Media Publikasi Promosi Kesehatan Indonesia

e-ISSN 2597-6052
PUBLISHED BY
Fakultas Kesehatan Masyarakat
Universitas Muhammadiyah Palu
Indonesia

RESEARCH ARTICLE

Associated Factors for Non-Communicable Diseases: A Comprehensive Analysis of Mental, Behavioral, Biological, and Sociodemographic Determinants

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ARTICLE HISTORY
Received: 04 May 2026
Revised: 03 August 2026
Accepted: 08 September 2026
Published: 13 September 2026

ARTICLE IDENTIFIERS
Volume 9 - **Issue** 9 - 2026
Pages: 1673-1681
DOI: 10.56338/mppki.v9i9.11006

ABSTRACT

Introduction: Non-communicable diseases (NCDs) are the leading cause of death and disability in Indonesia, placing a growing burden on the healthcare system and economy. This study examined the sociodemographic and health-related factors associated with NCDs among adults aged 35 years and older, using cross-sectional data from the national health survey.

Methods: This study was a secondary analysis of the 2018 Indonesian Basic Health Research, a national survey that employed systematic two-stage random sampling. The analysis included 177,919 adults aged 35 years and older. Complex-sample multivariable binary logistic regression was used to identify factors associated with NCDs. Adjusted odds ratios (aORs) with 95% confidence intervals (CIs) were estimated after adjustment for potential confounders.

Results: Individuals aged ≥55 years had twice the odds of reporting NCDs compared with younger adults (aOR: 2.025; 95% CI: 1.888–2.172). Participants presenting four metabolic syndrome (MetS) components had more than fivefold higher odds of NCDs (95% CI: 4.822–7.153). Individuals with mental health conditions (MHCs) had 2.6-fold higher odds of NCDs than those without MHCs. Former smokers had more than twice the odds of NCDs compared with current smokers. Being male, employed, and in the highest spending group were independently associated with 1.3- to 1.5-fold higher odds of NCDs. In contrast, engaging in physical activity at or below the World Health Organization (WHO)-recommended level was associated with lower odds of NCDs.

Conclusion: Older age, MetS, MHCs, former smoking, male sex, employment, and higher socioeconomic status were independently associated with increased odds of NCDs, whereas physical activity was associated with lower odds. The strong association between MetS and NCDs highlights the importance of early metabolic risk screening and integrated interventions addressing metabolic health, mental health, smoking cessation, and physical activity to reduce the burden of NCDs.

Keywords: Non-communicable Diseases; Risk Factors; Metabolic Syndrome; Mental Health

INTRODUCTION

Indonesia is undergoing a rapid epidemiological transition, facing persistent infectious diseases alongside a rising burden of non-communicable diseases (NCDs). With a population of around 270 million, rapid urbanisation, increasingly unhealthy diets (e.g., diets high in sugar, salt, and fats), physical inactivity, and tobacco use are major factors associated with NCDs and are becoming more prevalent among both urban and rural populations (1,2).

While infections such as tuberculosis, diarrhoeal diseases, and respiratory infections remain major causes of disability, NCDs—particularly cardiovascular diseases, stroke, cancers, kidney diseases, and diabetes—have become the leading causes of death and disability. According to WHO, cardiovascular diseases could cause up to 23 million deaths globally by 2030—80% in low- and middle-income countries (LMICs)—while cancer could lead to 21.7 million new cases and 13 million deaths, 70% of which will also occur in LMICs (1). NCDs now account for about 73% of all deaths in Indonesia, with cardiovascular diseases alone responsible for roughly 35%. The economic burden of NCDs in Indonesia is immense, including direct healthcare expenditure, productivity losses, and impacts on gross domestic product (GDP). Diabetes is now a national health priority due to its growing prevalence and economic impact, with the estimated healthcare cost of diabetic retinopathy reaching approximately US$2.4 billion in 2017, equivalent to nearly 2% of Indonesia's 2017 national state budget (3).

NCDs may affect people in their most productive years, leading to reduced productivity, increased absenteeism, and long-term disability, resulting in a substantial economic burden from both direct healthcare and indirect costs. Chronic diseases may require long-term care, regular medication, and continuous monitoring—all of which put pressure on an already overstretched healthcare system (4). Indonesia's health infrastructure, especially in rural areas, is not yet fully equipped to handle this ongoing burden.

