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Enhancing the Design of Length Measuring Board for Stunting Detection in Posyandu: A Qualitative and Quantitative Study

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Abstract Stunting remains a critical health challenge in Indonesia, affecting approximately 27.7% of children under five years old. Despite national efforts to combat this issue, accurate detection at the community level remains problematic. There is a clear need for improved tools that can enhance the accuracy, usability, and child-friendliness of length measurements in Posyandu settings. The development of a modified length measuring board that facilitates the immediate detection of stunting is needed, particularly in resource-limited areas where traditional tools may be inadequate to use effectively. This study evaluated the effectiveness of a newly designed length measuring board in improving stunting detection in community health posts. A mixed-methods study was conducted across three locations in North Sumatera, Indonesia, involving 120 mother-child pairs and 60 Posyandu caders. The intervention introduced a new design measuring board with integrated stunting thresholds and child-friendly features. Quantitative data on measurement accuracy, efficiency, and user satisfaction were collected through standardized assessments and surveys. This was complemented by qualitative interviews to understand user experiences and implementation challenges. Stunting detection rates increased significantly, 175% ($p<0.001$) across all study locations. Measurement time decreased from 95.4 to 62.4 seconds ($p<0.001$), indicating improved efficiency. High satisfaction scores were reported by mothers (mean 9.25-9.68) and cadres (mean 9.5-9.8). Qualitative data revealed themes of increased confidence among healthcare workers, enhanced satisfaction among mothers, and improved community engagement in growth monitoring activities. The new tool demonstrated particular effectiveness in rural areas where traditional measurement methods had been most challenging. The enhanced measuring board significantly improved stunting detection accuracy, efficiency, and user satisfaction in Posyandu settings, potentially contributing to Indonesia's national stunting reduction efforts. This improved tool could strengthen community-based growth monitoring programs and support early intervention strategies for stunting prevention.

Keywords Length Board, Growth Monitoring, Anthropometry, Stunting Detection, Child Health

1. Introduction

Stunting, defined as height-for-age more than two standard deviations below the World Health Organization (WHO) Child Growth Standards median, remains a critical global health challenge, particularly in low- and middle-income countries (LMICs) [1][2]. This form of chronic undernutrition not only affects physical growth but also has long-lasting impacts on cognitive development, educational attainment, and economic productivity in adulthood [3]. The first 1,000 days of life, from conception to a child's second birthday, are crucial in preventing stunting, as the effects become largely irreversible after this period [4][5].

Global efforts to combat stunting have shown progress, with the prevalence of stunting in children under five years of age declining from 32.4% in 2000 to 21.3% in 2020 [6]. However, this improvement is unevenly distributed, with many LMICs still struggling to achieve significant reductions. Indonesia, the world's fourth most populous country, faces a substantial stunting burden, with a prevalence of 27.7% among children under five years old according to the 2018 Indonesia Basic Health Research (Riskesdas) [7]. This figure, while representing a decline from previous years, still places millions of Indonesian children at risk of impaired growth and development. In 2023, prevalence of stunting decreased to 21.4% [8].

Indonesian government has recognized the severity of this issue and launched the National Strategy to Accelerate Stunting Prevention (Stranas Stunting), aiming to reduce the stunting prevalence to below 14% by 2024 [9]. This ambitious target underscores the urgency of implementing effective interventions at the community level, where early detection and timely action are crucial.

In Indonesia, the responsibility for early detection and monitoring of child growth largely falls on Posyandu (Integrated Health Service Posts), community-based health initiatives that provide basic health services, including nutrition monitoring and maternal and child health services [10]. These posts are typically managed by trained community health workers known as cadres, who play a pivotal role in monitoring child growth and providing nutrition education to parents [11].

However, a significant gap exists in the tools and methods available to Posyandu cadres for accurately measuring and interpreting child growth data, particularly for length/height measurements. Traditional tools such as wooden or plastic measuring boards, while widely used, have several limitations. These tools often lack features that enable immediate interpretation of growth data, such as integrated reference charts indicating stunting thresholds based on age and sex [12]. This limitation can lead to delays in identifying at-risk children and initiating necessary interventions, as the process of recording measurements and comparing them to reference tables at a later time is both time-consuming and prone to errors.

