Jurnal Epidemiologi Kesehatan Komunitas
6 (2), 2021, 254-260

JEKK

The Six Minute Walk Test as a Marker of Functional Capacity in Hypertensive Patients

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ABSTRACT

Background: Currently, hypertension becomes one of the leading issues not only for medical community but also to the broader societies. Even though hypertension could be symptomatic, in most case it didn't until the devastating complications shows up. Functional capacity is a simple tool based on our daily activity. The six-minute walk test could be one of the simplest ways in measuring functional capacity. Six-minute distance as the outcome of this test could be potentially a marker for functional capacity in hypertensive group compare to non-hypertensive group.
Methods: This is a case control study with 34 female participants in six-minute walking test.
Result: There are no significant different of age, height, weight, and body max index between those groups. The six-minute walking distance drastically difference between hypertensive and non-hypertensive group, 306m and 367m respectively with p-value < 0,01. Heart rate pre-test also statistically different between control group and case group. (75 bpm and 94 bpm, p-value = 0,027) Post-test blood pressure is notably distinctive between two groups. Additionally, systolic blood pressure post-test lower than initial value. Hypertension alters human functional capacity ominously.
Conclusion : The six-minute walk test could be applied as simple functional capacity marker in hypertension subject.

Keywords: Functional capacity; hypertension; six-minute walk test.

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Introduction

In year of 2012, there was 56 million death around the globe and 38 million of death caused by non-communicable diseases (NCD) that almost half of them caused by cardiovascular diseases (CVD). Around three quarters of those number come from low and middle country, like Indonesia.[1,2] The World Health Organization (WHO) South-East Asia Region (SEAR) is the "most-speeding "area of increasing number of NCD deaths compared to the 2000's data and 48% end-up with a premature death (before age 70).[1]

In Indonesia, CVD is still the top cause of death (stroke 21.2% and ischemic heart disease 8.9%) and CVD has been related with hypertension as its risk factor.[3] Hypertension trends to escalate in the developing countries like Indonesia and have been found associated with unhealthy lifestyle such as tobacco smoking, lack of physical activity, and alcohol consumption.[3,4] Data from Indonesia Family Life Survey-4 (ILFS-4) in 2007 shows 47.8% of Indonesia people had suffer hypertension in individuals 40 years and older.[5] Indonesian Family Life Survey-5 (ILFS-5) in 2018 reveals only 42.9% aware that they had hypertension.[3] Moreover from ILFS-5, there was only 14.8% going to routine checkup and 11.8% were using prescribed drug. While hypertensive as preventable disease, it had been found to be associated with sociodemographic such as age, gender, and income, urban residence, consumption, physical activity and other health condition like obesity, depression and stress, and lastly with frequency of doctor visits.[3]

American College of Cardiology (ACC) and American Heart Association (AHA) defines hypertension as blood pressure ≥130/80 mmHg meanwhile European Society of Cardiology (ESC) and European Society of Hypertension (ESH) defines hypertension as blood pressure ≥140/90 mmHg.[6] Our local guidelines in Indonesia from The Indonesian Heart Association (IHA) stated that hypertension is a condition when blood pressure ≥140/90 mmHg, in several measurement, and systolic pressure is a main consideration for diagnosis of hypertension.[7]

Cardiac rehabilitative is an integrated group of activates to control etiology of cardiovascular disease, physical improvement, mental and social of patient with CVD or high risk to get CVD to ensure or improve the physical condition. Cardiac rehab helps the patient to do self-secondary prevention. In hypertensive patient, they might develop physical disability caused by hypertensive-associated alteration of functional capacity. Intervention to prevent further progression of patho-mechanism of hypertensive needed to be done.

Six-minute walk test (6MWT) has been recognized as simple and safe tool for assessing functional capacity in cardiac rehab.[8] Some literatures were stated patient with hypertensive will had low six minute distance walk/6MWD (as the main outcome of the 6MWT).[8] Several clinical trials show considerably lower distance walk in hypertensive groups.[9-11] Theoretically, 6MWD lower in hypertensive group caused by vascular remodeling, and blood pressure may reduce with regular aerobic exercise within 4 weeks.[12] Because of that, this study is conducted to measure 6MWD to measure functional capacity in hypertension group and normal group, especially in Indonesia population.

Methods

Ethics

The institutional ethics committee approved this study protocol before execution. All subjects signed an informed consent from after being informed of the study aim and procedures.

Study design and sample size

This study was case control study with all female participants. The examiner was blinded to the participants' group to ensure objectivity of the 6MWD outcome. Considering the relationship between the 6 MWD and hemodynamic variables we used proportional sample size formula, the minimal sample size of this study was 33 participants, but to make it equivalent between both group we held the study with 34 participants.

