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Short Communication

Association between six-minute walk distance and prognosis of atherosclerotic coronary heart disease post-cardiac rehabilitation

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Abstract

Plaque accumulation in the coronary arteries is a major cause of coronary heart disease (CHD), a disease infamously known as a contributor for global death burden. Major adverse cardiac events (MACE) pose significant risks for CHD patients, highlighting the urgency of effective management and cardiac rehabilitation in CHD management. Studies have reported the role of the six-minute walk distance (6MWD) test in predicting outcomes for CHD patients; however, none have performed the investigation in Aceh setting. The aim of this study was to investigate the reliability of 6MWD as a prognostic factor for post-cardiac rehabilitation of patients with atherosclerotic CHD. A cross-sectional study was conducted in Dr. Zainoel Abidin Hospital, Banda Aceh, Indonesia. MACE was determined through in-person interviews, and phone calls with 30 atherosclerotic CHD patients who completed cardiac rehabilitation between August 2018 and September 2020. The association between 6MWD and prognosis, assessed by MACE incidence, was calculated. The results revealed that 6MWD was strongly associated with MACE occurrence during post-cardiac rehabilitation (p=0.029; prevalence ratio 4.5). Furthermore, CHD patients achieving 6MWD of more than 300 meters exhibited a lower incidence of MACE (10.5%) than patients with 6MWD of less than 300 meters (45.5%). In conclusion, the present study sheds light on the importance of improving functional capacity in patients with atherosclerotic CHD post-cardiac rehabilitation due to its significant association with the prognosis.

Keywords: Atherosclerosis, coronary heart disease, 6-minute walk test prognosis, cardiac rehabilitation, MACE

Introduction

Atherosclerosis is the main risk factor for cardiovascular disease (CVD), marked by the deposition of fibrous tissue, complex carbohydrates, lipids, blood and blood products, and calcium within the tunica intima of the heart's coronary arteries [1,2]. Coronary heart disease (CHD) is a global concern, where in 2022, its age-standardized prevalence rate reached 3,610.2 per 100,000 with a mortality rate of 108.8 per 100,000 [3]. It was estimated that the direct and

indirect cost of CVD was $378.0 billion from 2017 to 2018 [4]. With the increasing prevalence of CHD, optimal medical care is therefore essential [5].

Integrating cardiac rehabilitation into CHD treatment is widely accepted to restore cardiac function, manage risk factors, and ameliorate a patient's condition [6,7]. The six-minute walk distance (6MWD) test is one of the cardiac rehabilitation components that assesses daily activity capacity. This test assesses exercise suitability and measures pre-rehabilitation functional capacity, particularly for patients with chronic disease and multiple comorbidities that prevent more complex tests [8,9].

Studies have investigated the impact of 6MWD to determine the outcome for CHD patients during post-cardiac rehabilitation [5,10]. A study found that 6MWD was increased by 57.42 meters (m) during post-cardiac rehabilitation when compared to non-rehabilitated patients [5]. Another study reported the incidence of a major adverse cardiac event (MACE) at one year was 22%; 6MWD was shorter for patients with MACE compared to those without MACE [10]. Previous studies have investigated the role of the 6MWD test in predicting outcomes for CHD patients [5,10]; however, none of the studies were performed in Aceh, Indonesia. The aim of this study was to investigate the reliability of 6MWD as a prognostic factor for atherosclerotic CHD patients during post-cardiac rehabilitation.

Methods

Study design and setting
A cross-sectional study was conducted at Dr. Zainoel Abidin Hospital, Banda Aceh, Indonesia. Atherosclerotic CHD patients who completed cardiac rehabilitation between August 2018 and September 2020 were included. Atherosclerotic patients aged 18–70 years who underwent prior percutaneous coronary intervention or coronary artery bypass grafting surgery, completed 12 cardiac rehabilitation sessions, and willing to participate were included. All patients with ejection fraction below 40%, having other cardiovascular diseases, and having communication problems were excluded. Non-probability sampling was used for data collection. Oral informed consent was retrieved from each patient before the interview was performed.

Data collection
Demographic data including gender and age, risk factors such as lack of physical activity, obesity, hypertension, smoking, diabetes mellitus, dyslipidemia, stress, menopause, and family history of CHD were also collected. 6MWD was assessed and patients were divided into ≤300 m and >300 m group. The 6MWD was recorded based on the protocol reported previously [11].