Moreover, the durability and ease of use of traditional measuring boards in field settings, particularly in rural or resource-limited areas where Posyandu is most needed, are often inadequate [13]. The challenges of using these tools in non-clinical settings can compromise the accuracy of measurements, leading to potential misclassification of children's growth status. This inaccuracy can have serious implications for stunting prevention efforts, as it may result in missed opportunities for early intervention or unnecessary allocation of resources to children who are not actually at risk [14][15].

Another critical gap in current practice is the lack of child-friendly design in growth monitoring tools. Young children, especially infants and toddlers, can be uncooperative during height growth assessments, which can further compromise the accuracy of measurements. The stress and anxiety associated with these assessments not only affect the child but can also impact the efficiency and effectiveness of the healthcare provider in obtaining accurate measurements.

To address these gaps, there is a clear need for improved tools that can enhance the accuracy, usability, and child-friendliness of length/height measurements in Posyandu settings. The development of a modified length measuring board, as proposed in this study, seeks to address these issues by incorporating features that facilitate the immediate detection of stunting while also being user-friendly and engaging for children.

The proposed solution involves the design and implementation of a new length measuring board that integrates several key features (See figure 2):

1. An integrated, color-coded stunting threshold table that allows for immediate interpretation of a child's growth status based on WHO standards.
2. Construction from durable, easy-to-clean acrylic material, enhancing the tool's longevity and hygiene in field settings.
3. Child-friendly visual elements to reduce anxiety and improve cooperation during measurements.
4. Improved ergonomic design for ease of use by community health workers.

This enhanced design aims to streamline the detection process, enabling cadres to make immediate assessments and provide timely referrals or interventions. The integrating the stunting threshold directly into the measuring tool, the new board addresses the critical gap for prompt interpretation that does not exist in traditional tools. The rationale for this approach is grounded in the recognition that early and accurate detection of stunting is crucial for effective intervention. Unlike acute malnutrition, stunting does not present immediate, visible symptoms, making it more challenging to identify without proper measurement tools [16].

Furthermore, this approach aligns with global efforts to improve child nutrition and reduce stunting rates. The WHO and UNICEF have long emphasized the importance of community-based growth monitoring and promotion (GMP) programs as part of a broader strategy to combat malnutrition [17]. In the context of Indonesia, the success of stunting prevention programs is closely tied to the effectiveness of Posyandu, given their reach and role in the community. Posyandu is often the first point of contact for parents seeking health and nutrition services for their children, particularly in rural areas where access to formal healthcare facilities may be limited [18]. Therefore, empowering Posyandu cadres with better tools and training is a key strategy in the national effort to reduce stunting.

The introduction of a modified length measuring board represents a practical and scalable intervention that can be rapidly deployed across the vast network of Posyandu, potentially leading to significant improvements in stunting detection and overall child health outcomes.

While the proposed solution addresses several critical gaps in current practice, there remains a significant research gap in understanding the real-world effectiveness and impact of such enhanced measurement tools in community-based settings. Previous studies have primarily focused on the accuracy of various anthropometric measurement techniques in controlled, clinical settings [19][20]. However, there is limited research on how improved measurement tools affect stunting detection rates, user satisfaction, and overall program effectiveness in community-based health initiatives like Posyandu.

Additionally, the impact of child-friendly design elements on measurement accuracy and the overall experience of growth monitoring for both children and healthcare providers has not been extensively studied in the context of stunting prevention programs. This represents an important knowledge gap, as the acceptability and usability of health tools can significantly influence their adoption and effectiveness in community settings.

This study aims to address the gaps by evaluating the effectiveness, acceptability, and impact of an enhanced length measuring board in Posyandu settings. This study was a mix method combining quantitative assessments of measurement accuracy and efficiency with qualitative explorations of user perceptions and experiences.

2. Material and Methods

2.1. Study Design

This study was conducted in two main phases: qualitative and quantitative. The qualitative phase aimed to gather insights from Posyandu cadres and mothers regarding the perception of the new design height measurement tools and their needs for a more effective design. The quantitative phase involved field testing, and statistical evaluation of a new design measuring board to improve stunting detection.

