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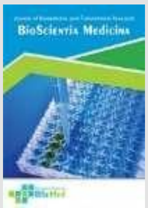

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The Relationship between Skeletal Muscle Strength and Cardiac Senescence Performance in the Elderly at Dr. Mohammad Hoesin General Hospital, Palembang, Indonesia

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ABSTRACT

Background: The aging process is physiological, but the onset, rate, and extent of the progression of aging at the cell, tissue, organ, and system level are very heterogeneous because they are influenced by genetic and environmental factors. The aging process is known to involve the entire body, including musculoskeletal and cardiovascular components. Several theories explain this association, including reduced muscle mass associated with chronic heart failure, decreased serum myostatin, and cross-talk between skeletal and cardiac muscle mediated by inflammatory cytokines. This study aimed to determine the relationship between skeletal muscle strength and cardiac performance in elderly patients at Dr. Mohammad Hoesin General Hospital, Palembang. **Methods:** This research is an analytical observational study with a cross-sectional design. The total sample size was 65 individuals who met the inclusion and exclusion criteria. Data analysis was carried out using the SPSS 25 for Windows program. **Results:** Handgrip strength has a significant relationship with diastolic dysfunction on a numerical scale ($p=0.009$). Low handgrip strength has a 3 times greater risk of experiencing diastolic dysfunction than patients with Normal Handgrip Strength. **Conclusion:** Skeletal muscle strength has a relationship with cardiac senescence performance in elderly patients at Dr. Mohammad Hoesin General Hospital, Palembang.

1. Introduction

Sarcopenia is a syndrome characterized by progressive loss of muscle mass and muscle strength. Sarcopenia is generally accompanied by decreased mobility and endurance, as well as slow gait. At the age of more than 50 years, muscle mass decreases by 1-2% per year. Apart from reducing quality of life, this is also associated with an increased risk of morbidity, hospitalization, health costs, and mortality.[3] The prevalence of sarcopenia in Taiwan, based on studies in elderly communities, was found to be 23.6% in men and 18.6% in women. In Indonesia, the prevalence of sarcopenia in the elderly is 38.3% in men and 33.9% in women. Sarcopenia has a multifactorial etiology, both modifiable and non-modifiable, such as genetics, neuromotor dysfunction, decreased endocrine function, and suboptimal nutritional intake. This is based on studies of the elderly in hospitals, communities, and rehabilitation centers. Around two-thirds of elderly people are estimated to be malnourished or at risk of becoming malnourished. Poor nutritional status in old age occurs due to anabolic resistance, namely a reduced response of the body to anabolic stimuli from nutritional intake, one of which is protein. This makes the need for protein higher in old age compared to young age. As a modifiable risk factor, nutrition is a potential target to improve or prevent loss of physical function in elderly.[1-5]

Aging of the cardiovascular system has long been thought to be due to the normal aging process. Several theories explain this association, including decreased muscle mass associated with chronic heart failure, decreased serum myostatin, and cross-talk between skeletal muscle and cardiac muscle mediated by inflammatory cytokines. Another study aimed to prove that sarcopenia is strongly associated with increased mortality due to cardiovascular disease in older adults and with an unfavorable prognosis in patients with chronic heart failure.[6-9] This study aimed to determine the relationship between skeletal muscle strength and cardiac senescence performance in the elderly **at** Dr. Mohammad Hoesin General Hospital Palembang, Indonesia.

2. Methods

This study is an observational analytical study using a cross-sectional design to assess the relationship between skeletal muscle strength and cardiac senescence performance in elderly patients at Dr. Mohammad Hoesin General Hospital Palembang. Primary data was taken by assessing skeletal muscle strength using a hydraulic hand dynamometer and echocardiography to determine the performance of cardiac senescence by assessing ejection fraction and diastolic dysfunction of the heart. A total of 65 research subjects participated in this study, where the research subjects met the inclusion criteria. The inclusion criteria for this study were all patients seeking treatment at the RSMH geriatrics clinic (age ≥60 years) and patients willing to take part in the research by signing informed *consent.* This study has received approval from the medical and health research ethics committee of Dr. Mohammad Hoesin General Hospital, Palembang, Indonesia.

