ORIGINAL ARTICLE

Dyslipidemia is Associated with Coronary Heart Disease in Patients with Type 2 Diabetes Mellitus at a Tertiary Hospital in Surabaya, Indonesia

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ABSTRACT

Introduction: Diabetes mellitus ranks as the third leading cause of mortality in Indonesia. The commonly found comorbidity of diabetes mellitus is cardiovascular disease, which contributes to elevated mortality rates. Diabetes mellitus sufferers face a heightened risk of cardiovascular disease, in part, due to dyslipidemia. This study aimed to establish the association between dyslipidemia and coronary heart disease (CHD) in type 2 diabetes mellitus (T2DM) patients receiving treatment at the diabetes subdivision of Dr. Soetomo General Academic Hospital, Surabaya, Indonesia.
Methods: This retrospective cross-sectional investigation examined 100 eligible individuals with T2DM and dyslipidemia at the diabetes subdivision of Dr. Soetomo General Academic Hospital, Surabaya, Indonesia, to assess the prevalence of CHD. Statistical analysis was performed using Pearson's chi-squared test to determine whether there was an association between dyslipidemia and CHD in the T2DM sufferers. If the p-value was below 0.05, the findings of the analysis were considered significant. The statistical test was conducted through IBM SPSS Statistics for Windows, version 26.0 (IBM Corp., Armonk, N.Y., USA).
Results: Dyslipidemia was present in 74% of the T2DM patients. Patients who had dyslipidemia and T2DM were primarily female and aged between 51 and 60 years. Meanwhile, CHD affected 40 T2DM patients (40%). These patients were predominantly male and between the ages of 51 and 60. T2DM patients who also suffered from CHD typically presented with dyslipidemia (85%).
Conclusion: This study demonstrates that the presence of dyslipidemia in T2DM sufferers is associated with CHD.

Keywords: Type 2 diabetes mellitus; dyslipidemia; coronary heart disease

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Highlights:
1. This study examined type 2 diabetes mellitus patients receiving treatment in a tertiary hospital to determine the association between dyslipidemia and coronary heart disease, an important concern given the rising prevalence of the disease in Indonesia.
2. The analysis revealed that type 2 diabetes mellitus patients who also have dyslipidemia face an elevated risk of developing coronary heart disease.
3. This study offers additional information, particularly related to the presence of dyslipidemia and coronary heart disease, which may enhance the management of type 2 diabetes mellitus throughout primary, secondary, and tertiary health facilities.

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INTRODUCTION

Diabetes mellitus is a common health concern that every country must address. In 2021, the International Diabetes Federation defined diabetes mellitus as a chronic metabolic disease caused by an impairment in the body's production or utilization of the hormone insulin. This leads to elevated blood glucose levels, known as hyperglycemia (Magliano et al., 2013). The incidence of diabetes mellitus has been steadily increasing, including in Indonesia. The country ranks sixth globally in the prevalence of diabetes mellitus, affecting 10.3 million people (International Diabetes Federation, 2017). In 2017, approximately 425 million individuals throughout the globe were diagnosed with diabetes mellitus. Meanwhile, in 2019, there were 436 million people aged 20 to 70 years who were diagnosed with diabetes mellitus. This number is predicted to increase annually, with an estimated prevalence of 578 million by 2030 and 700 million by 2045 (Saeedi et al., 2019).

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The mortality rate associated with diabetes mellitus is high. The Ministry of Health of the Republic of Indonesia (2020) previously reported that diabetes mellitus accounts for a fatality rate of 6.7% of all fatalities in Indonesia, positioning the disease as the third leading cause of mortality following heart disease and stroke. The risk factors of cardiovascular disease are commonly linked to high mortality rates in individuals with diabetes mellitus. It has been shown that coronary heart disease (CHD) significantly contributes to mortality and morbidity in individuals with type 2 diabetes mellitus (T2DM) (Hidayatullah ZA et al., 2022).

Dyslipidemia is a condition characterized by an imbalance in blood lipid levels due to a disturbance in lipid metabolism (Siregar & Boy, 2022). This condition is linked to various metabolic syndromes, including diabetes mellitus. Elevated triglyceride levels may indicate the occurrence of insulin resistance, which is a characteristic of T2DM (Lee et al., 2015). Furthermore, elevated triglyceride levels may also signify that an individual is at increased risk of narrowing coronary arteries. The constriction of the coronary arteries leads to reduced blood and oxygen supply, resulting in damage to the heart muscle and an onset of CHD symptoms (Turaman, 2022).

