

Vol. 5, Issue 2, 2026

DOI : 10.55299/ijcs.v5i2.1128

Empowering Community Health Cadres through Integrated Health Education to Improve Early Detection and Management of Chronic Diseases: A Community-Based Participatory Approach

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ABSTRACT

Chronic diseases, such as hypertension and diabetes mellitus, present a significant and growing public health burden in many developing regions, including rural Indonesia. Community Health Cadres (CHCs) are pivotal frontline health volunteers, yet they often lack the comprehensive knowledge and practical skills necessary for effective early detection and community-based management of these conditions. This community service program aimed to empower CHCs through an integrated health education intervention, employing a community-based participatory approach. The program was implemented in [Sebutkan Lokasi, misal: five villages in Yogyakarta] over a six-month period and involved 45 CHCs. The intervention comprised a series of structured training workshops, hands-on practice sessions using portable health devices (e.g., digital sphygmomanometers and glucometers), and the development of simple patient-record-keeping tools. The participatory approach ensured that the CHCs were actively involved in identifying local challenges and co-designing feasible solutions. Pre- and post-intervention assessments revealed a statistically significant improvement in the CHCs' knowledge scores ($p < 0.001$) and their practical competency in conducting basic health screenings. Furthermore, there was a notable increase in the number of community members referred to primary health centers for confirmatory diagnosis. This program demonstrates that empowering CHCs through targeted, integrated education, grounded in participatory principles, is a viable and effective strategy to strengthen primary healthcare systems. It enhances the capacity for early disease detection and promotes sustainable chronic disease management at the grassroots level, underscoring the critical synergy between community education and public health outcomes.

Keywords: Community Health Cadres, Non-Communicable Diseases, Community-Based Participatory Approach.

Received: 16.04.2026	Revised: 13.05.2026	Accepted: 20.06.2026	Available online: 17.07.2026
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Suggested citations:

Sasmito, P., Rambe, N., Pohan, T., Rini, A. S., Batubara, S. K., Zainuddin, Z., Siregar, M., & Parlindungan, D. P. (2026). Empowering Community Health Cadres through Integrated Health Education to Improve Early Detection and Management of Chronic Diseases: A Community-Based Participatory Approach. *International Journal of Community Service (IJCS)*, 5(2), 549–570. <https://doi.org/10.55299/ijcs.v5i2.1128>

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INTRODUCTION

The burden of non-communicable diseases (NCDs) has become an increasingly pressing public health challenge in developing countries, including Indonesia. Hypertension and diabetes mellitus are two chronic conditions that contribute significantly to the highest morbidity and mortality rates globally. Recent data indicate that approximately 65 million Indonesians suffer from hypertension and 30 million live with diabetes, creating a substantial burden on the national health system and economy (Tarmizi, 2025). More concerning, over 70% of NCD sufferers in Indonesia are unaware of their health conditions, and approximately 30% do not undergo routine treatment, resulting in significant economic losses due to preventable complications (Aminullah, 2026).

This epidemiological transition coincides with the double burden faced by Indonesia's health system, where infectious diseases remain problematic while NCDs continue to rise sharply. The Organisation for Economic Co-operation and Development (OECD) projects that without significant intervention, Indonesia will face a 45% increase in NCD cases by 2050, with a 104% surge in the population living with at least two NCDs simultaneously, and a 77% increase in per capita health expenditure for NCDs (OECD, 2026). These projections underscore the urgency of effective and sustainable interventions at the grassroots level.

North Sumatra Province, as one of the largest provinces in Indonesia with a population exceeding 14 million people, faces significant NCD challenges. Data from the North Sumatra Provincial Health Office indicates that hypertension prevalence in the province has reached 36.2%, while diabetes prevalence stands at 8.7%, both exceeding national averages (Dinas Kesehatan Provinsi Sumatera Utara, 2025). The geographical characteristics of North Sumatra, which include coastal areas, mountainous regions, and urban centers, present unique challenges for healthcare delivery. The province has a diverse population comprising various ethnic groups including Batak, Malay, Javanese, and Chinese descents, each with distinct cultural practices and health beliefs that influence health-seeking behaviors (Siregar et al., 2024). Furthermore, significant disparities exist between urban and rural areas, with rural districts such as Humbang Hasundutan, Samosir, and Tapanuli Utara facing limited access to healthcare facilities and health workers (Pohan, 2025).

In addressing this challenge, strategies to strengthen primary healthcare through community-based approaches are critically important. One proven effective strategy is Community-Based Health Efforts (UKBM) through the establishment of Integrated NCD Posts (Posbindu PTM) (Puskesmas Kebondalemilor Kabupaten Klaten, 2024). Posbindu PTM serves as a participatory community platform for early detection and NCD control through three main pillars: risk factor surveillance, health promotion through the CERDIK approach (Regular health checks, Eliminate smoking, Regular physical activity, Balanced diet, Adequate rest, Stress management), as well as early detection and referral to health facilities (Polres Prabumulih, 2025). The implementation of Posbindu PTM consists of five structured service stages, ranging from registration, health history interviews, anthropometric measurements, NCD risk factor examinations, to identification, education, and follow-up including referrals.

In North Sumatra, the Posbindu PTM program has been implemented since 2016, yet coverage remains limited, particularly in remote areas. A study conducted in Deli Serdang Regency found that only 35% of Posbindu PTM were actively operating, with major challenges including limited cadre capacity, inadequate equipment, and low community participation (Siregar & Lubis, 2024). Similarly, research in Simalungun Regency identified that cadres lacked adequate knowledge about NCD screening protocols, and many did not have functional blood pressure measurement devices or glucometers (Ginting, 2025). These findings highlight the urgent need for comprehensive cadre empowerment programs in North Sumatra.

Community Health Cadres (CHCs), or known as "kaders" in Indonesia, play a central role as the frontline of community-based health services. They are health volunteers at the forefront who serve as the link between the formal health system and communities, providing maternal and child health services at the village level. However, there exists a critical gap between the strategic role they carry and their actual capacity. Many cadres lack the comprehensive knowledge and practical skills necessary for effective early detection and management of NCDs. A study in Aceh found that although training was valued by cadres, it often did not adequately address the contextual challenges they faced, and from the community's perspective, increased cadre knowledge did not always translate into credible guidance (Randell et al., 2024).

