Majalah Ilmiah Fisioterapi Indonesia
Indonesian Scientific Journal of Physiotherapy

Original Research Articles
ISSN (Print): 2303-1921
ISSN (Online): 2722-0443
Volume 13, Number 02, Pages 242–247 (2025)
DOI: https://doi.org/10.24843/mifi.000000425

Analysis of Cholesterol Levels and Tension-Type Headache in the Elderly: A Cross-Sectional Study

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Received 03 February 2025; Received in revised form 12 February 2025; Accepted 14 February 2025; Published 01 May 2025

Abstract

Introduction: As individuals age, they experience a decline in bodily functions. Metabolic changes can influence cholesterol levels, which play a role in atherosclerosis and cardiovascular diseases. Previous studies have indicated a relationship between cardiovascular diseases and the occurrence of Tension-Type Headache (TTH). TTH is a primary headache characterized by episodic pain lasting from a few minutes to several weeks. The pain is typically described as a tightening or pressing sensation, with mild to moderate intensity, and is bilateral. However, the direct relationship between cholesterol levels and TTH remains underexplored. Therefore, this study aims to analyze the association between cholesterol levels and the occurrence of TTH in elderly individuals in Singapadu Tengah Village, Bali.
Methods: This cross-sectional study employed a purposive sampling technique, involving 72 elderly participants who met the inclusion and exclusion criteria. Cholesterol levels were measured using a GCU meter, while TTH occurrence was assessed through interviews using the HSQ questionnaire.
Results: Spearman's rho analysis indicated no significant correlation between cholesterol levels and the occurrence of TTH ($p = 0.135$, $r = 0.257$).
Conclusion: No significant correlation was found between cholesterol levels and TTH occurrence in Singapadu Tengah Village. Further studies with larger sample sizes and longitudinal designs are recommended to clarify this relationship.

Keywords: cholesterol levels, tension-type headache, elderly

Introduction

Indonesia is currently facing the impact of aging, particularly the phenomenon of an aging population. According to the Indonesian Central Bureau of Statistics (BPS) (2022), Indonesia entered the aging population phase in 2021, characterized by the percentage of elderly individuals exceeding 10% of the total population. Bali Province has a total population of 4,292,154, of which 568,380 individuals are aged 60 years and above, representing 12.37% of the total population. The high percentage of elderly individuals in Indonesia, particularly in Bali Province, has encouraged the government to prioritize the development of programs aimed at empowering the elderly, with the goal of improving their quality of life in various aspects, including health.[1] Aging is a natural and inevitable process. After reaching adulthood, the body attains its peak condition and then gradually begins to decline due to the reduction in the number of cells in the body. This leads to a decrease in bodily functions, commonly referred to as the aging process.[2] Consequently, over time, elderly individuals tend to become less physically active, which can lead to cholesterol accumulation in the liver.[3]

Cholesterol is a complex lipid compound naturally present in the human body. It is primarily produced in the liver, accounting for 80% of total cholesterol, while the remaining 20% comes from dietary sources and plays a crucial role in various bodily functions.[4] As the human body undergoes aging, the size of the pancreas and liver decreases, leading to a reduction in blood flow to the liver. This results in changes in bile lipid composition, though not in bile acid metabolism. Consequently, cholesterol secretion increases compared to that in younger adults.[5] Cholesterol is significant due to its role in atherosclerosis, a degenerative process affecting medium and large arteries, which is responsible for the majority of cardiovascular diseases.[6] The role of atherosclerosis in cardiovascular disease may also contribute to the occurrence of headaches in the elderly.

