



Relationship Between Handgrip Strength with the 6-Minute Walking Test Distance in Heart Failure Patients

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Abstract

Heart failure is a complex clinical syndrome characterized by objective evidence of an underlying structural abnormality or cardiac dysfunction that reduces the ability of the ventricles to fill or pump blood. One of the essential indicators in evaluating the condition of heart failure patients in treatment undergoing a cardiovascular rehabilitation program is an assessment of the ability to perform physical activity. Evaluation of physical activity ability can be determined through exercise capacity assessments such as the 6-minute walk test and Handgrip strength method. The aim of this study was to determine the relationship between handgrip strength and the distance travelled in a 6-minute walking test in patients with heart failure. This was a cross-sectional study of 55 heart failure patients at the Integrated Heart Center Department of RSUP Dr M. Djamil Padang from February 2022 to December 2022. Based on the Pearson correlation test, there was a statistically significant result between handgrip strength and distance in the 6-minute walking test with a P value of 0.01 ($p < 0.05$). There is a positive and statistically significant relationship between handgrips strength with a 6-minute walking test distance in heart failure patients.

Keywords: Handgrip Strength, 6-Min Walk Test, Distance, Heart Failure

1. INTRODUCTION

Heart failure is defined as a complex clinical syndrome with characteristic symptoms (eg shortness of breath, fatigue) that may occur at rest or with physical exertion. Heart failure is characterized by objective evidence of an underlying structural abnormality or cardiac dysfunction that reduces the ability of the ventricles to fill or pump blood. Heart failure conditions can reduce tolerance to physical activity (Yancy, et al. 2017).

To perform physical activity, a person relies heavily on the ability of the heart to increase output and the ability of skeletal muscles to use oxygen from the bloodstream. In healthy people, the increase in cardiac output during maximal physical activity can be up to 4-6 fold, but in patients with heart failure, this increase can be less than 50% of healthy people (Plowman, et al. 2011). This condition is one of the main reasons why it is important to assess the physical activity capacity of heart failure patients, especially after being hospitalized. Assessment of physical activity ability can be determined through an assessment of exercise capacity. The objective quantitative method recommended by the *American College of Sports Medicine (ACSM)* in assessing exercise capacity in patients with heart failure is the 6-minute walking test (Radi, 2019).

The principle of the 6-minute walking test is to assess the patient's ability to travel for six minutes, where the patient can stop for a moment if complaints arise. The 6-minute walking test is considered more representative of assessing a person's ability to carry out activities in daily life because most daily activities are carried out at a submaximal level

(Zhang, et al. 2017). However, the 6-minute walking test has several drawbacks and is not effective in several conditions such as severe deconditioning, balance disorders, lower limb disease, depression and anxiety in patients with heart failure which is quite high with a prevalence reaching 21.5% (Celano, et al. 2016). Therefore, recent studies have found a method that is more static but related to the cardiovascular system, thus it can describe exercise capacity such as *handgrip strength* (Kim, et al. 2020).

Handgrip strength or grip strength is the ability of a muscle or group of muscles of the upper extremities of the body to contract to withstand and receive maximum loads (Kim, et al. 2020). A study by Kim, et al. 2020 found that handgrips strength can be used as a predictor of exercise capacity in the coronary heart disease population receiving coronary intervention treatment. This study aimed to determine the relationship between handgrip strength and the distance travelled in a 6-minute walking test in patients with heart failure.

2. METHODS

This was a cross-sectional study conducted at the Integrated Heart Center Department of RSUP Dr M. Djamil from February 2022 to December 2022. The study population was all heart failure patients who were treated at the Integrated Heart Center at RSUP Dr M. Djamil. The study sample was part of the population that meets the inclusion and exclusion criteria, and the sample was obtained by a consecutive sampling technique. The number of study samples obtained using the correlation formula was 51 people.

The study data were obtained from direct measurements of the study sample, the 6-minute walking test was measured with a walking distance meter (meter) while the handgrip strength was measured with a Camry electronic dynamometer (kg). After a walking test for 6 minutes on the walking track that had been prepared, 10-15 minutes later, the patient underwent a handgrip strength test. The results of the 6-minute walk test distance measurements and handgrip strength data from the experiments were collected and analyzed. Data were analyzed statistically based on the variables assessed using the Statistical Package for Social Sciences (SPSS) computerized system for windows. Hypothesis testing was carried out with the Pearson test, reckoning that the distribution of data was normal and homogeneous. This study had passed an ethical review by the Research Ethics Commission Team at the Faculty of Medicine, Andalas University with letter number: 975/UN.16.2/KEP-FK/2022.

