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The Role of Age and Sex in Triglyceride and Total Cholesterol Levels among Adults: Implications for Degenerative Disease Risk

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ABSTRAK

Penyakit degeneratif, khususnya penyakit kardiovaskular, merupakan penyebab utama morbiditas dan mortalitas yang berkaitan dengan gangguan metabolisme lipid. Faktor demografi seperti usia dan jenis kelamin diduga memengaruhi variasi kadar trigliserida dan kolesterol total. Penelitian ini bertujuan untuk menganalisis peran usia dan jenis kelamin terhadap kadar trigliserida dan kolesterol total pada populasi dewasa sebagai indikator risiko penyakit degeneratif. Penelitian ini menggunakan desain observasional analitik dengan pendekatan cross-sectional terhadap 47 subjek dewasa menggunakan data sekunder. Analisis statistik meliputi uji Mann–Whitney, uji t independen, korelasi Spearman dan Pearson, serta regresi linear berganda. Hasil penelitian menunjukkan terdapat perbedaan signifikan kadar trigliserida dan kolesterol total berdasarkan jenis kelamin ($p<0,001$). Terdapat hubungan positif yang kuat antara usia dengan kadar trigliserida ($r=0,833$; $p<0,001$) dan kolesterol total ($r=0,844$; $p<0,001$). Analisis regresi menunjukkan usia berpengaruh signifikan terhadap trigliserida, sedangkan usia dan jenis kelamin merupakan prediktor signifikan terhadap kolesterol total. Disimpulkan bahwa usia dan jenis kelamin berperan dalam menentukan variasi profil lipid pada dewasa, sehingga penting dalam deteksi dini risiko penyakit degeneratif.

Kata kunci: Trigliserida, Kolesterol Total, Dislipidemia, Penyakit Degeneratif

ABSTRACT

Degenerative diseases, particularly cardiovascular disorders, are major causes of morbidity and mortality and are closely associated with lipid metabolism abnormalities. Demographic factors such as age and sex are considered to influence variations in triglyceride and total cholesterol levels. This study aimed to analyze the role of age and sex in determining triglyceride and total cholesterol levels among adults as indicators of degenerative disease risk. An analytical observational study with a cross-sectional design was conducted involving 47 adult subjects using secondary data. Statistical analysis included Mann–Whitney test, independent t-test, Spearman and Pearson correlation, and multiple linear regression. The results showed significant differences in triglyceride and total cholesterol levels based on sex ($p<0.001$). A strong positive correlation was found between age and triglyceride levels ($r=0.833$; $p<0.001$) as well as total cholesterol levels ($r=0.844$; $p<0.001$). Regression analysis indicated that age significantly affected triglyceride levels, while both age and sex were significant predictors of total cholesterol. In conclusion, age and sex play important roles in determining lipid profile variations among adults and may serve as important indicators for early detection of degenerative disease risk.

Keywords: Triglycerides, Total Cholesterol, Dyslipidemia, Degenerative Disease

INTRODUCTION

Degenerative diseases are a group of chronic conditions characterized by the progressive decline in the function of cells, tissues, and organs, which can significantly affect an individual's quality of life and productivity over time (Karwiti

et al., 2023). These diseases include various non-communicable conditions such as coronary heart disease, stroke, metabolic syndrome, hypertension, and diabetes mellitus, which generally develop gradually and are closely associated with aging, genetic factors, and unhealthy lifestyle patterns (Sheikh et al., 2024;Kawaguchi, 2023;Nurhayati & Kurniawidjaja, 2018). Globally, degenerative diseases, or non-communicable diseases (NCDs), represent the leading cause of morbidity and mortality, accounting for nearly two-thirds of total deaths each year worldwide (Herlina, 2023;Sheikh et al., 2024).