A study conducted by Zhang in 2016 found that cardiovascular disease is a variable influencing Tension-Type Headache (TTH) in the elderly. Participants with cardiovascular disease were more likely to experience TTH compared to those without cardiovascular disease. However, the mechanism underlying this relationship remains unclear, though it is suspected to have a genetic component. The vascular system may contribute to the pathogenesis of primary headaches, but further research is needed. Cardiovascular health plays a crucial role in neurological well-being.[7] Atherosclerosis, the most common condition leading to cardiovascular disease, is characterized by plaque buildup in

blood vessels, which obstructs blood flow. This process can lead to oxygen deficiency and vasoconstriction, manifesting as headaches or distension in head or neck structures.[8]

Headache is one of the most common neurological complaints among the elderly, affecting approximately 52% of this population.[9] The most common type of headache in the elderly is primary headache, specifically Tension-Type Headache (TTH). Although the prevalence of TTH declines after the age of 65, between 5.4% and 16.9% of individuals first experience headaches after this age, with 55.6% to 80.6% being diagnosed with TTH (10). The characteristics of headaches experienced by elderly patients may differ from those of younger individuals, potentially due to hormonal or metabolic factors.[9]

TTH is a primary headache disorder characterized by recurrent episodes of pain lasting from several minutes to several weeks. The pain is typically described as a squeezing or pressing sensation, with mild to moderate intensity, affecting both sides of the head (bilateral). This condition is generally not exacerbated by physical activity and is usually not accompanied by symptoms such as nausea and vomiting. However, photophobia or phonophobia may occur in some cases. Before the term "TTH" was adopted, this condition was known by various medical terms, including stress headache, tension headache, muscle contraction headache, and tension-type muscle headache.[10]

The relationship between cholesterol levels and TTH has not been extensively explored in previous studies. However, research by Rist found that total cholesterol and triglyceride levels are associated with primary headaches, specifically migraines with aura, but not with other types of headaches in the elderly (12). Although the relationship between cholesterol levels and cardiovascular disease has been widely studied, no research has specifically examined the correlation between cholesterol levels and TTH, particularly in elderly individuals. Therefore, this study aims to analyze the relationship between cholesterol levels and the occurrence of TTH in elderly individuals in Singapadu Tengah Village. The research hypothesis is that there is a relationship between cholesterol levels and the occurrence of TTH in the elderly population in this area.

This study is expected to provide new insights for healthcare professionals in understanding the risk factors for TTH in the elderly and assist in developing prevention strategies and public education. Additionally, the findings of this study may serve as a reference for further research on the relationship between lipid metabolism and primary headaches.

Methods

This study employs an observational analytic design with a cross-sectional approach. The research subjects were selected using a non-probability sampling technique, specifically purposive sampling, in Singapadu Tengah Village, Sukawati District, Gianyar Regency. Purposive sampling was applied to the population present and willing to participate in this study.

Data collection was conducted between March and June 2024. The total active elderly population in Singapadu Tengah Village is 210 individuals. To ensure a representative sample size, Slovin's formula (1960) was used to determine the minimum required sample size, which was calculated to be 68 participants. A total of 77 elderly individuals attended and agreed to participate in the study. However, only 72 participants met the inclusion and exclusion criteria.

The inclusion criteria were as follows: individuals aged over 60 years, residing in Singapadu Tengah Village, capable of effective communication, and voluntarily consenting to participate by signing an informed consent form. Exclusion criteria included elderly individuals with a history of head injury and those taking cholesterol-lowering medication. Five participants did not meet the inclusion criteria due to being under 60 years of age, resulting in a final sample size of 72 participants.

The study variables included cholesterol levels as the independent variable and tension-type headache (TTH) as the dependent variable. Cholesterol levels were measured using the Easy Touch GCU meter, which has a sensitivity of 86.67%, specificity of 53.33%, and an AUC of 0.789.13 Measurement results were categorized into three groups: normal cholesterol levels (160–200 mg/dL), borderline-high cholesterol levels (200–239 mg/dL), and high cholesterol levels (≥ 240 mg/dL). To minimize measurement bias, calibration of the device was performed before use, and test strips within their validity period were used.

Data collection for TTH was conducted through interviews using the Headache Screening Questionnaire (HSQ). This instrument has a sensitivity of 36% for diagnosing TTH and 92% for potential TTH, while its specificity is 86% for TTH and 48% for potential TTH (van der Meer et al., 2017). The HSQ consists of 10 questions and classifies results into three categories: <6 points (no TTH), ≥6 points (potential TTH), and 8 points (TTH). Structured interview questions were used to minimize bias in data collection.

