

Association of Hypercholesterolemia, Hyperuricemia, and Type 2 Diabetes Mellitus Among the Elderly in Kelating Village: A Cross-Sectional Study

I Made Suma Wirawan ^{1*}, Ni Made Aryani ², Kadek Nova Adi Putra ³, Dewa Ayu Tri Jayaningrat ⁴,
Cindy Fahira ⁵, I Dewa Ayu Made Dian Lestari ⁶

¹ Medical Faculty of Universitas Mahasaraswati Denpasar, Bali, Indonesia. Email: sumawirawan@unmas.ac.id

^{2, 3, 4, 5, 6} Department of Internal Medicine, Wangaya General Teaching Hospital Denpasar, Bali, Indonesia

ARTICLE INFO	ABSTRACT
Received: 15 Dec 2024	The prevalence of metabolic diseases, including hypercholesterolemia, hyperuricemia, and type 2 diabetes mellitus (T2DM), is increasing among the elderly. Various risk factors, such as diet, lifestyle, and aging, contribute to these conditions. This cross-sectional study aims to determine the prevalence and association of hypercholesterolemia, hyperuricemia, and T2DM among the elderly in Kelating Village, Bali. A total of 31 participants aged ≥ 60 years were included through purposive sampling. Blood samples were analyzed for fasting blood glucose, uric acid, and total cholesterol levels. Chi-square and Fisher's exact tests were used to evaluate statistical associations. The study found no significant associations between hypercholesterolemia and gender, age, or blood pressure ($p > 0.05$). Similarly, no significant relationships were observed between hyperuricemia and these variables. However, a significant association was found between fasting blood glucose levels and gender ($p < 0.05$). These findings highlight the need for further investigation into metabolic disorders among the elderly and targeted interventions to manage these conditions effectively. Keywords: Hypercholesterolemia, Hyperuricemia, Diabetes Mellitus, Elderly, Metabolic Disorders.
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INTRODUCTION

In elderly populations, there is often a decline in functional capacity, muscle strength, and mobility, which contributes to a more sedentary lifestyle. This condition makes elderly more vulnerable to metabolic diseases compared to other population groups and lead to various complications such as kidney dysfunction, atherosclerosis, cardiovascular and others. The most prevalent metabolic diseases in the elderly are hypercholesterolemia, hyperuricemia, and type 2 diabetes mellitus (T2DM).

The US National Cholesterol Education Program (NCEP) defines hypercholesterolemia as a total cholesterol level > 200 mg/dL (> 5.2 mmol/L) (1, 2). The condition is clinically important because cholesterol plays a significant role in the risk of cardiovascular diseases like coronary heart disease and stroke. The 2023 Indonesian Health Survey reports that the prevalence of coronary heart disease in Indonesia is 0.85%. Hypercholesterolemia in the elderly often goes undetected until complications arise, worsening prognosis and increasing healthcare costs. Its etiology includes genetic and acquired factors. Familial hypercholesterolemia, caused by LDL receptor gene mutations, impairs LDL clearance, raising plasma LDL levels. LDL balance depends on production and elimination via receptor or non-receptor pathways. Acquired causes include a sedentary lifestyle, high-fat diet, alcohol, smoking, obesity, metabolic syndrome, diabetes, hypothyroidism, liver disease, and certain medications (corticosteroids, hormonal contraceptives, thiazides). (3).

Hyperuricemia is a condition where serum uric acid levels increase above normal. In most epidemiological studies, categorized as hyperuricemia if serum uric acid levels more than 7.0 mg/dl in men and more than 6.0 mg/dl in women. Increased uric acid levels can occur due to increased uric acid metabolism (overproduction) due to a high

purine diet, decreased urinary uric acid excretion (underexcretion) due to excessive breakdown of nucleic acids, or a combination of both (4). Hyperuricemia can lead to gouty arthritis, gouty nephropathy, kidney stones, and comorbidities like chronic kidney disease (CKD), cardiovascular disease (CVD), and type 2 diabetes mellitus (T2DM). It's link to glucose metabolism involves hyperinsulinemia and insulin resistance. Insulin resistance and hypoxia stimulate xanthine oxidase, increasing uric acid and peroxide production, which disrupts nitric oxide balance and vascular tone. (1). Based on previous research in Banda Aceh with 27 samples T2DM, showed there was a positive correlation between fasting blood sugar levels and uric acid levels (2)