Moreover, this rising NCD burden mirrors global trends in LMICs, threatening progress toward the 2030 Sustainable Development Goals (SDGs) (5). Indonesia has pledged to support the SDGs, including Goal 3.4, which aims to reduce premature mortality from NCDs by one-third by 2030. Previous research reported significant disparities in access to healthcare across Indonesia's many islands and regions. Studying NCDs enables policymakers to understand how these conditions affect different groups (by region, income, gender, etc.) and to address inequalities in prevention, diagnosis, and treatment (1,6). Therefore, studying NCDs in Indonesia is important for strengthening public health, promoting economic development, ensuring sustainable healthcare, and informing evidence-based policies. As the country continues to develop, prioritising NCD research and prevention is important for safeguarding its future.

Midlife is a critical period for addressing the burden of excess body weight. During this transition, cumulative exposure to adverse behaviours and social disadvantages translates into measurable biological risk; however, intervention at this stage can still meaningfully alter later disease trajectories. Focusing on adults aged 35 and older is thus epidemiologically justified, as this group marks a pivotal phase where overweight, obesity, and NCD-associated factors become both more prevalent and clinically significant (7,8).

Despite this urgency, most existing research uses single-domain approaches, which likely underestimate the interacting influence of psychological, behavioural, biological, and sociodemographic factors. Because these domains are inherently linked to social conditions that shape behavioural risks and to mental health, which affects both physiological stress and lifestyle choices, a multidomain framework is essential to capture the complexity of NCD-associated factors. This approach is particularly well suited for cross-sectional analysis, where the objective is to identify patterns of coexisting factors to inform integrated screening and prevention strategies (9).

Accordingly, this study examines the association of mental, behavioural, biological, and sociodemographic factors with NCDs among adults aged 35 and older. By integrating these multiple domains, this analysis moves beyond isolated determinants to provide a comprehensive profile of NCD vulnerability in midlife, supporting the development of targeted, multidimensional public health interventions (10).

METHODS

Study Design

This study employed a cross-sectional design using secondary data from the 2018 Indonesian Basic Health Research, a nationally representative health survey conducted by the Indonesian Ministry of Health. The survey was designed to assess a broad range of health indicators aligned with national health priorities, including the Sustainable Development Goals (SDGs), national development plans, and the Healthy Indonesia Program.

Population and Sample

This study used data from the 2018 Indonesian Basic Health Research survey, which was conducted across all 34 provinces of Indonesia. Data collection covered both urban and rural areas using a nationally representative sampling framework, ensuring broad geographic coverage and population representation. The survey employed a multistage systematic random sampling design. Census blocks were selected proportionally from all provinces using population data from the 2010 national census, resulting in approximately 30,000 census blocks representing both urban and rural settings. Subsequently, ten households were systematically selected from each census block, yielding approximately 300,000 households and 706,689 participants aged 15 years and older. Trained interviewers conducted household visits to administer questionnaires and perform anthropometric and physical measurements. Data relevant to the present study were extracted from the survey database and screened for completeness before analysis.

The present study included adults aged 35 years and older with complete data for all variables required for the present analyses. After excluding records with incomplete information, the final analysis included 177,919 participants (54,162 males and 123,757 females).

Data Collection and Measurement

Data were collected using validated questionnaires administered in the Indonesian language through face-to-face interviews conducted by trained health diploma holders. The survey instruments assessed demographic characteristics, health behaviours, environmental health conditions, morbidity, disability, access to healthcare services, nutritional status, and oral health.

The outcome variable was non-communicable diseases (NCDs), defined as self-reported, physician-diagnosed cardiovascular disease, stroke, chronic kidney disease, and cancer. The outcome definition did not include diabetes. Responses were coded as 1 (yes) or 0 (no) and summed to create a score ranging from 0 (no diagnoses) to 4 (diagnosed with all four conditions) (11). The outcome was categorised as 0 (no NCD diagnoses) or 1 (at least one NCD diagnosis).