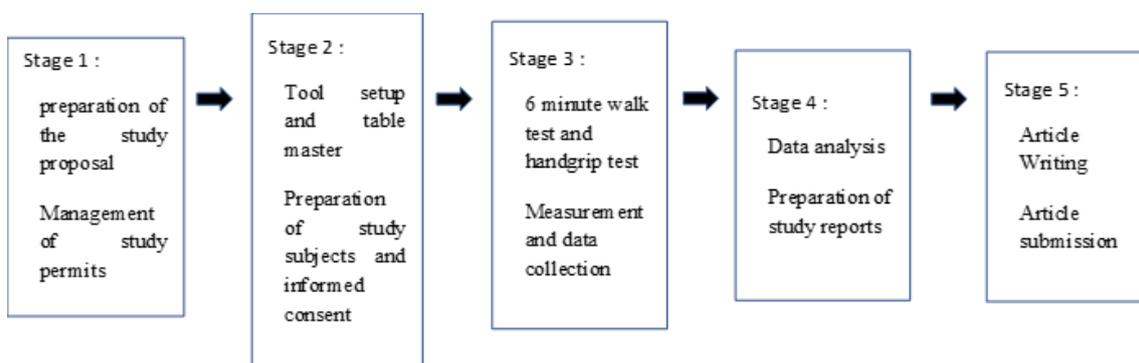


Figure 1. Study Flowchart

3. RESULT

The number of subjects studied was 51 heart failure patients who were treated at the Integrated Heart Center Department at RSUP Dr M. Djamil who met the inclusion criteria and were not in the exclusion criteria. In this study, 90% (n = 46) of all subjects were male, with an average age of 59.56 ± 10.263 years where the youngest age was 36 years and the oldest age was 79 years. The etiology of heart failure that was most commonly found in the study subjects was coronary heart disease i.e. 90% and the other 7.5% was caused by hypertension. Based on echocardiographic data, the average ejection fraction was 39 ± 11.32 . The basic characteristics of the study subjects are shown in Table 1.

Table 1. Data on the characteristics of the study subjects

No	Characteristics	Mean \pm SD	Number (%)
1	Age	59.56 \pm 10.263	
2	Gender		
	• Man	-	(46) 90%
	• Woman	-	(5) 10%
3	Weight	64.07 \pm 8.291	
4	Height	164.41 \pm 6.043	
5	Ejection Fraction	39.17 \pm 11.32	
6	Etiology		
	• Coronary heart disease		90%
	• Hypertension		7.5%
	• Other		2.5%

Handgrips Strength test showed that the average result of Handgrips strength in patients with heart failure was 16.44 kg. The lowest Handgrips Strength test result was 3.8 kg, while the highest was 34.1 kg. The mean systolic and diastolic blood pressure of the study subjects after the Handgrips Strength Test was 119.25 mmHg and 69.43 mmHg. The average value of the Handgrips Strength variable is shown in Table 2.

Table 2. Handgrips Variable Value

No	Variable	Mean \pm SD
1	Handgrips Strength	16.44 \pm 8.44
2	Baseline Heart Rate (HR)	77.98 \pm 9.22
3	HR after Handgrip	84.98 \pm 9.78
4	Baseline SBP	112.96 \pm 17.37
5	SBP after Handgrip	119.25 \pm 17.01
6	Baseline DBP	66.62 \pm 9.90
7	DBP after Handgrip	69.43 \pm 10.47

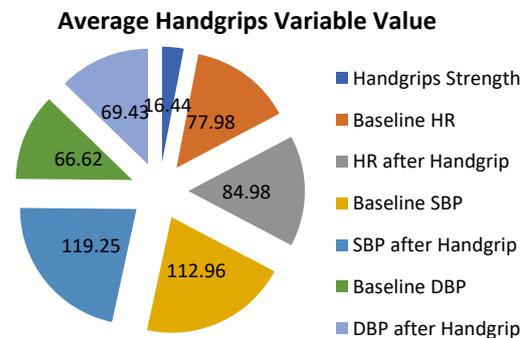


Figure 2. Diagram of the Handgrips Variable Value

The 6-minute walk test showed that the average result distance in patients with heart failure was 245.39 m. The 6-minute walk test showed that the shortest result was 40 m while the longest was 430 m. The mean systolic and diastolic blood pressure after the 6-minute walk test was 120.76 mmHg and 71.09 mmHg. The average value of the 6-minute walk test variable is shown in Table 3.

