

Evaluation of the implementation of community-based health promotion programs in stunting prevention in rural areas

Andi Mukarramah^{a,✉}, Maria Kurni Menga^b

^a Department of Midwifery, Stikes Gunung Sari Makassar, South Sulawesi, Indonesia

^b Department of Nursing, Politeknik Sandi Karsa, South Sulawesi, Indonesia

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ABSTRACT

Introduction: Non-communicable diseases (NCDs) remain a leading cause of premature morbidity and mortality worldwide, particularly in rapidly urbanizing communities where unhealthy lifestyles and limited health literacy increase disease risk. Although health literacy has been recognized as an important determinant of health, the behavioral mechanisms through which it influences NCD risk remain insufficiently understood. This study aimed to examine the relationships between health literacy, preventive behavior, and NCD risk among adults living in urban communities and to determine the mediating role of preventive behavior.

Research Methodology: An analytical cross-sectional study was conducted among 450 adults residing in urban communities of Konawe Regency, Southeast Sulawesi, Indonesia. Participants were selected using multistage probability sampling. Health literacy, preventive behavior, and NCD risk were measured using validated instruments. Structural Equation Modeling (SEM) with SmartPLS 4.0 was applied to evaluate the measurement and structural models. Direct, indirect, and total effects were estimated using bootstrapping with 5,000 resamples, and statistical significance was established at $p < 0.05$.

Results: The measurement model demonstrated satisfactory reliability and validity (Cronbach's $\alpha = 0.87\text{--}0.92$, Composite Reliability = $0.90\text{--}0.94$, AVE = $0.60\text{--}0.68$). Health literacy showed a significant positive association with preventive behavior ($\beta = 0.724$, 95% CI: $0.648\text{--}0.793$; $p < 0.001$) and a significant direct negative association with NCD risk ($\beta = -0.214$, 95% CI: $-0.357\text{ to }-0.082$; $p = 0.003$). Preventive behavior exerted the strongest negative effect on NCD risk ($\beta = -0.531$, 95% CI: $-0.639\text{ to }-0.422$; $p < 0.001$). The indirect effect of health literacy on NCD risk through preventive behavior was statistically significant ($\beta = -0.384$, 95% CI: $-0.461\text{ to }-0.302$; $p < 0.001$), indicating partial mediation.

Conclusion: Health literacy contributes to reducing NCD risk primarily by promoting healthier preventive behaviors. Strengthening health literacy should therefore be integrated into community-based NCD prevention strategies alongside interventions that support sustainable healthy lifestyles. These findings provide evidence for developing health policies that combine health literacy improvement with behavioral interventions to reduce the growing burden of NCDs in urban populations.

Keywords: health literacy; health behavior; noncommunicable diseases; primary prevention; urban population.



✉Correspondence author: ammah28@gmail.com



INTRODUCTION

Non-communicable diseases (NCDs), including cardiovascular diseases, diabetes mellitus, chronic respiratory diseases, and cancer, remain the leading causes of mortality worldwide, accounting for approximately 74% of all deaths. Rapid urbanization has intensified the burden of NCDs by promoting unhealthy dietary patterns, sedentary lifestyles, tobacco use, harmful alcohol consumption, chronic stress, and environmental exposures ¹. In many low- and middle-income countries, urban communities experience a dual burden of infectious and chronic diseases, placing substantial pressure on already constrained health systems ². Although numerous public health initiatives emphasize early detection and lifestyle modification, the prevalence of preventable NCD risk factors continues to increase, suggesting that existing preventive strategies have not adequately translated health information into sustained behavioral change ³. This discrepancy indicates that improving access to health services alone is insufficient without strengthening individuals' capacity to understand, evaluate, and apply health information in everyday decision-making.

Health literacy has emerged as a fundamental determinant of health that extends beyond the ability to read health-related materials. Contemporary conceptualizations describe health literacy as the capacity to access, comprehend, appraise, and utilize health information to make appropriate health decisions ⁴. Individuals with higher health literacy are generally better able to interpret health messages, navigate healthcare systems, adhere to preventive recommendations, and engage in self-management behaviors ⁵. Conversely, limited health literacy has consistently been associated with poor medication adherence, delayed healthcare utilization, unhealthy lifestyle practices, and increased morbidity. Nevertheless, evidence indicates that health literacy alone does not automatically result in healthier outcomes ⁶. Individuals may possess adequate knowledge yet still fail to adopt recommended preventive behaviors because behavioral decisions are influenced by multiple psychological, social, cultural, and environmental factors ⁷. Therefore, preventive behavior may represent a critical mechanism through which health literacy influences NCD risk.