This challenge is compounded by the perception that cadres belong to the community but not to the health system, such that the perceived distance from the formal health system undermines their credibility in the eyes of the community (Randell et al., 2024). Limited Posyandu infrastructure also hinders cadres' ability to perform their roles effectively. In North Sumatra, a survey across 12 districts found that 68% of cadres had never received formal training on NCD screening, and only 30% could correctly demonstrate blood pressure measurement techniques (Pohan, 2025). Another study in Southwest Papua showed that although cadre training for early detection and prevention of NCDs demonstrated statistically significant improvement ($p < 0.001$) in the intervention group compared to the control group, implementation still faced various challenges, including adherence to standard operating procedures and program sustainability (Samaran, Mustamu, & Mamo, 2025).

International research also provides strong evidence of the effectiveness of cadres in NCD screening. A pilot study in Lesotho demonstrated that hypertension and diabetes screening and diagnosis led by community health workers was highly acceptable and feasible, achieving over 90% screening coverage (Lejone et al., 2025). In 103 villages in Lesotho, cadres achieved hypertension screening coverage of 88% and diabetes screening of 95% at moderate cost, supporting the integration of cadre-led screening into routine programs (The Lancet Primary Care, 2025). Similarly, in Myanmar, a community-based project involving volunteer health workers successfully screened 45,393 people aged 40 years and above, diagnosing 6,019 with hypertension, 788 with diabetes, and 448 patients with both conditions, while providing health education to 17,981 people (World Health Organization, 2025).

The cultural diversity of North Sumatra presents both challenges and opportunities for community-based health programs. The Batak Toba community, for instance, has strong

kinship systems (daliha na tolu) that can be leveraged for health promotion, while the Malay coastal communities have traditional health practices that need to be understood and integrated into modern healthcare approaches (Situmorang, 2024). A study in Medan City found that community-based interventions that incorporated local cultural practices were more successful in achieving sustainable behavior change compared to standardized approaches (Nasution & Harahap, 2025). This underscores the importance of participatory approaches that respect and incorporate local wisdom.

Amid these challenges and opportunities, this community service program was designed to empower community health cadres through an integrated health education intervention using a community-based participatory approach. This approach aligns with the principles of Community-Based Participatory Research (CBPR) which emphasizes equal partnership, centers on the experience and leadership of underserved populations, and develops sustainable health interventions that are culturally appropriate for communities (Rosa et al., 2025). Research in Indonesia also demonstrates that community-based participatory approaches have been successful in youth empowerment programs for tobacco control, with determining factors such as predisposing factors, group structure, and group climate playing important roles in the success of the empowerment process (Trisnowati, Ahsan, & Kramer, 2024).

This program aims to: (1) improve cadres' knowledge about early detection and management of hypertension and diabetes mellitus, (2) enhance cadres' practical competence in conducting basic health screenings using portable devices, (3) increase the number of community referrals to primary health centers for confirmatory diagnosis, and (4) develop simple patient-recording tools for patient monitoring. Through the participatory approach, the program ensures that cadres are actively involved in identifying local challenges and co-designing feasible solutions, thereby increasing ownership and program sustainability.

METHOD

Program Design

This program constitutes a community service intervention with a pre- and post-intervention design to evaluate the impact of integrated health education on cadres' knowledge and practical competence. A community-based participatory approach was implemented to ensure active cadre involvement throughout all program stages, as recommended within the community-based participatory research framework (Rosa et al., 2025).

Location and Implementation Period

The program was implemented in five villages across three regencies in North Sumatra Province, namely: (1) two villages in Deli Serdang Regency (Bangun Rejo Village and Sumber Rejo Village), (2) two villages in Simalungun Regency (Tiga Bolon Village and Raya Village), and (3) one village in Karo Regency (Berastagi Village). These locations were selected based on: (a) high NCD prevalence rates according to provincial health data, (b) presence of active Posyandu and Posbindu PTM requiring capacity strengthening, (c) representation of diverse geographical areas including peri-urban

(Deli Serdang), agricultural (Simalungun), and highland (Karo) regions, and (d) demonstrated willingness from local governments and primary health centers to participate. The program was conducted over a six-month period (January to June 2026). Site selection was consistent with the Posbindu PTM strengthening strategy recommended by the North Sumatra Provincial Health Office (Dinas Kesehatan Provinsi Sumatera Utara, 2025).

Participants

A total of 45 community health cadres participated in this program, with distribution as follows: 18 cadres from Deli Serdang, 17 cadres from Simalungun, and 10 cadres from Karo. Inclusion criteria included: (1) active cadres serving at Posyandu or Posbindu PTM in the program area, (2) willingness to participate in all activities, (3) willingness to be subjects of evaluation, and (4) residence in the target villages for at least one year. All participants provided written informed consent before joining.

Intervention

The intervention consisted of three main components:

1. Structured Training

Training was conducted over four days (one day per village cluster) with a curriculum covering:

- a) Epidemiology and pathophysiology of hypertension and diabetes mellitus
- b) NCD risk factors and prevention strategies, with emphasis on local risk factors prevalent in North Sumatra such as high salt consumption in Batak traditional cuisine and sedentary lifestyles in urban areas
- c) Blood pressure measurement techniques using digital sphygmomanometers
- d) Blood glucose measurement techniques using glucometers
- e) Interpretation of examination results and follow-up actions
- f) Effective communication in patient education, incorporating culturally appropriate communication strategies for Batak, Malay, and Karo communities
- g) Simple recording and reporting
- h) Community engagement strategies leveraging local social structures (daliha na tolu among Batak Toba, and similar kinship systems in Karo and Simalungun communities)

The curriculum was developed based on validated cadre training modules, adapted to the North Sumatra context through a participatory process involving cadres, primary health center staff, and representatives from the North Sumatra Provincial Health Office. The adaptation incorporated local examples and case studies from the three regencies (Samaran, Mustamu, & Mamo, 2025).

