

Effectiveness of an integrated nutrition and sanitation education on community health cadres' knowledge and attitudes: A quasi-experimental study

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ABSTRACT

Stunting continues to represent a critical public health concern in Indonesia, with community health cadres playing a pivotal role in preventive efforts at the grassroots level. Despite this, empirical evidence evaluating integrated training approaches combining nutrition education with sanitation-based approaches remains limited. This study aimed to evaluate the effectiveness of the Integrated Stunting Prevention Education (SIDUCETING) program in improving the knowledge and attitudes of community health cadres. A quasi-experimental study with non-equivalent control groups was conducted from June to September 2019. A total of 63 cadres participated in the study, comprising an intervention group (n=32), and a control group (n=31). The intervention group consisted of a two-day SIDUCETING training program integrating nutrition-specific education with Community-Based Total Sanitation (STBM) principles, emphasizing experiential learning through practical demonstrations and hands-on skill development. Cadre's knowledge was measured using a 20-item questionnaire, while attitudes were assessed using a 15-item Likert-scale instrument at baseline and immediately following post-intervention. Data were analyzed using the Mann-Whitney U test and the Wilcoxon signed-rank test. Baseline assessments indicated no significant differences between groups in knowledge ($p=0.357$) or attitude scores ($p=0.985$). Post-intervention, the intervention group demonstrated significant improvements in both knowledge (median: 10 to 18, $p<0.001$) and attitudes (median: 42 to 54, $p<0.001$), while the control group remained unchanged. Between-group analysis revealed significant differences in knowledge change (Cohen's $d=0.22$; 95% CI: 0.05–0.39) and attitude change (Cohen's $d=0.76$; 95% CI: 0.52–1.01). No significant correlations were identified between demographic characteristics and outcomes. These findings indicate that the SIDUCETING intervention is effective in improving community health cadres' knowledge and attitudes toward stunting prevention, supporting the scalability of short-duration, integrated training programs for broader implementation with Indonesia's community health system.

Keywords:

Attitudes; Growth Disorders; Health Education; Health Knowledge; Indonesia; Practice

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INTRODUCTION

Stunting, defined as length-for-age or height-for-age below minus two standard deviations from the World Health Organization (WHO) growth standards, remains a major global public health challenge, affecting an estimated 148.1 million children under five years worldwide.¹ Beyond impaired physical growth, stunting is associated with long-term adverse consequences, including delayed cognitive development, poorer educational achievement, and reduced long-term economic productivity.² A recent Lancet series on maternal and child nutrition emphasized that effective reduction of malnutrition requires comprehensive approaches integrating nutrition-specific and nutrition-sensitive interventions, with community-based strategies as essential components for sustainable impact.³ In Southeast Asia, persistently high stunting prevalence continues to pose significant developmental challenges, requiring sustained multisectoral interventions to achieve Sustainable Development Goal targets by 2030.^{4,5}

Indonesia has made substantial progress in stunting reduction, with national prevalence declining from 37.2% in 2013 to 19.8% in 2024, representing a remarkable achievement in public health intervention.⁶ Nevertheless, approximately 4.48 million Indonesian children remain affected by stunting, with pronounced geographical disparities evident across provinces, ranging from 8.6% in Bali to 37.0% in East Nusa Tenggara.⁷ In response, the Indonesian government has reinforced its commitment, establishing stunting reduction as a national priority with ambitious targets to achieve 14.2%

prevalence by 2029. Achieving this goal will require accelerated implementation of evidence-based interventions, particularly at community levels.⁷

Community health cadres serve as the frontline health workforce in Indonesia, reaching approximately 280,000 integrated health posts nationwide.⁸ These volunteer workers play pivotal roles in growth monitoring, nutrition education, health service facilitation, and early detection of malnutrition within their communities. Despite their strategic positioning, substantial evidence indicates that cadres face significant challenges in executing their responsibilities effectively, particularly in interpreting growth curves, conducting accurate anthropometric measurements, and providing effective behavior change counseling to caregivers.^{9,10} International systematic reviews have confirmed that community health worker models can be effective in preventing and managing child undernutrition when supported by high-quality training and supervision, with key facilitators including community connection, close proximity to populations served, and investment in high-quality training and tools.¹¹

Evidence from systematic reviews demonstrates that targeted nutrition training for health workers can lead to meaningful improvement in child feeding practices and nutritional outcomes, with reported standardized mean differences ranging from 0.48 to 1.06 across multiple outcomes.¹² A recent scoping review of health promotion interventions grounded in Social Cognitive Theory (SCT) highlighted self-efficacy as the most utilized construct influencing behavior change, followed by observational learning through role models as the second most common approach.

Across diverse settings, SCT-based interventions consistently demonstrated beneficial impacts on health-related outcomes.¹³ Consistent with these findings, Indonesian studies have similarly documented that structured training programs can enhance cadre knowledge by 25% to 45%, attitudes toward stunting prevention, and growth monitoring skills.^{14,15} However, critical gaps persist in the literature, particularly with respect to the integration of nutrition-specific interventions with nutrition-sensitive approaches, particularly the alignment of Community-Based Total Sanitation (*Sanitasi Total Berbasis Masyarakat* [STBM]) and stunting prevention at the community health worker level.