Type 2 diabetes mellitus (T2DM) increased in the elderly population due to metabolic changes and decreased function of pancreatic β cells. The prevalence of T2DM increases with age. The prevalence of T2DM in the United States is estimated at 0.25% in individuals aged <20 years, 4.2% in individuals aged 18-44 years, and 17.5% in people aged 45-64 years. In individuals aged >65 years, the prevalence rate of T2DM is 26.8% related to the data per data that occurs worldwide (5). According to the 2018 Riskesdas report, based on age grouping, the 55-64 and 65-74 age groups are the ones that have T2DM and It is anticipated that the number of old people will keep growing (6, 7). T2DM is known as a silent killer disease because many patients are not aware before complications occur (8). Complications that occur due to T2DM are disorders of the blood vessels, both macrovascular and microvascular, as well as disorders of the nervous system or neuropathy. Macrovascular complications generally affect organs such as the heart, brain, and blood vessels, while microvascular complications can occur in the eyes and kidneys. T2DM will have an impact on the quality of human life and there is a significant increase in costs, therefore all parties, both society and government, are involved in preventing an increase in cases of diabetes mellitus (9). These three conditions can be part of the cause of chronic degenerative diseases or non-communicable diseases (NCDs) which are very detrimental and can even cause death.

There has been no research discussing the risk factors of these diseases in the elderly population of Kelating Village, Tabanan, previously. Based on this background, the researcher intends to examine the risk factors that influence the incidence of hypercholesterolemia, hyperuricemia and T2DM in elderly Kelating Village.

METHODS

This cross-sectional study examines the of T2DM, hyperuricemia, and hypercholesterolemia among the elderly in Kelating Village, Tabanan. The location was chosen due to the absence of prior studies. A purposive random sample of 31 participants (≥ 60 years) from the Segara Santhi group underwent fasting blood glucose (FBG), uric acid, and cholesterol tests using Accu-Chek after an 8-hour fast. Data were analyzed using SPSS 28.0 with Chi-square and Fisher's exact tests, and results were presented in frequency distribution tables.

RESULT

The study consisted of 31 respondents as research samples; 4 respondents aged ≥ 65 years were identified as elderly at risk, and 27 participants aged 60-64 years were identified as early elderly. Sample distribution by age, gender, fasting blood glucose, blood pressure, uric acid levels, blood glucose and total cholesterol is displayed in **Table 1** below.

Table 1: Distribution of Characteristics of Research Respondents

No.	Characteristics	Frequencies	Percentage (%)	Mean $\pm$ SD
1	Gender			
	Female	23	74.2	
	Male	8	25.8	
2	Age Group			
	60-64 years (Early Elderly)	27	87.1	1.87 $\pm$ 0.34
	≥ 65 year (Elderly at High Risk)	4	12.9	

No.	Characteristics	Frequencies	Percentage (%)	Mean $\pm$ SD
3	Fasting Blood Glucose			
	< 126 mg/dL	11	35.5	1.64 $\pm$ 0.48
	$\geq$ 126 mg/dL	20	64.5	
4	Blood Pressure			
	$\geq$ 140/90 mmhg	10	32.3	0.32 $\pm$ 0.47
	< 140/90 mmhg	21	67.7	
5.	Uric Acid Levels			
	< 7 mg/dL	14	45.2	1.45 $\pm$ 0.50
	$\geq$ 7 mg/dL	17	54.8	
6.	Total Cholesterol			
	<200 mg/dL	15	48.4	0.08 $\pm$ 1.47
	>200 mg/dL	16	51.6	
Total Participants		31	100	

