Volume 7, No. 1 January, 2026
p ISSN 2723-6927-e ISSN 2723-4339

Risk Factors Associated with Multivessel Coronary Artery Disease: A Cross-Sectional Study

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ABSTRACT
Cardiovascular disease (CVD) is the leading cause of death globally, with coronary artery disease (CAD) as its primary manifestation. Multivessel disease (MVD), involving two or more coronary vessels, carries higher risks of major cardiovascular events and long-term mortality than single-vessel disease (SVD). Despite extensive CAD research, determinants differentiating MVD from SVD remain inadequately characterized, especially in Indonesian populations where patterns differ from Western countries. This study aims to determine the significant risk factors for the occurrence of MVD. This retrospective cross-sectional study analyzed medical records of 122 patients undergoing coronary angiography (CAG) at Karawang Hospital (June–December 2023). Chi-square analysis identified MVD-associated risk factors; variables with $p < 0.025$ entered multivariate logistic regression. Diabetes mellitus (62.3%) and hypertension (50.0%) were main factors, significantly linked to MVD ($p = 0.019$ for hypertension, $p = 0.022$ for diabetes). Logistic regression confirmed them as independent predictors (diabetes: OR = 3.06, $p = 0.027$; hypertension: OR = 3.72, $p = 0.015$). Dyslipidemia lacked significance (OR = 1.89, $p = 0.271$), likely due to statins. These findings quantify hypertension and diabetes effects on MVD in an Indonesian setting, informing targeted prevention to reduce multivessel disease burden and improve outcomes.
Keywords*: Coronary artery disease; multivessel diasease (MVD); single-vessel disease (SVD)*

INTRODUCTION

Cardiovascular disease (CVD) is the world's leading cause of death, with around 19.8 million deaths in 2022, or 32% of the total global deaths (Hiczkiewicz et al., 2021; World Health Organization, 2025). One of its manifestations is coronary artery disease (CAD), which can involve one or more coronary vessels. Conditions involving two or more vessels are known as multivessel disease (MVD), which carry a high risk of major cardiovascular events, the need for revascularization, and long-term mortality. Classic risk factors such as hypertension, diabetes mellitus, dyslipidemia, old age, and impaired renal function are known to play a role in atherosclerosis (He et al., 2024; Pham et al., 2024), but evidence on the specific association of these factors with the incidence of MVD versus single-vessel disease (SVD) remains inconsistent. This gap suggests the need for further research to understand the independent determinants of MVD, particularly in diverse populations where risk factor prevalence and disease patterns may differ.

Recent studies have attempted to identify predictors of MVD with varying results. He et al. (2024) demonstrated that traditional risk factors including hypertension, diabetes, and dyslipidemia were associated with increased MVD prevalence in Chinese patients with acute coronary syndrome. Similarly, Mir et al. (2021) found that diabetes mellitus was a significant predictor of multivessel disease in young patients presenting with ST-segment elevation myocardial infarction. However, Pham et al. (2024) reported conflicting findings regarding the role of obesity in MVD development, suggesting that metabolic factors may be more important than anthropometric measurements. These inconsistencies highlight the need for population-specific studies to better characterize MVD risk factors.

The novelty of this study lies in its focus on the Indonesian population at a regional hospital setting, where the interaction between genetic predisposition, environmental factors, and healthcare access may create a unique risk profile. Furthermore, this study employs a

comprehensive approach by examining multiple risk factors simultaneously and using multivariate analysis to identify independent predictors, addressing the limitation of previous studies that examined risk factors in isolation.

The objectives of this research are threefold: (1) to identify the prevalence of traditional cardiovascular risk factors among patients undergoing coronary angiography, (2) to determine which risk factors are significantly associated with MVD compared to SVD, and (3) to quantify the independent contribution of each risk factor to MVD development through multivariate analysis. The benefits of this research extend to clinical practice by providing evidence-based guidance for risk stratification and targeted interventions, to public health through identification of priority areas for cardiovascular disease prevention programs, and to future research by establishing baseline data for longitudinal studies on MVD progression and outcomes in Indonesian populations.

METHODS

This study was conducted at the Karawang Regional General Hospital using medical record data taken from patients who underwent coronary angiography in June-December 2023. The research design used is cross-section, retrospective. The Inclusion Criteria are: (1). All patients who were treated by CAG; (2) Patient's age >=18 years. The exclusion criteria were: (1) Coronary angiography showed stenosis in the main branch <50%. Finally, 122 data were obtained that met the inclusion criteria. Patients were divided into single vessel disease group (22) and multivessel disease group (100) based on the number of blood vessels that experienced stenosis.