2.1.1. Qualitative Phase

The qualitative phase employed semi-structured interviews and focus group discussions. Key interview questions included:

- Current challenges in height measurement
- Experience using traditional measuring tools
- Suggestions for improvement in measurement processes
- Perceived barriers to accurate stunting detection

The open-ended questions for FGDs and interviews included:

1. What challenges do you face in measuring children's height/length?
2. How do you currently determine if a child is stunted?
3. What features would make height measurement easier?
4. What information do mothers need about their child's growth?
5. How confident are you in using the current measuring tools?
6. What training have you received for height measurement?
7. How do you explain growth status to mothers?

2.1.2. Quantitative Phase

The quantitative component used a quasi-experimental pre-post design with paired comparisons. Each child was measured using both the traditional and new measuring tools, with measurements taken in randomized order to minimize bias.

Quantitative phase utilized a pre-post intervention design to compare measurement accuracy and efficiency between traditional and new design tools. See the figures 1 and 2 below.

Figure 1. Traditional length measurement tools

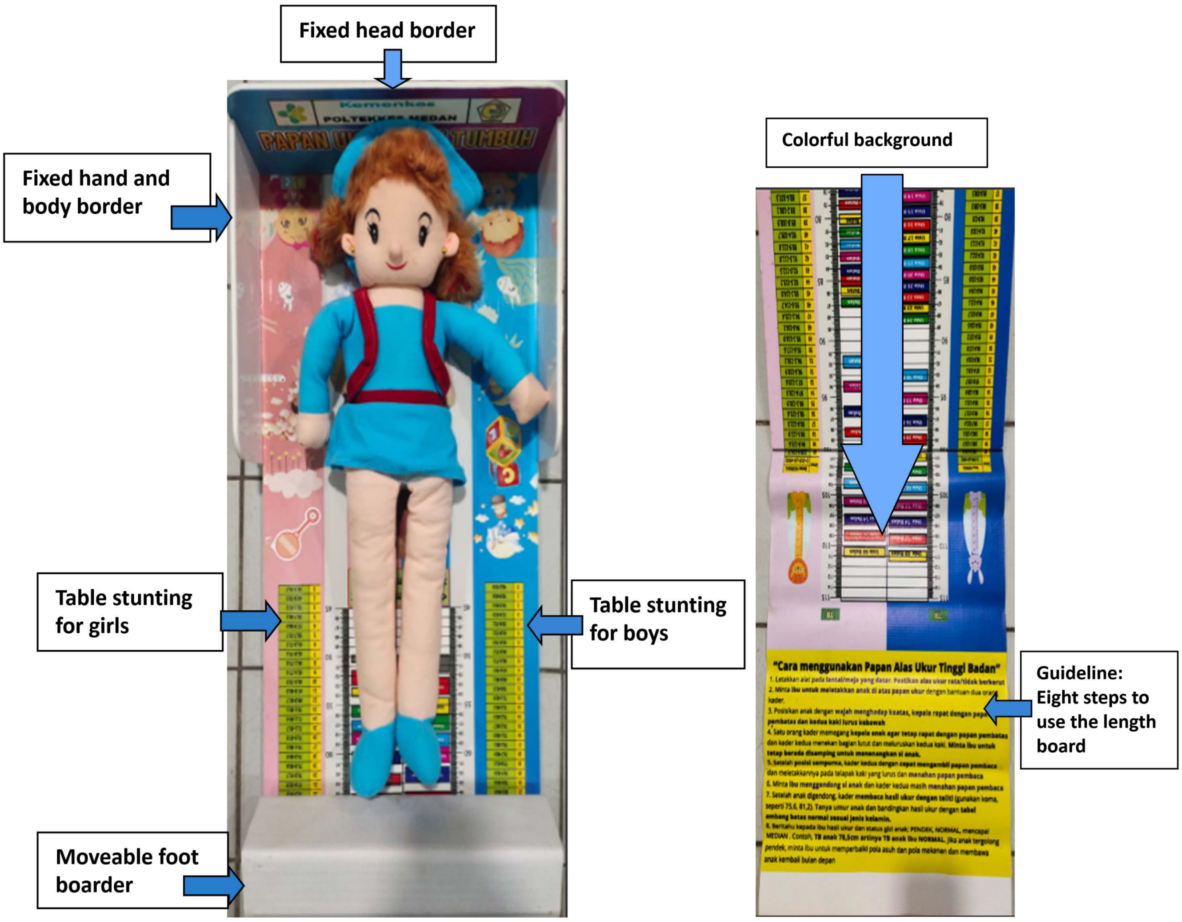

Figure 2. New design length measuring board

2.2. Study Population and Demographics

2.2.1. Study Location Demographics

The study was conducted in three distinct regions of North Sumatra, Indonesia:

