Volume 5, No. 8 August, 2024
p ISSN 2723-6927-e ISSN 2723-4339

Dyslipidemia And Hypertension Among Indonesian Hajj Pilgrims: A Cross-Sectional Study

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ABSTRACT
There has been an increase in the prevalence of cardiovascular disease in Indonesia due to an increased prevalence of hypertension. Cardiovascular disease is the primary cause of morbidity and mortality among Indonesian Hajj pilgrims. Dyslipidemia and hypertension are positively correlated, with dyslipidemia potentially contributing to hypertension through the mechanism of atherosclerosis. The primary objective of this study is to identify the association between hypertension and dyslipidemia among Indonesian hajj pilgrims. A cross-sectional study involving 114,069 participants in total. The Indonesian Hajj pilgrims in 2023 were the research population. Pre-embarkation medical exams were performed by qualified healthcare professionals, and data were taken from Hajj medical service records. Using bivariate analysis and the Chi-Square (χ2) test, the proportions of age and gender were compared between the hypertension and non-hypertension groups. The relationship between triglyceride, HDL, and LDL levels and hypertension was determined through logistic regression analysis. Logistic regression analysis was used to provide a multivariate analysis of the relationship between dyslipidemia and hypertension. The hypertension group has an average age of 60.2 + 11.6 years old ($p<0.0001$). There was no difference in the effect of gender on hypertension ($p=0.105$). HDL, LDL, and Triglyceride serum levels significantly affected the prevalence of hypertension ($p<0.0001$). Dyslipidemia was a risk factor for hypertension with an OR of 1.084 (1.057-1.112) (95% CI). Dyslipidemia is a risk factor for hypertension. Serum levels of HDL, LDL, and triglycerides affect blood pressure.
Keywords: Hypertension, dyslipidemia, risk factor, cardiovascular disease

INTRODUCTION

Ischemic heart disease, stroke, vascular disease, and kidney disease are among the complications of hypertension, which is accountable for 8.5 million fatalities annually on a global scale. Between 1990 and 2019, the global population of hypertension patients aged 30-79 years has doubled. Globally, the composition of the

number of people with hypertension consists of 59% women and 41% men. Of this composition, only 47% of women and 38% of men are treated (Zhou et al., 2021).

In Indonesia, hypertension in 2018 was 34.1% in the adult population. This number has increased compared to the prevalence in 2013, which was only 25.8%. The increasing prevalence of hypertension is a major contributor to cardiovascular disease in Indonesia (Ri, 2018). Indonesia is a Muslim country with the largest number of Hajj pilgrims. During Hajj, cardiovascular disease is the leading cause of morbidity and mortality (Widhidewi, Masyeni, & Pratiwi, 2020).

Abnormalities in serum cholesterol levels, triglycerides, and lipoproteins are characteristic of dyslipidemia. Atherosclerotic cardiovascular disease is associated with elevated serum levels of total cholesterol, triglycerides, and LDL cholesterol and lower serum levels of HDL cholesterol (Berberich & Hegele, 2022). Hypertension will cause shear stress on the endothelium, which induces oxidation stress, resulting in increased lipoprotein permeability in the vascular and the process of arteriosclerosis.

Hypertension and dyslipidemia are often related to each other. Both hypertension and dyslipidemia are risk factors for vascular damage and cardiovascular disease. Risk factors for cardiovascular disease and vascular damage include dyslipidemia and hypertension (Ming Ming Chen et al., 2022). In dyslipidemia, the interaction between LDL and ROS (Reactive Oxygen Species) will cause vasoconstriction. Dyslipidemia will also upregulate AT1 receptors that cause vasoconstriction through the effects of angiotensin II (Dąbrowska & Narkiewicz, 2023).

RESEARCH METHODS

Study Design and Data Extraction

Data from Indonesian hajj pilgrims in 2023 was analyzed for this cross-sectional study. The data were extracted from the medical service records of Hajj pilgrims, which were examined by trained medical personnel prior to embarkation. Pre-departure medical examinations were performed at a hospital or primary care facility. Identities, ages, genders, comorbidities, and examination results (including systolic and diastolic blood pressure, LDL cholesterol levels, HDL cholesterol levels, and Triglyceride levels) are among the data extracted from medical checkup records. A total of 209.782 hajj pilgrims aged over 18 years were recruited in this study to analyze the association between dyslipidemia and hypertension. This study is observational, so it does not require informed consent.

