, namely cardiogenic, myogenic, vasculogenic, and neurogenic.⁷ This research is one of the studies learn about functional capacity in T2DM patients using the 6MWT method which evaluate vascular and cardiorespiratory factors. The aim of this study is to evaluate factors that are associated with functional capacity in T2DM patients.

2. Material and methods

This is an analytic observational study with a cross sectional design to evaluate factors that are associated with functional capacity in T2DM patients. The sample was selected using non-probability sampling with consecutive sampling method. Fourty patients who had been diagnosed with diabetes mellitus based on

medical records, signed an informed consent, aged 40-70 years old in the internal clinic of Muhammadiyah Palembang Hospital was included in this study. The exclusion criterias are neuromusculoskeletal disorders in the inferior limb (trauma, ulcer, arthritis, hemiparesis, paralysis and others), unstable angina or myocardial infarction in the past month, systolic blood pressure > 180 mmHg and diastolic > 100 mmHg, cognitive impairment, pregnant patients, Congestive Heart Failure patients and moderate to severe asthma.

The functional capacity was assessed by 6MWT. Samples that meet the criteria are subject to 6MWT examination. Patient was asked to walk in a 50m long corridor for 6 minutes then the distance was measured. The factors that are evaluated in this study included age, duration of diabetes, *Body Mass Index* (BMI), *Ankle Brachial Index* (ABI) score, blood sugar, blood pressure and pulse rate. Diabetes duration, ABI score, BMI, blood sugar, blood pressure and pulse were assessed before 6MWT.

The ABI score examination is performed by using a handled Doppler probe at each extremity. Blood sugar level was determined based on glucometer using capillary blood. Blood pressure examination were performed with mercury sphygmomanometer in a sitting position. Measurement of blood pressure was carried out twice with a time interval of 3 minutes and the average was taken. Pulse rate was evaluated manually. This research has been approved by Ethics Committee of the Faculty of Medicine, Universitas Muhammadiyah Palembang.

6MWT was grouped into $\leq 300\text{m}$ and $> 300\text{m}$, the duration of diabetes was grouped into > 10 years and ≤ 10 years, age was grouped into > 60 years and ≤ 60 years, ABI scores were grouped into < 0.9 and ≥ 0.9 , the sugar level was grouped into $> 200\text{mg / dl}$ and $\leq 200\text{mg / dl}$, BMI was grouped into ≥ 25 and < 25 , pulse rates were grouped into $> 84 \text{ x/minute}$ and $\leq 84\text{x/minute}$, Systolic blood pressure was grouped into $\geq 140\text{mmHg}$ and $< 140 \text{ mmHg}$, diastolic blood pressure was grouped into $\geq 90\text{mmHg}$ and $< 90\text{mmHg}$. Analysis was performed using SPSS 25, univariate analysis followed by bivariate analysis with chi square and multivariate

analysis with logistic regression analysis. The significance of the test $p < 0.05$.

3. Results

Based on **table 1**, it is found that most of the T2DM patients had a distance covered at 6MWT less than 300m. Most of population study was patients with less than 60 years old and female. Risk factors such as increased age, obesity, low ABI score, high systolic blood pressure, high pulse rate and high sugar levels had lower percentage in this study.

Bivariate analysis was performed using the chi square test in **Table 2**, it was found that only ABI scores ($p = 0.016$) and BMI ($p = 0.03$) had a significant association with the distance covered at 6MWT likewise after multivariate analysis using logistic regression.

Table 1. Baseline Characteristics

Characteristics	N	%
Age		
40-59 years old	24	60.0
60-70 years old	16	40.0
Sex		
Man	16	40.0
Woman	24	60.0
Nutritional Status		
Non Obese	27	67.5
Obese	13	32.5
6MWT Distance		
≤300m	27	67.5
>300m	13	32.5
ABI Score		
<0,9	10	25.0
≥0,9	30	75.0
DM Duration		
>10 years	9	22.5
≤10 years	31	77.5
Blood Glucose		
>200mg/dl	10	25.0
≤200mg/dl	30	75.0
Heart Rate		
>84x/minute	10	25.0
≤84x/minute	30	75.0
Systolic BP		
≥140mmHg	11	27.0
<140 mmHg	29	72.5
Diastolic BP		
≥90 mmHg	30	75.0
<90 mmHg	10	25.0