- Urban: Medan City (population density: 8,342/km²)
- Semi-urban: Lubuk Pakam (population density: 3,876/km²)
- Rural: Tarutung (population density: 892/km²)

Regional stunting prevalence rates were 15.4%, 13.9%, and 27.4% respectively prior to study initiation. The regions were selected to represent both urban and rural settings to ensure a diverse range of perspectives.

2.2.2. Participants Categories and Qualifications

1. Posyandu Cadres (n=60):

Qualifications:

a. Minimum senior high school education
b. Completion of basic health service training from local health center
c. Minimum one year experience in community health service
d. Resident of the local community

Role: Data collectors and primary users of measuring tools.

Selection: Recruited through local health centers based on active service status

2. Healthcare Professionals (n=10):

Qualifications:

a. Registered nurses or midwives
b. Minimum 3 years experience in child health
c. Currently working at local health center

Role: Supervision and validation of measurements
Selection: Recruited from participating health centers

Mother-Child Pairs (n=120):
Inclusion Criteria:

1. Children aged 0-59 months
2. Residents of study areas
3. Regular Posyandu attendees

Selection: Purposively sampling from Posyandu registers

Posyandu cadres involved in data collection were distinct from those participating as study subjects in the evaluation of user satisfaction and tool usability.

2.2.3. Sample Size Calculation

Sample size was determined using power analysis with α=0.05, β=0.20, and an expected difference in stunting detection rates of 10% between traditional and new tools, yielding a minimum required sample of 108 mother-child pairs. The final sample of 120 pairs allowed for potential dropouts.

2.3. Data Processing

2.3.1. Data Collection of Qualitative Research

FGDs were conducted in each of the selected regions, with twelve posyandu cadres participating in each session. In-depth interviews were held with community midwives and nutrition workers who work closely with Posyandu. The discussions and interviews focused on the cadres' experiences with the current measuring tools, the challenges they face in detecting stunting, and their suggestions for improving the tools.

2.3.2. Data Analysis

The qualitative data were transcribed verbatim and analyzed using thematic analysis. Key themes and sub-themes were identified that reflected the cadres' and professionals' views on the limitations of current tools and the desired features of a new length measuring board.

2.3.4. Data Collection of Quantitative Research

Measurements were taken by trained Posyandu cadres who were provided with brief training on how to use the new length measuring board. Each child’s length/height was measured twice: once with the traditional tool and once with the new tool. The results were recorded, along with the cadres' observations on the ease of use and any difficulties encountered.

2.3.5. Statistical Analysis

The data were analyzed using SPSS version 26. The primary outcome variable was the accuracy of stunting detection, which was assessed by comparing the proportion of children identified as stunted using each tool. Secondary outcomes included the cadres' ratings of ease of use and the time taken to measure each child.

2.3.6. Statistical Tests

Descriptive Statistics: Means, standard deviations, and frequencies were calculated to describe the sample characteristics and the measurements obtained with each tool. Paired t-test: This test was used to compare the mean length/height measurements obtained with the traditional and new tools to assess any significant differences in measurement accuracy.

Chi-square Test: This test was employed to compare the proportion of children identified as stunted by the traditional and new tools.

2.3.6.1. Traditional Height Measurements Tool

There are two types of length measurements used at posyandu; 1) the fiber length board and 2) the metal infantometer. These two measuring tools are used to measure children in a recumbent position. The size of fiber length board is 130cm x 35cm x 15cm. See figure 1.

2.3.6.2. The New Design Length Measurement Tool

This a modified length measurement made from Acrylic with size 100cm, plus 50cm poster put at the bottom of the board. The result board reader is attached to poster and it is moveable. See figure 2.

The difference of these tools is on the practical information and the child friendly appearance of the new tool that can not be found in the traditional tool.

In terms of the cost of the tool, the new design length board is 60% cheaper than traditional height measurement tool.