Further evidence supports the value of integrated approaches that address both nutritional and environmental determinants of child growth. A systematic review and meta-analysis found that combined water, sanitation, and hygiene (WASH) components with nutrition interventions showed strong effects on height-for-age z-scores, suggesting that integrated approaches may be more effective than single-component interventions for improving child growth outcomes.¹⁶ Children living in households lacking improved sanitation demonstrate 40% greater likelihood of being stunted compared to those with adequate sanitation facilities, underscoring the importance of addressing WASH (water, sanitation, and hygiene) determinants alongside nutritional interventions for comprehensive stunting prevention.¹⁷

These persistent gaps reflect broader challenges commonly reported in the community health worker literature, including inadequate initial training, insufficient refresher education, weak supervision systems, and limited integration of complementary intervention components.¹⁸ Theoretical frameworks emphasizing adult learning principles, Social Cognitive Theory constructs, such as

self-efficacy and observational learning, as well as competency-based education approaches, suggest that effective cadre training must extend beyond didactic knowledge transfer to incorporate participatory methods, skills practice with feedback, and supportive supervision.^{19,20} According to the SCT framework, behavior change interventions are most effective when they strengthen self-efficacy through achievable goal setting, observational learning, as well as using performance feedback and reinforcement – principles that informed the pedagogical foundation of the SIDUCETING intervention.^{20,21}

In response to these identified gaps and informed by evidence-based training principles, the Integrated Stunting Prevention Education program, known by its Indonesian acronym SIDUCETING (*Sistem Edukasi Terpadu Pencegahan Stunting*), was developed. This intervention represents an innovative approach combining nutrition-specific education on growth monitoring, complementary feeding, and early malnutrition detection with nutrition-sensitive content on Community-Based Total Sanitation principles. The training is delivered over two intensive days in small groups of six to seven cadres to promote peer interaction, experiential learning, and collaborative problem-solving.

Despite the acknowledged importance of strengthening community health worker (cadre) capacity for stunting prevention, rigorous evaluations of integrated training interventions in Indonesian contexts remain limited. Existing studies largely emphasize short-term knowledge gains, with relatively little attention to changes in attitudes that may influence sustained behavior change. Moreover, few studies integrate nutrition and sanitation components within a unified training curriculum, and many rely on single-group pre-post designs without comparison groups, thereby constraining causal inference regarding intervention

effectiveness.^{22,23} Consequently, it remains unknown whether integrating nutrition-specific and nutrition-sensitive content within a single training curriculum can produce synergistic effects for cadre knowledge and attitudes, and whether such integrated approaches demonstrate advantages over conventional single-component training programs. Evidence is also limited regarding the effectiveness of short-duration integrated training across cadres with diverse demographic characteristics. Therefore, this study aimed to evaluate the effectiveness of the SIDUCETING intervention in improving the knowledge and attitudes of community health cadres regarding stunting prevention in Moyo Hilir District, Sumbawa Regency, West Nusa Tenggara Province, Indonesia.

METHODS

Study Design and Setting

This study employed a quasi-experimental design with non-equivalent control groups and was conducted in Moyo Hilir District, Sumbawa Regency, West Nusa Tenggara Province, Indonesia, between June and September 2019. Figure 1 presents a flow diagram showing participant enrolment, allocation, follow-up, and analysis. A quasi-experimental design was selected as true randomization at the individual level was not feasible in this community-based setting, where cadres operate within established Posyandu clusters and individual randomization could lead to contamination effects between intervention and control participants.

Population and Sampling

The target population consisted of all active community health cadres registered in Moyo Hilir District, Sumbawa Regency, involving the cadres from Posyandu that met the following inclusion criteria: (1) active cadre status for at least one year, (2) regular participation in monthly Posyandu activities, and (3)

willingness to participate in a two-day training program. Meanwhile, exclusion criteria included cadres who were pregnant or had health conditions preventing participation in extended training sessions. Cadres aged above 55 years were initially excluded from the sampling frame; however, those who self-reported ages within the eligible range were found to be slightly older during data collection, accounting for the presence of cadres aged 46-55 years in the final sample.

Sample size was calculated using G*Power 3.1 software for detecting differences between two independent groups. Based on previous Indonesian cadre training studies reporting effect sizes ranging from 0.60 to 0.80, a medium-to-large effect size (Cohen's $d=0.70$) was assumed. With $\alpha=0.05$ (two-tailed), statistical power of 0.80, and allocation ratio of 1:1, the minimum required sample size was 27 participants per group (total $n=54$). Anticipating approximately 15% attrition, recruitment of 32 participants per group was also targeted. Employing one-stage cluster Posyandu clusters were first stratified by geographic location, and then entire clusters were allocated to intervention or control conditions to minimize contamination. A total of 63 cadres were enrolled (intervention $n=32$, control $n=31$). Post-hoc power analysis confirmed that this sample size provided 82% power to detect the observed effect sizes. A limitation of cluster allocation rather than individual randomization becomes the potential for pre-existing group differences; however, baseline homogeneity testing confirmed comparability between groups on all measured characteristics.

Data Collection Instruments

Knowledge Questionnaire

Cadres' knowledge regarding stunting prevention was measured using a 20-item questionnaire developed by the research team with reference to national

and international guidelines on child nutrition and growth monitoring. Item construction was informed by Indonesian Ministry of Health stunting prevention guidelines and WHO child growth monitoring standards, drawing specifically on the National Strategy for the Acceleration of Stunting Prevention 2018–2024, the Report on the Situation of Stunted Children in Indonesia, the Village Pocket Book for Stunting Prevention, and the Technical Implementation Guidelines for Community-Based Total Sanitation (STBM).^{24–26} Responses were scored using a Guttman scale format (0 = incorrect, 1 = correct), with total scores ranging from 0 to 20. Knowledge levels were categorized as low (<56% correct, score <11), moderate (56–75% correct, score 11–15), or high (>75% correct, score >15). These cut-off points were established based on Bloom's taxonomy-based educational assessment standards commonly applied in Indonesian health education research, in which lower scores below 56% indicate inadequate mastery, scores between 56–75% indicate developing competency, and scores above 75% indicate satisfactory mastery of content.