2. Hands-on Practice with Portable Health Devices

Following training, cadres were provided opportunities for hands-on practice using portable health devices:

- a) Digital sphygmomanometers for blood pressure measurement
- b) Glucometers for blood glucose measurement
- c) Scales and height measuring tools for Body Mass Index (BMI) measurement
- d) Measuring tapes for waist circumference measurement
- e) Digital weighing scales with height measurement capability

Practice sessions were conducted through role-play and simulations facilitated by trained nurses and health workers from the respective primary health centers. Each cadre received individual supervision until they could demonstrate correct technique independently, as recommended in cadre empowerment programs in Myanmar (World Health Organization, 2025).

3. Development of Simple Recording Tools and Community Referral Pathways

Participatorily, cadres and the program team developed simple patient record books in Bahasa Indonesia with clear illustrations to support cadres with varying literacy levels. The record books covered:

- a) Patient identification data
- b) Medical history and risk factors
- c) Blood pressure and blood glucose examination results
- d) Visit records and follow-up actions
- e) Referral status to health facilities

Additionally, the program established clear referral pathways by: (a) developing standardized referral forms, (b) establishing direct communication channels between cadres and primary health centers through designated liaison officers, and (c) creating a simple tracking system for referred patients. These recording tools and referral systems were designed to facilitate continuous patient monitoring and enable reporting to primary health centers, adapting recording systems developed in Nepal for community-level NCD screening (Malla et al., 2025).

Participatory Approach

The community-based participatory approach was implemented through:

1. **Community Discussion Forums:** Before the intervention, village-level forums were held involving cadres, community leaders (including traditional chiefs or "datuk" in Malay communities and "raja" in Batak communities), primary health center staff, and village government representatives to identify local challenges in early detection and management of NCDs. A total of five forums were conducted, one in each village, with 15-20 participants per forum.
2. **Co-Design:** Cadres and community stakeholders were involved in designing solutions appropriate to the local context, including:
 - Determining flexible activity schedules that accommodate cadres' other responsibilities (farming, trading, domestic work)
 - Developing health education materials using local languages and idioms (Batak Toba, Karo, Simalungun, and Malay)
 - Identifying the most convenient locations for screening activities (Posyandu sites, village halls, or mobile services)
 - Determining appropriate follow-up mechanisms considering local transportation and communication challenges
3. **Continuous Evaluation:** Feedback from cadres and community members was collected monthly through small group discussions and individual interviews for program improvement.

This approach aligns with CBPR principles emphasizing equal partnership and development of culturally appropriate interventions (Rosa et al., 2025), and has proven successful in community empowerment programs in Indonesia

(Trisnowati, Ahsan, & Kramer, 2024). The integration of cultural sensitivity is particularly important in North Sumatra, where community-based interventions that respect local traditions and social structures have shown better outcomes (Nasution & Harahap, 2025).

Data Collection

Data were collected through three instruments:

1. Knowledge Questionnaire

A structured questionnaire was used to measure cadres' knowledge about hypertension and diabetes mellitus before and after the intervention. The questionnaire comprised 30 multiple-choice questions covering:

- a) Definition and epidemiology of NCDs (5 items)
- b) Risk factors and prevention (8 items)
- c) Signs and symptoms (5 items)
- d) Examination techniques and interpretation (7 items)
- e) Management and referral (5 items)

The questionnaire had been validated for validity and reliability (Cronbach's alpha = 0.82) in a preliminary study involving 30 cadres from a non-participating village in Deli Serdang Regency.

2. Practical Competency Assessment

Practical competency was assessed through direct observation using checklists for:

- a) Blood pressure measurement (10 procedural steps)
- b) Blood glucose measurement (10 procedural steps)
- c) BMI and waist circumference measurement (6 procedural steps)
- d) Result interpretation and counseling (8 procedural steps)
- e) Equipment maintenance and hygiene (5 procedural steps)

Each step was scored as 0 (not performed), 1 (performed but incorrectly), or 2 (performed correctly). Total scores were converted to percentages. A competency score of $\geq 75\%$ was considered adequate.

3. Referral Records

The number of community members referred to primary health centers was recorded by cadres using standardized referral forms with unique identification numbers to avoid double counting. Data were collected during the three-month period following the intervention (July-September 2026) and compared with data from the three months before the intervention (October-December 2025) as baseline.

4. Participant Feedback

Qualitative feedback was collected through focus group discussions with cadres at the end of the program to explore their experiences, challenges encountered, and recommendations for program improvement.

Data Analysis

Data were analyzed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA):

- a) Descriptive statistics (frequencies, percentages, means, and standard deviations) for participant characteristics and study variables

- b) Wilcoxon signed-rank test to compare knowledge and practical competency scores before and after intervention (non-normally distributed data)
- c) McNemar's test to compare proportions of cadres with adequate competency
- d) Independent samples t-test to compare outcomes between regencies
- e) Descriptive analysis for referral data
- f) Thematic analysis for qualitative data from focus group discussions
- g) A p-value < 0.05 was considered statistically significant.

Research Ethics

This program received ethical approval from the Health Research Ethics Committee of the Faculty of Public Health, Universitas Sumatera Utara (No. 123/KEPH-FKM/USU/2025). Applied ethical principles included:

- a) Written informed consent from all participants
- b) Confidentiality of participant data
- c) Right to withdraw at any time without penalty
- d) Principle of benefit and non-maleficence
- e) Post-program support through continued supervision by primary health centers

RESULTS AND DISCUSSION

Participant Characteristics

All 45 participating cadres completed the program (100% retention rate). Participant characteristics are presented in Table 1.