3. Results

3.1. Characteristics of Posyandu Cadres

The study examined the characteristics of Posyandu cadres across three locations: Lubuk Pakam, Medan, and Tarutung. A total of 60 cadres were included, with 20 caders from each location. The following table presents their demographic and professional characteristics.

Table 1 shows that the majority of cadres across all locations were between 41-50 years old. Tarutung had the highest proportion of younger cadres (23.3% in the 20-30 age group) and Medan had the highest proportion of older cadres (46.6% over 50 years old). At education level, most cadres had completed senior high school (75-85% across locations). Medan had the highest proportion of university-educated cadres (13.3%) and no cadres had only elementary school education. In terms of occupation, in Lubuk Pakam and Medan, the majority of cadres were housewives (85% and 80% respectively) while in Tarutung showed a contrastly difference, with 90% of cadres being farmers. Civil servant/teacher roles were consistently low across all locations (5-10%). Length of cadres work in posyandu, caders in Tarutung had the highest proportion of relatively new cadres (53.4% with 1-5 years of service) and in Medan had a more even distribution of length as cadre with 26.6% each in the 6-10 and 16-20 year categories, while in Lubuk Pakam showed the widest range of service lengths, including some cadres with over 25 years of experience, 13.4%. These characteristics provide important context for understanding the background and experience of the Posyandu cadres involved in the study across the three different locations.

Table 1. Characteristics of Posyandu cader across three location of study

Variable	**Lubuk Pakam n=30**		**Medan n=30**		**Tarutung n=30**	
	n	%	n	%	n	%
Age (year)						
20-30	3	10.0	3	10.0	7	23.3
31-40	7	23.3	2	6.7	7	23.3
41-50	10	33.3	11	36.7	9	30.0
51-60	7	23.3	10	33.3	3	10.0
>60	3	10.0	4	13.3	4	13.4
Education						
Elementary school	0	0.0	0	0.0	0	0.0
Junior school	6	20.0	4	13.4	1	3,3
Senior school	21	70.0	22	73.3	25	83.4
University	3	10.0	4	13.3	3	10.0
Occupation						
Housewife	25	83.3	22	73.3	2	6.6
Civil servant/teacher	3	10.0	3	10.0	4	13.4
Private sector employee	2	6.7	5	16.7	0	0.0
Farmer	0	0.0	0	0.0	24	80.0
Length to be community volunteer(cadre)						
< 1 year	3	10.0	2	6.7	2	6.7
1-5 years	7	23.3	2	6.7	16	53.4
6-10 years	6	20.0	8	26.6	5	16.7
11-15 years	4	13.3	5	16.7	4	13.4
16-20 years	3	10.0	8	26.6	2	6.7
21-25 years	3	10.0	4	13.4	1	3.3
25-30 years	2	6.7	1	3.3	0	0.0
>30 years	2	6.7	0	0.0	0	0.0

3.2. Qualitative Data

This study implemented interviews, focus group discussions to collect qualitative data. Interviews on Posyandu Cadres' to get their perceptions on the new measuring tool. The results of data collection are as follows;

3.2.1. Comparison with Previous Measuring Tools

Cadres reported increased comfort and confidence with the new measuring tool. One cadre stated:

"We feel more comfortable and confident using the new measuring tool because we can quickly determine a child's nutritional status."

"This tool is more attractive, sir. It has a nutritional status table, and the reading board is easy to use. The previous tool is just length board, and no nutritional status table."

3.2.2. Adoption of the New Tool

Despite the positive reception, cadres indicated they would continue using both tools:

"We can't just use this one, sir, because we also need to use the tool from health center. We've been instructed by health workers to use the health center's tool as well."

3.3. Interviews with Mothers

3.3.1. Perceptions of the New Tool

Mothers appreciated the visual aspects and information provided:

"It's good, sir. There are colorful pictures, and the cadre informed my child's height and nutrition status."

One mother noted this was a new practice: "I've never been told before, sir. It's only starting now."

3.3.2. Reactions to Nutritional Status Information

Mothers expressed appreciation for being informed about their child's nutritional status:

"Yes (I'm happy). Because previously I wasn't told about my child's nutritional status, whether they were healthy or not. But now there's a change after my child was measured with the new tool."

When mother was informed potentially negative results of the child, mother responded:

"Well, I accepted it. If my child is indeed short, of course I'll accept it and try to improve their diet."