Content validity of the knowledge questionnaire was established through expert review using Aiken's V coefficient, with item-level values ranging from 0.67 to 1.00, indicating acceptable to excellent content validity. The validation panel comprised three experts – a pediatric nursing specialist, a maternity nursing specialist, and a child health specialist – selected based on academic qualifications (minimum master's degree), professional experience (minimum five years in the relevant field), and familiarity with community-based health interventions in Indonesia. Construct validity was further assessed through pilot testing involving 30 cadres who were not included in the main study, resulting in the removal of one item with inadequate discrimination. The internal consistency of the finalized 20-item

knowledge questionnaire was assessed using Cronbach's alpha, yielding a coefficient of 0.850, demonstrating good reliability.

Attitude Questionnaire

Cadre's attitudes toward stunting prevention were measured using a 15-item questionnaire adapted from previous research on examining health worker attitudes related to child nutrition and growth monitoring. The original instrument was developed by Kharyati, (2015)²⁷ and subsequently modified by the researchers to enhance contextual relevance. Modifications included contextualizing three added items to reflect STBM-specific attitudes, adapting the language to match the local Indonesian dialects used in Sumbawa, and removing two items from the original instrument that were not applicable to the Posyandu cadre context. These modifications were undertaken to ensure cultural relevance and alignment with the integrated nutrition-sanitation approach of the SIDUCETING intervention. The questionnaire was recorded using a 4-point Likert scale format (1 = strongly disagree, 2 = disagree, 3 = agree, 4 = strongly agree), with total scores ranging from 15 to 60, with higher scores indicating more positive attitudes supporting stunting prevention activities. Attitudes were categorized as unfavorable (score <35, representing <58% of maximum score), neutral (score 35–50, representing 58–83%), or favorable (score >50, representing >83%). These thresholds were derived from the theoretical distribution of Likert scale responses, in which neutral attitudes are expected to cluster around the midpoint of the scale, and are consistent with categorization approaches used in comparable Indonesian health worker attitude research.

Content validity of the attitude instrument was established through expert review using Aiken's V coefficient, with values ranging from 0.67 to 1.00, indicating

acceptable to excellent validity. The same three-member expert panel that validated the knowledge questionnaire – comprising specialists in pediatric nursing, maternity nursing, and child health – also reviewed the attitude instrument, ensuring consistency in validation procedures. Construct validity was further examined through pilot testing with 30 cadres who were not included in the main study, resulting in the removal of two items with inadequate item-total correlations. The final 15-item attitude questionnaire demonstrated high internal consistency reliability with Cronbach's alpha of 0.880.

Intervention: SIDUCETING Program

The Integrated Stunting Prevention Education (SIDUCETING) program consisted of a two-day training delivered to small groups of six to seven cadres. The training was facilitated by nursing faculty members with expertise in community health, maternal-child health, and nutrition education. To ensure standardization across all sessions, trainers utilized identical standardized training modules and followed uniform Standard Operating Procedures (SOPs). Prior to implementation, a trainer orientation was conducted to harmonize instructional strategies, practical demonstrations, and assessment methods. The detailed structure and content of the SIDUCETING intervention are presented in Table 1.

Session 1: Didactic Instruction (Day 1, Morning)

This session covered three integrated modules: (1) stunting etiology, consequences, and national prevention strategies; (2) Community-Based Total Sanitation (STBM) principles and their relationship to child nutrition; as well as (3) nutrition-specific and nutrition-sensitive interventions during the first 1000 days. Its content was delivered via PowerPoint presentations with video demonstrations of anthropometric measurement and

counseling techniques, supplemented by interactive discussion.

Session 2: Practical Demonstrations (Day 1, Afternoon and Day 2, Morning)

Cadres practiced skills using the SIDUCETING Kit containing: infantometer, stadiometer, stunting identification mat with color-coded zones, WHO height-for-age growth charts (0-60 months), plotting materials, instruction manual, and interpretation guidelines. Training covered proper child positioning, measurement recording (0.1 cm precision), growth chart plotting and interpretation, identification of children at risk of stunting, caregiver counseling on growth and nutrition, as well as the six-step handwashing technique recommended by WHO.

Session 3: Re-demonstration and Assessment (Day 2, Afternoon)

Representative cadres re-demonstrated learned skills for peers and instructors, including anthropometric measurement, growth chart interpretation, and integrated nutrition-sanitation counseling. The instructors provided immediate feedback to reinforce learning, correct errors, and build confidence.

Control Group

Cadres assigned to the control group did not receive the SIDUCETING intervention and continued to carry out routine Posyandu activities with standard local health system support, thereby serving as the comparison group reflecting usual practice. Routine Posyandu activities constituting 'usual practice' included monthly growth monitoring sessions (body weight and length/height measurement), distribution of supplementary feeding, basic health education delivered by Puskesmas (community health center) staff during monthly visits, immunization services, and referral of identified cases to health facilities as needed. During the study

period, control group cadres did not participate in any structured training programs; however, they retained access to existing reference materials provided by the District Health Office. The use of usual

practice rather than an active control condition was intended to evaluate the added value of integrated training over standard community health service delivery.