The increasing prevalence of degenerative diseases, particularly cardiovascular disorders, has become a major public health concern due to its close association with modifiable metabolic disturbances, one of which is dyslipidemia (Xiong et al., 2020). Dyslipidemia is defined as an imbalance in blood lipid levels, including elevated triglycerides, total cholesterol, and low-density lipoprotein (LDL), which are recognized as major risk factors for the development of atherosclerosis and cardiovascular diseases (Pappan et al., 2025;Rinjani et al., 2022;Purva et al., 2020). This imbalance in lipid profiles contributes to endothelial damage through chronic inflammatory processes, facilitating the infiltration of lipoproteins into the arterial wall and accelerating the formation of atherosclerotic plaques (Hasheminasabgorji & Jha, 2021);Miura & Suzuki, 2019).

From a biochemical perspective, circulating triglycerides are hydrolyzed by the enzyme lipoprotein lipase (LPL), which is bound to the vascular endothelial surface, into free fatty acids (FFA) and glycerol (Gaggini & Gorini, 2023;Młynarska et al., 2025). Elevated levels of circulating FFA may trigger the production of reactive oxygen species (ROS), leading to oxidative stress and endothelial dysfunction (Sharma., 2025);Wu et al., 2022). This condition reduces the bioavailability of nitric oxide (NO), which plays a critical role in maintaining vascular homeostasis, thereby increasing the risk of atherogenesis and cardiovascular disease progression(Wu et al., 2022;Yang et al., 2024).

In addition to triglycerides, elevated total cholesterol also plays a significant role in the formation of atherosclerotic plaques. Cholesterol circulating in the form of low-density lipoprotein (LDL) can undergo oxidation to form oxidized LDL (oxLDL). These oxLDL particles are then taken up by macrophages, forming foam cells, which represent the early stage of fatty streak formation in the arterial wall. The accumulation of lipids in the arterial wall may lead to narrowing of blood vessels, ultimately increasing the risk of coronary heart disease and stroke (Moon et al., 2022;Perera et al., 2025).

Apart from metabolic factors, demographic factors such as age and sex are also known to influence individual lipid profiles. With increasing age, changes in lipid metabolism occur, including decreased activity of lipid-metabolizing enzymes and reduced expression of low-density lipoprotein (LDL) receptors in the liver, which may lead to elevated levels of cholesterol and triglycerides in circulation (Ghosh et al., 2017). On the other hand, hormonal differences between males and females also affect lipid metabolism. Estrogen has been shown to exert a protective effect by increasing LDL receptor expression, thereby enhancing cholesterol clearance from the bloodstream (Song et al., 2023)(Nunes, Ferreira, et al., 2022).

Although dyslipidemia is widely recognized as a major risk factor for degenerative diseases, variations in triglyceride and total cholesterol levels based on age and sex among adult populations remain an important area for further investigation as early indicators of cardiovascular risk. Understanding the relationship between demographic factors and lipid profiles is essential to support early detection and preventive strategies for degenerative diseases. Therefore, this study aims to evaluate the role of age and sex in the variation of triglyceride and total cholesterol levels among adults as potential risk factors for degenerative diseases.

METHOD

This study employed an analytical observational design with a cross-sectional approach to evaluate the role of age and sex in the variation of triglyceride and total cholesterol levels among adults. The study population consisted of adult individuals who underwent lipid profile examinations. A total of 47 participants were included using a total sampling technique based on the availability of laboratory data. The inclusion criteria were adult subjects with complete data on age, sex, triglyceride levels, and total cholesterol levels. This study utilized secondary data obtained from laboratory examination records, including age, sex, triglyceride levels, and total cholesterol levels. All data were screened for completeness prior to analysis.