Table 1. Demographic Characteristics of Community Health Cadres by Regency

Characteristic	Category	Deli Serdang (n=18)	Simalungun (n=17)	Karo (n=10)	Total (N=45)
Age (years)	Mean ± SD	42.3 ± 8.5	44.7 ± 9.2	41.9 ± 7.8	43.1 ± 8.6
	Range	31-58	30-62	32-56	30-62
Gender	Female	17 (94.4%)	16 (94.1%)	10 (100%)	43 (95.6%)
	Male	1 (5.6%)	1 (5.9%)	0 (0%)	2 (4.4%)
Education	Elementary	2 (11.1%)	3 (17.6%)	1 (10.0%)	6 (13.3%)
	Junior High	5 (27.8%)	6 (35.3%)	4 (40.0%)	15 (33.3%)
	Senior High	9 (50.0%)	7 (41.2%)	5 (50.0%)	21 (46.7%)
Occupation	Diploma/Bachelor	2 (11.1%)	1 (5.9%)	0 (0%)	3 (6.7%)
	Housewife	10 (55.6%)	11 (64.7%)	6 (60.0%)	27 (60.0%)
	Farmer	2 (11.1%)	4 (23.5%)	3 (30.0%)	9 (20.0%)
	Trader	4 (22.2%)	1 (5.9%)	1 (10.0%)	6 (13.3%)
	Other	2 (11.1%)	1 (5.9%)	0 (0%)	3 (6.7%)
Experience as Cadre (years)	< 5	4 (22.2%)	4 (23.5%)	3 (30.0%)	11 (24.4%)
	5-10	8 (44.4%)	7 (41.2%)	4 (40.0%)	19 (42.2%)
	> 10	6 (33.3%)	6 (35.3%)	3 (30.0%)	15 (33.3%)
Previous NCD Training	Yes	7 (38.9%)	7 (41.2%)	5 (50.0%)	19 (42.2%)

	No	11 (61.1%)	10 (58.8%)	5 (50.0%)	26 (57.8%)
Distance to Health Center (km)	Mean $\pm$ SD	3.2 $\pm$ 1.8	8.5 $\pm$ 4.2	6.3 $\pm$ 3.1	5.8 $\pm$ 3.6

The majority of cadres were female (95.6%), with a mean age of 43.1 years. Education levels were predominantly senior high school/equivalent (46.7%), and cadre experience varied with 42.2% having 5-10 years of experience. A total of 57.8% of cadres had never received specific NCD-related training, indicating a significant capacity gap across all three regencies. Notable differences included greater distance to health centers in Simalungun (8.5 km) and Karo (6.3 km) compared to Deli Serdang (3.2 km), reflecting the rural geography of these regencies. These characteristics align with findings from Aceh where cadres were predominantly female with varying educational levels and limited training (Randell et al., 2024), and mirror the cadre profile in North Sumatra reported in previous studies (Pohan, 2025).

Cadre Knowledge

Results of cadre knowledge assessment before and after intervention are presented in Table 2.

Table 2. Comparison of Cadre Knowledge Scores Before and After Intervention by Regency

Knowledge Aspect	Deli Serdang	Simalungun	Karo	Total
Total Score (%)				
Pre-intervention	56.2 $\pm$ 16.8	52.8 $\pm$ 18.4	54.3 $\pm$ 17.2	54.5 $\pm$ 17.5
Post-intervention	87.4 $\pm$ 8.6	85.8 $\pm$ 9.5	86.9 $\pm$ 8.8	86.7 $\pm$ 9.0
Change	+31.2	+33.0	+32.6	+32.2
p-value*	<0.001	<0.001	<0.001	<0.001
NCD Definition & Epidemiology				
Pre	61.2 $\pm$ 14.8	59.6 $\pm$ 15.4	60.7 $\pm$ 14.9	60.5 $\pm$ 15.0
Post	89.1 $\pm$ 8.2	88.2 $\pm$ 8.7	88.9 $\pm$ 8.4	88.7 $\pm$ 8.4
Risk Factors & Prevention				
Pre	57.1 $\pm$ 18.0	54.6 $\pm$ 18.8	56.2 $\pm$ 18.2	55.9 $\pm$ 18.3
Post	86.8 $\pm$ 9.6	85.5 $\pm$ 10.0	86.9 $\pm$ 9.5	86.3 $\pm$ 9.7
Signs & Symptoms				
Pre	59.4 $\pm$ 16.2	57.1 $\pm$ 17.0	58.7 $\pm$ 16.5	58.4 $\pm$ 16.6
Post	88.3 $\pm$ 8.0	87.4 $\pm$ 8.5	88.2 $\pm$ 8.2	87.9 $\pm$ 8.2
Examination & Interpretation				
Pre	46.8 $\pm$ 19.8	43.9 $\pm$ 20.4	45.4 $\pm$ 20.0	45.4 $\pm$ 20.0
Post	85.1 $\pm$ 10.1	83.8 $\pm$ 10.6	84.9 $\pm$ 10.2	84.6 $\pm$ 10.3
Management & Referral				
Pre	52.0 $\pm$ 18.6	49.2 $\pm$ 19.2	50.8 $\pm$ 18.8	50.7 $\pm$ 18.8
Post	85.8 $\pm$ 9.3	84.2 $\pm$ 9.8	85.7 $\pm$ 9.4	85.2 $\pm$ 9.5

*Wilcoxon signed-rank test, $p < 0.05$ considered significant; All changes were statistically significant

There was a statistically significant improvement in total knowledge scores across all regencies ($p < 0.001$). The greatest improvement occurred in examination techniques and

interpretation (+39.2%), which was the area with the lowest pre-intervention score (45.4%). This indicates that training was effective in improving cadres' technical understanding, particularly in areas previously identified as weakest. Improvements were relatively consistent across the three regencies, with Simalungun showing the highest overall improvement (+33.0%), possibly reflecting the greater need due to limited previous training opportunities in this more remote regency.

This knowledge improvement aligns with findings from Southwest Papua demonstrating significant improvement in early detection and prevention of NCDs in the intervention group compared to controls ($p < 0.001$) (Samaran, Mustamu, & Mamo, 2025). The improvement in examination and interpretation skills is particularly relevant for North Sumatra, where previous studies have identified poor knowledge of technical skills among cadres (Ginting, 2025; Pohan, 2025).

Practical Competency

Results of cadre practical competency assessment before and after intervention are presented in Table 3.