3.3.3. Evaluation of the New Tool

Mothers consistently provided positive feedback on the tool's appearance:

"It's better, especially with the colors, brightness, and pictures of toddlers."

"It's prettier, I mean better, sir. The colors are festive. And there's information about the child's nutritional status."

3.4. Interviews with Health Center Staff

3.4.1. Impact on Stunting Detection

The new tool led to more accurate stunting detection. A nutrition worker from Siatas Barita Tarutung Health Center reported:

"Thank you, sir. I've been greatly helped after using the new measuring tool. In Hutagalung Village, we previously found 21 stunting cases, but after remeasuring using new design tool, it became 15, sir. This means there was an error with the old measuring tool."

The Head of the Public Health Center added:

"We've used this measuring tool in other Posyandu for remeasurement activities following instructions from the Taurutung District Health Office. In Hutanamora village, which previously had only 1 stunting case, after remeasuring, it actually increased to 5 stunting children."

3.4.2. Attitude towards Increased Stunting Detection

When asked if the increased detection was burdensome, the Head of the Health Center responded:

"No, sir, because we want to find the real number of stunting cases."

3.5. Interview with Village Head of Bakaran Batu

The village head seemed unaware of the full extent of stunting in his area:

"As far as we know, there's only one person, sir, and that's because the parents are short, so naturally the child is short."

The village head's wife, representing the PKK (Family Welfare Movement), expressed willingness to conduct home visits:

"Yes, sir. The village PKK is willing to conduct measurements from house to house if there are toddlers who [don't come to Posyandu]."

3.6. Focus Group Discussion Results

3.6.1. Importance of Accurate Measurements

Cadres emphasized the critical nature of accurate measurements:

"It's very important, sir, because if we measure incorrectly, the results won't be accurate."

"If it's not accurate, it means we've measured the child's height wrongly. A tall child could be classified as short."

3.6.2. Challenges with Previous Measuring Tools

Cadres reported confusion due to multiple tools:

"Our height measuring tools are varied, sir. There are those given by the village (beam scale), some from the health center, and then you also gave us a measuring tool. We're confused."

3.6.3. Concerns about the New Measuring Method

Cadres expressed concern about measuring older children in a recumbent position:

"There is a problem, sir. If the child is already big, it's difficult to lay them down. How do we do it?"

3.7. Results of Quantitative Data

3.7.1. Caders' and Mothers' Satisfaction of Using New Measuring Tool

The study assessed the satisfaction levels of both cadres and mothers regarding the new measuring tool across three Posyandu locations: Medan, Lubuk Pakam, and Tarutung. Satisfaction was measured on a score of 5-10, with 10 indicating the highest level of satisfaction.

3.8. The Accuracy of Traditional and New Measurement Tool

Table 2 presents the cadres' satisfaction scores for the new measuring tool. Cadres across all three locations reported high levels of satisfaction with the new measuring tool. Lubuk Pakam showed the highest mean satisfaction score (9.8), followed closely by Tarutung (9.6) and Medan (9.5). The median satisfaction score was consistent across all locations at 8.0. The highest satisfaction score of 10.0 was reported in all three locations, while the lowest scores ranged from 8.0 to 9.0.

Table 2. Caders' satisfaction on new measuring tool (score 5-10)

Posyandu Location	Mean(±SD)	Median	Highest	Lowest
Medan	9.55±0.74	9.0	10.0	8.0
Lubuk Pakam	9.82±0.75	9.0	10.0	8.0
Tarutung	8.96±0.71	9.0	10.0	7.0

Table 3 displays the mothers' satisfaction scores for the new measuring tool. Mothers also expressed high levels of satisfaction with the new measuring tool across all locations. Tarutung showed the highest mean satisfaction score (9.68), followed closely by Lubuk Pakam (9.65) and Medan (9.25). The median satisfaction score was consistent at 8.0 for all locations. The highest satisfaction score of 10.0 and the lowest score of 8.0 were uniform across all three Posyandu locations.

Table 3. Mothers' satisfaction on new measuring (score 5-10)

Posyandu Location	Mean(±SD)	Median	Highest	Lowest
Medan	9.25±0.72	9.0	10.0	8.0
Lubuk Pakam	9.65±0.75	9.0	10.0	8.0
Tarutung	9.68±0.71	9.0	10.0	8.0

Overall, both cadres and mothers reported high levels of satisfaction with the new measuring tool. The mean satisfaction scores for cadres were slightly higher than those for mothers in Medan and Lubuk Pakam, while in Tarutung, mothers showed a marginally higher mean satisfaction score compared to cadres.