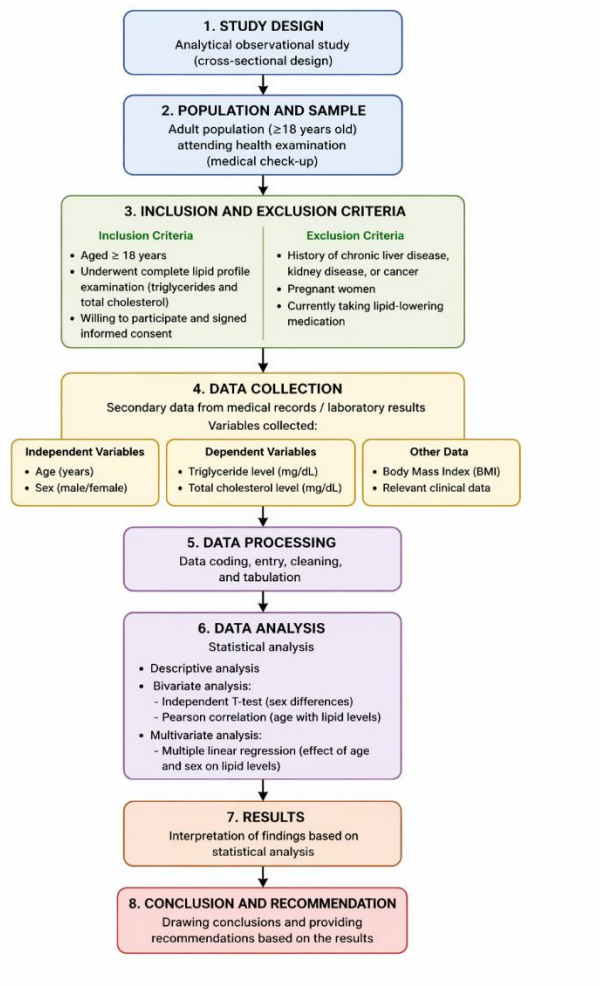

Figure 1. Flowchart of the Study

The dependent variables in this study were triglyceride levels and total cholesterol levels, while the independent variables were age and sex. Data analysis was performed using the Statistical Package for the Social Sciences (SPSS). Normality testing was conducted using the Shapiro–Wilk test. Bivariate analysis included the Mann–Whitney test, independent t-test, Spearman correlation, and Pearson correlation. Multivariate analysis was performed using multiple linear regression. A p-value of < 0.05 was considered statistically significant.

This study was approved by the Health Research Ethics Committee of Universitas Muhammadiyah Purwokerto (KEPK-UMP) with ethical clearance number KEPK/UMP/304/II/2026. The use of secondary data ensured that no direct risk was posed to participants, and all data were handled confidentially.

RESULTS

A total of 47 adult participants were included in this study to assess the role of age and sex in determining variations in triglyceride and total cholesterol levels. Preliminary analysis demonstrated notable differences in lipid profiles between male and female participants. In addition, increasing age was found to be associated with higher levels of triglycerides and total cholesterol. Further statistical analyses were conducted to examine these associations through comparative, correlation, and multivariate regression approaches. Comparative analysis revealed that triglyceride and total cholesterol levels differed significantly between male and female participants. Moreover, correlation analysis showed that both triglyceride and total cholesterol levels were positively associated with age. Multiple linear regression analysis was subsequently performed to determine whether age and sex independently predicted lipid profile variations among the participants.

Table 1
Difference in Triglyceride Levels by Sex

Sex	n	Mean Rank	p-value
Male	23	34.04	<0,001
Female	24	14.38	

A comparative analysis using the Mann–Whitney test revealed a statistically significant difference in triglyceride levels between male and female participants ($p < 0.001$). Male participants had a higher mean rank compared to females, indicating higher triglyceride concentrations among males.

Table 2
Difference in Total Cholesterol Levels by Sex

Sex	n	Mean ± SD	p-value
Male	23	222.80 ± 22.51	<0,001
Female	24	197.30 ± 13.79	

Analysis using the independent t-test showed that total cholesterol levels were significantly higher in males compared to females ($p < 0.001$). The mean total cholesterol level in males was 222.80 ± 22.51, while in females it was 197.30 ± 13.79. The mean difference between groups was 25.50 (95% CI: 14.58–36.41).

Tabel 3
Correlation between Age and Lipid Profile

Variables	Correlation Coefficient (r)	p-value
Age vs Triglyceride	0.833	<0.001
Age vs Total Cholesterol	0.844	<0.001

Correlation analysis revealed a strong positive association between age and triglyceride levels ($r = 0.833$, $p < 0.001$). Similarly, total cholesterol levels were strongly correlated with age ($r = 0.844$, $p < 0.001$), indicating that lipid levels increased with advancing age. Multiple linear regression analysis was performed to determine whether age and sex independently predicted triglyceride and total cholesterol levels among participants.