Study Population

209.782 Indonesian hajj pilgrims in 2023 were the population in this cross-sectional study. The inclusion criteria in this study were age over 18 years and complete medical records including identity, age, gender, comorbid diseases, and examination results of systolic blood pressure, diastolic blood pressure, LDL cholesterol levels, HDL cholesterol levels, and Triglyceride levels. The selection of study subjects was divided

into two stages. The first stage of 209.782 participants excluded 3.710 participants with incomplete data (age, sex, comorbid diseases), 25 pregnant women, 26.279 participants with type 2 Diabetes Mellitus, 8.225 participants had cardiovascular disease, 4.892 participants had heart failure, 25 participants had rheumatic heart disease, 513 participants had cardiomyopathy, 140 participants had structural heart disease, 4. 850 participants had arrhythmia, 918 participants had kidney disease, 1.005 participants had cerebrovascular disease, 454 participants had endocrine disease, 32 participants had systemic lupus erythematous disease, 126 participants had cancer, and 10.491 participants had hyperuricemia. In stage 2 selection, 15.769 participants who did not have blood pressure data, 8.069 participants who did not have LDL level data, and 7.013 participants who did not have HDL level data were excluded.

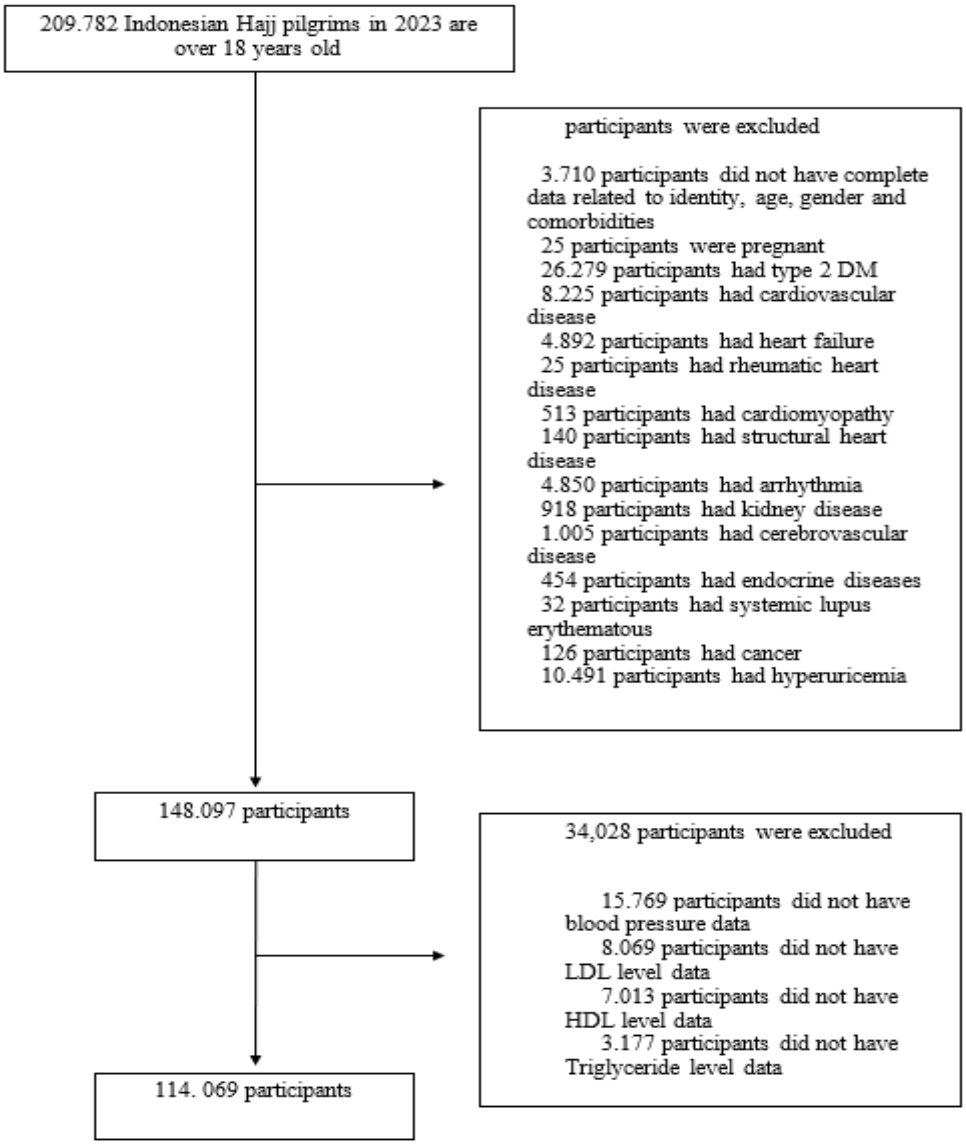

Figure 1. The flowchart selection of participants in the study

Diagnostic Criteria

When systolic blood pressure exceeds 140 mmHg and/or diastolic blood pressure exceeds 90 mmHg, hypertension is diagnosed. Grade 1 hypertension is determined when the systolic blood pressure measures are between 140-159 mmHg and/or the diastolic blood pressure measures are between 90-99 mmHg. Grade 2 hypertension is determined when the systolic blood pressure measures are between 160 and 179 mmHg and/or the diastolic blood pressure measures are between 100 and 109 mmHg. Grade 3 hypertension is diagnosed when the systolic blood pressure exceeds 180 mmHg and/or the diastolic blood pressure exceeds 110 mmHg (Williams et al., 2018). A diagnosis of dyslipidemia is proven if any of the following criteria: HDL values below 40 mg/dl, LDL levels above 160 mg/dl, or triglyceride levels exceeding 200 mg/dl (Indonesia, 2021).

