VOLUME 13 NOMOR 1 JUNE 2026 ISSN 2548 – 611X

JURNAL
BIOTEKNOLOGI & BIOSAINS INDONESIA

Homepage Jurnal: http://ejournal.brin.go.id/JBBI/index

ASSOCIATION BETWEEN SMOKING STATUS AND DIAGNOSED HEART DISEASE AMONG OLDER ADULTS IN INDONESIA: EVIDENCE FROM THE 2023 NATIONAL HEALTH SURVEY

Hubungan antara Status Merokok dan Diagnosis Penyakit Jantung pada Lansia di Indonesia: Bukti Survei Kesehatan Nasional 2023

Yuni Asri[1*], Dian Pitaloka Priasmoro[1], Sasmiyanto[2]
[1]Department of Nursing, Faculty of Health and Science, Institute of Technology Science and Health RS dr Soepraoen Kesdam V/Brawijaya, Malang, Indonesia
[2]Department of Nursing, Universitas Muhammadiyah Jember, Jember, Indonesia.
*Email: yuniasri@itsk-soepraoen.ac.id

ABSTRACT
Heart disease remains a leading contributor to illness and mortality among older adults globally, including in Indonesia. Although smoking is a well-established cardiovascular risk factor, limited national evidence has explored its relationship with heart disease among the Indonesian elderly. This study utilized data from 97,339 adults aged ≥60 years obtained from the 2023 Indonesia Health Survey (Survei Kesehatan Indonesia/SKI) to examine the association between smoking status and physician-diagnosed heart disease, considering various sociodemographic factors. Key variables included age, sex, education, marital status, place of residence, employment, and smoking behavior. Weighted bivariate analyses were conducted using chi-square tests to account for the complex survey design. The overall prevalence of heart disease was 3.5%. Significant associations ($p < 0.05$) were observed across all sociodemographic characteristics, including smoking status. Interestingly, heart disease prevalence was higher among non-smokers (2.6%) than among smokers (0.9%), which may suggest reverse causality or smoking cessation following diagnosis. These findings emphasize the influence of sociodemographic and behavioral factors on cardiovascular health among older Indonesians. Longitudinal research is needed to better understand the causal mechanisms underlying these associations, particularly regarding smoking behavior.

Keywords: *Elderly, Cardiovascular risk, Heart disease, Smoking, Indonesia*

ABSTRAK
Penyakit jantung tetap menjadi kontributor utama penyakit dan mortalitas di antara orang dewasa yang lebih tua secara global, termasuk di Indonesia. Meskipun merokok merupakan faktor risiko kardiovaskular yang mapan, bukti nasional yang terbatas telah mengeksplorasi hubungannya dengan penyakit jantung di antara orang tua Indonesia. Studi ini menggunakan data dari 97.339 orang dewasa berusia ≥60 tahun yang diperoleh dari Survei Kesehatan Indonesia 2023 (SKI) untuk memeriksa hubungan antara status merokok dan penyakit jantung yang didiagnosis oleh dokter, dengan mempertimbangkan berbagai faktor sosiodemografi. Variabel kunci meliputi usia, jenis kelamin, pendidikan, status perkawinan, tempat tinggal, pekerjaan, dan perilaku merokok. Analisis bivariat tertimbang dilakukan dengan menggunakan uji chi-square untuk memperhitungkan desain survei yang kompleks. Prevalensi keseluruhan penyakit jantung adalah 3,5%. Hubungan yang signifikan ($p < 0,05$) diamati di semua karakteristik sosiodemografi, termasuk status merokok. Menariknya, prevalensi penyakit jantung lebih tinggi di antara bukan perokok (2,6%) dibandingkan di antara perokok (0,9%), yang mungkin menunjukkan kausalitas terbalik atau berhenti merokok setelah diagnosis. Temuan ini menekankan

***Received**: 05 November 2025* ***Accepted**: 09 April 2026* ***Published**: 09 June 2026*

pengaruh faktor sosiodemografi dan perilaku terhadap kesehatan kardiovaskular pada lansia Indonesia. Penelitian longitudinal diperlukan untuk lebih memahami mekanisme kausal yang mendasari hubungan ini, terutama terkait perilaku merokok.