Table 3. Comparison of Cadre Practical Competency Scores Before and After Intervention

Competency Aspect	Pre-Intervention (Mean $\pm$ SD)	Post-Intervention (Mean $\pm$ SD)	Change	p-value*
Total Score (%)	44.3 $\pm$ 22.2	89.0 $\pm$ 8.3	+44.7	<0.001
Blood pressure measurement	42.8 $\pm$ 22.5	89.6 $\pm$ 8.7	+46.8	<0.001
Blood glucose measurement	38.2 $\pm$ 24.1	87.3 $\pm$ 9.2	+49.1	<0.001
BMI and waist circumference	55.6 $\pm$ 20.8	92.4 $\pm$ 6.5	+36.8	<0.001
Result interpretation/counseling	40.5 $\pm$ 21.3	86.7 $\pm$ 8.9	+46.2	<0.001
Equipment maintenance/hygiene	44.8 $\pm$ 22.0	88.8 $\pm$ 8.5	+44.0	<0.001

*Wilcoxon signed-rank test, $p < 0.05$ considered significant

Total practical competency improvement reached 44.7% (from 44.3% to 89.0%) and was statistically significant ($p < 0.001$). The highest improvement occurred in blood glucose measurement (+49.1%), which was the area with the lowest pre-intervention score (38.2%). This improvement reflects the effectiveness of hands-on practice sessions using portable devices and simulations facilitated by health workers. Prior to intervention, many cadres had never used glucometers or had only received theoretical explanations without practical training, a finding consistent with studies in Simalungun (Ginting, 2025).

This improvement in practical competency is critically important because research in Aceh found that although training was valued by cadres, from the community's perspective, improved knowledge did not always translate into credible guidance if not supported by adequate practical competency (Randell et al., 2024). This program addressed this issue by providing extensive opportunities for hands-on practice and simulation, thereby building cadres' confidence and credibility in the eyes of the community. The inclusion of equipment maintenance and hygiene skills is particularly relevant in North Sumatra, where equipment damage and poor infection control have been identified as challenges (Pohan, 2025).

Table 4. Proportion of Cadres with Adequate Practical Competency (Score $\geq 75\%$)

Competency Aspect	Pre-Intervention n (%)	Post-Intervention n (%)	Change
Blood pressure measurement	8 (17.8%)	42 (93.3%)	+75.5%
Blood glucose measurement	6 (13.3%)	40 (88.9%)	+75.6%
BMI and waist circumference	14 (31.1%)	43 (95.6%)	+64.5%
Result interpretation/counseling	7 (15.6%)	41 (91.1%)	+75.5%
Equipment maintenance/hygiene	9 (20.0%)	42 (93.3%)	+73.3%
All competency aspects	4 (8.9%)	38 (84.4%)	+75.5%

*McNemar's test, $p < 0.001$ for all aspects

Before the intervention, only 8.9% of cadres had adequate practical competency across all aspects. After the intervention, this proportion increased to 84.4% ($p < 0.001$). This demonstrates that the program not only improved average scores but also transformed the majority of cadres from incompetent to competent categories. The greatest improvement in the proportion of cadres achieving adequacy was in blood glucose measurement (+75.6%), reflecting the initial very low competency in this skill.

The three regencies showed similar patterns of improvement, though Simalungun cadres had slightly lower post-intervention scores (88.2%) compared to Deli Serdang (89.5%) and Karo (89.2%), likely reflecting the greater baseline challenges in the more remote regency with limited access to supervision from health centers. However, these differences were not statistically significant ($p=0.242$).

Impact on Referrals

Analysis of referral data from the three-month periods before and after intervention showed a significant increase in the number of community members referred to primary health centers for confirmatory diagnosis (Table 5).

Table 5. Comparison of Referral Numbers Before and After Intervention by Regency

Period	Deli Serdang	Simalungun	Karo	Total
3 months before intervention	22	13	12	47
3 months after intervention	62	45	49	156
Increase	+40 (181.8%)	+32 (246.2%)	+37 (308.3%)	+109 (231.9%)

The increase in referrals from 47 to 156 (a 231.9% increase) reflects the program's success in enhancing cadres' capacity to identify individuals with NCD risk factors and refer them to health facilities. This increase also indicates that cadres became more confident in conducting early detection and better understood referral criteria. The highest proportional increase occurred in Karo Regency (308.3%), where the baseline referral rate was lowest, reflecting the significant impact of capacity building in more remote areas.

Qualitative feedback from focus group discussions revealed that before the intervention, many cadres were unsure about what constituted abnormal blood pressure or glucose readings requiring referral. After training, they felt confident in their ability to identify at-risk individuals. A cadre from Simalungun shared: "Before, I only knew how to measure blood pressure but didn't understand what the numbers meant. Now I can explain to people whether their numbers are normal or need to see the doctor."

These findings align with the community-based project in Myanmar that successfully screened 45,393 people and referred thousands of patients for treatment (World Health Organization, 2025), as well as the study in Nepal that developed screening and referral guidelines for NCDs at the community level (Malla et al., 2025). This success also supports the Indonesian Ministry of Health's strategy to strengthen Posbindu PTM as a community-based health effort encompassing early detection, health promotion, and referral (Dinas Kesehatan Provinsi Sumatera Utara, 2025).

Qualitative Findings

Focus group discussions conducted with cadres after program completion revealed several important themes:

1. Increased Confidence and Motivation

Cadres across all three regencies reported increased confidence in their ability to perform health screenings and provide health education. A cadre from Deli Serdang stated: "Before, I was afraid of making mistakes when measuring blood pressure. Now I feel confident and community members trust me more." Another from Karo added: "People used to think we were just playing around. Now they come to us asking for check-ups."

2. Improved Community Acceptance

Cadres noted that community members showed greater trust and willingness to participate in screening activities after cadres demonstrated improved competence. A cadre from Simalungun observed: "When people saw that we could correctly measure blood pressure and explain the results, more of them came to Posyandu. Even my neighbors who previously never came now ask about their health."

3. Cultural Sensitivity as Key Success Factor

Participants emphasized that the use of local languages and incorporation of cultural practices were important for program success. A cadre from Karo noted: "Using Karo language in health education made people feel more comfortable and understood. They could ask questions without feeling shy." Similarly, a cadre from Simalungun highlighted: "We adapted the schedule to the farming season, so farmers could participate during the dry season when they are not planting."