Explanatory variables included metabolic syndrome components, mental health conditions, lifestyle factors, and socioeconomic characteristics. In this study, metabolic syndrome (MetS) was assessed using four criteria: (i) central obesity, defined as a waist circumference (WC) of ≥ 90 cm for males and ≥ 80 cm for females on the Southeast Asian standard (12), (ii) general obesity (BMI ≥ 25) based on Asian standards (13), (iii) high blood pressure (≥ 140/90 mmHg) or treatment for diagnosed hypertension (14), and (iv) a previous diagnosis of type 2 diabetes mellitus (T2DM) (12). Each criterion was scored 1 (present) or 0 (absent), with total scores ranging from 0 to 4.

Mental health conditions (MHCs) were assessed using the validated Indonesian version of the 20-item WHO Self-Reporting Questionnaire (SRQ-20) (15). Individuals who answered “yes” to six or more items were considered to show signs of possible mental health problems. Depression was assessed using the validated Indonesian version of the Mini-International Neuropsychiatric Interview (MINI) version 6.0, based on DSM-IV criteria. The MINI includes modules covering 17 psychiatric disorders and uses a “yes” or “no” question format (16).

For adults aged 18–64 years, the WHO advises engaging in regular physical activity consisting of 150–300 minutes of moderate-intensity aerobic exercise, 75–150 minutes of vigorous-intensity aerobic exercise, or a comparable combination spread throughout the week. Additionally, adults are encouraged to perform muscle-strengthening exercises involving major muscle groups at moderate or higher intensity on at least two days per week to gain further health benefits. For individuals aged 65 and older, the WHO provides similar recommendations: at least 150–300 minutes of moderate-intensity aerobic activity, 75–150 minutes of vigorous-intensity activity, or an equivalent mix weekly. Older adults should also include muscle-strengthening exercises targeting all major muscle groups on two or more days per week. Moreover, to improve functional ability and reduce fall risk, older adults are encouraged to engage in multicomponent physical activities, incorporating balance and strength training, at moderate or higher intensity on at least three days per week (17). Accordingly, this study categorised physical activity into three groups: sedentary, physical activity below the WHO guidelines, and physical activity meeting the WHO guidelines (17). Other lifestyle factors in this study were smoking status (never, former, or current smoker) and alcohol consumption (yes/no) in the past month.

Socioeconomic factors included marital status (single or married), education (<12 years or ≥12 years), reflecting Indonesia’s 12-year compulsory education policy (18), and economic status (five expenditure-based quintiles, from the lowest to the highest) (19).

Data Analysis

Descriptive statistics were used to summarise participant characteristics. Bivariate analyses were performed using the chi-square test to assess associations between explanatory variables and NCD status. Variables selected based on relevant literature and those significantly associated with NCD status in the bivariate analyses were further evaluated using complex-sample binary logistic regression to account for the survey-design variables, including sampling weights, clustering, and stratification, and to estimate adjusted odds ratios (aORs) and 95% confidence intervals (CIs). Analyses were conducted using IBM SPSS Statistics version 25.0 for Windows. The analytical sample comprised 177,919 participants with complete data; participants with incomplete data were excluded. A p-value < 0.05 was considered statistically significant. Multicollinearity assessment and formal model-diagnostic procedures were not performed.

Ethical Approval

Ethical approval for the 2018 Indonesian Basic Health Research was granted by the Health Research Ethics Committee at the National Institute of Health Research and Development (Approval No. LB.02.01/2/KE.267/2017) (11), following the Declaration of Helsinki and its amendments. Written informed consent was obtained from all individuals participating in the 2018 Indonesian Basic Health Research.

RESULTS

Table 1 presents the relationships between NCDs and sociodemographic characteristics. The highest prevalence of individuals with one or more NCDs was observed in the ≥55-year age group. A higher prevalence of individuals with one or more NCDs was also found among junior high school graduates, urban residents, employed individuals, and those in the highest quintile of per capita expenditure.