Prior to conducting the study, ethical approval was officially obtained from the Ethics Committee of FK UNUD under approval number 0912/UN14.2.2.VII.14/LT/2024. The researcher also secured permission to conduct the study from the authorities of Singapadu Tengah Village by submitting a formal request letter for data collection.

The data were analyzed using univariate statistical analysis, normality testing with the Kolmogorov-Smirnov test, and bivariate analysis using the Spearman's Rho non-parametric correlation test. Univariate analysis was conducted on age, gender, cholesterol levels, and TTH to assess the distribution of research characteristics. Normality testing was performed to determine whether the cholesterol level and TTH data were normally distributed. Bivariate analysis was conducted to examine the relationship between the independent and dependent variables, without any adjustments. Complete data were available for all variables, with no missing data. All statistical analyses in this study were performed using the Statistical Package for the Social Sciences (SPSS) version 29.0.

Results

The subjects in this study were active elderly individuals in Singapadu Tengah Village who met the inclusion criteria. The identification phase of the study is illustrated in Figure 1. None of the elderly individuals who attended refused to participate in the study. All subjects were highly open and cooperative throughout the research process. No missing data were recorded, and the analysis was conducted solely on the primary variables.

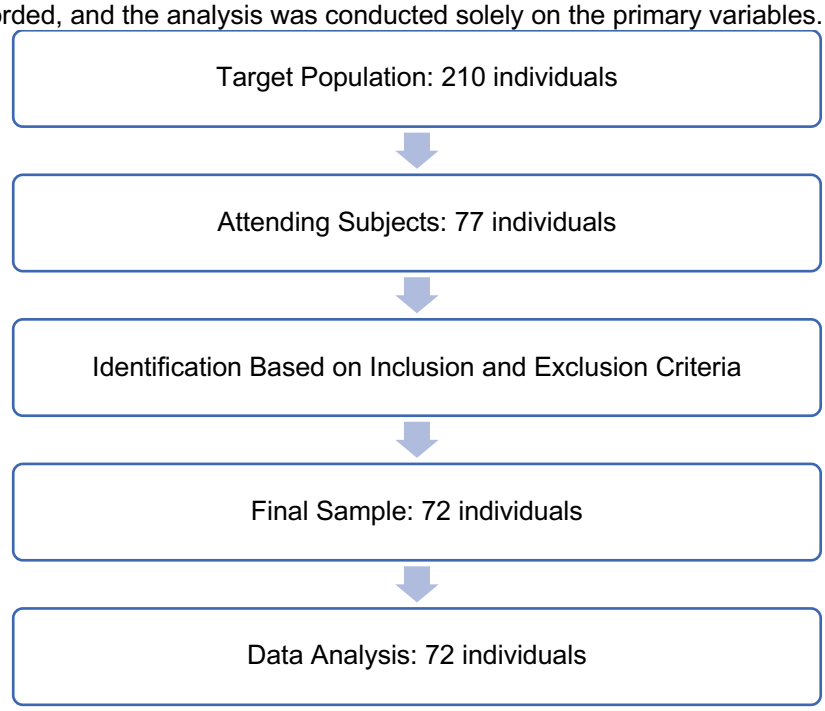

Figure 1. Subject Identification Phase

To provide a clearer overview of the data, the following tables present the results of descriptive and inferential statistical analyses. Table 1 outlines the frequency distribution of subject characteristics, offering a demographic and clinical profile of the elderly participants in Singapadu Tengah Village. Finally**,** Table 2 displays the results of Spearman's Rho correlation analysis, examining the relationship between cholesterol levels and the incidence of tension-type headache (TTH) in the study population.