Table 2. Statistical Analysis Factors Associated with Six Minute Walk Test

Independent variables	6SMT (n)		p Value ¹	Adjusted p Value ²
	≤ 300m	> 300m		
ABI score (<0.9)	10	0	0.016*	0.028*
DM duration (>10 years)	7	2	0.69	0.455
Blood glucose level (>200mg/dl)	10	0	0.284	0.201
Body Mass Index (≥25)	12	1	0.03*	0.02*
Heart rate (>84x/minute)	10	0	1.00	0.919
Age (≥60 years old)	13	3	0.177	0.130
Systolic Blood Pressure (≥140mmHg)	9	2	0.286	0.234
Diastolic Blood Pressure (≥90mmHg)	22	8	0.264	0.172

1. Chi square analysis

2. logistic regression analysis

*p<0.005

4. Discussion

Factors related to the functional capacity of T2DM patients in this study were ABI scores and BMI while

other factors such as age, duration of diabetes, blood sugar levels, pulse rate, systolic and diastolic blood pressure were not significantly associated with 6 MWT.

ABI score and BMI were consistently associated with functional capacity of T2DM patients based on previous studies. Research conducted by Latiri (2012) and Adeniyi (2009) show a relationship between increased BMI and decreased functional capacity in diabetes patients^{8,9}. Obesity is associated with increasing ventilation workload, ineffectiveness the work of the respiratory muscles and decreasing respiratory complaints. This will have an impact on decreasing exercise capacity¹⁰. Vascular disorders caused by Peripheral artery Diseases (PAD) associated with decreased distance covered during 6MWT¹¹. Based on study conducted by Silva (2015), diabetic patients with PAD based on ABI scores and had low functional capacity based on 6MWT were associated with higher cardiovascular risk¹².

Cardiogenic factors such as systolic blood pressure, diastolic blood pressure and pulse rate as well blood sugar factors assessed in this study did not have an association with 6MWT. This result are in line with a study conducted by Oliveira (2012) which shows that there is no relationship between blood sugar levels and 6MWT¹³. However, several other studies have shown different results. As pointed out by Barkai (1996), impaired physical capacity occurs due to poor blood sugar control and cardiovascular autonomic dysfunction⁶. Study conducted by Dinakar (2015) shows that poor exercise capacity is directly related to poor sugar control¹⁴. Based on research conducted by Adeniyi (2009), the factors associated with 6MWT in T2DM patients were BMI and age, while the duration of diabetes was not related to 6MWT⁹. The results of this study indicate that age and duration of diabetes are also not shown to have a significant relationship with the functional capacity of T2DM patients.

The pathophysiological mechanism hypothesis proposed by Nesti (2020), the factors that affect functional capacity consist of myocardiogenic, myogenic, vasculogenic, and neurogenic. Impulses from motor neurons are sent to the skeletal muscle, paralel with the impulses given to the cardiovascular centers in the brain stem to increase cardiac output and blood pressure mainly through sympathetic activation. During exercise, oxygen distribution and

variety of physiological functions such as pulmonary ventilation, gas exchange, cardiac output, blood distribution and diffusion, aerobic capacity of skeletal muscles including the perception of fatigue. In T2DM there is a defect in neural control cardiovascular response during exercise⁷.

Cardiogenic factor in T2DM patients is the presence of myocardial dysfunction during exercise. Decreasing in aerobic capacity can also be a secondary result of a decrease in the aerobic strength of the muscles. T2DM shows that there is an immature fatigue process which causes a decrease in exercise capacity thereby decreasing the duration of exercise. During muscle contraction, there is complex coordination between the cardiovascular system and muscles in order to optimize blood perfusion. Peripheral vascular resistance will be modulated in order to maximize blood flow to the working muscles. Vasodilation is associated with local mediators that maintain endothelial and smooth muscle function. This mechanism is decreased in T2DM patients. In addition, there is an increasing the incidence of chonotropic incompetence in T2DM patients⁷.

Variation finding on factors affecting the functional capacity of T2DM patients due to several related mechanisms that interact each other which is influenced on limiting exercise tolerance. Further research should be conducted on the factors that represent these interrelated mechanisms.

4. Conclusion

ABI Score and BMI are factors associated with functional capacity in T2DM patients.

5. Conflict of interest

The author declare that were no conflict of interest.

6. Funding statement

None.

7. Author contribution

N.M.E and R.A.T Design of study, N.M.E and R.A.T

statistical analysis, N.A and W.N.S technical support, N.A and W.N.S administrative support, N.A and W.N.S data collecting, N.M.E, R.A.T revised manuscript, N.M.E drafted the manuscript.

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