Statistical Analyses

SPSS Version 26 was used to analyze the data. Bivariate analysis was conducted using the Chi-Square (χ2) test to examine the relationship between age, gender, and hypertension status (hypertension or normotension). The basis for decision-making in the Chi-Square (χ2) test is the significance value (p-value) less than 0.05 (p-value <0.05). To investigate the impact of dyslipidemia on the prevalence of hypertension using age and gender as confounding variables., multivariate analysis was performed using logistic regression analysis. Odds ratio (OR) and 95% confidence interval (CI) were used to show the results of the multivariate logistic regression analysis. In logistic regression analysis, the criterion for decision-making is a significance value (p-value) below 0.05 (p-value <0.05).

RESULTS AND DISCUSSION

Table 1. Characteristics of Participants based Aged and Gender

Variables	Hypertension (n=46.455)	Non-hypertension (n=67.614)	χ^2	*p-value*
Aged (years, mean±sd)	60,2 ± 11,6	52,8 ± 12,7	11.994,4	<0,0001
Age			6.510,8	<0,0001
18 – 50 years	9.362 (24,3)	29.178 (75,7)		
> 50 years	37.093 (49,1)	38.436 (50,9)		
Gender			2,623	0,105
Male	20.631 (41,0)	29.699 (59,0)		
Female	25.824 (40,5)	37.915 (59,5)		

The hypertension group consisted of 46,455 participants, with a median age of 60.2 $\pm$ 11.6 years. The non-hypertension group consisted of 67,614 participants, with a median age of 52.8 $\pm$ 12.7 years. The hypertension group had a higher average age

compared to the non-hypertension group. However, there was no statistically significant disparity in the prevalence of hypertension between women and men.

Table 2. Characteristics Participants based Lipid Profiles

Conventional Lipid Profiles	Total (n=114.069)	Hypertension (n=46.455)	Non-hypertension (n=67.614)	*p-value*
HDL (mg/dl, mean±sd)	2. 56,92 ± 27,854	57,45 ± 28,136	56,56 ± 27,653	<0,0001
LDL (mg/dl, mean±sd)	. 126,21 ± 38,290	128,56 ± 39,298	124,60 ± 37,497	<0,0001
Triglycerides (mg/dl, mean±sd)	6. 131,52 ±64,929	136,43 ± 66,111	128,15 ± 63,887	<0,0001

The hypertension group had higher HDL, LDL, and Triglyceride levels than the non-hypertension group.