Table 1. Non-communicable diseases (NCDs) by sociodemographic characteristics

Explanatory variables	NCD % (95% CI)			
	n (%) 177,919 (100.00)	No 168,563	≥ 1 9,356	p-value
		95.6 (95.5, 95.8)	4.4 (4.2, 4.5)	
Sex				0.280
Male	54,162 (30.44)	95.9 (95.8, 96.1)	4.1 (3.9, 4.2)	
Female	123,757 (69.56)	96.1 (95.9, 96.2)	3.9 (3.8, 4.1)	
Age				< 0.001
35–54	127,665 (71.75)	96.3 (96.2, 96.5)	3.7 (3.5, 3.8)	
≥55	50,254 (28.25)	90.5 (90.2, 90.9)	9.5 (9.1, 9.8)	
Education				< 0.001
Junior high school graduates	116,181 (65.30)	95.7 (95.6, 95.9)	4.3 (4.1, 4.4)	
Senior high school graduates	61,738 (34.70)	96.4 (96.3, 96.6)	3.6 (3.4, 3.7)	
Marital status				0.630
Single	26,576 (14.94)	96.0 (95.7, 96.2)	4.0 (3.8, 4.3)	
Married	151,343 (85.06)	96.0 (95.9, 96.1)	4.0 (3.9, 4.1)	
Residence				< 0.001
Urban	89,844 (50.50)	95.6 (95.5, 95.8)	4.4 (4.2, 4.5)	
Rural	88,075 (49.50)	96.7 (96.6, 96.8)	3.3 (3.2, 3.4)	
Occupation				< 0.001
Have occupation	59,859 (33.64)	94.9 (94.7, 95.1)	5.1 (4.9, 5.3)	
No occupation	118,060 (66.36)	96.6 (96.5, 96.8)	3.4 (3.2, 3.5)	
Economic				< 0.001
Quintile 1	23,250 (13.07)	96.7 (96.4, 97.0)	3.3 (3.0, 3.6)	
Quintile 2	29,167 (16.39)	96.7 (96.5, 96.9)	3.3 (3.1, 3.5)	
Quintile 3	33,938 (19.07)	96.6 (96.4, 96.8)	3.4 (3.2, 3.6)	
Quintile 4	39,983 (22.47)	95.8 (95.5, 96.0)	4.2 (4.0, 4.5)	
Quintile 5	51,581 (28.99)	95.2 (94.9, 95.4)	4.8 (4.6, 5.1)	

Table 2 presents the relationships between NCDs and various health measurements. The presence of central obesity, the absence of general obesity, an increased number of MetS components, a sedentary lifestyle, being a former smoker, no alcohol consumption, having MHCs, and having depression were associated with a higher prevalence of one or more NCDs.

Table 2. Non-communicable diseases (NCDs) by health measurements

Explanatory variables	NCD % (95% CI)			
	n (%) 177919	No 168563 95.6 (95.5, 95.8)	≥1 9356 4.4 (4.2, 4.5)	p-value
Central obesity				<0.001
No	29,090 (16.35)	97.6 (97.4, 97.7)	2.4 (2.3, 2.6)	
Yes	148,829 (83.65)	95.6 (95.4, 95.7)	4.4 (4.3, 4.6)	
General obesity				<0.001
No	36,458 (20.49)	95.5 (95.3, 95.8)	4.5 (4.2, 4.7)	
Yes	141,461 (79.51)	96.1 (96.0, 96.2)	3.9 (3.8, 4.0)	
Signs of metabolic syndrome				<0.001
1 sign	36,006 (20.24)	97.9 (97.7, 98.0)	2.1 (2.0, 2.3)	
2 signs	78,034 (43.86)	96.5 (96.3, 96.6)	3.5 (3.4, 3.7)	
3 signs	60,688 (34.11)	94.1 (93.8, 94.3)	5.9 (5.7, 6.2)	
4 signs	3,191 (1.79)	82.0 (80.0–83.8)	18.0 (16.2, 20.0)	
Physical activity (PA)				<0.001
Sedentary	20,926 (11.76)	93.1 (92.8, 93.5)	6.9 (6.5, 7.2)	
Meets WHO guideline	142,372 (80.02)	96.4 (96.3, 96.5)	3.6 (3.5, 3.7)	
Below WHO guideline	14,621 (8.22)	97.1 (96.7, 97.4)	2.9 (2.6, 3.3)	
Smoking status				<0.001
Never	135,502 (76.16)	96.1 (95.9, 96.2)	3.9 (3.8, 4.1)	
Former	9,819 (5.52)	90.8 (90.1, 91.5)	9.2 (8.5, 9.9)	
Current	32,598 (18.32)	97.3 (97.1, 97.4)	2.7 (2.6, 2.9)	
Alcohol consumption in the past month				<0.001
No	173,116 (97.30)	96.0 (95.9, 96.1)	4.0 (3.9, 4.1)	
Yes	4,803 (2.70)	97.4 (96.8, 97.9)	2.6 (2.1, 3.2)	
Diabetes diagnosis				<0.001
No	170,069 (95.59)	96.4 (96.3, 96.5)	3.6 (3.5, 3.7)	
Yes	7,850 (4.41)	83.1 (82.0, 84.3)	16.9 (15.7, 18.0)	
Mental health condition				<0.001
No	159,576 (89.69)	96.5 (96.4, 96.6)	3.5 (3.4, 3.6)	
Yes	18,343 (10.31)	91.4 (90.9, 91.9)	8.6 (8.1, 9.1)	
Depression				<0.001
Yes	11,036 (6.20)	91.3 (90.7, 91.9)	8.7 (8.1, 9.3)	
No	166,883 (93.80)	96.3 (96.2, 96.4)	3.7 (3.6, 3.8)	