Table 1. Frequency Distribution of Subject Characteristics

Characteristics	Frequency (n)	Percentage (%)
Gender		
Male	28	38.9%
Female	44	61.1%
Age		
60–69 years	37	51.4%
70–79 years	17	23.6%
≥ 80 years	18	25.0%
Cholesterol Levels		
Normal	35	48.6%
Borderline High	22	30.6%
High	15	20.8%
TTH		
No TTH	54	75.0%
Potential TTH	12	16.7%
TTH	6	8.3%

As shown in Table 1, 28 participants (38.9%) were male, and 44 participants (61.1%) were female. The age distribution of subjects ranged from 60 to ≥ 80 years, with the majority (51.4%) falling within the 60–69-year age group. The lowest number of subjects (23.6%) was in the 70–79-year age group, while 18 participants (25.0%) were aged ≥ 80 years. The age classification follows the World Health Organization's (WHO) elderly age categorization.

Analysis of cholesterol levels among the elderly in Singapadu Tengah Village revealed that 35 participants (48.6%) had normal cholesterol levels, 22 participants (30.6%) had borderline high levels, and 15 participants (20.8%) had high cholesterol levels. Regarding TTH characteristics, out of 72 participants, 54 (75.0%) had no TTH, 12 (16.7%) were classified as having potential TTH, and 6 (8.3%) were diagnosed with TTH.

Table 2. Spearman's Rho Correlation Test Results for Cholesterol Levels and TTH

Variable Correlation	Correlation Coefficient (r)	p-value
Cholesterol Levels and TTH	0.257	0.135

Table 2 presents the results of the correlation analysis between cholesterol levels and TTH. The analysis indicates no significant correlation between the two variables, as shown by a p-value of 0.135. The correlation coefficient (r) was 0.257, suggesting a weak positive correlation. Although there was a tendency toward a positive relationship between cholesterol levels and TTH (r = 0.257), the result was not statistically significant (p = 0.135). This suggests that cholesterol levels may not be a primary factor influencing TTH, and other contributing factors may be involved in the occurrence of TTH within this population.

Discussion

Characteristics of Research Respondents

This study analyzed respondent characteristics based on four variables: gender, age, cholesterol levels, and TTH among 72 elderly individuals in Singapadu Tengah Village. The analysis revealed that out of 72 participants, 28 (38.9%) were male, while 44 (61.1%) were female. The demographic composition of the elderly population in this study was predominantly female, aligning with data from BPS in 2023, which reported that women accounted for 52.28% of the total elderly population in Indonesia.[11]

Regarding age distribution, participants ranged from 60 years to 80 years and older. The majority (37 participants, 51.4%) were in the 60–69 age group, followed by 17 participants (23.6%) in the 70–79 age group and 18 participants (25%) aged ≥ 80 years. According to BPS data from 2023, the 60–69 age group, often referred to as young elderly, represented the largest proportion (63.59%) of the elderly population.[11]

The cholesterol level variable was measured using the EasyTouch GCU meter. The results showed that 35 participants (48.6%) had normal cholesterol levels, 22 participants (30.6%) were in the borderline-high category, and 15 participants (20.8%) had high cholesterol levels. The analysis indicated that the majority of elderly individuals had normal cholesterol levels. These findings are consistent with a previous study conducted among elderly individuals in Mengwi Village, Badung Regency, which also found that most elderly individuals had normal cholesterol levels. According to that study, the relatively normal cholesterol levels were attributed to their active lifestyle, including performing household chores (sweeping, religious offerings, etc.), engaging in frequent labor-intensive activities (digging, cleaning rice fields, construction work), and participating in religious and cultural activities (ngayah or ngupoin).[12]