Data was processed using a statistical package for social science (SPSS) program version 25. The statistical analysis design used is univariate analysis and bivariate analysis. Univariate analysis was carried out to obtain an overview of the research variables. The results of the analysis are presented in the form of tables and narratives. Bivariate analysis aims to determine the relationship between skeletal muscle strength and the description of cardiac senescence performance. Data normality test using Kolmogorov Smirnov. To assess the hypothesis test, assess whether there is a relationship between skeletal muscle strength and the description of cardiac senescence performance using a Chi-square test. It is said that the relationship between the two variables will be statistically significant if the p-value is less than 0.05

3. Results

In this study, 38 subjects (58.5%) were female, and 27 subjects (41.5%) were male. The average age of the research subjects was 70.37 $\pm$ 7.28 years old. Age group≥70 years were 31 subjects (47.7%), and the <70 years group were 34 subjects (52.3%). The BMI of the research subjects was found to be an average of 23.41$\pm$ 4.26 kg/m^2, with a distribution of underweight BMI of 8 people (12.3%), normal BMI of 38 people (58.5%), overweight BMI of 15 people (23.1%), and obesity as many as 4 people (6.2%). Low to medium education was 49 subjects (75.4%), higher education was 16 subjects (24.6%). A history of smoking was found in 13 subjects (20%), while 52 subjects (80%) did not smoke. Only 6 subjects (9.2%) regularly exercised >100 minutes per week, while 59 subjects (90.8%) exercised <100 minutes per week. The most common comorbidities found in research subjects were hypertension in 41 subjects (63.1%), dyslipidemia in 33 subjects (50.8%), osteoporosis in 18 subjects (27.7%), chronic kidney disease in 16 subjects (24 .6%), diabetes mellitus as many as 15 subjects (23.1%), and stroke as many as 5 subjects

(7.7%). The drugs most commonly consumed were ACEi/ARBs by 32 subjects (49.2%), statins by 17 subjects (26.2%), paracetamol by 14 subjects (21.5%), vitamin D by 11 subjects (16, 9%), metformin in 10 subjects (15.4%), and aspirin in 8 subjects (12.3%). Echocardiographic parameters showed mean LVEDd 4.26 ± 0.61, mean IVSd 1.09 ± 0.15, mean LVPWd 0.97 ± 0.14, mean aortic diameter 3.35 ± 0.39, left atrial (LA) diameter mean 3.00 ± 0.52. IMVK had a median of 91.7g/$m^{2,}$ with the lowest value of 51.9 g/m^2 and the highest of 143 g/m^2. IMVK increased in 15 subjects (23.1%) and normal in 50 subjects (76.9%). The most common left ventricular geometry is typeconcentric remodeling in as many as 29 subjects (44.6%). The total cholesterol value has a median of 187 mg/dL, with the lowest value being 105 mg/dL and the highest being 416 mg/dL. The LDL value has a median of 125 mg/dL, with the lowest value being 54 mg/dL and the highest being 249 mg/dL. The HDL value has a mean of 53.32 ± 11.87. Triglyceride values had a median of 121 mg/dL, with the lowest value being 41 mg/dL and the highest being 286 mg/dL. The mean eGFR was 67.70 ± 22.62. Handgrip strength has a median of 20 kg, with the lowest value being 12 kg and the highest being 38 kg. Furthermore, the handgrip strength values were categorized into 2 groups based on EWGS and AWGS, resulting in low handgrip strength of 37 subjects (56.9%) and normal handgrip strength of 28 subjects (43.1%).

This research then presents a bivariate analysis between the variables in Table 2, which may be related to the occurrence of diastolic dysfunction and increased IMVK. A p-value <0.05 means that there is a significant relationship, and a p-value <0.25 is still considered to mean that this variable could be a confounder, so a multivariate analysis was carried out. The results of the bivariate analysis of diastolic dysfunction can be seen in Table 2. The results of the analysis show that handgrip strength has a significant relationship with diastolic dysfunction both on a numerical scale (p=0.009), categorical scale for low handgrip strength, and normal handgrip strength groups (p=0.002). Besides that, age variable (p=0.003), diabetes mellitus (p=0.183), chronic kidney disease (p=0.122), consumption of ACEi/ARB drugs (p=0.248), and metformin (p=0.133) is a significant confounding factor for the relationship between handgrip strength and diastolic dysfunction. The results of the bivariate analysis of IMVK can be seen in Table 3. The results of the analysis show that handgrip strength does not have a significant relationship with increasing IMVK.