Kata kunci: *Lansia, Risiko kardiovaskular, Penyakit jantung, Merokok, Indonesia*

INTRODUCTION

Cardiovascular disease (CVD) remains the world's leading cause of death, claiming around 17.9 million lives each year, or nearly one-third of all global deaths (World Health Organization 2021). Within this broad group, heart disease stands out as a persistent public health concern, especially as populations grow older. Longer life expectancy has brought undeniable social and economic benefits, yet it has also increased the number of people living with chronic conditions such as heart disease (Roth et al. 2020). The aging process itself, together with years of exposure to behavioral and metabolic risks, places older adults at greater vulnerability. This combination often leads to higher medical needs and rising healthcare costs (Donato et al. 2018; Liang et al. 2021; Guo et al. 2022).

The development of heart disease is influenced by many factors. Some cannot be changed, such as age, sex, and genetic background, while others are modifiable, including high blood pressure, obesity, poor diet, physical inactivity, and tobacco use (Benjamin et al. 2019). Among these, smoking has long been recognized as one of the most preventable yet persistent causes of cardiovascular problems. Cigarette smoke damages blood vessels, triggers inflammation, and promotes oxidative stress, processes that gradually accelerate atherosclerosis and other heart complications (Raggi et al. 2018; Addissouky et al. 2024).

Despite decades of public health campaigns, smoking remains widespread in many low- and middle-income countries, where cultural habits and social acceptance continue to shape behavior (Richa et al. 2025). Indonesia is a clear example. The country faces a dual burden of disease, dealing with both infectious illnesses and a rapid rise in non-communicable diseases such as heart disease (Siswati et al. 2022). Smoking is deeply ingrained in daily life, especially among men. According to national data from Basic Health Research (Riskesdas), more than 60% of adult males are current smokers (World Health Organization 2024).

Efforts to reduce smoking, including health warnings and media campaigns, have made some progress but have not yet changed long-standing social norms. Older adults, in particular, tend to continue smoking or have a long history of smoking behavior. Yet, surprisingly little research has examined how this habit relates to heart disease in Indonesia's elderly population using large-scale national data. Understanding this connection is essential, not only for health professionals but also for policymakers designing strategies to protect an aging society (Akter et al. 2024).

Indonesia's rapidly growing elderly population presents a pressing challenge. As rates of heart disease rise, so do questions about how demographic and lifestyle factors, such as age, gender, education, marital status, employment, and smoking, interact to influence cardiovascular health (Cini et al. 2024; Rusyda 2025).

This study therefore aims to explore the relationship between smoking status and diagnosed heart disease among older Indonesians, drawing on nationally representative data from the 2023 Indonesia Health Survey (Survei Kesehatan Indonesia/SKI). Beyond documenting prevalence, the study seeks to clarify how various social and behavioral factors shape heart disease risk in late life. The findings may help inform targeted prevention programs and equitable health policies for Indonesia's aging population (Pengpid and Peltzer 2019; Wihatno et al. 2025).

MATERIAL AND METHODS

Data Source and Study Design

This research adopted a cross-sectional study design using secondary data

from the *2023 Indonesia Health Survey* (*Survei Kesehatan Indonesia*, SKI), which was carried out by the Ministry of Health of the Republic of Indonesia. The SKI is a nationally representative survey designed to collect comprehensive demographic and health-related information from households across the country. It employs a multistage, stratified, probability sampling technique, ensuring that diverse regions and population groups are proportionally represented. The dataset used in this study was obtained through an official request and approval process via the Ministry's data-sharing platform (https://www.badankebijakan.kemkes.go.id/data-mikro-ski/). While cross-sectional data cannot establish causality, it allows researchers to examine significant associations between key variables within a large, nationally representative sample.

Study Population

The study population consisted of individuals aged 60 years and above who participated in the 2023 SKI. From this dataset, only respondents with complete information on smoking status and diagnosed heart disease were included in the analysis. This selection ensured that all variables necessary for the statistical procedures were consistently available, improving the reliability of the findings.