Abbreviations: T2DM, Type 2 Diabetes Mellitus;

Table 2. below provides a more detailed description of the respondents' distribution. Correspondents' cholesterol levels were grouped into two categories; hypercholesterolemia ($\geq$ 200 mg/dL) and normal (<200 mg/dL). Respondents with hypercholesterolemia were dominated by elderly women (45.2%) with an age above 65 years (32.3%). The results of Pearson chi-square analysis show no significant relationship between cholesterol levels and gender (p-value>0.05). Respondents' blood pressure was classified into hypertension ($\geq$ 140/90 mmhg) and normal. Hypercholesterolaemia condition was predominantly found in elderly without hypertension (35.5%). In chi square testing, no significant relationship between cholesterol levels and blood pressure (p-value>0.05).

Uric acid levels were grouped into two categories; hyperuricemia ($\geq$ 7 mg/dL) and normal (<7 mg/dL). Respondents with hyperuricemia were dominated by elderly female gender (35.5%) and age more than 65 years (25.8%). After conducting Pearson chi-square analysis, no significant relationship between uric acid levels and gender (p-value>0.05). (p-value>0.05).

T2DM is defined as blood sugar levels $\geq$ 126 mg/dL. Respondents with T2DM were dominant in male (19.4%). In the chi square analysis test, a significant relationship was found between blood sugar level (Type 2 DM) and gender. Type 2 DM is found more often at the age of >65 years (29%) and found in the elderly with normal blood pressure. In chi square testing, no significant relationship between cholesterol levels and blood pressure (p-value >0.05).

Table 2: Distribution of Respondents' Characteristics Based on Gender, Age, blood pressure in uric acid levels, fasting Blood Glucose, total cholesterol

	Gender			Age			Blood Pressure		
	F	M	P-Value	60-64 y.o	>65 y.o	P-value	≥140/90	<140/90	P value
Cholesterol									
Without hypercholesterolemia (<200 mg/dL)	9 (29%)	6 (19.4%)	0.113	4 (12.9%)	11 (35.5%)	0.704	5 (16.1%)	10 (32.3%)	1.000
Hypercholesterolemia (>200 mg/dL)	14 (45.2%)	2 (6.5%)		6 (19.4%)	10 (32.3%)		5 (16.1%)	11 (35.5%)	
Uric Acid									
Without Hyperuricemia (< 7 mg/dL)	12 (38.7%)	2 (6.5%)	0.240	6 (19.4%)	8 (25.8%)	0.441	5 (16.1%)	9(29%)	1.000

	Gender		P-Value	Age		P-value	Blood Pressure		
	F	M		60-64 y.o	>65 y.o		≥140/90	<140/90	P value
Hyperuricemia (≥7 mg/dL)	11 (35.5%)	6 (19.4%)		4 (12.9%)	13 (25.8%)		5 (16.1%)	12 (38.7%)	
Fasting Blood Glucose									
Without T2DM (< 126 mg/dL)	18 (58.1%)	2 (6.5%)	0.012	8 (25.8%)	12 (38.7%)	0.262	7 (25.8%)	13 (41.9%)	1.000
T2DM (≥ 126 mg/dL)	5 (16.1%)	6 (19.4%)		2 (6.5%)	9 (29%)		3 (9.7%)	8 (25.8%)	

Table 3 below shows an overview of hyperuricemia effects on hypercholesterolemia. Respondents' uric acid levels were categorized into hyperuricemia (uric acid ≥7) and non-hyperuricemia (uric acid <7). The chi-square test showed no significant relationship between cholesterol levels and uric acid levels (p-value > 0.05).