Major adverse cardiac event (MACE)
MACE, defined as the occurrence of heart disease-related death, rehospitalization, heart attack and stroke. The presence of MACE was screened by a trained enumerator via phone interview to with the patients or their closest relatives (for cases of dead patients). The questions were asked with 'Yes' and 'Never' options for the occurrence of heart attacks, heart disease-related rehospitalization, and stroke histories during post-cardiac rehabilitation. In the case of dead patients, the cause of death was asked.

Statistical analysis
Univariate analysis presented the frequency distribution of the patients' characteristics. A Spearman rank correlation coefficient test was used to explore the correlation between 6MWD and MACE. The SPSS version 25.0 software was used for all statistical analyses (IBM SPSS, Chicago, IL, USA). Using table 2x2, the prevalence ratio (PR) was calculated by comparing the prevalence of MACE in 6MWD≤300 m group with that in 6MWD>300 m group. The results describe how often (more or less likely) individuals with 6MWD≤300 m have MACE compared to those with 6MWD>300 m.

Results

Of a total 122 patients who underwent cardiac rehabilitation from August 2018 to September 2020, 67 patients met the inclusion criteria. Thirty-seven patients were excluded due to having ejection fraction below 40% (n=7), other cardiovascular disease (n=12), incomplete medical records (n=16), and communication problems (n=2). Out of 30 patients recruited, most of them were male (90%) and 50% aged 56–65 years. Leading risk factors included lack of exercise (80%), obesity (70%), hypertension (66.7%), and smoking (56.7%) (**Table 1**). More than 60% of respondents achieved 6MWD of more than 300 m (**Table 2**).

Table 1. Baseline characteristics and risk factors of patients included in the study (n=30)

Variable	Frequency	Percentage
Gender		
Male	27	90.0
Female	3	10.0
Age (year)		
36–45	4	13.3
46–55	6	20.0
56–65	15	50.0
>65	5	16.7
Risk factor		
Lack of physical activity	24	80.0
Obesity	21	70.0
Hypertension	20	66.7
Smoke	17	56.7
Diabetes mellitus	9	30.0
Dyslipidemia	9	30.0
Stress	3	10.0
Menopause	2	6.7
Having family history of CHD	2	6.7

Table 2. Distribution of 6MWD pattern and MACE in CHD patients with post-cardiac rehabilitation (n=30)

Variable	Frequency	Percentage
Six-minute walk distance		
≤300 m	11	36.7
>300 m	19	63.3
MACE occurrence		
Yes	7	23.3
No	23	76.7
Death		
Yes	3	10.0
No	27	90.0
Rehospitalization		
Yes	3	10.0
No	27	90.0
Recurrent heart attack		
Yes	2	6.7
No	28	93.3
Stroke		
Yes	2	6.7
No	28	93.3

Seven respondents experienced MACE (23.3%) consisting of three deaths (10%), three rehospitalizations (10%), two recurrent heart attacks (6.7%) and two stroke events (6.7%). One rehospitalization was due to medication discontinuation and comorbidities, while the other two were due to recurrent heart attacks (**Table 2**).

A significant relationship was observed between 6MWD and the prognosis of patients with atherosclerotic CHD post-cardiac rehabilitation (p=0.029), suggesting that patients with 6MWD≤300 m were more likely to experience MACE (**Table 3**). Among 11 respondents with 6MWD≤300 m, five respondents experienced MACE (45.5%). In contrast, 19 respondents with 6MWD>300 m, where 17 of which remained free from MACE (89.5%). The prevalence ratio

generated from **Table 3** was PR=4.5, indicated that patients with 6MWD≤300 m have 4.5 times risk of having MACE compared to those with 6MWD>300 m.

Table 3. Association between 6MWD and prognosis of CHD patients post-cardiac rehabilitation

Six-minute walk distance (6MWD)	With MACE		No MACE		p-value
	n	%	n	%	
≤300 m	5	45.5	6	54.5	0.029*
>300 m	2	10.5	17	89.5	

CHD: coronary heart disease; MACE: major adverse cardiac event
*Statistically significant at $p<0.05$

Discussion

In the present study, some primary risk factors among patients including lack of exercise, obesity, hypertension, and smoking. A lack of exercise contributes to 9% of annual premature deaths. As suggested by a previous study, increasing physical activity could increase average life expectancy by 0.68 years [12]. Therefore, to prevent cardiovascular disease, it is advisable to have regular moderate exercise for 30 minutes for at least five days a week or; having intense exercise for a shorter length of time, such as 15 minutes of running for five days a week [13].

Obesity ranks as the second most prevalent risk factor in the present study. Obesity increases the risk of atherosclerosis CHD through insulin resistance and inflammation, fostering fat layers to atherothrombosis by visceral adipose [14]. Obesity-related inflammation promotes both low-density lipoprotein oxidation and atherogenesis [14]. Diminished nitric oxide bioavailability in obese people leads to atherosclerosis and endothelial dysfunction [14].