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Participants

Characteristic of all participants were summarized in table 1. Thirty-four female participants assessed from our medical record. Control group were randomly selected from non-hypertensive patient and case group were randomly selected from hypertensive patient. Eligibility of the participant was considered reliant on some criteria such as: age >18 years old, no walking limitation, and no history of neuromusculoskletal problem during last 6 months. The additional criteria for case group were has been diagnosed with primary hypertension (systolic blood pressure ≥140 mmHg and/or diastolic pressure ≥90 mmHg).

All participant was undergoing history taking and physical examination for the valuation of their individual characteristic. The blood pressure and heart rate were measure twice, before the 6 MWT and 10 minutes after test. The examiner was the same pre and post 6 MWT and the test was held between 14.00 – 16.00 (Jakarta Time) and in the presence of a physicians.

Information about onset of hypertension, smoking habits, history of hospitalization, and anti-hypertensive drug were collated from medical record and questioner. Nevertheless, walking problem, previous cardiac problem, and exercise habit

Table 1. Sample Characteristic; age, simple anthropometric, blood pressure and heart rate before and after 6 MWT, and 6 MWD

Variable	**n=34**			
	Mean	**SD**	**Min**	**Max**
Age (years)	48	6,7	34	62
Height (cm)	156	15,4	149	165
Weight (kg)	65	10,2	54	93
BMI (kg/m^2)	26	4	22	38
6MWD (m)	337	34,9	288	396
SBP before (mmHg)	123	26,3	96	212
DBP before (mmHg)	84	13	59	112
HR before (bpm)	88	14,3	53	108
SBP after (mmHg)	136	22,4	98	180
DBP after (mmHg)	86	13,1	68	120
HR after (bpm)	86	12,1	55	107
Percentage (%)				
Female	100			
Obesity	57			
Hypertension	50			
Extremity and back pain	0			
Cardiac Problem	0			
Hospitalized by cardiac reason	0			
Walking difficulty	0			
Smoking	0			
Exercise (3 times/week,@30min)	15			
Using anti-hypertensive drug	11			

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were collated from questioner. We were assigning one on one instructor which previously standardized to accompany participant during answering the questioner. Measurement of body height and weight was gotten using an analogue scale and rounded to the closest decimal value. The body mass index calculated with divided body weight (kg) with body height^2 (m^2). Blood pressure (systolic and diastolic) was measured with manual sphygmomanometer with standardized operator with sitting position. Meanwhile, heart rate was obtain using automatic pulse-oximeter device. The blood pressure and heart rate were measured twice with 1-2 minutes interval.

The 6 MWT

All participant was requested not to doing physical activity 24 hour prior the test. The 6 MWT were performed in square jogging track. The length of each sides of the jogging track was 12 meter long. The participants were instructed to walk as fast as they could along the jogging track. They were allowed to either to slowing down or rest in their position whenever they need and raised their hand if they felt impossible to continue the task. The participants were get notified when three minutes left and asked to stop when the time is up. The pre and post hemodynamic were collected.

Statistical analysis

Data from all participant were recorded with questioner form. Characteristic of the subjects and initial data variable were presented descriptively in tubular and text form. Numerical data were presented in the form of mean, standard deviation, min and max value. Categorical data were showed as frequency distribution (n, %).

Relationship between categorial and numerical variables divided into two groups (normal blood pressure and increase blood pressure) and the data than were compared among them with p values less than 0.05 were considered statically significant.

Result

All variable in this research has normality test > 0.05. It's mean all variables normally distribute. Tables 2 shows age, simple anthropometric, blood pressure and heart rate before and after 6 MWT, and 6 MWD. The mean age of all sample still in reproductive age category (less than retired age, 55 years old) and unfortunately the mean BMI shows mostly they are in obesity group by Asia Pacific classification. The mean result of 6 MWD also below expected value by international prediction 6MWD, which minimum 400m. All sample is female, because this activity during working hours and man with productive age are working. The data also shows from 50% hypertensive group, only 15% takes drug regularly and only 11% doing regular exercise.

On blood pressure analysis, the group divided into two groups; normo-tensive group and hypertensive group. Total sample is 26 sample and they are equally distribute, 13 samples in each group. There are no statically different in age, both group still in reproductive age group. BMI values also not statically different and both group are classify as obese. Total 6MWD distance shows statically different in both group with p-value 0,001, however even in normo-tension group, still less than expected value (400m). Blood pressure, both systolic and diastolic, in both group statically different. Hypertensive group has high SBP and DBP (>140/90mmHg). Heart Rate from both group also statically different, whereas hypertensive group relatively more high. SBP after test shows significantly different, moreover mean SBP before and after test is increasing in normo-tension group but decrease in hypertensive group. DBP after test also significantly different from both groups.