Inclusion and Exclusion Criteria

Participants were eligible for inclusion if they were aged 60 years or older at the time of data collection and had provided complete responses for all essential study variables, including age, sex, educational attainment, marital status, employment status, smoking status, area of residence, and heart disease diagnosis. Respondents who were younger than 60 years or who had missing or inconsistent responses for these variables were excluded from the analysis. This approach ensured that the final dataset reflected only valid and complete cases.

Variables and Measurements

The dependent variable in this study was *diagnosed heart disease*, determined from participants' self-reported responses to whether a health professional had ever diagnosed them with heart disease. Responses were coded as "Yes" (1) for those with a confirmed diagnosis and "No" (0) for those without.

The independent variables included several sociodemographic and behavioral characteristics: age group (60–69, 70–79, and 80–112 years), sex (male or female), educational level (no formal education, primary, lower secondary, upper secondary, and higher education), marital status (never married, married, or divorced), place of residence (urban or rural), employment status (currently working or not working), and smoking status (smoker or non-smoker). All variables were coded as categorical to align with the analytic framework used in this study.

Statistical Analysis

Descriptive statistics were used to summarize the respondents' sociodemographic and health characteristics. Associations between independent variables and the outcome variable, diagnosed heart disease, were assessed using the Chi-square (χ^2) test. All statistical analyses were performed using IBM SPSS Statistics version 27.0.1, with statistical significance determined at $p < 0.05$. To account for the SKI's complex survey design, sampling weights provided in the dataset were applied. These adjustments accounted for stratification, clustering, and unequal selection probabilities, ensuring that the results were representative of the national elderly population.

Ethics Approval

This study was conducted in accordance with established ethical guidelines for secondary data analysis, particularly concerning the confidentiality and protection of participant information. The use of SKI data was formally approved under ticket number 240675B7CC9C4327, with an accompanying confidentiality agreement (No. FRM/SMKI-PUSDATIN/70/0108/2024).
Data access was granted through the official website of the Ministry of Health of the Republic of Indonesia (https://www.badankebijakan.kemkes.go.id/data-mikro-ski/).

RESULTS AND DISCUSSION

Result

Respondent Characteristics

A total of 97,339 elderly respondents aged 60 years and above were included in the analysis. The largest proportion of participants were in the 60–69 year age group (68.3%), followed by those aged 70–79 years (24.9%) and 80 years or older (6.8%). The gender distribution was nearly balanced, with 49.0% men and 51.0% women.

Regarding educational attainment, 42.0% of respondents had completed primary school, while 26.7% reported having no formal education, and only 7.0% had reached higher education. In terms of marital status, the majority were married (68.4%), with 30.4% divorced and a small proportion (1.3%) never married.

More than half of the elderly participants resided in urban areas (54.1%), while 45.9% lived in rural settings. Most respondents (67.8%) were still working, indicating continued economic participation in later life. Additionally, 28.5% of the sample identified as current smokers, suggesting that tobacco use remains relatively common among Indonesia's older population.

The overall prevalence of diagnosed heart disease among these elderly respondents was 3.5%, reflecting a notable but still moderate burden of cardiovascular morbidity within this demographic group.

Table 1. Distribution of Respondent Characteristics Among Elderly Individuals in Indonesia (n = 97,339)

Variables	Frequency (n)	Percent (%)
Age Group (Years)		
(60-69)	66.435	68.3%
(70-79)	24.282	24.9%
(80-112)	6.622	6.8%
Sex		
Male	47.662	49.0%
Female	49.677	51.0%
Education Attainment		
No Formal Education	25.982	26.7%
Primary School	40.880	42.0%
Lower Secondary	10.431	10.7%
Upper Secondary	13.188	13.5%
Higher Education	6.858	7.0%
Marital Status		
Never Married	1.222	1.3%
Married	66.554	68.4%
Divorced	29.563	30.4%
Area of Residence		
Urban	52.671	54.1%
Rural	44.668	45.9%
Employment Status		
Not Working	31.329	32.2%
Currently Working	66.010	67.8%
Smoking Status		
Yes	27.750	28.5%
No	69.589	71.5%
Diagnosed Heart Disease		
Yes	3.395	3.5%
No	93.944	96.5%

Bivariate Analysis

The Chi-square test revealed several significant associations between respondents' sociodemographic characteristics and the prevalence of diagnosed heart disease. Age was strongly associated with heart disease (p = 0.001), with the highest proportions observed among older age groups, specifically, 1.0% among individuals aged 70–79 years and 0.2% among those aged 80 years and above. Sex also showed a statistically significant relationship (p = 0.002), where men (1.8%) had a slightly higher prevalence compared to women (1.7%).