SVD is defined as the presence of a blockage in one blood vessel with >50% stenosis in the left anterior descending, left circumflex artery or right coronary artery or intermediate and first branching of the main artery (such as diagonal branching, marginal obtuse branching, marginal acute branching, etc.). MVD is defined as the presence of at least 2 blockages of blood vessels with >50% in the main arteries (left main artery, left anterior descending, left circumflex artery, right coronary artery and or intermediate branching and first branching of the main artery (such as diagonal branching, obtuse marginal branching, acute marginal, etc.). Hypertension is defined as blood pressure >=140/90 based on the ESH guideline obtained during the initial examination, or is in the process of hypertension treatment. Diabetes mellitus is a blood sugar level at >200mg/dL, fasting blood sugar >126mg/dL, blood sugar 2 hours post prandial >200mg/dL, or a history of taking medication. Dyslipidemia is a total cholesterol level >200mg/dL, LDL >130mg/dL, or a history of taking medication. Renal failure is an eGFR<60mL/min/1.73m2 condition obtained during the examination prior to the CAG procedure. Body Mass Index (BMI) ≤25 kg/m2 is defined as normal, and BMI >25kg/m2 is defined as obesity. Smoking is the consumption of at least 1 cigarette per day in the last 6 months.

Statistical analysis using SPSS 30.0 (IBM). The research data is shown by the frequency of results as an average +- standard deviation or median. A comparison of the effects of each categorical variable is made by chi square or fischer's exact test. The variable that meets p<0.025 on chi square was followed by correlation determination using multivariate logistic regression analysis. The results are displayed as 95% confidence intervals (Cis) and hazard ratio (OR). Two-sided P<0.05 is considered to have significant statistical value. Model 1 is hypertension, diabetes, dyslipidemia, age >65 years, renal failure with eGFR <60mL/min/1.73m2 and a family history of CAD.

RESULTS AND DISCUSSION

Based on the data in Table 1, it shows that of the total 122 respondents who underwent coronary angiography at Karawang Hospital for the June-December 2023 period, most of the patients were male (68.0%), while 39 were women (32.0%). The age group <65 years dominated, namely 98 people (80.3%), while the age of ≥65 years was 24 people (19.7%). Based on the BMI category, most of the patients were included in the normal category (≤ 25 kg/m²) as many as 97 people (79.5%), and obese (>25.0 kg/m²) as many as 25 people (20.5%). The most risk factors in patients were diabetes mellitus as many as 76 people (62.3%), followed by hypertension as many as 61 people (50.0%), active smokers as many as 75 people (61.5%), and dyslipidemia as many as 42 people (34.4%). In addition, there was a family history of CAD in 3 patients (2.5%), renal failure in 17 patients (13.9%), and a history of previous myocardial infarction (previous AMI) in 21 patients (17.2%).

Table 1. Distribution of respondent characteristics

Variabel	N (122)	%
Gender		
Male	83	68.0
Women	39	32.0
Age (years)		
<65 years old	98	80.3
≥65 years old	24	19.7
IMT (kg/m²)		
Normal (≤ 25)	97	79.5
Obesity (>25)	25	20.5
Hypertension	61	50.0
Diabetes Mellitus	76	62.3
Dyslipidemia	42	34.4
Active smokers	75	61.5
CAD family history	3	2.5
Renal Failure	17	13.9
Previous AMI	21	17.2

Based on Table 2, the Chi-square test results show that there is a significant relationship between hypertension and the incidence of multivessel coronary artery disease (MVD) with a value of p = 0.019 (p < 0.05). Most patients with hypertension had MVD as many as 55 people (50%), while patients without hypertension had MVD as many as 45 people (50%), showing a significantly different distribution between the groups with and without hypertension. It can be concluded that hypertension is associated with an increased incidence of multivessel CAD compared to patients without hypertension.

Table 2. Relationship of Hypertension to Multivessel CAD

Hypertension	MVD (%)	SVD (%)	n	%	p-value
Yes	55	6	61	50%	**0.019**
No	45	16	61	50%	
Total	100	22	122	100%	

Based on Table 3, the results of the Chi-square test showed that there was a significant association between diabetes mellitus and the incidence of multivessel CAD with a value of p =

0.022 ($p < 0.05$). Most patients with diabetes experienced MVD as many as 67 people (55%), compared to patients without diabetes as many as 33 people (45%). This suggests that patients with diabetes have a higher tendency to develop coronary artery disease in more than one blood vessel.

Table 3. DM Relationship to Multivessel CAD

DM	MVD (%)	SVD (%)	n	%	p-value
Yes	67	9	76	62,3 %	**0.022**
No	33	13	46	37,7 %	
Total	100	22	122	100%	

Based on Table 4, the Chi-square test results on the relationship between dyslipidemia and multivessel CAD incidence showed a value of $p = 0.202$ ($p > 0.05$), which means that there was no significant association between dyslipidemia and MVD occurrence. A total of 37 patients (31%) with dyslipidemia had MVD, while 63 patients (52%) without dyslipidemia also had MVD, showing a relatively balanced distribution between groups.