Discussion

The influence of arterial hypertension on target organ damage has been widely investigated. Studies also showed that exercise capacity is significantly decreased in patients with arterial hypertension.[13] Hypertension could effects functional capacity in several ways. Maximal oxygen consumption depends on several physiological parameters: ventilation, oxygen diffusion at the lung level, oxygen transport by the circulation, peripheral perfusion and diffusion, and mitochondrial function. The

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most significant limiting factor to peak oxygen uptake (about 70%) is the convective oxygen transport by the circulation of blood.

The endothelial dysfunction in patients with arterial hypertension leads to significant impairments in blood oxygen transport. Alternation of hemoglobin-oxygen supply may be the cause of decreased oxygen uptake in arterial hypertension patients.[14] Furthermore in other research, which revealed that antihypertensive treatment with nebivolol that stimulates nitric oxide production, improves endothelium-dependent dilatation and finally improves blood oxygen transport in hypertensive patients.[15] function in arterial hypertension is impaired, which contributes to lower oxygen consumption and induces oxidative stress which also could be the reason for lower peak oxygen uptake in the arterial hypertension population. [16] In our study, we found statistically difference 6 MWD between non-hypertensive group and hypertensive group.

The adequate response of the systemic circulation to exercise is increased cardiac and stroke volume index and decreased systemic vascular resistance. This also happens in hypertensive patients, but to a lesser extent than in normotensive individuals. The possible reasons could be endothelial dysfunction, increased circulating levels of catecholamines and angiotensin II, or increased diastolic filling pressure.[17] Another explanation for increased peripheral vascular resistance in arterial hypertension could be an increase in sodium gradient across the sarcolemma, which induces increase in Ca^{2+} and causes vasoconstriction, which further significantly increases blood pressure during exercise in arterial hypertension patients in comparison with normotensive individuals. The arteriolar remodelling in arterial hypertension, consequent changes in wall/lumen ratio could also decrease vasodilatation during exercise, which contributes to lower exercise capacity.[18] Lifestyle modifications, including exercise and weight reduction, significantly improved large and small vascular remodelling. These are the reason why exercise is considered to be an efficient additional therapy for arterial hypertension.[19]

Table 2. Characteristic, Blood Pressure, Heart rate and 6 WMD differences between two groups

Variable	Normo-tensive	Hypertensive	*P value*
Age (years)	47	50	0,125
Height (cm)	157	154	0,9
Weight (kg)	65	55	0,85
BMI (kg/m^2)	26	27	0,5
6MWD (m)	367	306	< 0,01*
SBP before (mmHg)	112	155	< 0,01*
DBP before (mmHg)	75	94	< 0,01*
HR before (bpm)	82	94	0,027
SBP after (mmHg)	118	153	< 0,01*
DBP after (mmHg)	76	96	0,001*
HR after (bpm)	85	88	0,448

The atrial blood pressure is usually reduced below baseline pre-exercise in hypertensive patients, called post-exercise hypotension (PEH).[20] It usually happens after aerobic exercise and affects both, systolic and diastolic blood pressure, but not heart rate.[21] In our study, systolic blood pressure is decreasing after exercise compared to initial pressure in hypertensive group. However it doesn't apply to diastolic blood pressure. There are several possibilities of mechanism which try to explain that phenomenon such as vasodilation

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differentiation between normotensive group vs hypertensive group and "atrial baroreflex reset" after exercise in hypertensive patient.[20,21] Moreover, recent clinical trial shows greater impact of the hemodynamic changes than blood pressure such as cardiac output, stroke volume, and left ventricular end-diastolic volume.[22]

Conclusion

Hypertensive is still become burden in case of morbidity and mortality, especially in developing country like Indonesia. Hypertensive has been know with long term catastrophic complication, such as stroke and vascular diseases. However, it also could affects functional capacity prior to catastrophic complication. In this case control study group, we know that hypertensive could impairs functional capacity that measured with 6 minutes walking distances. Additionally, hypertension also affects hemodynamic (systolic blood pressure, diastolic blood pressure) at post-exercise compare to non-hypertensive.

Acknowledgement

We would like to acknowledge the support from dr. Ritha Allo Somba as Head of Puskesmas Keluarahan Ciracas and all the staff for support during the study.

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