4. Challenges in Maintaining Skills

Despite the positive outcomes, cadres expressed concern about maintaining their skills over time. Several mentioned needing regular refresher training and supervision. A cadre from Deli Serdang stated: "We need periodic training. If we don't practice for a while, we might forget the steps." This aligns with research in Southwest Papua identifying sustainability as a key challenge (Samaran, Mustamu, & Mamo, 2025).

5. Equipment Availability

Cadres highlighted the importance of having adequate and functioning equipment. Some noted that their Posyandu had only one sphygmomanometer that was used for both adults and children, creating practical challenges. A cadre from Simalungun

shared: "We have only one blood pressure device for the whole village. During screening events, we often have long queues, and people lose patience."

6. Need for Health Center Support

Cadres expressed appreciation for the support provided by health centers during the program but noted that this support needed to be sustained. A cadre from Karo stated: "The nurses from the health center were very helpful. But we hope they continue coming to supervise us, not just during the training period."

Discussion

Effectiveness of the Participatory Approach

This program demonstrates that a community-based participatory approach involving cadres in problem identification and co-design of solutions is highly effective in enhancing capacity and program sustainability. Cadres who were actively involved demonstrated a strong sense of ownership and were more motivated to apply the skills they learned. The integration of cultural elements—such as using local languages, adapting to farming schedules, and leveraging kinship systems—was particularly important in the diverse North Sumatran context.

Previous research in Indonesia has shown that determinants of community empowerment processes include predisposing factors, group structure, and group climate, which play important roles in the success of community-based programs (Trisnowati, Ahsan, & Kramer, 2024). In this program, these factors were accommodated through:

- a) **Predisposing factors:** Increasing cadres' awareness of the importance of their roles and the urgency of NCDs through initial education
- b) **Group structure:** Forming learning groups and peer support systems among cadres across villages
- c) **Group climate:** Creating a supportive environment through discussion forums and positive feedback

The participatory approach was particularly effective in addressing the specific challenges of the North Sumatra context. For example, in the agricultural districts of Simalungun, the program schedule was adapted to coincide with the non-planting season when farmers have more free time. In Karo highlands, the program incorporated elements of the "kerja sama" (mutual cooperation) tradition that is strong in the region. In Deli Serdang, the approach leveraged the established Posyandu infrastructure and existing relationships with community leaders.

This approach also addressed the challenges identified in Aceh, where cadres were found to belong to the community but not to the health system (Randell et al., 2024). By involving cadres in program design and bridging relationships with primary health centers through clear referral systems and designated liaison officers, this program helped reduce the gap between cadres and the formal health system. The establishment of direct communication channels between cadres and health center staff was particularly valued by participants.

Factors Contributing to Program Success

Several factors contributed to the success of this program:

1. Partnership with Local Institutions

Strong partnerships with village governments, primary health centers, and community organizations were essential. The involvement of traditional leaders in community engagement activities enhanced program credibility and acceptance. In Batak communities, the support of "raja" (traditional chiefs) was particularly valuable, while in Malay coastal communities, the backing of "datuk" or religious leaders facilitated community participation. This finding aligns with research in Medan City, which found that community-based interventions that incorporated local cultural practices were more successful in achieving sustainable behavior change compared to standardized approaches (Nasution & Harahap, 2025).

2. Practical, Hands-On Training

The emphasis on practical skills and competency-based training was more effective than traditional lecture-based approaches. Cadres valued the opportunity to practice with real equipment and receive individual feedback. This is consistent with the experiential learning theory, which suggests that adults learn best through experience and reflection.

3. Culturally Appropriate Materials

The development of health education materials using local languages, idioms, and examples made the content more accessible and relevant to both cadres and community members. For example, in the Batak community, traditional food examples and cooking practices were incorporated into discussions about diet and nutrition, making the risk factor education more relatable. The use of visual aids and simple illustrations was particularly important for cadres with lower literacy levels.

4. Peer Support and Learning Groups

The formation of learning groups and peer support networks among cadres created opportunities for ongoing learning and mutual support. Cadres reported that they continued to practice together between formal training sessions, reinforcing their learning. A cadre from Karo explained: "We formed a small group and we practice together every week. If one of us forgets a step, others remind her."

5. Clear Referral Pathways

The establishment of clear referral pathways, including standardized forms and direct communication channels with health centers, helped ensure that the cadres' screening activities translated into actual care for community members. This addresses a common challenge in community-based health programs where screening is conducted but follow-up is inadequate.

Challenges and Barriers

Despite the positive outcomes, the program faced several challenges:

1. Geographic Barriers

The dispersed nature of the target villages, particularly in Simalungun and Karo, made logistics difficult and increased the time and resources required. Some cadres traveled over 10 kilometers to attend training sessions. Future programs should consider more localized training venues or mobile training approaches.

2. Competing Responsibilities

Many cadres had competing responsibilities, including work (farming, trading) and domestic duties. Scheduling that accommodated these responsibilities was essential but sometimes difficult. A cadre from Simalungun noted: "During the planting season, I cannot attend training because I need to work in the rice fields. We need training schedules that consider the farming calendar."

3. Limited Equipment

The program provided devices for training, but cadres noted that their Posyandu often lacked sufficient equipment for ongoing screening activities. While each village was provided with one set of equipment through this program, cadres felt that more equipment would be needed for community-wide screening.

4. Health Worker Turnover

Some primary health centers experienced staff turnover during the program period, which affected continuity of supervision. This highlights the need for institutionalized rather than person-dependent support systems.

5. Community Awareness

Despite improvements in screening capacity, cadres noted that community awareness of NCDs remained low in some areas. Many people were reluctant to attend screening events because they felt healthy. Continued health promotion efforts will be needed alongside screening programs.

Comparison with Other Regions

The results of this program are comparable to similar programs in other regions of Indonesia and other countries. The improvement in knowledge scores (+32.2%) and practical competency (+44.7%) is similar to the findings in Southwest Papua where training showed significant improvement in the intervention group (Samaran, Mustamu, & Mamo, 2025). The increase in referrals (231.9%) is consistent with the Myanmar community-based project (World Health Organization, 2025) and the Lesotho screening program (Lejone et al., 2025).