Hypertension, the third major risk factor in the present study, was the most prevalent comorbidity among CHD patients [15]. The pathogenesis of hypertension involves nitric oxide and prostacyclin deficiency, activation of the renin-angiotensin-aldosterone system (RAAS), oxidative stress, and inflammatory cytokines [16].

 In this study, we found smoking is among the most prevalent cardiovascular risk factors. This finding is consistent with a previous study, where persistent smoking is the biggest predictor of a first recurrent CAD [15]. Smoking is an independent risk factor for CHD and appears to have a multiplicative effect with the other major risk factors for CHD including high serum cholesterol levels, untreated hypertension, and diabetes [4]. Smoking contributes to the progression of CHD through inflammation, impaired endothelial function, platelet dysfunction, elevated oxidative stress, and atherosclerosis [17]. Smoking elevates the risk of plaque formation at arterial damage by increasing oxidized high- and low-density lipoprotein.[17] Endothelial damage promotes platelet adhesion, and triggers clotting [17]. Moreover, smoking is associated with increased risk of thrombosis, which leads to sudden cardiac death by blood flow occlusion to the heart [17].

As presented in detail in **Table 3**, more than 60% of CHD patients achieved 6MWD exceeding 300 m post-cardiac rehabilitation. Men have sixfold higher 6MWD than women, presumably because of weaker leg muscles in women than that in men [18]. Other factors affecting 6MWD are aging and obesity [17]. Aging reduces 6MWD, correlated with a loss of muscle mass, strength, and endurance, as well as an increase in sedentary lifestyles among the elderly. Obesity lowers 6MWD due to increased workload for the same intensity of exercise. The study also found a strong correlation between exercise and 6MWD [18]. The 6MWD is highly sensitive to path length, impacting speed and distance. Being wealthy was correlated with achieving longer 6MWD [19]. Furthermore, walking strategy can affect the speed and distance achieved after the 6MWD test [19].

In this present study, there were 7 patients (23.3%) experienced MACE. This number was smaller as compared with a previous study that found 48.4% MACE rate, where 17.6% of which were fatal [20]. Elevated MACE risk correlates to larger infarct size, suboptimal recovery from myocardial injury, co-morbidities, and ongoing inflammation [20]. Multiple MACE were independently correlated to diabetes and hypertension [20]. Older age, being female, cerebrovascular disease, and cardiogenic shock independently elevate the risk of MACE [21]. Moreover, patient compliance can contribute to a higher incidence of MACE-free [20].

The 6MWT is a quick, easy, and useful tool to track patients' functional capacity and encourage them to stay physically active [22]. In CHD patients, higher cardiorespiratory fitness (CRF) correlates with lower morbidity and mortality, though the exact cause remains unknown [23]. A study indicated that increasing metabolic equivalent (MET) during exercise could reduce all-cause death risk and cardiovascular-related death by 13% and 15%, respectively [24]. It is worth noting that, in this present study, the PR for MACE was 4.5 (PR>1) for patients with 6MWD≤300 m as compared to those with 6MWD>300 m. This data suggests that those with poor functional capacity (as suggested by 6MWD of less than 300 m), were likely to experience MACE during post-rehabilitation.

This is the first study in Aceh, Indonesia, to have investigated the association between 6MWD to poorer outcome in atherosclerotic CHD patients during post-cardiac rehabilitation, suggesting that 6MWD can be utilized as a predictor for CHD outcomes. Nonetheless, we acknowledge some limitations in this study including biases from the retrospective nature and self-reporting nature of the study. Bias could also emerge from the limited number of subjects recruited herein. Therefore, future studies should be performed prospectively with higher number of subjects.

Conclusion

The incidence of MACE in atherosclerotic CHD patients following the rehabilitation was associated with 6MWD status. Rehabilitated atherosclerotic CHD patients with poor 6MWD (≤300 m) were likely to experience MACE. It is therefore important to improve the functional capacity of the patients, especially those with atherosclerotic CHD, as an effort to achieve better post-cardiac rehabilitation prognosis.

Ethics approval

The Ethical Committee on Medical Research of Medical School at Universitas Syiah Kuala, Banda Aceh, Indonesia, has approved this study with registration 279/EA/FK-RSUDZA/2021.

Competing interests

The authors declare that there is no conflict of interest.

Underlying data

On request, the first author will provide access to the derived data that supports the results of this study.

How to cite

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