Similarly, elderly individuals in Singapadu Tengah Village remain actively engaged in various activities. In addition to daily chores and work, they have a routine yoga schedule. Regular yoga practice serves as a preventive measure against various diseases and helps maintain cholesterol levels within the normal range. Yoga positively influences body composition and lipid profiles by increasing the activation of hepatic lipase and lipoprotein lipase, which enhance triglyceride absorption by adipose tissue and impact lipoprotein metabolism. Moreover, yoga improves LDL receptor sensitivity and facilitates reverse cholesterol transport, aiding macrophage cholesterol efflux through HDL mediation. Yoga also provides antioxidant and anti-inflammatory benefits, reducing inflammatory markers and metabolic risk factors. In conclusion, the combination of breathing exercises, stretching, and flexibility training in yoga enhances metabolic function and promotes lipid utilization as an energy source, potentially leading to increased HDL levels and decreased total cholesterol, triglycerides, and LDL.[13]

In this study, TTH characteristics were measured using the HSQ questionnaire. The assessment revealed that 54 participants (75%) did not have TTH, 12 participants (16.7%) were at risk of developing TTH, and 6 participants (8.3%) experienced TTH. Based on the data analysis, it can be concluded that the majority of elderly individuals in Singapadu Tengah Village did not experience TTH. These findings differ from previous studies, which reported that out of 35 elderly respondents, 17 (49%) had TTH.[14]

Relationship Between Cholesterol Levels and TTH in the Elderly

The correlation analysis between cholesterol levels and tension-type headache (TTH) among elderly individuals in Singapadu Tengah Village yielded a correlation coefficient of 0.257 with a significance value of p = 0.135, indicating a statistically non-significant relationship (p > 0.05). This weak positive correlation suggests a minimal direct association, which cannot be considered robust or clinically meaningful. These findings are consistent with previous studies reporting associations between total cholesterol and triglyceride levels and primary headaches, particularly migraine with aura, but not with other headache types in elderly populations.[15]

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While cholesterol is vital for maintaining cellular function, elevated levels—particularly hypercholesterolemia—are known to increase the risk of atherosclerotic cardiovascular disease. Atherosclerosis contributes to plaque formation, vascular narrowing, and potential vascular spasms, which may result in headaches or sensations of tension in the head and neck regions.[8]

Cholesterol has also been identified as a contributing factor to hypertension. Evidence suggests a positive correlation between increased cholesterol levels and hypertension incidence.5 Elevated blood pressure disrupts sodium-potassium pump activity, increasing intracellular calcium concentrations, thereby promoting smooth muscle contraction and vasoconstriction. Concurrently, acidosis and localized ischemia in brain tissue may cause vasodilation of parenchymal arteries. These changes, influenced by neurogenic and biological mechanisms, lead to increased cerebral blood flow and intracranial pressure, which can provoke headaches.[18]

The correlation results from this study indicate that factors other than cholesterol levels may play a more significant role in the occurrence of TTH in elderly individuals, or that the influence of cholesterol is insufficient to impact the prevalence of TTH in Singapadu Tengah Village. Although this study did not establish a significant relationship between cholesterol levels and TTH among the elderly, previous investigations have identified other relevant variables linked to TTH in this demographic.

One study demonstrated a significant association between cardiovascular disease and certain types of primary headaches. Participants with cardiovascular conditions were more likely to experience TTH compared to healthy individuals, although the precise mechanisms remain unclear and may involve genetic factors. The vascular system may contribute to the pathogenesis of primary headaches, yet further investigation is warranted. The importance of cardiovascular health in maintaining neurological well-being should not be underestimated.[7]

In addition to cardiovascular disease, psychological stress is commonly associated with TTH in the elderly. A study conducted at the Srikandi Elderly Health Post found a significant relationship between stress levels and TTH risk. Common stressors in elderly individuals include poor sleep quality and environmental disturbances, both of which exacerbate TTH. In those suffering from TTH, stress can trigger pericranial muscle pain. Moreover, untreated non-communicable diseases can increase psychological stress, manifesting as sadness, fatigue, appetite loss, and reduced interest in daily activities, which may delay medical intervention. Persistent stress in elderly individuals can eventually develop into chronic stress.[14]