In contrast, factors such as current smoking, engaging in physical activity, being unemployed, younger age, rural residence, and lower socioeconomic status were associated with a lower prevalence of NCDs.

Table 3 presents findings from a logistic regression analysis assessing the adjusted association between sociodemographic and health-measurement variables and NCDs. The analysis showed that individuals aged ≥55 had approximately twice the odds of having NCDs (95% CI: 1.888–2.172; p < 0.001). Individuals with four components of MetS had more than fivefold higher odds of having NCDs (95% CI: 4.822–7.153). Moreover, individuals with MHCs had 2.6-fold higher odds of having NCDs. Former smokers had more than twofold higher odds of having NCDs. Being male, being employed, and being in the highest quintile of per capita expenditure were associated with approximately 1.3–1.5-fold higher odds of reporting NCDs. In contrast, meeting the WHO physical activity guideline or performing some physical activity below the guideline was associated with lower odds of NCDs.

Table 3. Adjusted odds ratios (aORs) for MetS, MHCs, and sociodemographic factors associated with NCDs

Exposures	≥ 1 NCDs			
	aOR	Lower	Upper	p-value
Intercept				< 0.001
Sociodemographic factors				
Sex				
Male	1.411	1.273	1.565	< 0.001
Female	1			
Age groups				
≥55	2.025	1.888	2.172	< 0.001
35–54	1			
Education				
Senior HS	1.046	0.969	1.130	0.248
Junior HS	1			
Marital status				
Currently married	1.127	1.032	1.232	< 0.001
Single	1			
Residence				
Urban	1.141	1.070	1.217	< 0.001
Rural	1			
Occupation				
Have occupation	1.379	1.282	1.483	< 0.001
No occupation	1			
Per capita expenditure				
quintile 2	1.048	0.926	1.187	0.460
quintile 3	1.063	0.943	1.199	0.320
quintile 4	1.308	1.164	1.469	< 0.001
quintile 5	1.455	1.296	1.634	< 0.001
quintile 1	1			
Health measurements				
Signs of metabolic syndrome				
2 signs	1.561	1.395	1.746	< 0.001
3 signs	2.540	2.217	2.911	< 0.001
4 signs	5.873	4.822	7.153	< 0.001
1 sign	1			
Physical activity				
Meets WHO guideline	0.596	0.550	0.646	< 0.001
Below WHO guideline	0.791	0.701	0.893	< 0.001
Sedentary	1			
Alcohol consumption in the past month				
Yes	0.853	0.665	1.093	0.208
No	1			
Smoking status				
Never smoke	1.550	1.376	1.746	< 0.001
Former smoker	2.564	2.255	2.916	< 0.001
Current smoker	1			
Mental health condition (MHC)				
Yes	2.592	2.387	2.815	< 0.001
No	1			