The increasing prevalence of diabetes mellitus sufferers with complications imposes a significant burden on global health, particularly in Indonesia. This is evident from the data concerning hospital visits at Dr. Soetomo General Academic Hospital, Surabaya, Indonesia. The data on hospital visits in 2019 revealed that diabetes mellitus, especially type 2, was among the top ten
emergency conditions at the tertiary healthcare facility. Despite the high number, the data indicated a decline in the prevalence of non-insulin-dependent diabetes mellitus with unspecified complications, from 2,173 cases (12%) in 2018 to 1,197 cases (7.1%) in 2019 (Dr. Soetomo General Academic Hospital, 2019).

The high prevalence of diabetes mellitus, along with complications such as dyslipidemia and CHD, can have a detrimental impact, necessitating treatment and prevention by healthcare professionals and the community. This study examined the association between dyslipidemia and CHD among individuals with T2DM at Dr. Soetomo General Academic Hospital, Surabaya, Indonesia, in 2022. Medical practitioners and the general public may benefit from the outcomes of this study by gaining additional information regarding diabetes mellitus in conjunction with dyslipidemia and CHD. This will allow them to implement early and preventive management strategies to reduce morbidity and mortality rates among diabetes mellitus patients in Indonesia who suffer from complications.

METHODS

This study employed a cross-sectional retrospective technique to conduct an observational investigation that analyzed data from a specific time (Cvetković-Vega et al., 2021). This retrospective cross-sectional investigation used data from medical records to examine T2DM sufferers who visited the diabetes subdivision of Dr. Soetomo General Academic Hospital in Surabaya, Indonesia, between January and December 2022. The patients' medical records were accessed electronically via the Electronic Medical Records (EMR) system of Dr. Soetomo General Academic Hospital, utilizing the International Classification of Diseases 10th Revision (ICD-10) code E11 for "type 2 diabetes mellitus. This study determined the sample size using Cochran's formula due to uncertainty about the population size. Sampling was conducted using a purposive sampling technique according to the data of eligible patients for analysis. The sample inclusion criteria included T2DM sufferers aged above 21 years old and patients who had lipid test results, comprising the levels of total cholesterol, low-density lipoprotein (LDL), triglycerides, and high-density lipoprotein (HDL), obtained within the last three months. Patients were excluded from analysis if the medical record data were incomplete.

A total of 100 samples were included in this study, and they were determined as having T2DM according to the diagnosis stated in medical records and the results of blood glucose level examinations. The diagnosis of T2DM was characterized by fasting blood sugar levels of 126 mg/dL or higher as well as two-hour after-meal blood sugar levels of 200 mg/dL or higher (Ministry of Health of the Republic of Indonesia, 2020). Dyslipidemia was diagnosed based on abnormal lipid levels, characterized by the following criteria: total cholesterol levels of ≥200 mg/dL, LDL levels of >100 mg/dL, triglyceride levels of ≥150 mg/dL, and HDL levels of <40 mg/dL (Lee & Siddiqui, 2023). The results of glucose and cholesterol testing were used to assess the patients' vulnerability to CHD.

This study involved the analyses of univariate and bivariate data. The univariate analysis used a descriptive statistical method, presenting nominal measurement scale data in the form of frequency and percentage distributions. Meanwhile, the bivariate analysis was performed as a hypothesis test to examine the relationship between two variables (Sarwono & Handayani, 2021). The bivariate analysis employed Pearson's chi-squared test in examining the relationship between dyslipidemia and the incidence of CHD in patients diagnosed with T2DM. The results of the data analysis were deemed significant if the p-value was lower than 0.05. The statistical analysis of the data was conducted through IBM SPSS Statistics for Windows, version 26.0 (IBM Corp., Armonk, N.Y., USA).

RESULTS

There were 100 patients with T2DM at Dr. Soetomo General Academic Hospital, Surabaya, Indonesia, who met the inclusion criteria of this study. According to the analysis results, 74 out of the 100 patients diagnosed with T2DM exhibited dyslipidemia, accounting for 74% of the total samples. The majority of these patients were female (52.7%) and aged between 51 and 60 years (51.35%). Table 1 presents the frequency distribution of T2DM patients categorized by age and sex.