The results showed that patients with low handgrip strength had a risk of experiencing diastolic dysfunction with a PR (prevalence ratio) of 3.401 (CI95% 1.051 – 11.003) compared to patients with normal handgrip strength. Patients with age $\geq$ 70 years old have a risk of experiencing diastolic dysfunction with a PR of 3.839 (CI95% 1.146 – 12.862). Patients taking metformin have a risk of experiencing diastolic dysfunction with a PR of 4.674 (CI95% 0.756 – 28.887).

4. Discussion

Diastolic dysfunction can be caused by cardiac fibrosis caused by increased collagen deposition in the interstitium, which is partly mediated by inflammatory processes. Low-grade systemic inflammation is associated with high arterial stiffness, which in turn is associated with ventricular stiffening and diastolic heart failure. In this study, there were 38 subjects (58.4%) with diastolic dysfunction, with 24 subjects (63.2%) aged $\geq$ 70 years old. The relationship between variables that could be factors influencing the incidence of diastolic dysfunction in this study was analyzed using the chi-square test. From this analysis, it was found that the variables age, comorbidities in the form of diabetes mellitus, chronic kidney disease, and use of drugs such as ACEi/ARB and metformin had a p-value <0.25, which played a role as factors influencing the incidence of diastolic dysfunction in research subjects. This. Hypertension has a p-value = 0.591, which does not have a significant influence on the incidence of diastolic dysfunction in the subjects of this study. This could be because the majority of research subjects experienced hypertension in old age or also due to controlled treatment. From the echocardiography results, it was only found that 8 research subjects had left ventricular geometry in the form of concentric hypertrophy, which is one of the effects of long-term uncontrolled hypertension.[10-13]

Low handgrip strength was found in 38 subjects (55.3%) with diastolic dysfunction, while normal handgrip strength was found in 26 subjects (68.5%) without diastolic dysfunction with a value of p=0.009. The results of this study indicate that handgrip plays a role as a factor associated with diastolic dysfunction. Well, after carrying out multiple regression analysis, the p-value = 0.041 was obtained, which states that handgrip is an independent factor in the occurrence of diastolic dysfunction along with age and metformin consumption with a p-value = 0.029 and a p-value = 0.097 regardless of comorbid factors and use of other drugs. The results of this study are in line with the research of Pang et al., showing a significant relationship between ASMI, handgrip strength, and MVK with left ventricular diastolic function but not with IMVK or left ventricular systolic function. After conducting a regression test between the factors age, gender, BMI, smoking and alcohol consumption habits, history of hypertension, and T2DM, handgrip strength still had a positive relationship with the E/A ratio (r = 0.154, P = 0.019) and e´-av (r = 0.175, P = 0.008), as well as a negative relationship with the E/e´-av ratio (r = -0.136, P = 0.038). There is no significant correlation between Handgrip and LVM. This research also found no correlation between Handgrip and IMVK.[14-16]