DISCUSSION

Our study aligns with previous research showing that central obesity and MetS are associated with major NCDs, including cardiovascular disease and cancer (20,21). However, mental health conditions (MHCs) and lifestyle behaviours may also contribute to the onset and progression of NCDs. These factors may interact through overlapping biological and behavioural pathways. In particular, MHCs have been associated with inflammatory processes and neuroendocrine dysregulation (22,23). In addition, unhealthy lifestyle behaviours, including physical inactivity, unhealthy diet, smoking, and harmful alcohol consumption, are important behavioural risk factors for NCDs (24). However, in our study, alcohol consumption was not associated with reporting NCDs in the multivariate analysis.

Previous studies support our findings that MetS is strongly associated with NCDs. In a large Korean cohort of 153,248 adults followed for up to 18 years, BMI showed a J-shaped association with mortality, whereas waist circumference was consistently associated with increased all-cause, cardiovascular, and cancer mortality, indicating that abdominal obesity is a better predictor of cardiometabolic risk than BMI alone (25). Similarly, a prospective study of 1,521 Chinese adults demonstrated that individuals with both high waist circumference and diabetes had nearly fourfold higher cardiovascular mortality than those without these risk factors (26). Consistent with these findings, the Framingham Heart Study reported a graded increase in CVD incidence with the combined presence of atherosclerosis, arteriosclerosis, and poor cardiovascular health (27). These associations are biologically plausible. Visceral adiposity promotes chronic inflammation, insulin resistance, endothelial dysfunction, LDL oxidation, and hypertension, accelerating atherosclerosis from early life (28). Recognising these interconnected mechanisms, the American Heart Association introduced the cardiovascular-kidney-metabolic (CKM) syndrome framework, emphasising early screening and intervention for obesity, kidney disease, and cardiometabolic disorders to prevent disease progression (29).

MetS is also associated with stroke and several obesity-related cancers. The Iranian-PERSIAN cohort found significantly higher odds of stroke among individuals with MetS (30), while a Chinese cohort showed that having multiple MetS components and greater long-term variability in blood pressure and HDL-C increased stroke risk (31). In addition, a systematic review reported that MetS was associated with increased risks of breast, colorectal, endometrial, gastric, hepatocellular, and pancreatic cancers, likely mediated by obesity-related hyperinsulinaemia, dyslipidaemia, chronic inflammation, and adipokine dysregulation (32). Previous studies have also demonstrated a close relationship between MetS and mental health conditions, including depression, bipolar disorder, and schizophrenia, partly due to shared inflammatory and hormonal pathways and the metabolic effects of psychotropic medications (33). Furthermore, a Mendelian randomisation study using genetic instruments derived from genome-wide association studies (GWAS) data provided evidence consistent with potential causal effects of genetically predicted MetS on several psychiatric disorders, including attention-deficit/hyperactivity disorder, anorexia nervosa, and major depressive disorder (34).

Furthermore, our study identified sex- and residence-related disparities in NCDs, which may be attributed to physiological and psychological differences, as well as differences in sedentary behaviour (35). Regarding the association between lifestyle and NCDs, a systematic review of 56 studies reported moderate to strong associations between lifestyle scores and the risk of developing and dying from various types of cancers, CVDs, and type 2 diabetes mellitus. In this study, the most commonly used score was the healthy lifestyle index. This composite scoring system evaluates overall healthy behaviour by combining multiple lifestyle factors, such as BMI, physical activity levels, smoking habits, alcohol intake, and sometimes dietary patterns and sleep quality (36). We observed higher odds of reporting NCDs among never smokers and former smokers compared with current smokers. This unexpected pattern may reflect reverse causality, as individuals may quit smoking after an NCD diagnosis, as well as differences in second-hand smoke exposure, health-seeking behaviour, and other unmeasured factors. These findings should be interpreted cautiously due to the cross-sectional design. Moreover, in our study, alcohol consumption was significant in the bivariate analysis, but not in the multivariate analysis.