Educational attainment demonstrated a clear gradient (p = 0.001); respondents with no formal education (0.6%) and those who completed only primary school (1.1%) reported higher rates of heart disease than those with more advanced education levels. A similar pattern appeared in relation to marital status (p = 0.002), with married individuals exhibiting the highest prevalence of heart disease (2.4%) compared to those who were divorced (1.1%) or never married (0.0%).

Significant differences were also found by place of residence (p = 0.001). Participants living in urban areas had a higher prevalence of heart disease (2.5%) than their counterparts in rural areas (0.9%), possibly reflecting variations in access to healthcare and diagnostic services. Employment status was another factor significantly related to heart disease (p = 0.001); those who were currently working showed a prevalence of 2.0%, while non-working individuals had a slightly lower prevalence (1.4%).

An unexpected pattern emerged in relation to smoking status (p = 0.001). The prevalence of diagnosed heart disease was lower among smokers (0.9%) than among non-smokers (2.6%). This counterintuitive finding may suggest reverse causality, where individuals cease smoking after being diagnosed with heart disease, or may be influenced by early mortality among long-term smokers.

Table 2. Bivariate Association Between Respondent Characteristics and Heart Disease (Chi-Square Test, n = 97,339)

Variabel	Diagnosed Heart Disease				*p-value*
	Yes		No		
	N (3.395)	(3,5%)	N (93.944)	(96,5%)	
Age Group (Years)					0.001*
(60-69)	2.169	(2.2%)	64.266	(66.0%)	
(70-79)	986	(1.0%)	23.296	(23.9%)	
(80-112)	240	(0.2%)	6.382	(6.6%)	
Sex					0.002*
Male	1.750	(1.8%)	45.912	(47.2%)	
Female	1.645	(1.7%)	48.032	(49.3%)	
Education Attainment					0.001*
No Formal Education	579	(0.6%)	25.403	(26.1%)	
Primary School	1.098	(1.1%)	39.782	(40.9%)	
Lower Secondary	450	(0.5%)	9.981	(10.3%)	
Upper Secondary	786	(0.8%)	12.402	(12.7%)	
Higher Education	482	(0.5%)	6.376	(6.6%)	
Marital Status					0.002*
Never Married	20	(0.0%)	1.202	(1.2%)	
Married	2.346	(2.4%)	64.208	(66.0%)	
Divorced	1.029	(1.1%)	28.534	(29.3%)	
Area of Residence					0.001*
Urban	2.480	(2.5%)	50.191	(51.6%)	
Rural	915	(0.9%)	43.753	(44.9%)	
Employment Status					0.001*
Not Working	1.401	(1.4%)	29.928	(30.7%)	
Currently Working	1.994	(2.0%)	64.016	(65.8%)	

Variabel	Diagnosed Heart Disease				*p-value*
	Yes		No		
	N (3.395)	(3,5%)	N (93.944)	(96,5%)	
Smoking Status					0.001*
Yes	878	(0.9%)	26.872	(27.6%)	
No	2.517	(2.6%)	67.072	(68.9%)	

Note: *p = <0.05

Discussion

This study demonstrated that several sociodemographic factors, age, sex, educational level, marital status, area of residence, employment status, and smoking behavior, were significantly associated with the prevalence of diagnosed heart disease among older adults in Indonesia. Although smoking is widely recognized as a modifiable risk factor for cardiovascular disease, an unexpected pattern emerged: non-smokers showed a higher prevalence of heart disease than smokers. This finding may reflect reverse causality, in which individuals quit smoking after being diagnosed with heart disease, or the effect of smoking-related early mortality, where heavy smokers die before reaching older age (Jeong et al. 2021; Nabi Husain et al. 2023; Rahman et al. 2025).