Table 3. Age and gender-based subgroup analysis of lipid profile differences between hypertension and non-hypertension

Conventional Lipid Profiles	Hypertension	Non-hypertension	*p-value*	Hypertension	Non-hypertension	*p-value*
Age (years)		< 50 years			> 50 years	
HDL (mg/dl, mean±sd)	55.81 ± 28.57	55.49 ± 27.37	0,001	57.86 ± 28.01	57.38 ± 27.84	<0,0001
LDL (mg/dl, mean±sd)	126.29 ± 37.93	121.62 ± 36.34	<0,0001	129.13 ± 39.61	126.86 ± 38.20	<0,0001
Triglycerides (mg/dl, mean±sd)	138.7 ± 69.52	125.34 ± 65.44	<0,0001	135.86 ± 65.21	130.28 ± 62.60	<0,0001
Gender		Male			Female	
HDL (mg/dl, mean±sd)	54.98 ± 28.34	53.94 ± 28.02	<0,0001	59.42 ± 27.82	58.62 ± 27.19	<0,0001
LDL (mg/dl, mean±sd)	125.8 ± 37.98	123.05 ± 36.96	<0,0001	130.77 ± 40.19	125.81 ± 37.87	<0,0001
Triglyceridees (mg/dl, mean±sd)	142.66 ± 70.29	139.1 ± 69.12	<0,0001	131.46 ± 62.13	119.57 ± 58.04	<0,0001

Both the under and over 50-year groups have the same characteristics of HDL cholesterol levels between hypertension and non-hypertension, while LDL cholesterol and triglyceride levels are higher in hypertension. Based on gender, both men and women had higher HDL, LDL, and triglyceride levels in the hypertension group compared to the non-hypertension group.

Correlation Dyslipidemia with Hypertension Risk

The prevalence of hypertension was assessed by doing multivariate analysis using logistic regression analysis to examine the association with dyslipidemia. In logistic regression analysis, the decision-making criterion is if the significance value (p-value) is

below 0.05 (p-value < 0.05). It can be inferred that dyslipidemia has an association with the prevalence of hypertension.

Table 4. Association of Dyslipidemia and the risk of Hypertension

Variable	Hipertension (n=46.455)	Non-hipertension (n=67.614)	χ^2	*p-value*	OR_1 (95% CI)	OR_2 (95% CI)
Dyslipidemia			5,408	0,02		
Yes	18.174 (41,2)	25.989 (58,8)			1,11 (1,083-1,137)	1,084 (1,057-1,112)
No	28.281 (40,5)	41.625 (59,5)			-	-

The number of participants who have dyslipidemia has a lower prevalence of hypertension when compared to participants who do not have dyslipidemia, with a total of 18,174 people and 28,281 people, respectively. The Chi-Square test findings indicate that the dyslipidemia variable has a significance value (p-value) of 0.02 (p-value <0.05). This suggests a statistically significant association between dyslipidemia and the prevalence of hypertension. Furthermore, based on unifactorial logistic regression analysis or without age and gender as confounding variables, the OR1 (95% CI) value was 1.11 (1.083-1.137). Hypertension risk is increased by dyslipidemia; the odds ratio is 1.11 times greater in the dyslipidemia group than in the non-dyslipidemia group. Additionally, when age and gender were taken as factors that could influence the results, the multivariate logistic regression analysis showed a higher odds ratio (OR2) of 1.084 (95% confidence interval: 1.057-1.112). This indicates that dyslipidemia is a significant risk factor for hypertension, with the odds of developing hypertension being 1.084 times higher in the dyslipidemia group compared to the non-dyslipidemia group.