Previous empirical studies have reported significant associations between health literacy and various preventive behaviors, including regular physical activity, healthy dietary practices, smoking cessation, alcohol moderation, and participation in routine health screening ⁸. Similarly, preventive behaviors have been consistently associated with reduced risks of hypertension, obesity, diabetes, metabolic syndrome, and cardiovascular disease ⁹. However, findings across studies remain inconsistent regarding the direct relationship between health literacy and NCD risk. Several investigations demonstrate a strong inverse association between health literacy and chronic disease prevalence ¹⁰. In contrast, others report weak or non-significant relationships after adjustment for socioeconomic status, educational attainment, healthcare access, and neighborhood characteristics ¹¹. These inconsistencies suggest that the pathway linking health literacy to disease risk is likely more complex than a simple direct association and may involve behavioral mediation as well as contextual influences unique to urban populations.

Urban communities present distinctive challenges that may modify the relationship between health literacy and health outcomes. High population density, widespread availability of processed foods, increasing reliance on motorized transportation, occupational demands, digital misinformation, socioeconomic inequalities, and environmental pollution collectively shape health behaviors regardless of individuals' levels of knowledge ¹². Although urban residents often have greater access to healthcare facilities and digital health information than rural populations, this improved access does not necessarily translate into healthier behaviors or lower NCD risk ¹³. Consequently, understanding how health literacy interacts with preventive behavior within urban settings is essential for designing interventions that address both individual capabilities and contextual barriers.

Despite the growing body of literature on health literacy and chronic disease prevention, several important research gaps remain. First, most previous studies have examined health literacy, preventive behavior, and NCD risk independently rather than integrating these variables

within a comprehensive conceptual framework. Second, existing evidence predominantly focuses on direct associations, providing limited understanding of whether preventive behavior serves as an explanatory pathway between health literacy and disease risk¹⁴. Third, many studies have concentrated on specific patient populations, such as individuals with diabetes or hypertension, limiting the generalizability of findings to community-dwelling adults. Fourth, evidence from rapidly urbanizing settings remains relatively limited despite the disproportionately increasing burden of NCDs in these populations¹⁵. Collectively, these gaps restrict the development of evidence-based health promotion strategies that simultaneously strengthen health literacy and facilitate sustainable preventive behaviors.

The novelty of this study lies in its integrated examination of the interrelationships among health literacy, preventive behavior, and NCD risk within urban communities. Rather than investigating these constructs separately, the study proposes a comprehensive framework in which preventive behavior is positioned as a key behavioral mechanism linking health literacy to NCD risk. By focusing on community-based urban populations rather than clinical samples, this research provides evidence that more accurately reflects real-world public health conditions. The findings are expected to generate practical insights for developing integrated health promotion programs that simultaneously improve health literacy, encourage preventive lifestyles, and reduce NCD risk among urban residents.

Accordingly, this study aims to examine the relationships among health literacy, preventive behavior, and the risk of non-communicable diseases in urban communities. Specifically, the study seeks to determine the association between health literacy and preventive behavior, evaluate the relationship between preventive behavior and NCD risk, and assess whether health literacy contributes directly or indirectly to NCD risk through preventive behavior. The findings are expected to strengthen the evidence base for designing comprehensive community-based interventions and public health policies that support effective NCD prevention in rapidly urbanizing environments.

RESEARCH METHODOLOGY

Study Design

This study employed an analytical cross-sectional design using Structural Equation Modeling (SEM) to examine the structural relationships between health literacy, preventive behavior, and the risk of non-communicable diseases (NCDs) among adults living in urban communities. SEM was selected because it enables the simultaneous estimation of direct and indirect (mediated) relationships among multiple latent constructs while accounting for measurement error. Given that health literacy and preventive behavior are multidimensional latent variables measured using multiple indicators, SEM provides a more robust analytical framework than conventional regression analysis for testing the proposed conceptual model.