The strong association between heart disease and older age groups is consistent with previous evidence indicating that aging is one of the most important non-modifiable risk factors for cardiovascular disease. With age, cumulative exposure to behavioral and metabolic risks, along with physiological decline, increases susceptibility to cardiovascular pathology (Zhou et al. 2022; Zhao et al. 2024). The slightly higher prevalence of heart disease among males compared with females also mirrors global patterns. Biological differences in lipid metabolism and hormonal protection, combined with behavioral factors such as smoking and occupational stress, may help explain this trend (Hernandez-Hernandez et al. 2022; Lindsey et al. 2024).

Education emerged as another significant determinant. Individuals with lower educational attainment had a higher prevalence of heart disease, reinforcing the role of education as a social determinant of health. Education influences a person's ability to access information, adopt healthy behaviors, and seek timely medical care (Khaing et al. 2017). Similarly, marital status was related to heart disease risk, with married individuals showing higher prevalence than divorced or never-married respondents. This pattern may partly reflect age differences, since married individuals tend to be older, but could also indicate greater diagnosis rates due to higher health awareness or access to medical services among those living with a partner (Dhindsa et al. 2020).

The study also revealed differences based on residential area. Urban residents were more likely to report a diagnosis of heart disease than rural residents. This could reflect better access to diagnostic facilities and healthcare in cities rather than true differences in disease burden, suggesting the possibility of underdiagnosis in rural regions (Fanaroff et al. 2022; Pierce et al. 2025). A notable pattern was also found for employment status, respondents who were still working showed a higher prevalence of heart disease compared with those not working. Occupational stress, lifestyle habits, and selection bias in self-reporting may partly explain this observation (Virtanen et al. 2017; Kubera et al. 2022).

Although smoking is a well-documented risk factor for cardiovascular morbidity and mortality, the finding that non-smokers had higher heart disease prevalence requires cautious interpretation. Possible explanations include behavioral changes following diagnosis, underreporting of smoking habits, or residual confounding from unmeasured factors such as diet, physical activity, or healthcare access. Further, smoking-related premature mortality could have reduced the number of high-risk smokers in the elderly sample, producing a misleading inverse association.

Several limitations should be acknowledged. First, the cross-sectional design prevents causal inference. Second, the measure of heart disease relied on self-reported diagnosis, which may be affected by recall

or reporting bias. Third, smoking was classified using a binary variable, without details on smoking duration, intensity, or cessation history. Fourth, potential confounders such as diet, physical activity, or comorbidities were not captured. Lastly, reverse causality remains a plausible explanation, particularly for the unexpected relationship between smoking and heart disease.

Despite these limitations, the findings underscore the importance of addressing cardiovascular health among Indonesia's elderly population, particularly for groups with low educational attainment, men, and urban residents. Public health initiatives should not only promote smoking cessation but also strengthen screening and diagnostic efforts across both urban and rural areas. The counterintuitive findings related to smoking further highlight the need for longitudinal studies that incorporate more nuanced measures of smoking behavior to clarify causal pathways.

CONCLUSION

This study identified significant associations between various sociodemographic factors and the prevalence of diagnosed heart disease among older adults in Indonesia. Age, sex, education, marital status, residence, employment, and smoking status were all meaningfully related to heart disease. Although causality cannot be inferred due to the study design, these findings provide valuable insight into the characteristics of elderly individuals most at risk for cardiovascular conditions. The evidence may help guide health policymakers and practitioners in developing equitable, context-specific prevention and intervention strategies aimed at reducing cardiovascular risk among Indonesia's aging population.

ACKNOWLEDGMENT

The authors express their sincere gratitude to the Institut Teknologi Sains dan Kesehatan RS Dr. Soepraoen Kesdam V/Brawijaya Malang for its academic support and guidance throughout this research. Appreciation is also extended to the Ministry of Health of the Republic of Indonesia for granting access to the 2023 *Indonesia Health Survey (Survei Kesehatan Indonesia/SKI 2023)* dataset. Finally, the authors acknowledge the helpful role of artificial intelligence–based language tools, which assisted in refining the clarity and coherence of this manuscript.