Table 4. Relationship of Dyslipidemia to Multivessel CAD

Dyslipidemia	MVD (%)	SVD (%)	n	%	p-value
Yes	37	5	42	34,4%	**0.202**
No	63	17	80	65,6%	
Total	100	22	122	100%	

Based on the binary logistic regression analysis in Table 5, there were two variables that showed a significant influence on the incidence of valvular heart disease in the study sample with a significance threshold of $p<0.05$. The history of DM had a regression coefficient of B=1.118 with a significance value of p=0.027, resulting in an odds ratio (OR) of 3.058 (95% CI: 1.134–8.245), which indicated that respondents with a history of DM were 3.06 times more at risk of developing MVD than without a history of DM. Furthermore, a history of HT was a stronger risk factor with B=1.313 and p=0.015, resulting in OR=3.718 (95% CI: 1.293–10.693), so that respondents with hypertension had a 3.72 times greater chance of developing MVD than those without hypertension. In contrast, dyslipidemia variables did not show a statistically significant association with MVD incidence with significance values of p=0.271 and OR=1.885 (95% CI: 0.609–5.829).

Table 5. Results of binary logistics management analysis among risk factors for MVD

Variabel	B	Say.	OR Exp(B)	95% CI for OR
DM	1.118	.027	3.058	1.134- 8.245
HT	1.313	.015	3.718	1.293- 10.693
Dyslipidemia	.634	.271	1.885	0.609-5.829

Discussion

In this study, most of the patients were 80.3% under 65 years old. These findings suggest that coronary heart disease does not only occur in the elderly age group. The process of atherosclerosis is now widely found at a younger age due to the increasing prevalence of risk factors such as hypertension, diabetes mellitus, and an unhealthy lifestyle. Research by He et al. (2024) shows that although the incidence of heart disease increases with age, factors such as

diabetes and hypertension can accelerate the process of atherosclerosis even in younger individuals. In addition, the study of Ge and Li (2018) confirms that in young patients with acute coronary syndrome, the presence of hypertension and diabetes mellitus can accelerate the development of more severe coronary heart disease. The tendency to increase heart disease at a young age is also influenced by lifestyle factors, such as a diet high in saturated fat, smoking habits, and lack of physical activity. Yamada-Harada et al. (2019) stated that the increasing prevalence of diabetes and hypertension at a young age has shifted the epidemiology of coronary artery disease to a younger age compared to the previous decades. Another study by Li et al. (2020) in premature CAD patients showed a high burden of risk factors at a young age, including hypertension and dyslipidemia, which contribute to the early onset of multivessel disease (MVD). Therefore, primary prevention through the promotion of a healthy lifestyle is increasingly important, even for the productive age group.

In this study, it was found that most patients around 79.5% had BMI in the normal category (≤ 25 kg/m²). These findings appear to contrast with the common concept that obesity is one of the main risk factors for coronary heart disease (Pham et al., 2024). However, this condition can be explained by the presence of patients with hypertension or diabetes who have not reached the degree of obesity, but have undergone vascular changes due to metabolic and inflammatory factors. Based on research by Ge and Li (2018), patients with hypertension and diabetes mellitus can experience a more severe degree of coronary artery disease despite having a normal BMI. This suggests that the risk of heart disease depends not only on weight, but also on metabolic qualities and the presence of comorbidities. In addition, Sani et al. (2008) add that although normal BMI can reduce cardiovascular risk in general, risk factors such as hypertension and diabetes still play a dominant role in the atherosclerosis process. The STABILITY substudy study by Christersson et al. (2022) found that patients with a normal BMI of up to 35 kg/m² had the lowest cardiovascular mortality, while extreme BMI (<20 or ≥ 35 kg/m²) increased risk, supporting that metabolic factors are more crucial than obesity alone. Therefore, a clinical approach to the risk of coronary heart disease must consider metabolic and vascular factors as a whole, not just based on anthropometric parameters such as BMI.

Based on the results of the Chi-Square test, it was shown that diabetes mellitus was significantly related to the incidence of MVD ($p = 0.022$). Multivariate logistic regression analysis corroborated these findings with a regression coefficient of $B = 1.118$, $p = 0.027$, and an odds ratio (OR) = 3.058 (95% CI: 1.134–8.245) so that patients with diabetes had a three times greater risk of developing MVD than those without. Pathophysiologically, chronic hyperglycemia causes endothelial dysfunction, increased oxidative stress, and systemic inflammation that accelerates the formation of atherosclerotic plaques in more than one blood vessel. Yamada-Harada et al. (2019) mentioned that diabetes exacerbates atherosclerosis through endothelial dysfunction and inflammatory mechanisms. While Turner et al. (1998) found that uncontrolled diabetes significantly increases the risk of coronary heart disease due to arterial stiffness and plaque accumulation. Other studies also concluded that diabetes is an independent predictor of the occurrence of MVD (Arshad et al., 2025; Mir et al., 2021). Laakso et al. (2012) explain that chronic hyperglycemia causes eNOS uncoupling and a decrease in NO, which worsens endothelial dysfunction in atherosclerosis. These results confirm the importance of controlling blood glucose levels through medication and lifestyle modifications. Early detection of vascular complications in diabetic patients is also key in the prevention of multivessel involvement and reduced risk of severe cardiovascular events.