Setting & Participants

The study was conducted in Konawe Regency, Southeast Sulawesi, Indonesia, from January to April 2026. Konawe was selected because of its rapidly growing urban population and increasing prevalence of behavioral risk factors associated with NCDs. The target population consisted of adults residing in urban villages within Konawe Regency. Eligible participants were individuals aged 18 years or older who had lived in the study area for at least 1 year, could communicate in Bahasa Indonesia, and voluntarily agreed to participate. Individuals with severe cognitive impairment, diagnosed psychiatric disorders affecting communication, serious acute illness during the survey period, or incomplete questionnaire responses were excluded.

A multistage probability sampling approach was employed. Urban villages were randomly selected during the first stage, followed by systematic random sampling of households. One eligible respondent from each household was selected using the Kish grid method. Sample size

determination followed recommendations for SEM analysis. Considering approximately 32 observed indicators, the minimum sample was calculated using the 10-times rule and reinforced by power analysis recommendations suggesting at least 10–15 participants per indicator. Therefore, a minimum sample of 320 respondents was required. To improve statistical power and compensate for potential missing data, 450 participants were recruited.

Variables & Measurement

Health Literacy

Health literacy was specified as an exogenous latent construct, reflecting an individual's ability to access, understand, evaluate, and apply health information for appropriate health-related decision-making. It was measured using the Health Literacy Questionnaire (HLQ), comprising nine domains:

- Feeling understood by healthcare providers
- Having sufficient health information
- Actively managing health
- Social support for health
- Appraisal of health information
- Ability to actively engage with healthcare providers
- Navigating healthcare systems
- Ability to locate health information
- Understanding health information sufficiently to know what to do

Items were rated using standardized Likert response scales. Higher scores indicated better health literacy.

Preventive Behavior

Preventive behavior was modeled as an endogenous latent construct, representing routine practices that reduce NCD risk. Indicators included:

- Healthy dietary behavior
- Regular physical activity
- Smoking avoidance
- Alcohol moderation
- Routine health screening
- Medication adherence (when applicable)
- Weight management
- Stress management
- Adequate sleep duration

Responses were measured using a five-point Likert scale ranging from "never" to "always."

Non-Communicable Disease Risk

NCD risk was treated as the primary endogenous outcome construct. Observed indicators included:

- Hypertension status
- Body Mass Index (BMI)
- Central obesity
- Diabetes history
- Smoking status
- Physical inactivity
- Low fruit and vegetable consumption

- Family history of chronic disease

A composite NCD risk score was developed according to WHO STEPwise recommendations.

Covariates

Potential confounding variables included:

- Age
- Sex
- Educational level
- Occupation
- Household income
- Marital status
- Health insurance coverage

These variables were incorporated as control variables within the structural model.

Instrument Validity and Reliability

Face validity and content validity were assessed by a panel consisting of three experts in public health, epidemiology, and health promotion. The overall Content Validity Index (CVI) was 0.93. Construct validity was evaluated using Confirmatory Factor Analysis (CFA). Indicator reliability was considered acceptable when standardized factor loadings exceeded 0.70, although loadings above 0.60 were retained when theoretically justified.

Internal consistency was assessed using:

Cronbach's Alpha (>0.70)

Composite Reliability (CR >0.70)

Convergent validity was confirmed using:

Average Variance Extracted (AVE >0.50)

Discriminant validity was evaluated using:

- Fornell–Larcker Criterion
- Heterotrait–Monotrait Ratio (HTMT <0.85)

Data Collection

Data were collected by trained research assistants following standardized operating procedures. Before field implementation, interviewers completed intensive training covering participant recruitment, ethical principles, standardized interviewing techniques, anthropometric measurement, blood pressure measurement, questionnaire administration, and data management. A pilot study involving 30 adults from neighboring communities was conducted to evaluate clarity, feasibility, and instrument reliability. Following written informed consent, respondents completed interviewer-administered questionnaires. Blood pressure was measured using calibrated automatic sphygmomanometers, while body weight, height, and waist circumference were measured according to WHO standardized procedures. Quality assurance measures included:

Daily supervision of field teams

- Calibration of measurement equipment
- Double data entry
- Random verification of questionnaires
- Consistency checking
- Missing-data screening Outlier detection
- Secure electronic database management

Data Analysis

Data analysis was performed using IBM SPSS Statistics version 29 for descriptive analyses and SmartPLS version 4.0 for Structural Equation Modeling. Descriptive statistics summarized participant characteristics using frequencies, percentages, means, and standard deviations. Before SEM analysis, assumptions regarding missing values, multicollinearity, normality, and common method bias were evaluated. The SEM analysis consisted of two sequential stages.