REFERENCES

Addissouky TA, El Sayed IET, Ali MMA, Wang Y, El Baz A, Elarabany N, Khalil AA (2024) Oxidative stress and inflammation: elucidating mechanisms of smoking-attributable pathology for therapeutic targeting. Bull Natl Res Cent 48:16. https://doi.org/10.1186/s42269-024-01174-6

Akter S, Rahman MdM, Rouyard T, Aktar S, Nsashiyi RS, Nakamura R (2024) A systematic review and network meta-analysis of population-level interventions to tackle smoking behaviour. Nat Hum Behav 8:2367–2391. https://doi.org/10.1038/s41562-024-02002-7

Benjamin EJ, Muntner P, Alonso A, Bittencourt MS, Callaway CW, Carson AP, et al (2019) Heart Disease and Stroke Statistics—2019 Update: A Report From the American Heart Association. Circulation 139. https://doi.org/10.1161/CIR.0000000000000659

Cini KI, Dumuid D, Francis KL, Wulan NR, Sawyer SM, Handy Agung F, et al (2024) The relationship between non-communicable disease risk and mental wellbeing in adolescence: a cross-sectional study utilising objective measures in Indonesia. BMC Public Health 24:3416. https://doi.org/10.1186/s12889-024-20902-1

Dhindsa DS, Khambhati J, Schultz WM, Tahhan AS, Quyyumi AA (2020) Marital status and outcomes in patients with cardiovascular disease. Trends Cardiovasc Med 30:215–220. https://doi.org/10.1016/j.tcm.2019.05.012

Donato AJ, Machin DR, Lesniewski LA (2018) Mechanisms of Dysfunction in the Aging Vasculature and Role in

Age-Related Disease. Circ Res 123:825–848. https://doi.org/10.1161/CIRCRESAHA.118.312563

Fanaroff AC, Evans PT, Nathan AS (2022) Rural-Urban Disparities in Cardiovascular Outcomes. J Am Coll Cardiol 79:280–282. https://doi.org/10.1016/j.jacc.2021.11.016

Guo J, Huang X, Dou L, Yan M, Shen T, Tang W, Li J (2022) Aging and aging-related diseases: from molecular mechanisms to interventions and treatments. Signal Transduct Target Ther 7:391. https://doi.org/10.1038/s41392-022-01251-0

Hernandez-Hernandez ME, Zee RYL, Pulido-Perez P, Torres-Rasgado E, Romero JR (2022) The effects of biological sex and cardiovascular disease on COVID-19 mortality. American Journal of Physiology-Heart and Circulatory Physiology 323:H397–H402. https://doi.org/10.1152/ajpheart.00295.2022

Jeong S-M, Jeon KH, Shin DW, Han K, Kim D, Park SH, Cho MH, Lee CM, Nam K-W, Lee SP (2021) Smoking cessation, but not reduction, reduces cardiovascular disease incidence. Eur Heart J 42:4141–4153. https://doi.org/10.1093/eurheartj/ehab578

Khaing W, Vallibhakara SA, Attia J, McEvoy M, Thakkinstian A (2017) Effects of education and income on cardiovascular outcomes: A systematic review and meta-analysis. Eur J Prev Cardiol 24:1032–1042. https://doi.org/10.1177/2047487317705916

Kubera B, Kohlmann T, Peters A (2022) Psychological stress, body shape and cardiovascular events: Results from the Whitehall II study. Compr Psychoneuroendocrinol 9:100104. https://doi.org/10.1016/j.cpnec.2021.100104

Liang Z, Wang W, Wang Y, Ma L, Liang C, Li P, Yang C, Wei F, Li S, Zhang L (2021) Urbanization, ambient air pollution, and prevalence of chronic kidney disease: A nationwide cross-sectional study. Environ Int 156:106752. https://doi.org/10.1016/j.envint.2021.106752

Lindsey ML, Usselman CW, Ripplinger CM, Carter JR, DeLeon-Pennell KY (2024) Sex as a biological variable for cardiovascular physiology. American Journal of Physiology-Heart and Circulatory Physiology 326:H459–H469. https://doi.org/10.1152/ajpheart.00727.2023