In this study, hypertension showed a significant association with MVD incidence in both Chi-Square analysis (p = 0.019) and multivariate logistic regression analysis (B = 1.313; p = 0.015; OR = 3,718; 95% CI: 1,293–10,693). This shows that hypertensive patients are almost four times more likely to experience MVD than normotenance patients. Pathophysiologically, chronic high blood pressure causes endothelial injury due to increased shear stress, triggers vascular dysfunction, increased lipid permeability, and the formation of broader atherosclerotic plaques. de Carvalho Cantarelli and Castello (2015) reported that hypertension accelerates the process of atherosclerosis and narrowing of coronary arteries. Meanwhile, Ge and Li (2018) emphasized that hypertension is an independent risk factor for MVD, especially in young patients. In addition, He et al. (2024) also showed that hypertension is a major predictor of MVD in patients with acute coronary syndrome. A study by Dai et al. (1999) confirmed that low shear stress in the area of arterial bifurcation exacerbates the endothelial atherogenic phenotype. According to research conducted by Nababan et al. (2019), compared to individuals without hypertension, patients with hypertension had a higher incidence, extent, and severity of coronary atherosclerosis and were more likely to experience an increased adverse cardiovascular event. Appropriate interventions, such as antihypertensive therapy, low-salt diets, and stress reduction, can help reduce the burden of diffuse atherosclerosis on which MVD is based.

In this study, the role of dyslipidemia did not show a significant relationship with the incidence of MVD (p = 0.202). The logistic regression results also showed values of p = 0.271 and OR = 1.885 (95% CI: 0.609–5.829), which means that although dyslipidemia contributes to atherosclerosis, its role in MVD incidence is not dominant compared to hypertension and diabetes mellitus. These findings may be influenced by the use of statin therapy in most patients, which can lower LDL levels and stabilize plaques. However, the research of Alamir et al. (2018) found a strong association between high LDL and low HDL levels and the severity of coronary artery disease, including MVD. Research by Mahalle et al. (2014) also showed that certain patterns of dyslipidemia are associated with a higher cardiovascular risk in patients with coronary artery disease. Hermans et al. (2016) reported that atherogenic dyslipidemia (high TG and low HDL) increased the risk of silent CAD in diabetic patients even though LDL was controlled. Other studies have shown that dyslipidemia is closely related to the occurrence of CAD severity (Shashu & Baru, 2022). Although not statistically significant in this study, lipid profile control remains important as part of the comprehensive management of coronary heart disease.

This study has several limitations such as the cross-sectional design does not allow causality inference because the temporal precedence between risk factors and MVD cannot be determined with certainty, selection bias arises because samples come from patients who underwent angiography at only conducted at Karawang Hospital, not a random representation of the general population, so the prevalence rate of MVD may be higher and generalizability is limited. There are possible unmeasured confounders such as family history, stress levels, diet, and genetic factors that are not fully measured in the analysis, coronary angiography has technical limitations including two-dimensional imaging which can cause measurement errors and inter-observer variation in interpretation, the widespread use of statins in the study population may obscure the true role of dyslipidemia.

CONCLUSION

This cross-sectional study at Karawang Hospital analyzed risk factors for multivessel

coronary artery disease (MVD) in patients undergoing coronary angiography, revealing that 79.5% had normal BMI and 80.3% were under 65 years, underscoring that CHD risk stems from complex metabolic factors beyond anthropometrics and reflecting an epidemiological shift toward younger ages due to rising modifiable risks. Diabetes mellitus and hypertension emerged as strong independent predictors of MVD, with odds ratios of 3.058 (95% CI: 1.134–8.245) and 3.718 (95% CI: 1.293–10.693), respectively, highlighting their role in diffuse atherosclerosis. Dyslipidemia showed no significant association ($p = 0.202$), likely attributable to prevalent statin use, though atherogenic patterns may still contribute to pathogenesis. Overall, the findings stress optimal control of metabolic and cardiovascular risks via early detection, intensive management, and lifestyle modifications to curb MVD burden. For future research, prospective longitudinal studies in diverse Indonesian cohorts could evaluate long-term outcomes of risk factor interventions and explore genetic-environmental interactions in MVD progression.

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