Table 3. The Value of the 6 minute walking test

No	Variable	Mean ± SD
1	Walking distance	245.39 ± 96.69
2	Baseline HR	79.11 ± 10.48
3	HR after a 6-minute walk test	85.98 ± 12.23
4	Baseline SBP	114.64 ± 17.79
5	SBP after 6 minutes of walking test	120.76 ± 18.86
6	Baseline DBP	67.39 ± 10.34
7	DBP after a 6-minute walking test	71.09 ± 10.13

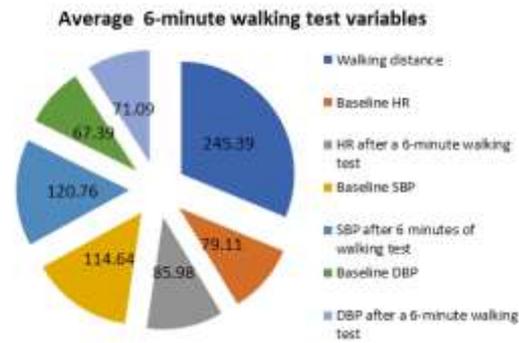


Figure 3. Diagram of the Value of the 6 minute walking test

The results of the handgrip strength and distance in the 6-minute walking test conducted by the study subjects were then analyzed using the Pearson correlation test, with the correlation results shown in Figure 4. Based on the correlation test, a significant correlation or relationship was found between handgrip strength and distance in the 6-minute walking test with a P value of 0.01. The P value which is less than 0.05 can indicate that the greater the handgrips strength value, the further the distance travelled by the study subjects in the 6-minute walking test. The relationship between handgrip strength and distance travelled in the 6-minute walking test are shown in the Table 4 and Figure 4 below.

Table 4. The relationship between handgrip strength and distance travelled in the 6-minute walking test

Variable	Mean ± SD	P value	r value
Handgrips strength	16.44 ± 8.44 kg	0.01	0.249
6-minute walking test	245.39 ± 96.69 m		

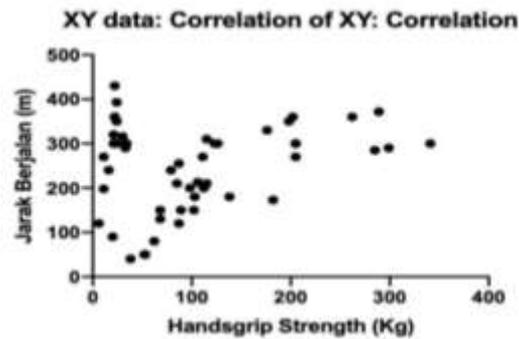


Figure 4. Graph of correlation between 6MWT and handgrips strength in heart failure patients

4. DISCUSSION

Based on the characteristics of the subjects, most of the study subjects were male with a percentage of 90% ($n = 46$). In addition, the average subject's cardiac ejection fraction was 39.17 ± 11.32 , which was included in the low ejection fraction category. The findings of characteristic data on the subject of this study were in accordance with a study by Carolyn in 2019 which showed that the most common type of heart failure in male patients was HF with reduced ejection fraction (HFrEF) or heart failure with a low ejection fraction (Lam, et al. 2019).

The most common aetiology of heart failure in the subjects of this study was coronary heart disease (90%), and the average age of the subjects was 59.56 ± 10.263 years or they were still in their productive age (under 60 years). The etiological characteristics, age, and sex of the study subjects are in line with the results of a study from Wakabayashi which showed that the incidence of coronary heart disease was more common in males than females, especially at a younger age (Wakabayashi, 2017).

The average handgrip strength obtained in this study was 16.44 ± 8.44 kg with the lowest being 3.8 kg and the highest being 34.1 kg. Based on a study by Amaury in 2017, the results of handgrip strength in this study were in a low category with a cut-off point for normal handgrip strength measurements of 32.3 kg (Amaris, et al. 2018). The results of handgrips strength in this study were low in heart failure patients in accordance with the results of a study conducted by McGrath et al in 2019 which showed that out of 4141 subjects who had low handgrips strength, 252 of them developed congestive heart failure during the follow-up period of 5.6 ± 4.5 years (McGrath, et al. 2019).