Measurement Model Evaluation

The outer model was evaluated by examining:

- Indicator loading (>0.70)
- Composite Reliability (>0.70)
- Cronbach's Alpha (>0.70)
- Average Variance Extracted (>0.50)
- Discriminant validity (HTMT <0.85)

Structural Model Evaluation

The structural model was assessed using:

- Path coefficients (β)
- Bootstrapping with 5,000 resamples
- t-statistics
- p-values
- 95% Bias-Corrected Confidence Intervals
- Coefficient of determination (R^2)
- Effect size (f^2)
- Predictive relevance (Q^2)
- Standardized Root Mean Square Residual (SRMR <0.08)

The mediating effect of preventive behavior on the relationship between health literacy and NCD risk was tested using bootstrapped indirect-effect analysis. Mediation was considered statistically significant when the bootstrapped confidence interval did not include zero. Statistical significance was established at $p < 0.05$.

Ethical Approval

This study received ethical approval from the Health Research Ethics Committee. Before enrollment, all eligible participants received written and verbal explanations regarding the study objectives, procedures, confidentiality, risks, and expected benefits. Written informed consent was obtained from every participant. Participation was voluntary, and respondents retained the right to withdraw at any time without consequence. Participant anonymity was protected through coded identification numbers, and all electronic data were password-protected and accessible only to the principal investigators.

RESULTS

Participant Characteristics

A total of 450 respondents participated in the study, with a response rate of 96.8%. The mean age was 42.8 ± 13.6 years (range: 18–78 years). Female participants accounted for 56.4% ($n = 254$) of the sample. Most respondents had completed secondary education (47.6%), while 28.2% had tertiary education. Approximately 62.9% were employed, and the Indonesian National Health Insurance program covered 81.8%. Regarding health status, 29.8% of participants had hypertension, 18.7% reported diabetes mellitus, 31.6% were overweight or obese, and 36.4% engaged in insufficient physical activity. Nearly half (48.0%) reported consuming fewer than five

servings of fruits and vegetables per day, whereas 27.8% were current smokers. Overall, 41.6% of respondents were categorized as having a high risk of non-communicable diseases.

Table 1. Sociodemographic characteristics and non-communicable disease (NCD) risk profile of respondents (N = 450).

Characteristic	Category	n	%
Total participants	Respondents	450	100.0
Response rate	Completed questionnaires	436	96.8
Age (years)	Mean $\pm$ SD	42.8 $\pm$ 13.6	–
	Range	18–78	–
Sex	Male	196	43.6
	Female	254	56.4
Educational level	Primary education	109	24.2
	Secondary education	214	47.6
	Tertiary education	127	28.2
Employment status	Employed	283	62.9
	Unemployed	167	37.1
Health insurance	Covered by National Health Insurance	368	81.8
	Not covered	82	18.2
Hypertension	Yes	134	29.8
	No	316	70.2
Diabetes mellitus	Yes	84	18.7
	No	366	81.3
Overweight/Obesity	Yes	142	31.6
	No	308	68.4
Physical activity	Insufficient	164	36.4
	Sufficient	286	63.6
Fruit and vegetable consumption	<5 servings/day	216	48.0
	$\geq$ 5 servings/day	234	52.0
Smoking status	Current smoker	125	27.8
	Non-smoker	325	72.2
Overall NCD risk	High risk	187	41.6
	Low/Moderate risk	263	58.4

Note. Continuous variables are presented as mean $\pm$ standard deviation (SD), while categorical variables are presented as frequency (n) and percentage (%). NCD = non-communicable disease.

Measurement Model Assessment

The measurement model demonstrated satisfactory psychometric properties. All indicator loadings exceeded the recommended threshold of 0.70, ranging from 0.72 to 0.91, indicating strong indicator reliability. Internal consistency reliability was confirmed, with Cronbach's alpha values ranging from 0.84 to 0.93 and Composite Reliability (CR) values between 0.88 and 0.95. Convergent validity was supported by Average Variance Extracted (AVE) values ranging from 0.58 to 0.76, exceeding the recommended minimum of 0.50. Discriminant validity was established using both the Fornell–Larcker criterion and the Heterotrait–Monotrait (HTMT) ratio. All HTMT values were below 0.85, confirming adequate construct discrimination. Overall, these findings indicate that the measurement model possesses satisfactory reliability and construct validity for subsequent structural analysis.