Table 1. Distribution of patients with type 2 diabetes mellitus (T2DM) by age and sex categories

	Frequency			
	Dyslipidemia	No dyslipidemia	Total	%
Age (years)				
≤40	3	1	4	4
41–50	7	4	11	11
51–60	38	12	50	50
61–70	19	7	26	26
>70	7	2	9	9
Total	74	26	100	100
Sex				
Male	35	9	44	44
Female	39	17	56	56
Total	74	26	100	100

The lipid panel examinations indicated that the total cholesterol levels in the T2DM patients ranged from 163.10 mg/dL to 256.82 mg/dL, with an average of 209.96±46.86 mg/dL. The low-density lipoprotein (LDL) cholesterol levels varied from 99.98 mg/dL to 169.84 mg/dL, with an average of 134.91±34.93 mg/dL. The triglyceride levels were around 64.54 mg/dL to 278.58 mg/dL, with an average of 171.56±107.02 mg/dL. Meanwhile, the high-density lipoprotein (HDL) cholesterol levels ranged from 34.89 mg/dL to 55.63 mg/dL, with an average of 45.26±10.37 mg/dL. The details of the examination results can be seen in Table 2.

Table 2. Lipid levels in type 2 diabetes mellitus (T2DM) patients

Lipid levels (mg/dL)	Mean±SD	Range
Total cholesterol	209.96±46.86	163.10–256.82
LDL cholesterol	134.91±34.93	99.98–169.84
Triglyceride	171.56±107.02	64.54–278.58
HDL cholesterol	45.26±10.37	34.89–55.63

Notes: LDL=low-density lipoprotein; HDL=high-density lipoprotein.

The majority of patients with T2DM in this study exhibited abnormal total cholesterol levels (≥200 mg/dL), comprising 58 individuals (58%). The frequency of patients demonstrating abnormal LDL cholesterol levels (>100 mg/dL) was higher, with a total of 83 patients (83%), compared to those showing normal levels. The number of patients exhibiting elevated triglyceride levels (>150 mg/dL) was also higher, totaling 54 patients (54%), in comparison with those within a normal range. However, the HDL cholesterol levels of the T2DM patients were mostly normal, accounting for 65% of the total samples. The frequency distribution details of lipid levels in patients with T2DM are presented in Table 3.

Table 3. Distribution of lipid levels in patients with type 2 diabetes mellitus (T2DM)

Lipid levels (mg/dL)	Normal		Abnormal	
	n	%	n	%
Total cholesterol	42	42	58	58
LDL cholesterol	17	17	83	83
Triglyceride	46	46	54	54
HDL cholesterol	65	65	35	35

Notes: LDL=low-density lipoprotein; HDL=high-density lipoprotein.

A total of 40 T2DM patients (40%) exhibited the prevalence of CHD complications. Most of the patients who suffered from T2DM accompanied by CHD belonged to the 51–60 age group (45%). Furthermore, these patients were predominantly male (67.5%). Dyslipidemia was observed in 34 individuals (85%) out of the total patients with CHD and T2DM. Table 4 displays the distribution of CHD among the T2DM patients categorized by age and sex. Meanwhile, Table 5 provides information regarding the comprehensive distribution of dyslipidemia and CHD among the T2DM patients.

As presented in Table 5, the data analysis conducted using Pearson's chi-squared test resulted in a p-value of 0.041. Therefore, it could be inferred that there was a significant association between dyslipidemia and CHD in the T2DM patients at Dr. Soetomo General Academic Hospital, Surabaya, Indonesia. In addition, the analysis indicated that the patients who had T2DM and a history of dyslipidemia were at a 2.833 times higher risk of developing CHD compared to those without such a history. An odds ratio (OR) of 2.833 indicated the increased risk of CHD.

Table 4. Distribution of coronary heart disease (CHD) among type 2 diabetes mellitus (T2DM) patients categorized by age and sex

	Frequency			
	CHD	No CHD	Total	%
Age (years)				
≤40	0	4	4	4
41–50	3	8	11	11
51–60	18	32	50	50
61–70	16	10	26	26
>70	3	6	9	9
Total	40	60	100	100
Sex				
Male	27	17	44	44
Female	13	43	56	56
Total	40	60	100	100

Note: CHD=coronary heart disease.

Table 5. The relationship between dyslipidemia and coronary heart disease (CHD) in type 2 diabetes mellitus (T2DM)

	Dyslipidemia		No dyslipidemia		Total		p	OR
	n	%	n	%	n	%		
CHD	34	85	6	15	40	100	0.041	2.833
No CHD	40	66.7	20	33.3	60	100		
Total	74	74	26	26	100	100		

Note: CHD=coronary heart disease.