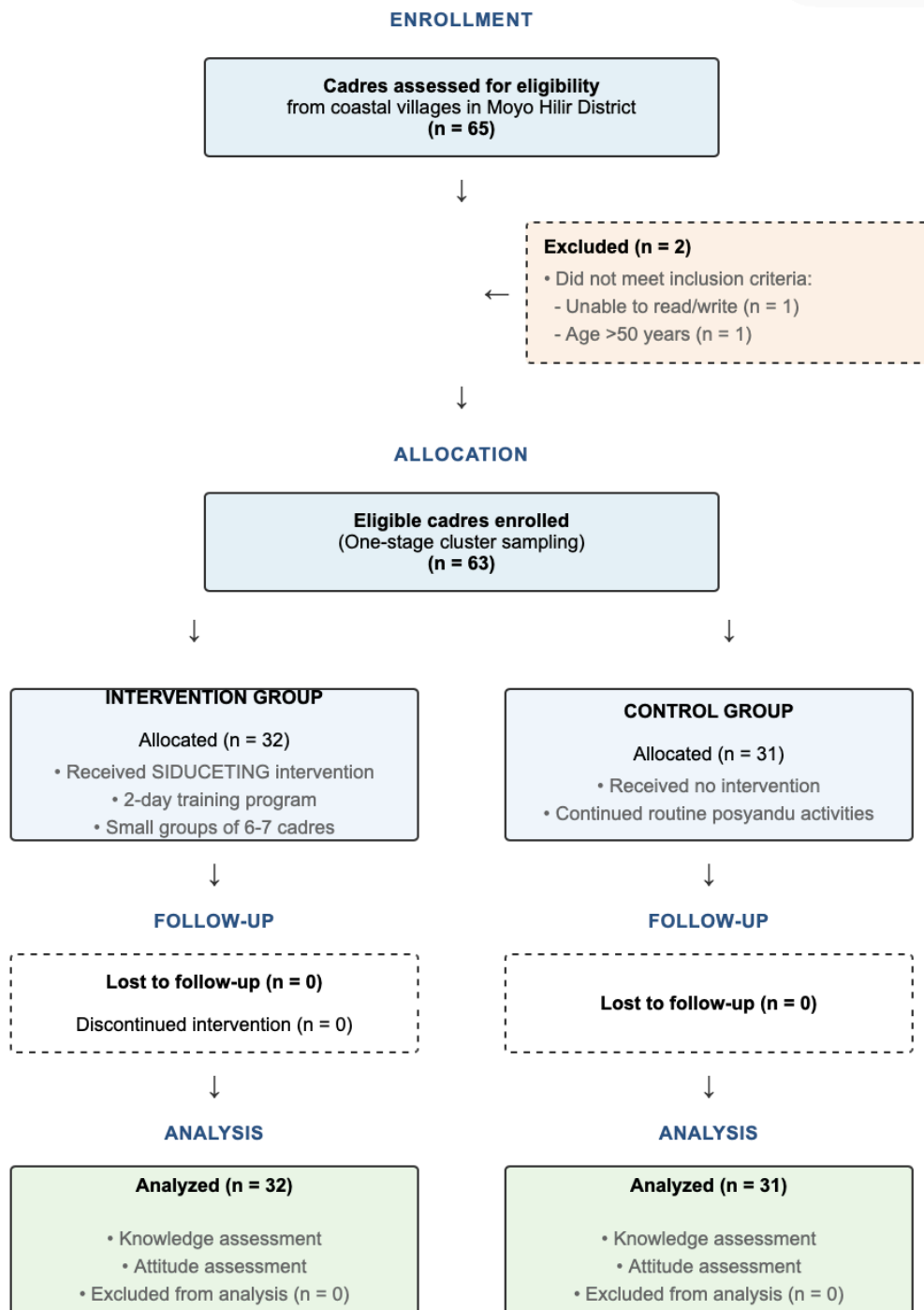


Figure 1. CONSORT flow diagram

Table 1. Structure and Components of SIDUCETING Intervention

Session	Timing	Duration	Learning Objectives	Content Components	Teaching Methods	Materials/Tools	Success Indicators
Session 1: Didactic Instruction	Day 1, Morning	3 hours	<i>By the end of this session, cadres will be able to:</i> 1. Define stunting and explain its etiology and consequences 2. Describe the national stunting reduction strategy 3. Identify the five pillars of STBM 4. Explain the relationship between sanitation and child nutrition 5. Describe critical interventions during the first 1000 days	- Stunting definition, etiology, and consequences - National stunting reduction strategy - Community-Based Total Sanitation (STBM) principles - Five pillars of STBM - Integration of nutrition-specific and nutrition-sensitive interventions - First 1000 days critical window	- PowerPoint presentations - Video demonstrations - Interactive discussion - Question and answer session - Experience sharing	- SIDUCETING module - Video on anthropometric measurement - Video on counseling approaches - Discussion guide	≥80% correct on knowledge post-test items (Session 1 content) - Active participation (≥1 question/comment per cadre) - Verbal demonstration of STBM-nutrition linkage understanding
Session 2: Practical Demonstrations	Day 1, Afternoon & Day 2, Morning	5 hours	<i>By the end of this session, cadres will be able to:</i> 1. Correctly position	- Proper child positioning for measurement - Accurate length/height	- Live demonstrations - Hands-on practice - Supervised skill practice	SIDUCETING Kit containing: Infantometer, Stadiometer, Stunting mat (tikar stunting), WHO height-for-age	≥80% skill checklist score for anthropometric measurement 100% accuracy in growth chart

Session	Timing	Duration	Learning Objectives	Content Components	Teaching Methods	Materials/Tools	Success Indicators
			children for length/height measurement 2. Perform accurate anthropometric measurements (± 0.1 cm) 3. Plot measurements correctly on WHO growth charts 4. Interpret growth patterns and identify at-risk children 5. Demonstrate proper handwashing technique 6. Deliver nutrition-sanitation counseling messages	measurement technique • Reading and recording measurements • Plotting on WHO growth charts • Interpreting growth chart patterns • Identifying children at risk of stunting • Counseling caregivers on growth status • WHO six-step handwashing technique • Linking sanitation to nutrition	• Small group activities • Peer practice sessions • Instructor feedback	charts (0-60 months), Plotting markers, Instruction manual, Interpretation guidelines, Example cases	plotting (3 practice cases) • Correct interpretation in ≥ 2 of 3 case scenarios • Demonstration of all 6 handwashing steps
Session 3: Re-demonstration and Assessment	Day 2, Afternoon	2 hours	<i>By the end of this session, cadres will be able to:</i> 1. Independently perform complete	• Cadre re-demonstration of: Anthropometric measurement, Growth chart plotting, Growth chart interpretation, Integrated	• Peer teaching • Performance assessment • Immediate corrective feedback • Group discussion	• SIDUCETING Kit • Assessment checklist • Feedback forms • Case scenarios	• $\geq 80\%$ score on skill assessment checklist • Successful re-demonstration completion (pass/fail) • Delivery of ≥ 3 key counseling messages without prompting