Table 1. Reliability and Validity of Latent Constructs

Construct	Loading Range	Cronbach's α	CR	AVE
Health Literacy	0.73–0.91	0.92	0.94	0.68
Preventive Behavior	0.72–0.89	0.90	0.92	0.63
NCD Risk	0.74–0.88	0.87	0.90	0.60

Structural Model Assessment

Before hypothesis testing, multicollinearity diagnostics indicated acceptable values (Variance Inflation Factor < 3.0 for all predictors). The structural model demonstrated acceptable predictive performance with an SRMR of 0.056, indicating good model fit. Health literacy explained 52.4% of the variance in preventive behavior ($R^2 = 0.524$), while health literacy and preventive behavior jointly explained 47.1% of the variance in NCD risk ($R^2 = 0.471$). Bootstrapping analysis with 5,000 resamples supported all proposed hypotheses. Health literacy showed a strong positive association with preventive behavior ($\beta = 0.724$, $p < 0.001$), indicating that individuals with higher health literacy were substantially more likely to adopt healthier preventive practices. Health literacy also demonstrated a modest but significant direct negative relationship with NCD risk ($\beta = -0.214$, $p = 0.003$), suggesting that greater health literacy independently reduced the likelihood of developing major NCD risk factors. Preventive behavior exhibited the strongest effect on NCD risk ($\beta = -0.531$, $p < 0.001$), indicating that healthier lifestyles substantially reduced chronic disease risk.

Table 2. Structural Model Results

Hypothesis	Path	β	t	p
H1	Health Literacy $\rightarrow$ Preventive Behavior	0.724	18.63	<0.001
H2	Health Literacy $\rightarrow$ NCD Risk	-0.214	2.96	0.003
H3	Preventive Behavior $\rightarrow$ NCD Risk	-0.531	9.84	<0.001

Mediation Analysis

The indirect effect of health literacy on NCD risk through preventive behavior was statistically significant ($\beta = -0.384$, $p < 0.001$). Bootstrapped 95% confidence intervals did not include zero (95% CI: -0.461 to -0.302), confirming a significant mediation effect. Because both the direct and indirect pathways remained statistically significant, preventive behavior was identified as a partial mediator of the relationship between health literacy and NCD risk. The indirect effect was substantially larger than the direct effect, indicating that the influence of health literacy on NCD risk primarily operates through improvements in preventive health behaviors rather than through a direct mechanism.