Table 3: Distribution of Respondent Characteristics Based on Hypercholesterolemia in Hyperuricemia

Total Cholesterol			
	Without hypercholesterolemia	Hypercholesterolemia	p-value
Uric Acid Levels			
Without Hyperuricemia (< 7 mg/dL)	4 (12.9%)	10 (32.3%)	0.073
Hyperuricemia (≥7 mg/dL)	11 (35.5%)	6 (19.4%)	
Total	15 (48.4%)	16 (51.6%)	31 (100%)

Table 4 below shows an overview of Hyperuricemia and Hypercholesterolemia effects on Fasting Blood Glucose. Respondents' uric acid levels were categorized into hyperuricemia (uric acid ≥7) and non-hyperuricemia (uric acid <7). Respondents hypercholesterolemia level were categorized into hypercholesterolemia (≥200 mg/dL) and normal (<200 mg/dl). The chi-square test showed no significant relationship between both uric acid levels and hypercholesterolemia with fasting blood glucose levels (p-value > 0.05).

Table 4: Distribution of Respondent Characteristics Based on Fasting Blood Glucose in hyperuricemia and Fasting blood glucose in hypercholesterolemia

Fasting Blood Glucose			
	Without T2DM (< 126 mg/dL)	T2DM (≥ 126 mg/dL)	p-value
Uric Acid Levels			
Without Hyperuricemia	12 (38.7%)	2 (6.5%)	0.570
Hyperuricemia	8 (25.8%)	9 (29%)	
Total	20 (64.5%)	11 (35.5%)	31 (100%)
Total Cholesterol			
Without hypercholesterolemia (<200 mg/dL)	8 (25.8%)	7 (22.6%)	0.273
Hypercholesterolemia (>200 mg/dL)	12 (38.7%)	4 (12.9%)	

Total	20 (64.5%)	11 (35.5%)	31 (100%)
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DISCUSSION

The US National Cholesterol Education Program (NCEP) defines hypercholesterolemia as a total cholesterol level > 200 mg/dL (> 5.2 mmol/L) (10, 11). The condition is clinically important because cholesterol plays a significant role in the risk of cardiovascular diseases like coronary heart disease and stroke (12). According to the 2018 RISKESDAS, the prevalence of hypercholesterolemia in Indonesia among the 65-74 age group is approximately 38.2%, with a slight decrease in the age group over 75 years (32.9%). This data shows the high prevalence of hypercholesterolemia among the elderly in Indonesia (6).

In this study, we found that there were no significant relationship between cholesterol levels and gender. This result is consistent with the study conducted by Rahmawati et al at the Seyegan Health Center in Yogyakarta (13). Fadhil et al also reported no significant relationship between cholesterol and gender (14). Physiologically, the decrease in estrogen levels in postmenopausal women can contribute to an increase in LDL synthesis (15), however, key factors such as diet and lifestyle should not be overlooked as potential biases in the results of the study above.

Hypercholesterolemia was predominantly found in elderly individuals aged ≥ 65 years. This study show no significant relationship was found between cholesterol levels and age. This result is also consistent with the study conducted by Pasadena et al at RSUD Nyi Agung Serang Kulon (16). As age increases, the risk of developing hypercholesterolemia tends to rise. This is due to the tendency of the elderly to be less physically active. In addition, muscle mass in the elderly typically decreases, while fat mass increases. These changes occur as a result of the decline in metabolic hormones such as insulin, growth hormone, and androgens, which leads to the body's inability to break down cholesterol, resulting in increased cholesterol levels in the blood (17). The difference between the research results and the theory may be due to the small sample size and uneven distribution.

In this study, hypercholesterolemia was found to have no association with high systolic and diastolic blood pressure. Previous study by Permatasari et al, has shown that the association between hypercholesterolemia and hypertension (18). Hypercholesterolemia can be related to hypertension through several mechanisms. Atherosclerosis caused by lipid disturbances can lead to structural changes in large arteries, resulting in a decrease in their elasticity. Additionally, endothelial dysfunction caused by hypercholesterolemia can reduce the production, release, and activity of nitric oxide, as well as cause abnormal vasomotor activity, which can ultimately develop into hypertension. Renal microvascular disturbances influenced by lipids can also contribute to the onset of hypertension (19).