Session	Timing	Duration	Learning Objectives	Content Components	Teaching Methods	Materials/Tools	Success Indicators
			anthropometric assessment 2. Accurately interpret and communicate growth status 3. Deliver integrated counseling messages to caregivers 4. Demonstrate confidence in applying learned skills	nutrition-sanitation counseling messages	Confidence building activities		Self-reported confidence ≥ 3 (scale 1-4)
Total Duration	2 days	10 hours	15 learning objectives across 3 sessions	Comprehensive integration of theory and practice	Active learning approach	Complete SIDUCETING package	Minimum passing: $\geq 80\%$ on assessments

Data Collection Procedures

Data collection was conducted at three time points: baseline (pre-intervention), immediately post-intervention for the intervention group, and time-matched assessment for the control group. Following informed consent, all cadres completed the 20-item knowledge and 15-item attitude questionnaires in 30-45 minutes with research assistants available for clarification.

Four undergraduate nursing students served as research assistants and underwent a half-day training session on questionnaire administration procedures, including standardized instructions for participants, clarification of potentially ambiguous items, and maintaining neutrality during data collection. To reduce the risk of assessment bias, research assistants were blinded to group allocation. Following baseline assessment, cadres in the intervention group participated in the two-day SIDUCETING training and immediately repeated both questionnaires. Control group cadres completed identical questionnaires at equivalent intervals without training. The immediate post-test timing was intentionally selected to assess the initial effect of the intervention on knowledge acquisition and attitude formation. Although this approach does not permit evaluation of long-term retention or behavioral change, it is appropriate for assessing whether the intervention successfully achieved its proximal learning objectives prior to subsequent reinforcement and field application.

Statistical Analysis

Data were analyzed using SPSS version 25.0. Descriptive statistics were used to summarize participant characteristics, including age (25-35, 36-45, 46-55 years), education (junior high, senior high, university), and length of cadre experience. Categorical variables were

reported as frequencies and percentages, while continuous variables were reported as means $\pm$ SD or medians with interquartile ranges based on normality assessed by Shapiro-Wilk test.

Baseline homogeneity was tested using Kolmogorov-Smirnov test (age), chi-square test (education), and Mann-Whitney U test (experience, knowledge). Selection of statistical tests was based on data distribution and measurement level: the Kolmogorov-Smirnov test was used for continuous variables to assess distributional equivalence; chi-square test for categorical variables with adequate expected cell frequencies; and Mann-Whitney U test for ordinal data or continuous data that violated normality assumptions. Within-group changes were analyzed using Wilcoxon signed-rank test (knowledge) and paired t-test (attitudes). Between-group post-intervention differences were assessed using Mann-Whitney U test for both knowledge and attitude data, as both variables demonstrated non-normal distributions in the combined sample.

Effect sizes were calculated using Cohen's d adapted for non-parametric data (small=0.2, medium=0.5, large=0.8). There were 95% confidence intervals for effect sizes calculated using bootstrap resampling (1000 iterations) to account for the non-normal distribution of data. Spearman's correlation examined the correlation between demographics and outcomes (weak $|r| < 0.3$, moderate $|r| = 0.3-0.7$, strong $|r| > 0.7$). Statistical significance was set at $\alpha = 0.05$ (two-tailed), and missing data (<5%) were handled via listwise deletion.

RESULTS

Participant Characteristics and Baseline Homogeneity

Table 2 presents demographic characteristics of participating cadres. Most

intervention group cadres were aged 25-35 years (53.1%), while control group cadres were predominantly 36-45 years (54.8%). Age distribution indicated no significant difference between groups ($p=0.711$, Kolmogorov-Smirnov test). Educational attainment was comparable, with most

cadres completing senior high school (intervention: 62.5%; control: 51.6%; $p=0.297$). Mean cadre experience was 6.88 ± 5.723 years (intervention) and 9.23 ± 6.119 years (control), with no significant difference ($p=0.585$).

Table 2. Characteristics of Cadres in Intervention and Control Groups (n = 63)

Characteristic	Intervention (n = 32)	Control (n = 31)	p value
	f (%) / Mean $\pm$ SD	f (%) / Mean $\pm$ SD	
Age			0.711 ^a
25-35 years	17 (53.1%)	11 (35.5%)	
36-45 years	14 (43.8%)	17 (54.8%)	
46-55 years	1 (3.1%)	3 (9.7%)	
Education			0.297 ^a
Junior high school	5 (16.5%)	10 (32.3%)	
Senior high school	20 (62.5%)	16 (51.6%)	
University degree	7 (21.9%)	5 (16.1%)	
Years of experience as cadre	6.88 ± 5.723	9.23 ± 6.119	0.585 ^b

Note: ^aChi-square test; ^bMann-Whitney U test

Baseline and Post-Intervention Knowledge and Attitudes

Table 3 presents knowledge and attitude scores. At baseline, knowledge scores did not differ significantly between groups, with both the intervention group (median = 10; IQR 9-11) and control group (median = 9; IQR 9-10) classified within the low knowledge category (<56% correct; $p = 0.357$). Following the intervention, the intervention group demonstrated a marked increase in knowledge, reaching the high knowledge category (median 18, IQR 17-

18, >75% correct), while no meaningful change was observed among controls (median 9; IQR 9-10; $p<0.001$), resulting in a statistically significant between-group difference. Baseline attitude scores were likewise comparable between groups (both median = 42, neutral category; $p=0.985$). Post-intervention assessment indicated a substantial improvement in attitudes among intervention participants (median = 54, IQR 52-55), shifting to the favorable category, while the controls remained neutral (median 42, IQR 40-42; $p<0.001$).