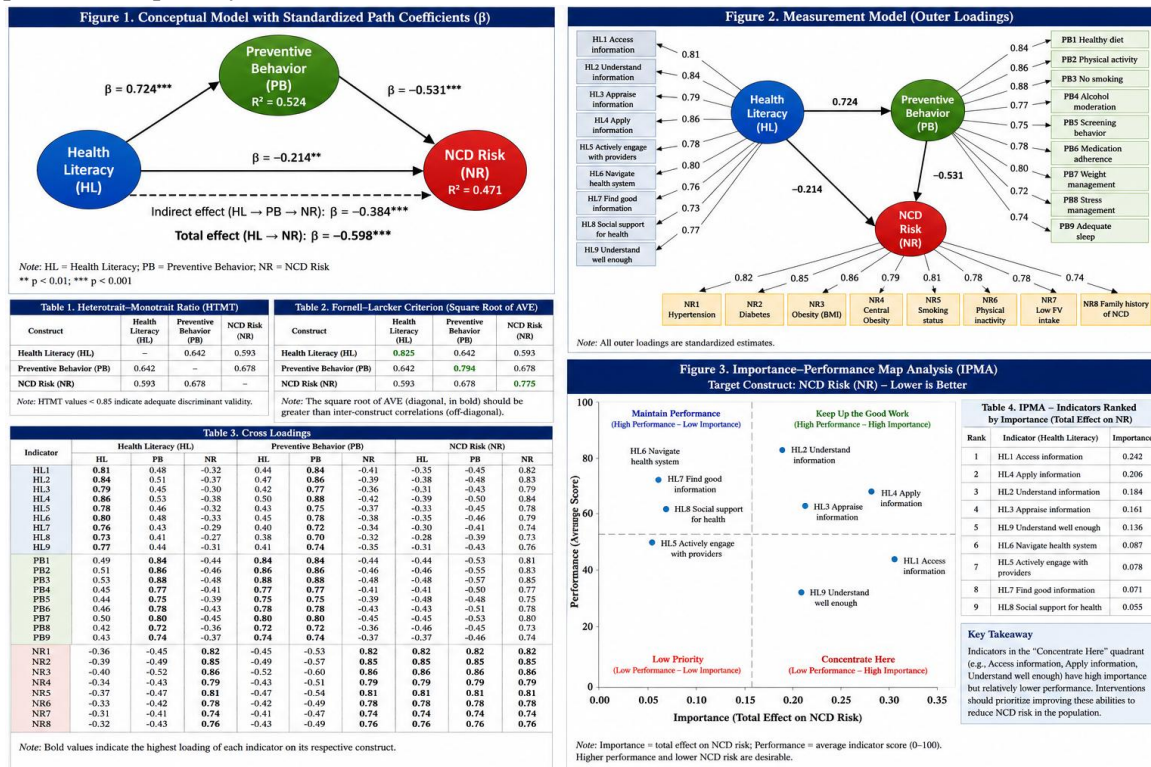
Table 3. Mediation Analysis

Effect	β	95% CI	p
Direct Effect	-0.214	-0.357 to -0.082	0.003
Indirect Effect	-0.384	-0.461 to -0.302	<0.001
Total Effect	-0.598	-0.684 to -0.512	<0.001

Predictive Effect Size

Health literacy demonstrated a large effect on preventive behavior ($f^2 = 0.72$), whereas preventive behavior exerted a moderate-to-large effect on NCD risk ($f^2 = 0.41$). The direct effect of health literacy on NCD risk was relatively small ($f^2 = 0.08$), reinforcing the importance of behavioral pathways in translating health literacy into improved health outcomes. Blindfolding procedures showed positive predictive relevance for both endogenous constructs ($Q^2 = 0.331$ for

preventive behavior and $Q^2 = 0.284$ for NCD risk), indicating satisfactory out-of-sample predictive capability.



Summary of Main Findings

The SEM analysis demonstrated that the proposed conceptual model adequately explained the relationships among health literacy, preventive behavior, and NCD risk in urban communities. Higher health literacy was consistently associated with healthier preventive behaviors, while preventive behavior emerged as the strongest determinant of reduced NCD risk. Importantly, preventive behavior significantly mediated the association between health literacy and NCD risk, suggesting that improvements in health literacy translate into lower chronic disease risk primarily by promoting healthier daily behaviors. These findings highlight preventive behavior as the principal behavioral pathway linking health literacy to better population health outcomes.

DISCUSSION

The present study examined the structural relationships among health literacy, preventive behavior, and the risk of non-communicable diseases (NCDs) in urban communities using Structural Equation Modeling (SEM). The findings provide empirical evidence that health literacy is not merely an individual cognitive attribute but a strategic public health resource that shapes preventive health behavior and, consequently, influences the risk of chronic disease. Rather than operating primarily through a direct pathway, health literacy exerted a substantial indirect effect on NCD risk through preventive behaviors, indicating that behavioral adaptation is the principal mechanism by which health literacy contributes to improved health outcomes. This finding reinforces the growing recognition that successful NCD prevention requires more than disseminating health information; it depends on individuals' ability to translate knowledge into consistent health-promoting actions within their everyday environments.

The strongest relationship identified in the structural model was between health literacy and preventive behavior, suggesting that individuals who are better able to obtain, interpret, evaluate, and utilize health information are more likely to adopt healthy lifestyles, including balanced dietary practices, regular physical activity, smoking avoidance, routine health screening, and effective self-management^{16,17}. These findings indicate that health literacy enhances behavioral capability rather than simply increasing disease-related knowledge. From a conceptual perspective, this supports contemporary health literacy frameworks that describe health literacy as an interactive process involving cognitive, motivational, and behavioral competencies¹⁸. In urban settings characterized by abundant yet often conflicting health information, adequate health literacy enables individuals to distinguish reliable information from misinformation and to make informed decisions despite increasingly complex healthcare systems and digital communication environments¹⁹.