Tabel 4
Multiple Linear Regression Analysis for Triglyceride Levels

Variables	B	95% CI	p-value
Age	3.948	2.423–5.474	<0.001
Sex	-9.207	-27.569–9.155	0.318

Age was identified as a significant predictor of triglyceride levels ($p < 0.001$), whereas sex was not significantly associated with triglyceride levels after adjustment for age.

Tabel 5
Multiple Linear Regression Analysis for Total Cholesterol Levels

Variables	B	95% CI	p-value
Age	5.093	4.378–5.809	<0.001
Sex	26.170	17.555–34.785	<0.001

Both age and sex were independently associated with total cholesterol levels ($p < 0.001$).

DISCUSSION

The results of this study indicate that age and sex play a role in the variation of triglyceride and total cholesterol levels among adults. The analysis demonstrated a significant association between increasing age and both triglyceride and total cholesterol levels. In addition, differences in triglyceride and total cholesterol levels were observed between males and females. These findings suggest that demographic factors may influence lipid profiles, which are closely associated with the risk of degenerative diseases, particularly cardiovascular disorders.

The relationship between advancing age and blood lipid levels has been reported in several previous studies. As individuals age, physiological changes occur in lipid metabolism, leading to increased levels of triglycerides, total cholesterol, and low-density lipoprotein (LDL) in plasma (Nunes, da Silva Ferreira, et al., 2022;Zhang et al., 2018). These changes are associated with reduced efficiency of lipid metabolism and alterations in the function of organs involved in lipid regulation, particularly the liver. Experimental studies have shown that aging is associated with changes in cholesterol metabolism, including cholesterol accumulation in the liver and alterations in cholesterol synthesis in certain tissues such as the brain (Nunes, da Silva Ferreira, et al., 2022). These metabolic changes may lead to lipid imbalance and contribute to elevated lipid levels in the bloodstream.

In addition to metabolic alterations, increased body adiposity with aging may also contribute to elevated lipid levels. The accumulation of adipose tissue, particularly visceral fat, may trigger lipotoxicity, which has been associated with several degenerative diseases, including cardiovascular disease, type 2 diabetes mellitus, and other metabolic disorders (Chung, 2021). Epidemiological studies have also shown that the prevalence of dyslipidemia increases significantly after the age of 30 and reaches its highest levels in individuals over the age of 50 (Li et al., 2023). These findings indicate that age is an important risk factor in the development of lipid metabolism disorders.

From a biochemical perspective, circulating triglycerides are hydrolyzed by the enzyme lipoprotein lipase (LPL), which is located on the vascular endothelial surface, producing free fatty acids (FFA) and glycerol (Sharma., 2025) Elevated circulating FFA levels may stimulate the production of reactive oxygen species (ROS), leading to oxidative stress within the vascular system (Ghosh et al., 2017). Oxidative stress can reduce the bioavailability of nitric oxide (NO), which plays an essential role in maintaining endothelial function. Impaired endothelial function is considered one of the earliest mechanisms involved in the development of atherosclerosis, which underlies many cardiovascular diseases (Pappan et al., 2025;Yang et al., 2024).

In addition to triglycerides, elevated total cholesterol also plays a crucial role in the development of atherosclerosis. Cholesterol circulating in the form of low-density lipoprotein (LDL) may undergo oxidation to form oxidized LDL (oxLDL). These oxLDL particles are subsequently taken up by macrophages through scavenger receptors, resulting in the formation of foam cells, which represent the initial stage of fatty streak formation within the arterial wall. The accumulation of foam cells may eventually develop into atherosclerotic plaques, leading to narrowing of blood vessels and increasing the risk of coronary heart disease and stroke (Pappan et al., 2025;Lata et al., 2026). This process indicates that disturbances in lipid metabolism not only affect circulating lipid levels but also contribute to structural changes in the vascular wall.