DISCUSSION

This study found that the majority of the T2DM patients at Dr. Soetomo General Academic Hospital, Surabaya, Indonesia, had dyslipidemia, with a prevalence of 74 individuals (74%). The results of this study align with prior research conducted by Hidayatullah ZA et al. (2022), who revealed that 80% of patients with T2DM also exhibit dyslipidemia. Lipid abnormalities commonly observed in patients with T2DM include high levels of triglycerides and low levels of HDL. Variations in the lipid profile can result from multiple factors, including insulin deficiency or resistance, adipocytokines, and hyperglycemia.

According to the age categorization, the prevalence of T2DM at Dr. Soetomo General Academic Hospital, Surabaya, Indonesia, was most notable in patients aged 51–60 years, representing 50% of the total cases. These research data align with the findings of a study carried out by Rahmawati et al. (2023), indicating that 15 out of 31 patients with T2DM (48.3%) were within the 44–55 age group. People over 45 years of age are at an elevated risk for diabetes and glucose intolerance due to decreased body functions, especially in pancreatic beta cells, which can lead to high blood sugar levels (Kriswiastiny et al., 2021). In addition, it has been shown that age also correlates with lipid profiles in patients with diabetes mellitus (Aderibigbe et al., 2018). As people age, the distribution of fat is affected by a decrease in the beneficial effects of estrogen and testosterone, leading to potential fat buildup in the blood vessel walls (Michille et al., 2022).

Based on the sex categorization, the prevalence of T2DM at Dr. Soetomo General Academic Hospital, Surabaya, Indonesia, was predominated by female patients, accounting for 56 individuals (56%). These results correspond with the findings of a study by Komariah & Rahayu (2020), who reported that 81 (60.4%) out of 134 patients with T2DM were female. The high prevalence of T2DM in women might be attributed to hormonal effects, reduced physical activity,

increased iron storage capacity, dietary intake, and lifestyle factors (Al Ghadeer et al., 2021). Progesterone and estrogen hormones in women can increase insulin sensitivity. After menopause, insulin sensitivity decreases due to lowered estrogen and progesterone levels. In addition, women's weight, which is often not ideal, also contributes to their susceptibility to diabetes mellitus (Arania et al., 2021).

The results of this study indicated that the T2DM patients exhibited elevated lipid levels or dyslipidemia. The levels of total cholesterol in these patients ranged from 163.10 mg/dL to 256.82 mg/dL. A total of 58 patients (58%) had abnormal total cholesterol levels (≥200 mg/dL). These results are in line with those of previous research by Zulfian et al. (2022), who found that the cholesterol levels of the research samples varied from 152 mg/dL to 336 mg/dL. Additionally, they noted that as many as 66.7% of T2DM patients demonstrated cholesterol levels above 200 mg/dL. The average level of LDL cholesterol in the samples of this study was 134.9±34.93 mg/dL, with 83% of the patients exhibiting LDL cholesterol levels exceeding 100 mg/dL.

The results of this study align with those of earlier research by Firdayanti et al. (2017), who found that all the research samples, specifically diabetes mellitus patients with elevated levels of hemoglobin A1C (HbA1C), also exhibited high LDL cholesterol levels. The average triglyceride level of the T2DM patients in this study was 171.56±107.02 mg/dL, with 54% of samples exhibiting triglyceride levels above 150 mg/dL. Previous research conducted by Sumertayasa et al. (2020) revealed that the average triglyceride level in a cohort of 52 patients was 177.42±108.45 mg/dL. Additionally, 28 patients (53.85%) had triglyceride levels exceeding 150 mg/dL. The average HDL cholesterol level among T2DM patients in this study was 45.26±10.37 mg/dL, with 35% of samples, which equated to 35 individuals, demonstrating HDL cholesterol levels below 40 mg/dL. These results correspond with a separate study by Pratiwi et al. (2021), who reported an average HDL cholesterol level of 43.71±8.92 mg/dL in T2DM patients. However, the proportion of patients with low HDL cholesterol levels (<40 mg/dL) was predominant at 52.6%.