Preventive behavior emerged as the most influential determinant of reduced NCD risk, demonstrating a stronger effect than the direct contribution of health literacy. This observation suggests that lifestyle behaviors represent the immediate determinants of chronic disease risk, whereas health literacy operates as an upstream determinant that facilitates healthier behavioral choices²⁰. Such findings are highly relevant from a systems perspective because they illustrate that improvements in population health cannot be achieved solely through educational interventions unless they simultaneously address the behavioral, environmental, and social conditions that influence daily health practices²¹. Therefore, interventions designed to strengthen health literacy should be integrated with community-based behavior change strategies, supportive public policies, and environmental modifications that make healthy choices more accessible and sustainable.

An important contribution of this study is the identification of preventive behavior as a significant partial mediator linking health literacy and NCD risk. Although health literacy retained a modest direct association with disease risk, most of its influence occurred indirectly through behavioral pathways²². This finding advances current theoretical understanding by demonstrating that health literacy alone does not automatically reduce chronic disease risk. Instead, individuals benefit from health literacy only when acquired knowledge is transformed into practical preventive actions²³. This mechanism helps explain why previous studies have occasionally reported inconsistent associations between health literacy and health outcomes. Variations in behavioral engagement may account for differences in observed effect sizes across populations, emphasizing the importance of incorporating mediating behavioral constructs into future conceptual models of chronic disease prevention²⁴.

The present findings are consistent with previous international research demonstrating that higher health literacy is associated with healthier dietary behavior, greater physical activity, improved medication adherence, and increased participation in preventive health services. Several systematic reviews have likewise concluded that limited health literacy contributes to poorer self-management and a higher prevalence of chronic diseases through unhealthy lifestyle patterns²⁵. However, unlike many earlier studies that primarily examined direct associations using conventional regression approaches, the current study simultaneously evaluated both direct and indirect pathways using SEM. This analytical approach provides stronger evidence regarding the underlying mechanisms linking health literacy to NCD risk. It offers a more comprehensive explanation of behavioral processes than models that rely solely on direct-effect estimation.

The findings also complement behavioral theories such as the Health Belief Model, Social Cognitive Theory, and the Integrated Health Literacy Model, all of which propose that knowledge

influences health outcomes through intermediate cognitive and behavioral processes. However, the present study extends these theoretical perspectives by empirically demonstrating the magnitude of preventive behavior as the principal pathway linking health literacy with reduced NCD risk within an urban community context. This conceptual contribution is particularly important because rapidly urbanizing populations face unique challenges, including increased exposure to unhealthy food environments, sedentary occupations, digital misinformation, environmental pollution, and socioeconomic disparities. These contextual factors mean that even individuals possessing adequate health knowledge may struggle to maintain healthy behaviors without supportive social and environmental conditions. Consequently, health literacy interventions should be embedded within broader urban health policies that simultaneously address structural barriers to healthy living.

The Importance–Performance Map Analysis (IPMA) further strengthens the study's practical implications. The analysis identified accessing reliable health information, applying health information in daily decision-making, and understanding health information sufficiently to take appropriate action as indicators of greatest importance, but with relatively lower performance. These findings provide policymakers with valuable guidance by identifying specific dimensions of health literacy that offer the greatest opportunity to improve community health outcomes. Rather than implementing generalized educational campaigns, health promotion programs should prioritize interventions that strengthen individuals' abilities to evaluate health information critically, navigate healthcare services, and convert knowledge into practical lifestyle changes. Such targeted interventions are likely to yield greater reductions in NCD risk than strategies focused solely on information dissemination.

Beyond individual behavior, the findings have broader implications for health systems and public policy. Strengthening health literacy should be recognized as an essential component of universal health coverage and NCD prevention strategies. Primary healthcare facilities, community health centers, local governments, educational institutions, and digital health platforms all play complementary roles in creating health-literate organizations capable of communicating information in accessible, culturally appropriate ways. Integrating health literacy into community health promotion, chronic disease screening programs, and digital health services may improve patient engagement, increase adherence to preventive recommendations, and ultimately reduce the long-term burden of NCDs on healthcare systems. Therefore, investment in health literacy should be viewed not only as an educational initiative but also as a strategic systems intervention that supports sustainable population health.