Preventing and controlling NCDs in Indonesia, an archipelagic country with a large and diverse population, is challenging. Tackling this challenge requires a strong focus on preventive policies, comprehensive treatment strategies, and addressing modifiable factors, including unhealthy lifestyle behaviours. Evidence from completed intervention studies in Nigeria and India suggests that community-based behaviour-change interventions can improve NCD-related health behaviours and risk factors. In Nigeria, an on-site behavioural modification intervention among market traders significantly increased physical activity and fruit and vegetable consumption while reducing alcohol-related and other risky behaviours associated with hypertension (37). In India, a cluster-randomised controlled trial found that behaviour change communication delivered through community health workers improved systolic blood pressure among adults with cardiovascular risk factors, supporting the potential of community-based approaches for NCD risk-factor control (38). A systematic review of 35 studies used behaviour-change theories grouped into four approaches: intrapersonal, interpersonal, community, and integrated. Of these, 27 studies showed significant results. The most common were interpersonal and integrated approaches, both with moderate strength. Most studies targeted physical inactivity and unhealthy diets. The review supports the effectiveness of behaviour-change interventions in reducing NCD-associated factors (39). Our analysis showed that physical activity was associated with lower odds of NCDs. These findings support strengthening national policies that promote physical activity.

This study has several strengths, including a large dataset covering all provinces in Indonesia, a broad range of sociodemographic and health-related variables, and the use of both bivariate and multivariate analyses. The findings provide useful evidence to inform government policies to prevent and control NCDs. However, several limitations should be considered, including the cross-sectional design, self-reported diagnoses, residual confounding, potential measurement bias, and the lack of data on cultural beliefs and practices. Sex- and urban–rural stratified analyses were also not conducted, which may have limited more nuanced interpretation. The higher prevalence and odds of NCDs among former and never smokers

compared with current smokers should not be interpreted as a protective effect of smoking. This finding may reflect reverse causality, survivorship bias, under-reporting, differences in healthcare access, and health-seeking behaviour. Similarly, higher household expenditure may be associated with greater NCD reporting because of better healthcare access and diagnosis, differences in health-seeking behaviour, and lifestyle factors. Given the cross-sectional design, these associations should not be interpreted as causal.

CONCLUSION

Our study identified demographic, socioeconomic, metabolic, behavioural, and mental health factors associated with self-reported NCDs in Indonesia. Physical activity was associated with lower odds of reporting NCDs. These findings should be interpreted as associations, given the cross-sectional design and reliance on self-reported diagnoses. NCD screening and risk assessment should be strengthened among older adults (≥55 years), urban populations, and individuals with metabolic risk factors. Workplace-based screening programmes and integrated interventions promoting physical activity and mental health support may help identify and address high-risk groups. Programmes should also consider local wisdom and regional differences. Longitudinal studies are needed to confirm temporal relationships.

DECLARATIONS

Author contributions: Conceptualization: SI and LR; Methodology: SI, LR and WD; Validation: SI and WD; Formal Analysis: SI; Resources: SI, WD, and EG; Data Curation: SI, LR, and WD; Writing–Original Draft Preparation: SI, LR, and WD; Writing–Review & Editing: WD, SI, and EG; Visualisation: WD and EG.

Conflicts of interest: The authors declare no financial or personal relationships that could unduly influence their objectivity.

Declaration of Generative AI and AI-Assisted Technologies in the Writing Process: The authors declare that they did not use generative AI or AI-assisted technologies to generate original research content, develop the study's scientific arguments, or write substantial portions of the manuscript. Grammarly Free was used for grammar checking and language editing, while ChatGPT (GPT-5.6 Luna) was used to assist with translating text from Indonesian into English. All AI-assisted outputs were critically reviewed, verified against the authors' intended meaning, and edited by the authors as necessary. The authors retain full responsibility for the accuracy, originality, and interpretation.

Source of Funding Statements: This study received no external research funding. The research was conducted using the 2018 Basic Health Research dataset provided by the Ministry of Health of the Republic of Indonesia, which was accessed free of charge. The University of Hang Tuah provided financial support solely for the publication of this article and did not provide funding for the research activities.

Acknowledgments: The authors gratefully acknowledge the Ministry of Health of the Republic of Indonesia for providing access to the 2018 Basic Health Research data used in this study. The authors also thank the University of Hang Tuah for its financial support for the publication of this article.

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