However, the North Sumatra context presented some unique challenges and opportunities. The province's diversity—with coastal, highland, and urban areas; multiple ethnic groups; and varying levels of healthcare access—required a flexible approach that could be adapted to local conditions. The program's success in achieving relatively consistent results across three different regencies suggests that the participatory, adaptable approach is effective across diverse contexts.

Implications for Policy and Practice

The findings of this program have important implications for health policy and practice in North Sumatra and beyond:

1. Cadre Capacity Strengthening

The significant improvement in knowledge and practical competency demonstrates that investment in structured and integrated cadre training is highly beneficial. Policies supporting continuous training and provision of portable health equipment for cadres

should be prioritized. The North Sumatra Provincial Health Office should consider expanding this program to all 33 regencies/cities in the province. The strong results from Simalungun and Karo—regencies that previously had limited cadre training—suggest that the program can be effectively implemented even in resource-constrained settings.

2. Integration into the Health System

This program demonstrates the importance of bridging the relationship between cadres and the formal health system. Policies supporting bidirectional referrals, integrated recording, and routine supervision by health workers will enhance cadre effectiveness. As found in Aceh, cadres need to be viewed not merely as community volunteers but as part of the broader health system (Randell et al., 2024). The use of designated liaison officers in this program proved effective and should be institutionalized.

3. Cultural Adaptation

The success of culturally adapted approaches suggests that programs should be designed with attention to local culture, language, and social structures. The North Sumatra Health Office should develop culturally sensitive program guidelines that can be adapted by different districts. This aligns with the provincial government's commitment to culturally appropriate health services, as articulated in the North Sumatra Health Development Plan 2025-2030 (Pemerintah Provinsi Sumatera Utara, 2025).

4. Sustainability Approaches

The short-term success of this program needs to be followed by sustainability strategies including:

- a) Periodic refresher training conducted by primary health centers
- b) Strengthened monitoring and evaluation systems
- c) Continued partnerships with village governments and primary health centers
- d) Incentives for cadres to maintain motivation, which could include recognition in village meetings, priority access to health services, and small allowances where feasible
- e) Ensuring adequate equipment and supplies at the Posyandu level
- f) Experience in Myanmar demonstrates that recognition of cadres' roles and establishment of community trust funds can support program sustainability after project completion (World Health Organization, 2025). In North Sumatra, some villages have established "dana desa" (village funds) that could potentially support health activities, a possibility that should be explored.

5. Health Equity

This approach contributes to health equity by improving access for rural communities to NCD screening services. As emphasized within the CBPR framework, this approach offers an equity-based perspective in operationalizing people-centered care (Rosa et al., 2025). By empowering cadres from the community itself, this program reduces access barriers and improves cultural appropriateness of services. The program's success in remote Simalungun villages, where travel to health centers can take several hours, is particularly significant for health equity.

6. Economic and Health Impact

Investment in cadre capacity strengthening has significant economic and health impacts. OECD analysis shows that if Indonesia achieved risk factor prevalence levels in the top quartile of OECD and EU countries, there would be 945,991 preventable new NCD cases per year, a 6.8% reduction in premature mortality, 5.3% health expenditure savings, and a 1.4% GDP increase (OECD, 2026). Programs like this, when scaled across North Sumatra's 14 million population, could contribute substantially to these outcomes. The program also directly contributes to achieving Sustainable Development Goal (SDG) target 3.4 to reduce premature mortality from NCDs by one-third by 2030.

Program Limitations

This program has several limitations that should be acknowledged:

1. Pre-Post Design without Control Group

This limitation makes it difficult to isolate the effect of the intervention from other factors that may have influenced outcomes, such as increased general awareness about NCDs or the influence of other programs in the area. Without a control group, we cannot definitively attribute all improvements to the intervention.

2. Short Evaluation Timeframe

Evaluation was conducted immediately after the intervention, thus it has not yet been possible to assess long-term sustainability of impact. Cadres themselves expressed concern about maintaining skills over time, indicating that a longer follow-up period would be valuable.

3. Limited Sample Size

With 45 cadres from three regencies, generalization of results to the broader North Sumatra province (33 regencies/cities) should be done cautiously. However, the selection of diverse regencies representing different geographical and cultural contexts does support some degree of generalizability.

4. Potential Social Desirability Bias

Cadres may have provided "expected" answers in questionnaires and competency assessments, although efforts were made to minimize this bias through clear communication about the non-evaluative purpose of the assessment. The use of practical competency assessments rather than only self-report helps reduce this bias.

5. Focus on Hypertension and Diabetes

This program only focused on two major NCDs and did not include other NCDs such as heart disease, stroke, and cancer, which also represent a significant burden in Indonesia and in North Sumatra specifically. A study in Medan found that cancer incidence is increasing in the province, highlighting the need for broader NCD programs (Siregar et al., 2024).

6. Gender Imbalance

The program largely engaged female cadres, and male cadres might have different needs and motivations. The very low male participation (4.4%) is consistent with the

general pattern in Indonesia but may limit the program's effectiveness in contexts where male involvement in community health activities is important. Future programs should consider strategies to encourage male cadres to participate.

Recommendations for Future Development

Based on the results and discussion, several recommendations for future development:

1. Research with Stronger Design

Studies with cluster randomized controlled trial designs are needed to evaluate program effectiveness more rigorously and measure long-term impact on population health outcomes. A follow-up study in the same villages after 12 months would provide valuable data on sustainability. The North Sumatra Provincial Health Office could collaborate with universities to conduct such research.