Table 3. Baseline and Post-Intervention Knowledge and Attitudes of Cadres

Variable	Intervention Group (n = 32)	Control Group (n = 31)	p value
	Median (IQR Q1-Q3)	Median (IQR Q1-Q3)	
Pre-intervention knowledge	10 (9-11)	9 (9-10)	0.357
Post-intervention knowledge	18 (17-18)	9 (9-10)	<0.001*
Pre-intervention attitude	42 (39-43)	42 (40-43)	0.985
Post-intervention attitude	54 (52-55)	42 (40-42)	<0.001*

*Note: Mann-Whitney U test was performed; IQR = Interquartile range (Q1 = 25th percentile, Q2 = 50th percentile, Q3 = 75th percentile); $p < 0.05$ statistically significant

Within-Group Changes in Knowledge and Attitudes

Within-group analyses (Table 4) present significant improvement in the intervention group across both outcome measures. Knowledge scores increased from a median of 10 (IQR 9-11) to 18 (IQR 17-18; $p < 0.001$, Wilcoxon signed-rank test), progressing from low to high knowledge category. In contrast, the

control group showed no significant change in knowledge levels (both assessments: median 9, IQR 9-10; $p = 0.324$). Intervention group attitudes improved significantly from a median 42 (IQR 39-43) to 54 (IQR 52-55; $p < 0.001$, paired t-test), shifting from neutral to favorable. No significant change in attitudes was observed among controls, whose median scores remained stable (median 42 at both assessments; $p = 0.564$).

Table 4. Within-Group Changes in Knowledge and Attitudes from Pre-Intervention to Post-Intervention

Variable	Intervention Group (n = 32)		p value	Control Group (n = 31)		p value
	Pre-intervention	Post-intervention		Pre-intervention	Post-intervention	
	Median (IQR Q1-Q3)	Median (IQR Q1-Q3)		Median (IQR Q1-Q3)	Median (IQR Q1-Q3)	
Knowledge	10 (9-11)	18 (17-18)	<0.001*	9 (9-10)	9 (9-10)	0.324
Attitude	42 (39-43)	54 (52-55)	<0.001*	42 (40-43)	42 (40-42)	0.564

*Note: Wilcoxon signed-rank test was performed; IQR = Interquartile range (Q1 = 25th percentile, Q2 = 50th percentile, Q3 = 75th percentile); $p < 0.05$ statistically significant

Between-Group Comparison of Change Scores

Between-group comparisons of change score (Table 5) demonstrated that gains in knowledge were significantly greater in the intervention group (median = 8.00; IQR 7-9) compared to the controls (median 0.00, IQR -1 to 0; $p < 0.001$), with a

small effect size (Cohen's $d = 0.22$; 95% CI: 0.05-0.39). Attitude change was also significantly greater in the intervention group (median = 11.00; IQR 6-20) versus controls (median -1.00, IQR -1 to 1; $p < 0.001$), demonstrating a moderate-to-large effect size (Cohen's $d = 0.76$; 95% CI: 0.52-1.01).

Table 5. Between-Group Comparison of Change Scores in Knowledge and Attitudes

Variable	Intervention Group (n = 32)	Control Group (n = 31)	p value	Effect Size	CI
	Median Change (IQR Q1-Q3)	Median Change (IQR Q1-Q3)		Cohen's d	95%
Knowledge change	8.00 (7-9)	0.00 (-1 to 0)	<0.001*	0.22	0.05-0.39
Attitude change	11.00 (6-20)	-1.00 (-1 to 1)	<0.001*	0.76	0.52-1.01

*Note: $p < 0.05$ statistically significant; analyzed using Mann-Whitney U test; IQR = Interquartile range; Change scores calculated as (post-intervention score - pre-intervention score); Effect size interpreted as small ($d \approx 0.2$), medium ($d \approx 0.5$), or large ($d \approx 0.8$) according to Cohen's conventions; 95% CI estimated by bootstrap resampling

Relationships Between Demographic Characteristics and Outcomes

Table 6 presents correlations between demographics and outcomes. Age showed weak negative correlations with knowledge ($r=-0.216$, $p=0.089$) and attitudes ($r=-0.126$, $p=0.324$). Education showed weak positive correlations with knowledge ($r=0.236$, $p=0.063$) and

attitudes ($r=0.212$, $p=0.095$). Years of cadre experience showed weak and non-significant correlations with knowledge ($r=-0.170$, $p=0.182$) and attitudes ($r=-0.026$, $p=0.840$). None of these correlations reached statistical significance, indicating intervention effectiveness was consistent across demographic subgroups.

Table 6. Correlations Between Demographic Characteristics and Knowledge and Attitude Outcomes

Demographic Variable	Knowledge		Attitude	
	r	p	r	p
Age	-0.216	0.089	-0.126	0.324
Education	0.236	0.063	0.212	0.095
Years of experience as cadre	-0.170	0.182	-0.026	0.840

Note: Analyzed using Spearman's rank correlation coefficient; r = correlation coefficient; p = significance level; No statistically significant correlations detected (all $p > 0.05$)

DISCUSSION

The SIDUCETING intervention represents a novel contribution to community health worker training for stunting prevention by integrating nutrition-specific and nutrition-sensitive components within a single, unified curriculum. In contrast to conventional cadre training programs, which typically address nutrition education and sanitation promotion as separate domains, SIDUCETING explicitly links these complementary approaches through the theoretical framework of environmental enteric dysfunction. This framework enables cadres to understand the underlying rationale for combining nutritional and sanitation interventions and clarifies why integrated strategies are more effective than single-component approaches. This integration distinguishes SIDUCETING from existing training models and addresses a critical gap in cadre education programs in Indonesia.