In this study, the normal IMVK value was used as a reference to the American Society of Echocardiography. It was found that the mean IMVK increased in 15 subjects (23%), while the IMVK was normal in 50 subjects (77%). IMVK increased across age groups≥ 70 years as many as 9 subjects (60%), with a p-value = 0.277. This shows an insignificant relationship between age and IMVK. This result is because, in old age, there can be an increase in left ventricular mass, but it does not reach the normal threshold. This can be found in physiological cardiac aging. Left ventricular diastolic dysfunction characterized by impaired left ventricular filling is considered a predictor of heart failure. Previous studies in Korean young and elderly adults have shown that reduced relative skeletal muscle mass is associated with impaired left ventricular diastolic function. Interestingly, in our partial correlation model, only grip strength, not relative skeletal muscle mass, was positively correlated with left ventricular diastolic function. The mechanisms underlying the relationship between muscle strength and left ventricular diastolic function remain unclear. One reason may be that the decline in muscle strength and quality with age is greater than the decline in muscle mass. Additionally, the low level of physical activity that often accompanies decreased muscle strength may affect left ventricular diastolic function; according to the atherosclerosis risk in communities study, higher levels of physical activity are associated with good left ventricular diastolic function. As we know, skeletal muscle loss and decreased muscle strength are important characteristics of sarcopenia. Nevertheless, as muscle strength was considered superior to muscle mass in predicting unfavorable outcomes, in 2018, the European Working Group on Sarcopenia in Older People 2 (EWGSOP2) updated the definition of sarcopenia and considered low muscle strength as a key parameter of sarcopenia. Furthermore, grip strength, which is an easy and quick way to measure muscle strength, is associated with CVD incidence and mortality. However, the relationships and possible mechanisms of the observed associations have not been fully established. Given that the left ventricular systolic function of the participants was preserved and such associations may occur more frequently in left ventricular decompensation, it is demonstrated that the association between grip strength and left ventricular diastolic function observed in this study will advance our understanding of the pathological processes that may mediate the relationship between grip strength and cardiovascular prognosis.[17-20]

Table 1. General characteristics of research subjects.

Characteristics	Total (n)	Percentage (%)
Gender		
Male	27	41,5
Female	38	58,5
Age (years)	70,37 ± 7,28	
≥ 70	31	47,7
< 70	34	52,3
BMI (kg/m²)	23,41 ± 4,26	
Normal	38	58,5
Overweight	15	23,1
Obesity	4	6,2
Underweight	8	12,3
Education		
Low-middle	49	75,4
High	16	24,6
Smoking history		
Yes	13	20,0
No	52	80,0
Exercise		
<100 minutes/week	59	90,8
≥100 minutes/week	6	9,2
Comorbid		
Hypertension	41	63,1
Diabetes mellitus	15	23,1
Chronic kidney disease	16	24,6
Dyslipidemia	33	50,8
Stroke	5	7,7
Osteoporosis	18	27,7
Consumption of medicines		
ACEi/ARB	32	49,2
Aspirin	8	12,3
Statin	17	26,2
Metformin	10	15,4
Vitamin D	11	16,9
Paracetamol	14	21,5
Echocardiography		
LVEDd	4,26 ± 0,61	
lVSd	1,09 ± 0,15	
LVPWd	0,97 ± 0,14	
Ao	3,35 ± 0,39	
LA	3,00 ± 0,52	
IMVK	91,70(51,9 – 143)	
Increased	15	23,1
Normal	50	76,9
Left ventricle geometry		
Normal	21	32,3
Concentric remodeling	29	44,6
Concentric hypertrophy	8	12,3
Eccentric remodeling	7	10,8
Left ventricular ejection fraction	75,15 ±7,08	
Laboratory		
Total cholesterol	187 (105 – 416)	
LDL	125 (54 – 249)	
HDL	53,32 ± 11,87	
Triglycerides	121 (41 – 286)	
eGFR	67,70 ± 22,62	
Handgrip	20 (12 - 38)	
Low handgrip strength	37	56,9
Normal handgrip strength	28	43,1

Table 2. Relationship between various variables on diastolic dysfunction.