2. Program Scale-Up

Given the program's success in three regencies, there is strong justification for scaling up to other regencies in North Sumatra. A phased approach could start with regencies that have similar characteristics (such as Langkat, Dairi, and Toba Samosir), followed by more challenging settings. Key considerations for scale-up include:

- a) Standardization of training materials while allowing for local adaptation
- b) Integration with existing Posbindu PTM strengthening efforts
- c) Coordination with district health offices to ensure local ownership
- d) Development of a trained pool of facilitators to deliver training

3. Development of More Comprehensive Training Modules

Training modules could be developed to include other NCDs such as cervical and breast cancer, as planned in Myanmar (World Health Organization, 2025). In North Sumatra, cervical cancer is a significant health issue, and integrating training on cervical cancer screening and referral would be valuable. The modules should also include stress management and mental health, which are important issues in NCD management. Given the diverse ethnic groups in North Sumatra, the modules should be available in multiple local languages.

4. Technology Integration

Utilization of technology such as tablet-based clinical applications to support clinical decision-making by cadres, as proven effective in Lesotho (Lejone et al., 2025), could improve accuracy and efficiency. In North Sumatra, the increasing availability of mobile phone networks (including 4G coverage even in many rural areas) presents opportunities for mobile health (mHealth) interventions. However, careful consideration of technological literacy and equipment costs is needed. A hybrid approach—starting with simple applications on smartphones available to some cadres, gradually expanding as capacity improves—might be appropriate.

5. Strengthening Monitoring and Evaluation Systems

Continuous monitoring and evaluation systems should be developed to track cadre performance and patient outcomes over time, including reminder systems to ensure follow-up visits. The monitoring system should be integrated with the existing health

information system (Sistem Informasi Kesehatan) used by primary health centers. Simple formats such as monthly reporting forms, as used in this program, should be institutionalized.

6. Multi-Sector Partnerships

Strengthening partnerships with village governments, the private sector, and community organizations to support program sustainability. In North Sumatra, several companies operate plantations and could potentially support community health programs as part of their corporate social responsibility activities. The "Corporate Social Responsibility" (CSR) funds from companies such as palm oil, rubber, and tobacco companies could be explored.

7. Incentive Development

Appropriate incentive models need to be studied to maintain cadre motivation, including social recognition, advanced training, and possible financial incentives. A pilot program in Deli Serdang could explore different incentive models (e.g., recognition at village meetings, priority health services, small monthly allowances) and evaluate their effectiveness.

8. Integration of Traditional Health Systems

The Batak traditional healing system (called "data" or "belian") and Malay traditional health practices have significant influence in North Sumatran communities. Future programs should explore ways to work with traditional healers to promote NCD prevention and early detection, building on the cultural sensitivity already incorporated in this program. Research in Malaysia has shown that integrating traditional healers into NCD programs can be effective, and similar approaches could be tested in North Sumatra.

CONCLUSION

This community health cadre empowerment program through integrated health education with a community-based participatory approach successfully and significantly improved cadres' knowledge and practical competence in early detection and management of hypertension and diabetes mellitus in three regencies of North Sumatra Province. Total knowledge improvement of 32.2% ($p < 0.001$) and practical competency improvement of 44.7% ($p < 0.001$) demonstrate the effectiveness of structured training interventions accompanied by hands-on practice. The 231.9% increase in community referrals to primary health centers reflects the program's tangible impact on access to health services at the community level, with the highest proportional increase occurring in the most remote regency (Karo: 308.3%).

The success of this program was primarily supported by the participatory approach that involved cadres in problem identification and co-design of solutions, thereby creating a sense of ownership and high motivation. The integration of culturally appropriate elements—such as using local languages, adapting to farming schedules, and leveraging kinship systems—was particularly important in the diverse North Sumatran context,

with strong partnerships with local institutions including village governments, primary health centers, and traditional leaders contributing to program effectiveness.

This approach also helped bridge the gap between cadres and the formal health system, which had previously been a barrier to optimal utilization of cadre potential. The establishment of clear referral pathways and direct communication channels with health centers was critical to translating screening activities into actual care for community members.

These findings have important implications for strengthening Indonesia's primary healthcare system, particularly in North Sumatra, in facing the continuously increasing NCD burden. With data showing that 65 million Indonesians suffer from hypertension and 30 million have diabetes (Tarmizi, 2025), and that over 70% of NCD sufferers are unaware of their condition (Aminullah, 2026), cadre empowerment becomes a highly relevant and cost-effective strategy. The program's success in remote and resource-constrained settings in North Sumatra suggests similar approaches could be effective in other parts of Indonesia with comparable characteristics.

This program demonstrates that empowering cadres through integrated, comprehensive education grounded in participatory principles is a viable and effective strategy to strengthen primary healthcare systems, enhance early disease detection capacity, and promote sustainable chronic disease management at the grassroots level. This underscores the critical synergy between community education and public health outcomes, in line with the promotive and preventive health service transformation efforts being promoted by the Indonesian Ministry of Health (Aminullah, 2026).

For sustainability and impact expansion, consistent policy support from the North Sumatra Provincial Government, cross-sector partnerships, continuous capacity development, and investment in monitoring and evaluation systems are required. The successful implementation of the Posbindu PTM program in North Sumatra depends on sustained commitment from all stakeholders, including the provincial health office, district health offices, primary health centers, village governments, community leaders, and the cadres themselves. With collective commitment from all stakeholders, community health cadre empowerment can become a main pillar in the national effort to control the NCD epidemic and achieve universal health coverage in Indonesia.

Funding Statement

"No external funding was received for this study."

Ethical Compliance

This study was conducted in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki Declaration and its later amendments. Informed consent was obtained from all adult participants, while parental/guardian consent and participant assent were secured for minor participants. Institutional permission was granted by the pesantren leadership (*kyai*). Anonymity and confidentiality of all participants and the research site were strictly maintained through pseudonyms.

Data Access Statement

No datasets were generated or analyzed during the current study.

Conflict of Interest declaration

The authors declare that they have no competing interests, financial or otherwise, in relation to this research. No external funding or institutional affiliations have influenced the design, implementation, analysis, or reporting of this study.

Acknowledgment

The authors thank the North Sumatra Provincial Health Office, the District Health Offices of Deli Serdang, Simalungun, and Karo, and the village governments for their support. We are grateful to the community health cadres, primary health center staff, and community members for their active participation. This program was supported by the Faculty of Public Health, Universitas Sumatera Utara.

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Published by IPI Global Press in collaboration with the Inovasi Pratama Internasional Ltd