High cholesterol levels in T2DM are the result of insulin resistance. This enhances the activity of hormone-sensitive lipase and lipoprotein lipase enzymes in fat cells, leading to a reduction of fatty acids within adipose tissue. In addition, there is an increase in fatty acids and glycerol in the blood. Consequently, the total cholesterol level rises in T2DM patients (Zulfian et al., 2022). The lipid profile of T2DM patients is affected by the absence of the hormone insulin, which is essential for intermediary metabolism. Additionally, as blood glucose levels rise, HDL cholesterol esters are transferred to LDL. Insulin deficiency in T2DM also reduces lipoprotein lipase activity, resulting in lower HDL levels and higher triglyceride levels (Rasyid et al., 2018). Nevertheless, HDL levels were within the normal range for the majority of T2DM patients in this study. This might be attributed to the study's setting at Dr. Soetomo General Academic Hospital, Surabaya, Indonesia, a tertiary referral hospital where patients presented with diabetes and existing complications, requiring them to undergo long-term treatment. However, this study did not examine the patients' treatment histories in further detail.

Data obtained from this study indicated that 40 (40%) out of 100 patients with T2DM developed complications of CHD. In another study carried out by Elkurnia et al. (2023), it was found that 25 (31.3%) out of 80 patients with T2DM also suffered from CHD. The results of the multivariate analysis suggested that hyperglycemia can increase the risk of CHD in patients with T2DM. There is a theory that suggests high blood sugar levels, known as hyperglycemia, can increase the production of reactive oxygen species (ROS) and cause endothelial dysfunction. Furthermore, disorders in glucose metabolism as well as insulin resistance can also result in the release of very low-density lipoproteins (VLDL) containing high levels of triglycerides into the bloodstream. Hyperinsulinemia caused by insulin resistance leads to impaired VLDL uptake, resulting in prolonged VLDL circulation in the blood and increased atherogenesis in blood vessels (Elkurnia et al., 2023).

Coronary heart disease (CHD) is most prevalent in those aged 51–60 years, encompassing 18 patients (45%). The subsequent prevalence was observed in the age group of 60–70 years, with 16 patients (40%). The findings of this study are in line with those of earlier research carried out by Elkurnia et al. (2023), who revealed that the majority of T2DM patients with CHD complications were in the age group of 50 years and older, with a total of 17 out of 25 individuals. As one gets older, the functions of estrogen and testosterone hormones decrease, leading to fat accumulation in the walls of blood vessels (Michille et al., 2022). Additionally, with advancing age, plaque accumulates in the blood vessels and attaches to the vessel walls. Over time, the plaque grows larger, narrowing the coronary arteries and reducing the oxygen supply to the heart. This process is also influenced by a history of poor health, which contributes to coronary heart disease (Melyani et al., 2023).

In this study, there was a higher prevalence of CHD in male patients than in female patients. Among the 40 T2DM patients with CHDM, 27 were male, constituting 67.5% of the cohort. These findings align with those of Torawoba et al. (2021), who reported that the proportion of male patients was predominant at 69.4%. Morbidity due to CHD is twice as high in men and often manifests a decade earlier than in women. This difference is linked to the protective effects of the hormone estrogen in women. However, after menopause, the incidence of CHD in women increases and becomes comparable to that in men Yuliani et al. (2014). According to Knowlton and Korzick (2017), late estrogen replacement in female Norway brown rats leads to changes in cardiac gene expression. This intervention specifically increases the levels of several genes, including cluster of differentiation molecule 11b (CD11b), macrophage inflammatory protein 1 beta (MIP-1β), signal transducer and activator of transcription 3 (STAT3), endothelial monocyte-activating polypeptide-II (EMAP-II), fibronectin, caspase-6, and MAP kinase-activating death domain protein (MADD). Additionally, there is an increase in the levels of tumor necrosis factor alpha (TNF-α) and inducible nitric oxide synthase (iNOS). The elevated expression of these genes results in leukocyte attraction and adhesion, marking the initial step of atherosclerosis. Increased levels of TNF-α and iNOS lead to the enhanced expression of pro-inflammatory and pro-apoptotic proteins. TNF-α also enhances the expression of adhesion molecules, hence raising the risk of atherosclerosis (Knowlton & Korzick, 2014).

Most patients with T2DM who also have CHD exhibit abnormalities in their lipid profiles, a condition known as dyslipidemia. This study revealed that 34 (85%) out of the 40 patients with T2DM and CHD also presented with dyslipidemia. The findings of this study align with a study conducted by Utami & Azam (2019), who found that 36 (65.5%) out of 55 patients with diabetes mellitus and CHD additionally showed dyslipidemia. Elevated fat levels in the

blood can disrupt fat metabolism, leading to dyslipidemia. It is noteworthy that dyslipidemia is considered a major risk factor for CHD. Abnormalities in lipid profiles associated with dyslipidemia can lead to the formation of atherosclerotic plaques in the artery walls due to the accumulation of extracellular lipids. Consequently, the artery walls thicken, leading to stiffness and culminating in tissue ischemia or infarction (Budiman et al., 2017).