This study evaluated the effectiveness of an integrated education intervention combining stunting prevention

content with Community-Based Total Sanitation training among health cadres in Moyo Hilir District, Sumbawa. The findings indicate that cadres who participated in SIDUCETING program experienced significant improvements in both knowledge and attitudes compared with those in the control group who continued routine activities without additional training. These findings contribute important evidence to the growing body of literature on community-based approaches for stunting prevention in Indonesia and align with national strategies emphasizing multi-sectoral convergence in addressing childhood malnutrition.

The substantial knowledge improvements observed in the intervention group reflect the effectiveness of the two-day structured training program, that combined didactic instruction with practical demonstrations and skill-building exercises. These results are consistent with recent Indonesian studies documenting significant knowledge gains following cadre training interventions. Kurniawan et al. (2025)²⁸ reported sustained improvements in cadre knowledge gains

following the implementation of a web-based application for cadres, demonstrating that focused educational interventions are able to produce measurable knowledge improvements that persist over time. Yustiari et al. (2023)²⁹ likewise found that innovative education programs significantly enhanced cadre knowledge about stunting prevention through structured monthly sessions with handbook modules. The consistency of these findings across different intervention modalities suggests that the clarity, relevance, and structure of education may play a more decisive role in knowledge acquisition than the specific mode of delivery.

The magnitude of attitude changes observed in this study warrants careful interpretation within the context of educational intervention literature. The moderate-to-large effect size indicates that SIDUCETING was effective not only in transferring knowledge but also in shaping cadres' perceptions of their roles and responsibilities in stunting prevention. Mediani et al. (2022)³⁰ emphasized the critical relationship between knowledge and attitudes among health cadres, finding that knowledge became the primary factor significantly related to cadre attitudes toward stunting management. In the present study, The SIDUCETING intervention's integration of role-play, demonstrations, and hands-on practice with anthropometric tools likely facilitated this attitude transformation by building confidence and self-efficacy alongside factual knowledge. Irdawati et al. (2024)³¹ similarly documented that capacity-building efforts incorporating practical skill development produced more substantial behavioral intention changes than knowledge-focused interventions alone.

The integration of stunting prevention education with STBM training represents a theoretically grounded approach that aligns with Indonesia's

national stunting reduction strategy. The Indonesian Presidential Regulation 72 of 2021 explicitly designates STBM as a key nutrition-sensitive intervention, acknowledging that poor sanitation and environmental contamination are major contributors to childhood growth failure. Within this policy framework, the SIDUCETING intervention reinforces the role of Posyandu as the primary community-based platform for growth monitoring and nutrition services, while simultaneously reinforcing STBM implementation at the household level. By equipping cadres with integrated knowledge and skills, the intervention contributes to progress toward SDG 2 (ending all forms of malnutrition by 2030) and SDG 3 (ensuring healthy lives and promoting well-being), positioning community health workers as key agents in achieving Indonesia's national development targets.

Empirical evidence from Indonesia further supports the rationale for integrating sanitation and nutrition interventions. Multiple Indonesian studies have documented strong associations between household sanitation practices and stunting outcomes, providing empirical justification for this integrated approach.^{32,33} Analyses of the five STBM pillars have identified significant relationships between stunting outcomes and practices related to water and food management, solid waste disposal, and hygiene behaviors, with particularly strong effects for handwashing with soap, safe drinking water management, and solid waste disposal practices.^{34,35} The mechanistic pathway linking sanitation to stunting operates primarily through environmental enteric dysfunction, a chronic subclinical intestinal condition resulting from constant fecal-oral contamination that produces nutrient malabsorption despite adequate food intake.^{36,37}

Evidence regarding the superiority of integrated versus single-component interventions presents nuanced findings requiring careful consideration, however, it remains mixed and warrants cautious interpretation. Although integrated approaches align conceptually with the multifactorial etiology of stunting, research examining multifaceted interventions aimed at changing health professional behavior has not consistently demonstrated superior effectiveness over well-designed single-component approaches.³⁸ Rather, successful integrated interventions appear to depend on how behaviors are organized and presented, with greater effectiveness observed when practices are grouped according to daily routines and real-life contexts rather than by health domains. The SIDUCETING curriculum's focus on the first 1,000 days of life daily caregiving activities may have contributed to its effectiveness by creating meaningful connections between sanitation and nutrition behaviors within realistic family contexts.

The two-day training duration represents a pragmatic compromise between comprehensive content coverage and practical implementation constraints typical of community-based programs.³⁹ While international evidence suggests that longer training periods, including three-day intensive sessions combined with standardization exercises, may optimize anthropometric measurement accuracy, shorter, well-designed programs have also demonstrated effectiveness when they emphasize active learning and skills practice.³¹ In this intervention, The SIDUCETING program's emphasis on demonstrations, practice with measurement tools, and re-demonstration by participants likely maximized skill acquisition within the available timeframe. However, although effective in the short term, two-day training still requires supporting mechanisms to ensure consistency of skills over time. Without ongoing supervision,

refresher training, and continuous practice opportunities, initial training effects may erode, particularly for technical skills such as anthropometric measurement that require regular reinforcement to maintain accuracy. Program planners should therefore consider SIDUCETING as an initial capacity-building intervention that must be complemented by systematic follow-up support. Recent systematic reviews have further identified that training duration does not predict effectiveness as strongly as the quality of practical skill-building components and the relevance of content to daily work responsibilities.⁴⁰

The absence of significant correlation between demographic characteristics and knowledge or attitude changes in this study suggests that the SIDUCETING intervention is effective across cadres with varying educational backgrounds, ages, and years of experience. This finding shows important implications for program scalability, as it indicates that the intervention does not require highly educated cadres or extensive prior experience to achieve meaningful improvements. Research examining factors influencing cadre empowerment success has identified knowledge, attitudes, practices, self-efficacy, and sectoral support as key determinants rather than demographic characteristics.³⁰ The homogeneity of pre-intervention knowledge and attitudes between groups strengthens confidence that observed improvements resulted from the intervention itself rather than pre-existing differences in cadre capabilities.