Physiologically, stress leads to respiratory hyperventilation, which decreases carbon dioxide levels in the blood, resulting in alkalosis. This state promotes calcium influx into cells, causing excessive muscle contraction and potentially leading to headaches.[19] Stress also intensifies the activation of central nociceptive pathways. It stimulates nuclear factor-kappa B (NF-κB), elevating the production of cyclooxygenase-2 (COX-2) and inducible nitric oxide synthase (iNOS), both of which cause vasodilation and redistribute blood flow toward the lower body. This compromises cerebral oxygen supply, activates cranial muscles, and contributes to the onset of TTH. Sustained peripheral and central sensitization ultimately facilitates chronic TTH.[14]

Additional findings from a study conducted among hypertensive patients aged 45–74 years in Keramat Village, Martapura Timur District, revealed a significant association between cholesterol levels and headache prevalence in this population. Participants with abnormal cholesterol levels frequently experienced headaches ranging from mild to severe. Those with borderline-high cholesterol most commonly reported mild headaches, whereas participants with high cholesterol levels predominantly experienced moderate-intensity headaches. Although headaches linked to hypercholesterolemia are typically characterized as migraines, field observations identified cases of TTH, often accompanied by neck muscle stiffness.[8]

A study by Hagen (2018) examining the relationship between lifestyle factors and the incidence of TTH concluded that habits such as smoking, physical inactivity, and alcohol consumption were not significantly associated with TTH risk.[20] However, individuals with TTH often report sedentary lifestyles, difficulties in relaxation following work, and poor sleep duration.[17]

The findings of the present study further support the conclusion that cholesterol levels are not significantly associated with TTH incidence among the elderly. This may be due to the lack of control for other potential contributing factors in the study design. These uncontrolled variables could be involved in the etiology of TTH. Despite the absence of a direct association between the variables under investigation, it remains essential for the elderly to pay attention to their overall health, particularly concerning comorbidities such as heart disease, hypertension, and psychological stress. Therefore, maintaining cholesterol within normal limits is imperative for preventing complications that could contribute to or exacerbate TTH.

Several limitations should be considered in interpreting these findings. First, the relatively small sample size limits the generalizability of the results to the broader elderly population. Second, the study did not control for confounding factors that may have influenced the incidence of TTH. Third, the reliance on questionnaires introduces the possibility of subjective bias and reduces the reliability of TTH diagnosis. Fourth, the use of non-laboratory cholesterol measurement tools with limited accuracy may have affected data precision. Finally, the scarcity of existing literature on the association between cholesterol levels and TTH in elderly populations constrains the development of hypotheses and interpretation of findings.

Conclusion

This study found no significant relationship between cholesterol levels and tension-type headache (TTH) in older adults in Singapadu Tengah Village ($p > 0.05$). However, other factors such as cardiovascular disease, hypertension, and stress may play a more significant role in TTH incidence among the elderly, as supported by previous research. These findings suggest that the prevention and management of TTH in older adults should focus more on factors with stronger associations, such as blood pressure control, stress management, and overall cardiovascular health.

Future research should consider a longitudinal study design with regular monitoring of cholesterol levels and other risk factors. Additionally, incorporating variables such as dietary patterns, physical activity, and psychological stress may provide a more comprehensive understanding of the contributing factors to TTH in older adults.

Author Contribution

Alfioni Angleque George Putri: Conceptualization, methodology, data collection, data analysis, and manuscript drafting.
Anak Agung Gede Angga Puspa Negara: Supervision, guidance on research design, and critical review of the manuscript.
Indah Paramita: Supervision, validation, and manuscript editing.

Anak Agung Gede Eka Septian Utama: Supervision, methodological consultation, and final manuscript review.

Acknowledgments

The authors would like to express their gratitude to the Faculty of Medicine, Universitas Udayana, for providing the academic support and facilities necessary for conducting this study.

Conflict of Interest Statement

The authors declare that there are no conflicts of interest related to this study.

Funding Sources

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Ethics Statement

This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. Ethical approval was obtained from the Research Ethics Committee of the Faculty of Medicine, Universitas Udayana (Approval No. 0912/UN14.2.2.VII.14/LT/2024). All participants provided informed consent prior to data collection.

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