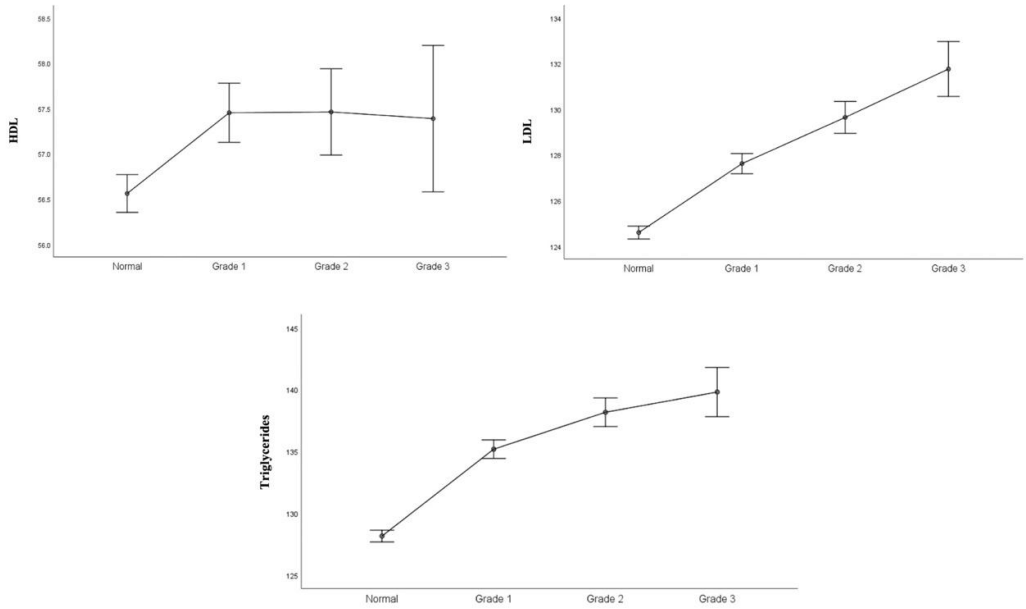

Figure 2. Levels of HDL, LDL, Triglycerides, and various blood pressure levels

This study shows that increased HDL, LDL, or triglyceride levels will increase blood pressure. An elevation in HDL, LDL, or triglyceride levels causes an increase in blood pressure. However, an increase in HDL levels does not correlate proportionally with an increase in blood pressure. There is a positive correlation between elevated levels of LDL and Triglycerides and an increase in blood pressure.

Discussion

The objective of this study is to determine the association between dyslipidemia and hypertension. This study can be concluded that dyslipidemia increases the risk factor of hypertension 1.084 times compared to non-dyslipidemia. Dyslipidemia and hypertension are interrelated. Dyslipidemia can cause hypertension through various mechanisms, including decreased vascular elasticity due to the process of atherosclerosis. LDL plays a greater role in the atherosclerosis process compared to other cholesterol. The process of atherosclerosis begins with LDL oxidation and internalization into the subendothelial layer. Dyslipidemia also causes endothelial dysfunction, leading to a decrease in NO production (Haba et al., 2019). Hypertension is caused by impaired arterial vasodilation. NO plays vasodilatation that occurs in the arterial endothelium. In dyslipidemia, reduced NO causes vasoconstriction (Harrison, Coffman, & Wilcox, 2021). Dyslipidemia causes stimulation of LDL into ROS, which causes the release of eNOS and decreases the amount of NO production. The decrease in NO production causes peripheral vasoconstriction (Shaito et al., 2022). Dyslipidemia additionally results in the activation of AT1 receptors, which enhances the vasoconstrictive impact of angiotensin II and hence raises blood pressure (do Vale et al., 2020).

A cross-sectional study conducted by Wyszyńska et al. showed that an increase in LDL and triglycerides had a 5-fold risk of hypertension (Wyszyńska, Łuszczki, Sobek, Mazur, & Dereń, 2023). In addition, cross-sectional research conducted by Chen et al. with a study population of Chinese people showed that high blood pressure was also correlated with increased triglyceride and LDL levels (Siwei Chen & Cheng, 2022). A study conducted by Chrusciel et al. revealed a significant correlation between elevated HDL concentration and systolic blood pressure (Chruściel et al., 2022).

Our study has several advantages, including a large study population. The study also excluded confounding variables related to factors that may increase blood pressure, such as history of heart disease, diabetes, and pregnancy. This study also shows the characteristics of lipid profiles and blood pressure based on age and gender. As a cross-sectional study, this research is limited in that it is unable to establish a causal link between hypertension and dyslipidemia. Furthermore, this study did not examine the correlation between each lipid profile and elevated systolic or diastolic blood pressure.

Conclusion

This study showed that hypertension risk factors are increased in individuals with dyslipidemia. An increase in LDL cholesterol and triglycerides is proportional to increased blood pressure. High blood pressure tends to occur in the elderly. No statistically significant disparity was observed in blood pressure according to gender. Consistent monitoring of blood pressure and lipid profiles in healthcare facilities is important in this study. We acknowledge the Department of Cardiology and Vascular Medicine, Faculty of Medicine, Universitas Airlangga, Indonesia.

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