The practical competencies addressed in SIDUCETING directly correspond to well-documented gaps in Indonesian cadre performance. Observational studies have documented that only a small proportion of untrained cadres can accurately record weights or interpret anthropometric measurements, highlighting the urgent need for structured training in these technical skills.⁴¹ The

SIDUCETING curriculum explicitly targets these deficiencies through structured instruction in measurement techniques, equipment calibration, growth chart plotting and interpretation, and counseling skills for caregiver communication. This approach is consistent with international standards for growth monitoring training, which advocate for an appropriate balance between conceptual understanding and skills-based learning, delivered through supervised practical experience, case-based learning, and hands-on practice with immediate feedback.⁴² Research on anthropometric measurement reliability demonstrates that following standardized training protocols, community health workers can achieve satisfactory precision with reliability coefficients above acceptable thresholds,^{43–45} though ongoing quality assurance remains essential to maintain measurement accuracy over time.⁴⁶

The sustainability of training effects represents a critical consideration for program planning and resource allocation. Follow-up studies conducted in Indonesia have reported that knowledge gains can be sustained, or even further improved, up to four weeks after training when cadres are supported by appropriate reinforcement mechanisms.³⁹ However, evidence from longer-term evaluations presents more complex findings. Some interventions have shown knowledge retention for up to twelve months following training when accompanied by regular practice opportunities and standardized follow-up assessments,⁴⁷ yet others have documented erosion of training effects in the absence of supportive supervision, refresher training, and continuous practice opportunities to apply newly acquired skills.

Within the Indonesian cadre system, several structural challenges may further constrain the long-term impact of

training interventions. These include irregular and spontaneous training resulting in unequal access, insufficient standardized measurement equipment, and time constraints due to competing responsibilities that may compromise long-term effectiveness.³⁰

LIMITATIONS

Several limitations should be considered when interpreting these findings. The relatively short follow-up period limited to immediate post-intervention assessment prevents conclusions regarding knowledge and attitude retention over time or about the translation of improved competencies into sustained behavior change in field practice. Moreover, the study was conducted in coastal areas of a single district, which may limit generalizability to other Indonesian regions with different cultural contexts, resource availability, or health system structures. The implementation obstacles found in urban and mountainous areas may differ significantly from those we observed in this coastal setting.

Additionally, the quasi-experimental design with cluster allocation rather than individual randomization introduces potential selection bias, although baseline homogeneity testing mitigated this concern. While the results are promising, several factors may have inflated the knowledge scores. The immediate post-test design tends to measure memorization rather than mastery, and the desire to please researchers (social desirability) can often skew self-reported data. Because what people say often differs from what they do, these attitudes should be viewed as a starting point rather than a guaranteed change in field practice. Future research should employ randomized controlled designs with longer follow-up periods, assess behavioral outcomes and

child health indicators alongside knowledge and attitudes, as well as evaluate implementation in diverse geographic and socioeconomic contexts across Indonesia.

IMPLICATIONS

The findings have several important implications for stunting prevention programs in Indonesia and similar resource-constrained settings. Structured short-duration training programs are able to achieve meaningful improvements in cadre knowledge and attitudes when carefully designed to incorporate practical skill-building alongside didactic content. Health authorities and program managers should prioritize quality over quantity in training design, emphasizing demonstrations, hands-on practice, and immediate feedback rather than passive lecture-based approaches. The two-day duration also demonstrates that effective training did not require extended time commitments that would take cadres away from their communities for prolonged periods. The SIDUCETING model offers a scalable approach for strengthening Posyandu services and STBM implementation by building cadre capacity in both domains simultaneously. Integration of the program into routine Puskesmas training schedules are able to support Indonesia's national stunting reduction targets while contributing to broader SDG 2 (Zero Hunger) and SDG 3 (Good Health and Well-being) goals through enhanced community-based nutrition and sanitation services.

CONCLUSION

This quasi-experimental study demonstrated that the Integrated Stunting Prevention Education (SIDUCETING) intervention effectively improved community health cadres' knowledge and

attitudes toward stunting prevention in Moyo Hilir District, Indonesia. The two-day structured training program, which integrated nutrition-specific education with Community-Based Total Sanitation principles and emphasized practical skill development through demonstrations and hands-on practice, produced statistically significant improvements in both knowledge (median increase of 8 points, $p < 0.001$) and attitudes (median increase of 11 points, $p < 0.001$) compared to control groups. The intervention's effectiveness across cadres with varying demographic characteristics suggests potential for broad scalability within Indonesia's community health system. These findings also support the national stunting reduction strategy's emphasis on multi-sectoral convergence. Besides, these further indicate that well-designed, short-duration training programs incorporating active learning methods can meaningfully enhance frontline health worker capabilities for malnutrition prevention.

AUTHOR CONTRIBUTIONS

AS: Methodology, Writing - Review & Editing, Formal analysis, Writing - Original Draft, and Supervision. LL: Methodology, Writing - Review & Editing, and Supervision. FH: Methodology, Writing - Review & Editing, and Supervision. NHT: Formal analysis, and Writing - Original Draft. CPSHJ: Formal analysis, Writing - Original Draft. SRM: Formal analysis, and Writing - Original Draft. RM: Formal analysis, and Writing - Original Draft. ALDR: Formal analysis, and Writing - Original Draft. YGM: Formal analysis, and Writing - Original Draft.

ETHICAL CONSIDERATIONS

Ethical approval for this study was obtained from the Medical and Health Research Ethics Committee, Faculty of

Medicine, Public Health, and Nursing, Universitas Gadjah Mada (KE/FK/0621/EC/2019) with approval granted on April 3, 2020. All participants provided written informed consent after receiving detailed information regarding study purposes, procedures, potential risks, benefits, confidentiality, voluntary participation, and withdrawal rights at any time without consequence.

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CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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