The handgrips test procedure is strongly influenced by the condition of the hands, thus the patients with heart failure with a history of hand surgery in the last 3 months and disorders of the upper limbs in the last 7 days were not included in the test because they were included in the exclusion criteria (Shiba, et al. 2019). In addition, heart rate, and systolic and diastolic blood pressure were found to increase when compared before and after the handgrips test was carried out. Heart rate increased from 77.98 beats per minute to 84.98 beats per minute. Systolic and diastolic blood pressure increased from initially 112.96 and 66.62 to 119.25 and 69.43, respectively (Diaz, et al. 2019). These results indicate that the handgrips test can affect the cardiovascular system, i.e. increase heart rate and blood pressure, therefore the handgrips test can describe a person's ability to perform physical activity and the prognosis or degree of severity of heart failure suffered (Mani, 2019).

The 6-minute walk test (6MWT) is a simple but reliable test to determine functional capacity and ability to carry out daily physical activities in heart failure patients. 6MWT

is influenced by muscle mass and the ability of the lower limbs, i.e. a person's legs which usually decrease in function in patients with severe heart failure or the elderly (Wibowo, et al. 2020). In this study, it was found that the average distance travelled by the study subjects during 6MWT was 245.39 m. This distance was considered short because <300 meters was the cut-off to determine the distance travelled by the 6MWT. These results are in line with a study by Giannitsi, et al. in 2020 which showed that if the patient's 6MWT distance is less than 200 meters, the risk of death will increase in patients with stable heart failure, and a distance of < 300 meters indicates a poor prognosis in patients with heart failure.

The increase in heart rate before 6MWT was 79.11 beats per minute to 85.98 beats per minute, and the increase in systolic and diastolic blood pressure before and after 6MWT was 114.64 mmHg and 67.39 mmHg to 120.76 mmHg and 71.09 mm Hg, which indicated the effect of 6MWT on cardiovascular function. These results are in accordance with Wibowo's 2020 study which showed that 6MWT can demonstrate the ability of the heart and lungs in patients with coronary heart disease and heart failure due to chronic obstructive pulmonary disease (COPD) (Wibowo, et al. 2020).

The results of the Pearson correlation test between Handgrip Strength and the 6-minute walking test (6MWT) distance on the study subjects showed an r-value of 0.249, the hypothesis was accepted, thus it can be concluded that there is a correlation between handgrips strength and 6MWT distance in heart failure patients. The r value obtained from the correlation test was positive, indicating that the relationship between handgrip strength and 6MWT distance was positive, that is, the greater the handgrip strength value, the farther the 6MWT distance could be achieved by the study subjects. The p-value of ≤ 0.000 indicates that there is a statistically significant relationship between handgrip strength and the 6MWT distance.

The study's results above are in line with a study conducted by Zhang et al., on 106 subjects, which showed that there was a positive relationship between the distance of the 6-minute walking test and handgrips strength with an r-value of 0.221 and a p-value of 0.029. Zhang et al. found that the results of the 6MWT are representative of the results for aerobic exercise, while the handgrips strength measurements are representative of the measurements for anaerobic exercise (Zhang, et al. 2017). The success of the 6MWT is influenced by many factors such as age, gender, weight, height, strength, and muscle mass, thus the results of the 6MWT are more varied and more difficult to be applied than the handgrip strength test. The handgrips strength test is an easier and simpler test to measure the ability of the skeletal muscles, especially the upper limb muscles, because the upper limbs are not as much influenced by muscle mass, weight, height and other factors as in the case of 6MWT. 6MWT and handgrips strength test can be used to predict the risk of heart disease and stroke in someone, especially at high risk, as well as determine the prognosis mortality in heart failure patients (Zhang, et al. 2017).

5. CONCLUSION

Based on the study conducted on 51 samples, it was found that the average handgrip strength in heart failure patients was 16.44 ± 8.44 kg and the average 6MWT distance was 245.39 ± 96.69 m. Based on the correlation test, it was found that there was a statistically significant correlation or relationship between handgrip strength and the 6-minute walking test distance with a P value of 0.01. Therefore, it can be concluded that there is a positive and statistically significant relationship between handgrip strength and the 6-minute walking test distance in heart failure patients.

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