Characteristics	**Diastolic dysfunction (n=38)**	**No diastolic dysfunction (n=27)**	**p-value**
Gender			
Male	21 (55,3%)	17 (63%)	0,535
Female	17 (44,7%)	10 (37%)	
Age (years)			
$\geq$ 70	24 (63,2%)	7 (25,9%)	0,003
< 70	14 (36,8%)	20 (74,1%)	
BMI (kg/m^2)			
Normal	30 (78,9%)	23 (85,2%)	0,747
Excess/Less	8 (21,1%)	4 (14,8%)	
Smoking history			
Yes	30 (78,9%)	22 (81,5%)	0,801
No	8 (21,6%)	5 (19,2%)	
Exercise			
<100 minutes/week	33 (86,8%)	26 (96,3%)	0,388
≥100 minutes/week	5 (13,2%)	1 (3,7%)	
Comorbid			
Hypertension	25 (65,8%)	16 59,3%)	0,591
Diabetes mellitus	11 (28,9%)	4 (14,8%)	0,183
Chronic kidney disease	12 (31,6%)	4 (14,8%)	0,122
Dyslipidemia	18 (47,4%)	15 (55,6%)	0,515
Stroke	4 (10,5%)	1 (3,7%)	0,309
Osteoporosis	11 (28,9%)	7 (25,9%)	0,788
Consumption of medicines			
ACEi/ARB	21 (55,3%)	11 (40,7%)	0,248
Aspirin	6 (15,8%)	2 (7,4%)	0,452
Statin	9 (23,7%)	8 (29,6%)	0,591
Metformin	8 (21,1%)	2 (7,4%)	0.133
Vitamin D	6 (15,8%)	5 (18,5%)	0,772
Paracetamol	9 (23,7%)	5 (18,5%)	0,746
Laboratory			
Total cholesterol (>200mg/dL)	15 (39,5%)	12 (44,4%)	0,689
LDL (>130mg/dL)	15 (39,5%)	11 (40,7%)	0,918
HDL (<40 mg/dL)	5 (13,2%)	1 (3,7%)	0,388
Triglycerides (<150mg/dL)	7 (18,4%)	6 (22,2%)	0,706
Handgrip			
Handgrip strength	18 (12 – 38)	23,04 ± 6,003	0,009
Low	38 (55,3%)	6 (22,2%)	0,002
Handgrip strength			
Normal	26 (68,5%)	8 (29,6%)	

Table 3. Relationship of various variables to left ventricular mass index.

Characteristics	IMVK increased (n=15)	IMVK normal (n=50)	p-value
Gender			
Male	9 (60%)	22 (56%)	0,277
Female	6 (40%)	28 (44%)	
Age (years)			
> 70	22 (56%)	30 (60%)	0,646
< 70	28 (44%)	20 (40%)	
BMI (kg/m^2)			
Normal	11 (73,3%)	42 (84%)	0,449
Excess/Under	4 (26,7%)	8 (16%)	
Smoking history			
Yes	12 (80%)	40 (80%)	
No	3 (20%)	10 (20%)	1,000
Exercise			
<100 minutes/week	13 (86,7%)	46 (92%)	0,615
≥100 minutes/week	2 (13,3%)	4 (8%)	
Comorbid			
Hypertension	12 (80%)	29 (58%)	0,122
Diabetes mellitus	5 (33,3%)	10 (20%)	0,308
Chronic kidney disease	4 (26,7%)	12 (24%)	1,000
Dyslipidemia	12 (80%)	21 (42%)	0,010
Stroke	2 (13,3%)	3 (6%)	0,325
Osteoporosis	6 (40%)	15 (30%)	0,535
Consumption of medicines			
ACEi/ARB	11 (73,3%)	21 (42%)	0,033
Aspirin	3 (20%)	5 (10%)	0,373
Statin	7 (46,7%)	10 (20%)	0,051
Metformin	5 (33,3%)	5 (10%)	0,043
Vitamin D	2 (13,3%)	9 (18%)	1,000
Paracetamol	4 (26,7%)	10 (20%)	0,721
Laboratory			
Total cholesterol (>200mg/dL)	9 (60%)	18 (36%)	0,098
LDL (>130mg/dL)	9 (60%)	17 (34%)	0,071
HDL (<40 mg/dL)	4 (26,7%)	2 (4%)	0,008
Triglycerides (<150mg/dL)	5 (33,3%)	8 (16%)	0,157
Handgrip	21,50 (12 - 36)	19,27 ± 6,452	0,130
Handgrip strength Low	10 (66,7%)	24 (48%)	0,204
Handgrip strength Normal	5 (33,3%)	26 (12%)	

5. Conclusion

There is a relationship between handgrip strength and left ventricular diastolic dysfunction in elderly patients at Dr. Mohammad Hoesin General Hospital, Palembang.

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