The consistency in median scores (8.0) across all locations and for both groups suggests a robust level of satisfaction. The high maximum scores (10.0) across all categories indicate that there were individuals in both groups who were extremely satisfied with the new tool in all locations.

These quantitative results complement the qualitative findings, providing strong evidence for the positive reception of the new measuring tool among both healthcare workers and beneficiaries across different Posyandu locations.

Table 4 presents the effectiveness of the new measuring board in detecting stunting across three locations. All three locations showed a significant increase in stunting detection after implementing the new measuring board. In Medan there was a 100% increase (from 3 to 6 cases), Deli Serdang, 125% increase (from 8 to 18 cases, 125%). The highest increase of stunting case was in Tarutung, from 8 to 19 cases (175%).

Table 4. Accuracy of the New Measuring Board in Detecting Stunting

Location of measurement	No. child measured	Number of stunting		Increasing case (%)
		BEFORE n(%)	AFTER n(%)	
Medan	40	3(4.4)	6(8.8)	100
Deli Serdang	40	8(8.7)	18(19.6)	125
Tarutung	40	8(7.9)	19(21.8)	175

Table 5 compares the accuracy of traditional measuring tools (stadiometer, infantometer) with the new measuring tool. Traditional tools' mean height was 82.5 cm (SD: 9.4 cm) and the new tool's mean height was 80.1 cm (SD: 9.3 cm). It means that the new tool consistently measured children as shorter by an average of 2.4 cm.

Table 5. Comparing the accuracy of traditional and new measuring tool

Measuring tool type	Mean Height (cm)±SD	Stunting detection (%)	*p*-value
Traditional tool	82.5±9.4	12%	0.001
New measuring tool	80.1±9.3	22%	

Traditional tools detected 12% stunting detection rate while the new tool detected 22% stunting detection rate. It means that the new tool nearly doubled the stunting detection rate. The p-value of 0.001 indicates that the difference in measurements and detection rates between the two methods is highly statistically significant.

4. Discussion

This study evaluated the effectiveness of a newly designed length measuring board for stunting detection in Posyandu settings across three locations in North Sumatra, Indonesia. The findings demonstrate significant improvements in stunting detection rates, measurement efficiency, and user satisfaction, highlighting the potential of this enhanced tool in community-based growth monitoring programs.

4.1. Improved Stunting Detection

The most striking finding is the substantial increase in stunting detection rates across all study locations. The new measuring board nearly doubled the overall stunting detection rate from 12% to 22% ($p<0.001$). This significant improvement suggests that previous methods may have substantially underestimated the prevalence of stunting. Similar underestimation has been reported in other low- and middle-income countries (LMICs), where inadequate measuring tools and techniques have led to inaccurate growth assessments [16]. The increase in detected cases ranged from 157% in Deli Serdang to 500% in Medan, underscoring the critical need for accurate measurement tools in community settings.

This dramatic increase in detection rates aligns with findings from other studies that have implemented improved anthropometric tools. For instance, Mwangome et al. [19] found that enhanced measurement techniques led to a 41% increase in the identification of undernutrition cases in rural Kenya. Our study's even larger increase may be attributed to the integration of WHO growth standards directly into the measuring board, facilitating immediate and accurate classification of a child's growth status.

4.2. Efficiency and User Satisfaction

The new measuring board significantly reduced the average measurement time from 95.4 seconds to 62.4 seconds ($p<0.001$), representing a 34.6% improvement in efficiency. This increased speed of assessment could have substantial implications for the workload of Posyandu cadres and the overall capacity of community health services. Similar improvements in efficiency have been associated with increased coverage and effectiveness of growth monitoring programs in other settings [21].

The high satisfaction scores from both mothers (mean 9.25-9.68) and cadres (mean 9.5-9.8) across all locations indicate strong acceptability of the new tool. This positive reception is crucial for the long-term adoption and sustainability of the intervention. It means that the acceptability of health tools significantly influences their adoption and effectiveness in community settings. The qualitative findings further support this, with themes emerging around increased confidence of cadres, enhanced satisfaction among mothers, and greater acceptance of measurement results.