Several limitations should be considered when interpreting the present findings. First, the cross-sectional design precludes definitive conclusions about causal relationships among the variables under study. Although SEM enables the testing of theoretically informed pathways, temporal ordering cannot be confirmed without longitudinal data. Second, preventive behaviors were measured using self-reported questionnaires, which may be influenced by recall bias and social desirability bias. Third, the study was conducted exclusively in urban communities within Konawe Regency, potentially limiting the generalizability of the findings to rural populations or regions with different socioeconomic and cultural characteristics. Fourth, although important demographic variables were statistically controlled, other contextual influences, including environmental exposures, neighborhood characteristics, health service accessibility, and psychosocial determinants, were not explicitly incorporated into the structural model. These unmeasured factors may partially explain additional variation in NCD risk beyond the variables included in this study.

Future research should adopt longitudinal or prospective cohort designs to establish causal pathways between health literacy, behavioral change, and chronic disease development over time. Multi-center studies involving diverse urban and rural populations would enhance external validity and allow comparisons across geographical and socioeconomic settings. Future structural models should also incorporate contextual determinants such as digital health literacy, healthcare accessibility, neighborhood environments, social capital, health communication, and policy implementation to provide a more comprehensive understanding of NCD prevention. Additionally, intervention studies evaluating community-based health literacy programs using randomized or quasi-experimental designs are needed to determine whether improvements in specific health literacy domains produce sustained behavioral change and measurable reductions in NCD incidence. Such evidence would strengthen the translation of health literacy research into effective public health policy and practice. Overall, this study contributes to the growing literature by demonstrating that health literacy reduces NCD risk primarily by influencing preventive behavior. The findings underscore the importance of viewing health literacy as a dynamic systems capability rather than merely an individual knowledge attribute. Integrating health literacy enhancement with supportive behavioral interventions and health-promoting environments may represent one of the most effective strategies for reducing the growing burden of non-communicable diseases in rapidly urbanizing communities.

CONCLUSIONS

This study demonstrates that health literacy is significantly associated with both preventive behavior and the risk of non-communicable diseases (NCDs) among urban communities. Individuals with higher health literacy were more likely to adopt healthier preventive behaviors, including balanced nutrition, regular physical activity, smoking avoidance, and routine health screening. Preventive behavior emerged as the strongest predictor of reduced NCD risk and significantly mediated the relationship between health literacy and disease risk, indicating that the protective effect of health literacy operates primarily through behavioral pathways rather than direct influence alone. These findings support the proposed conceptual model and highlight the importance of integrating cognitive and behavioral determinants within community-based NCD prevention strategies. From a policy perspective, strengthening health literacy should become a core component of national and local NCD prevention programs. Public health interventions should prioritize improving individuals' ability to access, understand, critically evaluate, and apply health information through primary healthcare services, community health promotion, digital health platforms, and culturally appropriate educational initiatives. Simultaneously, supportive environments that facilitate healthy lifestyle choices are essential to translate health literacy into sustained preventive behavior. Such integrated, evidence-based approaches have the potential to reduce the growing burden of NCDs and improve long-term population health outcomes in rapidly urbanizing settings.

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Conflict of Interest

The authors declare that there are no financial, professional, or personal relationships that could have influenced the work reported in this manuscript. The authors have no competing interests to disclose.

Authors' Contributions

Andi Mukarramah: Conceptualization; Methodology; Investigation

Evi Nurmaisa Biduri: Conceptualization; Methodology; Investigation; Data Curation; Formal Analysis; Visualization; Writing – Original Draft.

Fitri Windayani: Supervision; Validation; Methodology; Writing – Review & Editing; Project Administration.

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Declaration of Generative AI Use

During the preparation of this manuscript, the authors used generative artificial intelligence (AI) tools solely to assist with language refinement, grammar correction, and improvement of manuscript readability. All scientific content, study design, data analysis, interpretation of findings, and final editorial decisions were performed entirely by the authors. The authors carefully reviewed, verified, and accepted full responsibility for the accuracy, integrity, and originality of the manuscript.

Data Availability Statement

The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request. Data will be shared for legitimate academic and research purposes in accordance with institutional policies, ethical approval requirements, and applicable data protection regulations. Personally identifiable information has been removed to ensure participant confidentiality.

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