Hyperuricemia is an increase in uric acid levels that exceeds normal limits. High consumption of purine foods can cause hyperuricemia. The purpose of this research was to determine the relationship between age and gender with the incidence of hyperuricemia (20). In this study, we found that there's no significant relationship between uric acid levels with gender and age. This contradicts the findings of a study by Tomander, which reported there were significant association and positive correlation between age and uric acid. The age associated increase in uric acid was explained by age related changes in renal function; the kidneys are unable to remove uric acid from the body adequately (21). The difference between the research results and the theory may be due to the small sample size and uneven distribution.

Hyperuricemia condition was predominantly found in elderly without hypertension (38.7%). In this study has shown no significant relationship between cholesterol levels and blood pressure. Previous study by Tomoha has shown, hyperuricemia was significantly and positively associated with systolic blood pressure and diastolic blood pressure. Previous study has shown that the association between hyperuricemia and hypertension was partly mediated by obesity (21)

T2DM is defined as blood sugar levels ≥ 126 mg/dL. According to this study, 2 out of 10 respondents with T2DM are between the ages of 60 and 64, and 9 out of 21 respondents with the disease are over 65. Overall, the risk incidence of disease in the elderly is 67.7%. This study revealed no association between T2DM and age group. These results show that, across all age categories examined, the prevalence of T2DM in the study population is comparatively uniform. These findings run counter to some earlier research that demonstrated that increased insulin resistance and

pancreatic β -cell dysfunction make older age the primary risk factor for type 2 diabetes. Amaia et al. showed that early elderly people have a 2.28 times greater risk than elderly people for T2DM (22). This reflects the specific characteristics of the population studied, where other risk factors such as diet, lifestyle, physical activity, and genetic predisposition may play a greater role than age alone in determining the occurrence of T2DM (22). Although T2DM is usually diagnosed in middle-aged or elderly people, a new trend for type 2 diabetes is emerging at an earlier age as a result of unhealthy lifestyles.

There were 6 older males and 5 older women who reported having T2DM. Based on these findings, it was determined that gender and the prevalence of T2DM were significantly correlated. These findings are corroborated by research by Professor Naveed Sattar of the Institute of Cardiovascular and Medical Science, which shows that the amount of body fat determines risk. Specifically, men are more likely to develop central obesity, which increases the risk of metabolic disorders and, consequently, T2DM (23). Another study supports the findings, According to Rahmi et al. assessment of the prevalence of T2DM in the Padang population, men are more likely than women to develop the disease (7). T2DM can affect anyone, both women and men, where there are factors that cause T2DM such as genetics/heredity, besides that it can also be influenced by unhealthy diet patterns, obesity, and stress (23).

In this study, there was also no significant relationship between uric acid levels and hypercholesterolemia with fasting blood glucose levels. Previous study show that, serum uric acid levels are associated with various metabolic conditions. Although its serum levels are higher in men compared to women probably due to the estrogen inhibitory effect on the reabsorption of uric acid, the rate of hyperuricemia increases after menopause in female population (24). Elevated levels of serum uric acid have been suggested to be related with hypertension and T2DM (25). The risk of new onset diabetes mellitus has been supposed to be significantly correlated with uric acid levels (26). The risk of developing impaired fasting glucose has been reported to be increased in male subjects with elevated serum uric acid levels (27). Positive correlation has been suggested to exist between serum uric acid levels and both incident T2DM and impaired fasting glucose.

CONCLUSION

This study examined the prevalence and associations of hypercholesterolemia, hyperuricemia, and T2DM among elderly residents of Kelating Village. The findings indicate that while hypercholesterolemia and hyperuricemia were common, no significant correlations were found with gender, age, or blood pressure. However, a significant association was noted between fasting blood glucose levels and gender. These results suggest that metabolic disorders in the elderly may be influenced by multifactorial causes beyond traditional risk factors. Given the potential health complications associated with these conditions, regular screening and lifestyle interventions tailored for the elderly population remain essential in mitigating risks and improving overall health outcomes.

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