This process indicates that disturbances in lipid metabolism not only affect circulating lipid levels but also contribute to structural changes in the vascular wall (Ro et al., 2025;Zhang et al., 2018). Several factors, including body fat distribution, differences in energy metabolism, and lifestyle factors may influence these differences. Furthermore, estrogen in females is known to exert a protective effect on lipid metabolism by increasing the expression of LDL receptors in the liver, thereby enhancing the clearance of cholesterol from the bloodstream (Harlinda et al., 2022). This mechanism explains why females of reproductive age generally exhibit lower cholesterol levels compared with males.

Apart from hormonal influences, lifestyle differences may also contribute to variations in lipid profiles between males and females. Factors such as high-fat dietary patterns, smoking habits, alcohol consumption, and levels of physical activity are known to contribute to elevated triglyceride and cholesterol levels in the blood. Several studies have also reported that males are more likely to experience metabolic risk factors compared with females, particularly during the productive age group (Jin et al., 2018;Ward et al., 2026).

Dyslipidemia, characterized by elevated triglyceride and total cholesterol levels, represents a modifiable risk factor in the development of various chronic and degenerative diseases. This condition may lead to tissue damage through mechanisms involving systemic inflammation, oxidative stress, and lipid deposition within the vascular wall, which contribute to impaired cardiovascular and metabolic function (Pappan et al., 2025;Oparil et al., 2019). Therefore, regular monitoring of lipid profiles is important as part of early detection and prevention strategies for cardiovascular disease.

Epidemiological reports also indicate that the prevalence of dyslipidemia among adult populations continues to increase in many countries. Data from the Korean Society of Lipidology and Atherosclerosis reported that the prevalence of dyslipidemia in adults exceeds 40% and increases with advancing age (Cheung et al., 2020). Other studies have also reported that dyslipidemia represents a significant public health problem among older populations in several countries, including those in Asia (Li et al., 2023). Similar findings have also been reported in Indonesia, where the prevalence of dyslipidemia increases with advancing age, from 9.3% among adults aged 25–34 years to 15.5% among those aged 55–64 years (Muzakkir & Antonius, 2025). These findings indicate that dyslipidemia has become an important public health concern in Indonesia and may be influenced by lifestyle-related factors such as high-fat dietary patterns, low physical activity, smoking habits, and sedentary behavior.

This trend is consistent with the findings of the present study, which demonstrated a strong positive association between age and both triglyceride and total cholesterol levels. National health data in Indonesia also reported that approximately 35.9% of the population aged ≥15 years had abnormal cholesterol levels, with higher prevalence observed among women and urban populations(Saragih, 2020). In addition, recent multicenter studies in Indonesia demonstrated that dyslipidemia management among high cardiovascular risk patients remains suboptimal, further emphasizing the importance of early lipid

profile screening and preventive strategies (Ng et al., 2025).

The findings of this study indicate that age is a significant predictor of triglyceride levels, while both age and sex are independent predictors of total cholesterol levels. These results suggest that demographic factors play an important role in determining lipid profile variations among adults. Therefore, evaluating triglyceride and total cholesterol levels based on age and sex may serve as an early indicator in screening for the risk of degenerative diseases.

Although this study provides an overview of the relationship between age, sex, and lipid profiles among adults, several limitations should be considered. The relatively small sample size and the use of secondary data may limit the generalizability and statistical power of the findings, although the study only included two independent variables in the regression model. In addition, this study did not include other factors that may influence lipid levels, such as body mass index, dietary patterns, physical activity, smoking habits, and history of metabolic diseases (Mohamed et al., 2023). herefore, future studies with larger sample sizes and more comprehensive variables are needed to provide a broader understanding of lipid profile determinants among adults.

CONCLUSION

This study demonstrates that age and sex contribute to variations in triglyceride and total cholesterol levels among adults. Increasing age was significantly associated with higher triglyceride and cholesterol concentrations, while sex differences were particularly evident in total cholesterol levels after multivariate analysis. These findings highlight the importance of considering demographic factors in the evaluation of lipid profiles. Early monitoring of triglyceride and total cholesterol levels based on age and sex may support preventive strategies for degenerative diseases, particularly cardiovascular disorders.

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