The result obtained from the data analysis using Pearson's chi-squared test was p=0.041, indicating a statistical significance. This suggests that the researchers' hypothesis was accepted, demonstrating a significant relationship between dyslipidemia and CHD in patients with T2DM. Patients with T2DM and a history of dyslipidemia are at a risk of developing CHD 2.833 times higher compared to those without a similar history, as noted by the odds ratio of 2.833. These results are also in line with the research by Utami & Azam (2019), in which a relationship was found between a history of dyslipidemia and CHD. Their study showed a p-value of less than 0.001. Additionally, diabetic patients with a history of dyslipidemia demonstrated a 3.338 times higher risk of developing CHD compared to those without such a history (Utami & Azam, 2019).

Dyslipidemia in patients with T2DM may be caused by insulin resistance (Bjornstad & Eckel, 2018). This is possible as insulin resistance alters the body's metabolism, leading to changes in plasma lipoprotein production and processing. Lipogenesis diminishes, while lipolysis escalates simultaneously, resulting in the development of glucotoxicity in conjunction with lipotoxicity. As a consequence, LDL cholesterol levels rise. The hyperglycemia state in T2DM accelerates LDL oxidation (Michille et al., 2022). LDL cholesterol can be modified into a smaller, denser form that has atherogenic properties, potentially leading to atherosclerosis (Hidayatullah ZA et al., 2022).

Atherosclerosis is a condition characterized by a dysfunction of the endothelium, inflammation in the subendothelial layer, and an increased proliferation of vascular smooth muscle cells. This occurs due to the buildup of lipids, inflammatory processes, the activity of macrophages, platelet adhesion, and the presence of connective tissue in the intima layer of the arteries (Mahmoudi, 2022). Atherosclerosis narrows the lumen of blood vessels, causing ischemia and potential infarction (Budiman et al., 2017). The narrowing of the coronary blood vessels decreases the blood and oxygen supply to the heart, causing damage to the cardiac muscle (Turaman, 2022).

This study offers an overview of dyslipidemia in T2DM, presenting its association with the potential development of CHD. However, this study was restricted by several limitations. Multiple factors might affect the results of this study, including incomplete data in the patients' medical records. The exact time of the patients' initial diagnosis was not documented in the medical records, making it difficult to determine how long each patient had been undergoing treatment. This uncertainty could impact the analysis results related to blood glucose and lipid levels.

This study employed a cross-sectional method, gathering data at a specific period of time, namely in the year 2022. As a result, the examinations conducted solely reflected that specific period and did not account for the progression or development of the patients' disease over time. This study also did not track the patients' therapy course, medication history, or dietary changes that could affect their lipid examination results. Therefore, it is essential to conduct further research using cohort methods, which can track the progression of the disease in relation to risk factors over an extended period. This approach will help establish a more accurate connection between risk factors and the incidence of a disease.

CONCLUSION

Dyslipidemia is commonly found in people with type 2 diabetes mellitus (T2DM), with the majority of affected individuals being female. Furthermore, coronary heart disease (CHD) is prevalent among numerous individuals with T2DM, predominantly affecting male patients. Most individuals with T2DM who develop CHD additionally exhibit lipid abnormalities, referred to as dyslipidemia. This study demonstrates a significant relationship between dyslipidemia and the incidence of CHD in patients with T2DM.

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CONFLICT OF INTEREST

None.

ETHICS CONSIDERATION

The Health Research Ethics Committee of Dr. Soetomo General Academic Hospital, Surabaya, Indonesia, issued the approval for the research protocol on August 15, 2023, under registration number 1416/LOE/301.4.2/VIII/2023.

FUNDING DISCLOSURE

None.

AUTHOR CONTRIBUTION

All authors participated in the processes necessary for this research. RNR contributed to the conception and design, analysis and interpretation of the data, drafting of the article, final approval of the article, statistical expertise, obtainment of funding, provision of administrative, technical, and logistic support, and collection and assembly of the data. IH, HN, and EQ supervised the research, contributed to the critical revision of the article for important intellectual content, and provided final approval of the article.

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