Nabi Husain MGH, Brijeshkumar UR, Agarwal A, Manishbhai PD, Ghotra M, Panjiyar BK (2023) Impact of Smoking Cessation on Cardiovascular Outcomes: A Systematic Review

Pengpid S, Peltzer K (2019) Prevalence and Predictors of Current and Former Tobacco Use among Older Adults in Indonesia. Asian Pacific Journal of Cancer Prevention 20:395–401. https://doi.org/10.31557/APJCP.2019.20.2.395

Pierce JB, Ng SM, Stouffer JA, Williamson CA, Stouffer GA (2025) Rural/Urban Disparities in Cardiovascular Disease in the US—What Can be Done to Improve Outcomes for Rural Americans? Am J Cardiol 248:10–15. https://doi.org/10.1016/j.amjcard.2025.03.033

Raggi P, Genest J, Giles JT, Rayner KJ, Dwivedi G, Beanlands RS, Gupta M (2018) Role of inflammation in the pathogenesis of atherosclerosis and therapeutic interventions. Atherosclerosis 276:98–108. https://doi.org/10.1016/j.atherosclerosis.2018.07.014

Rahman M, Alatiqi M, Al Jarallah M, Hussain MY, Monayem A, Panduranga P, Rajan R (2025) Cardiovascular Effects of Smoking and Smoking Cessation: A 2024 Update. Glob Heart 20. https://doi.org/10.5334/gh.1399

Richa S, Praveen S, Albariqi AA, Abullais SS, Mahmood SE, Alsamghan A, Bharti RK, Bahamdan GK (2025) Global Trends and Emerging Frontiers in Smoking and Smokeless Tobacco Research: A Bibliometric Analysis over the Past Decade. Healthcare 13:1224.

https://doi.org/10.3390/healthcare13111224

Roth GA, Mensah GA, Johnson CO, Addolorato G, Ammirati E, Baddour LM, et al (2020) Global Burden of Cardiovascular Diseases and Risk Factors, 1990–2019. J Am Coll Cardiol 76:2982–3021. https://doi.org/10.1016/j.jacc.2020.11.010

Rusyda AL (2025) Exploring the Non-Communicable Disease Burden in Indonesia – Findings from the 2023 Health Survey. Indonesia Journal of Public Health Nutrition 5. https://doi.org/10.7454/ijphn.v5i2.1064

Siswati T, Paramashanti BA, Rialihanto MP, Waris L (2022) Epidemiological Transition in Indonesia and Its Prevention: A Narrative Review. Journal of Complementary and Alternative Medical Research 50–60. https://doi.org/10.9734/jocamr/2022/v18i130345

Virtanen M, Elovainio M, Josefsson K, Batty GD, Singh-Manoux A, Kivimäki M (2017) Coronary heart disease and risk factors as predictors of trajectories of psychological distress from midlife to old age. Heart 103:659–665. https://doi.org/10.1136/heartjnl-2016-310207

Wihatno E, Asri Y, Kushayati N, Parahita DP (2025) Urban-Rural Disparities in Smoking Prevalence, Consumption, and Indoor Smoking Habits Among Older Adults in Indonesia. Care : Jurnal Ilmiah Ilmu Kesehatan 13:30–41. https://doi.org/10.33366/jc.v13i1.6704

World Health Organization (2021) Cardiovascular diseases (CVDs). https://www.who.int/news-room/fact-sheets/detail/cardiovascular-diseases-(cvds)

World Health Organization (2024) Ministry of Health and WHO release Global Adult Tobacco Survey Indonesia Report 2021. https://www.who.int/indonesia/news/detail/22-08-2024-ministry-of-health-and-who-release-global-adult-tobacco-survey-indonesia-report-2021

Zhao D, Wang Y, Wong ND, Wang J (2024) Impact of Aging on Cardiovascular Diseases. JACC: Asia 4:345–358. https://doi.org/10.1016/j.jacasi.2024.02.002

Zhou M, Zhao G, Zeng Y, Zhu J, Cheng F, Liang W (2022) Aging and Cardiovascular Disease: Current Status and Challenges. Rev Cardiovasc Med 23. https://doi.org/10.31083/j.rcm2304135