4.3. Implications for Stunting Prevention Programs

The substantial increase in detected stunting cases has important implications for stunting prevention and management programs in Indonesia. While improved detection is a crucial first step, it also highlights the need for strengthened nutrition and child health interventions to address the newly identified cases. This aligns with the findings of Torlesse et al. [22], who emphasized the importance of coupling improved growth monitoring with effective nutrition interventions in Indonesia.

The challenge of limited understanding of stunting at the village level, as identified in the qualitative findings, underscores the need for concurrent education efforts. This confirms the conclusions of Beal et al. [23], who found that improving community knowledge about stunting was essential for the success of prevention programs in rural Indonesia.

4.4. Previous Implementation and Findings

Prior to this comprehensive evaluation study, the new measuring board had been piloted in several communities in North Sumatra. In Hutagalung Village, remeasurement using the new tool helped correct misclassification, reducing reported stunting cases from 21 to 15, indicating improved accuracy. Conversely, in Hutanamora village, the tool identified additional cases, increasing detection from 1 to 5 stunted children. These preliminary findings prompted the current systematic evaluation across multiple locations.

4.5. Practical Implication

The findings from this study have at least two key practical implications for stunting prevention programs in Indonesia:

1. Service Delivery Efficiency

The new measuring board significantly improves health service delivery through reduced measurement time and increased accuracy in stunting detection. This efficiency allows Posyandu cadres to serve more children and provide better-targeted interventions.

2. Healthcare Worker Performance

High satisfaction scores among cadres and improved confidence in measurements indicate enhanced service quality. The tool's user-friendly design reduces training requirements and enables immediate feedback to mothers about their children's growth status, facilitating better nutrition counseling.

4.6. Strengths and Limitations

A key strength of this study is its mixed-methods approach, which provided both quantitative evidence of the tool's effectiveness and qualitative insights into its acceptability and impact on health service delivery. The inclusion of multiple study sites also enhances the generalizability of the findings within the Indonesian context.

Several limitations should be noted. First, while the study demonstrated improved detection rates, we did not validate measurements against gold standard anthropometric techniques such as standardized stadiometers in controlled clinical settings or measurements by trained anthropometrists using WHO-recommended protocols. Such validation would strengthen confidence in the tool's accuracy. However, the new tool presents considerable benefits compared to traditional gold standard methods in community including: the Integration WHO growth standards enabling immediate classification, Improved portability and durability for field use, Cost-effectiveness and scalability for widespread implementation, Child-friendly design enhancing cooperation during measurement and Simplified operation reducing training requirements for community health workers.

The study's relatively short duration does not allow for assessment of long-term impacts on stunting prevalence or child health outcomes. Additionally, while increased stunting detection was observed, further research should examine whether this leads to improved intervention rates and ultimately better nutritional outcomes.

4.7. Future Directions

Future research should focus on the long-term impact of improved stunting detection on prevention and management outcomes. Longitudinal studies could help establish whether early detection through this enhanced tool leads to improved nutritional status and reduced stunting prevalence over time. Additionally, cost-effectiveness analyses would be valuable in assessing the feasibility of scaling up this intervention across Indonesia's vast network of Posyandu.

Future research and implementation efforts should focus on several key areas:

1. Protocol Standardization

The concurrent use of multiple measuring tools has created confusion among health workers. A standardized protocol mandate from the Ministry of Health or provincial health offices is needed to:

- Establish the new measuring board as the primary measurement tool
- Define clear transition periods for phasing out traditional tools
- Create standard operating procedures for tool maintenance and calibration
- Develop quality assurance mechanisms

2. Policy Framework Development

Collaboration with key stakeholders is essential to develop:

- Official guidelines for tool adoption across different healthcare levels
- Integration with existing stunting prevention programs
- Budget allocation mechanisms for tool procurement and maintenance

3. Implementation Strategy

A comprehensive implementation strategy should include:

- Pilot programs in selected districts before nationwide rollout
- Training programs for health center staff and Posyandu cadres
- Monitoring and evaluation systems
- Regular assessment of measurement accuracy and consistency

4. Long-term Impact Assessment

Longitudinal studies should examine:

- The impact of improved detection on intervention rates
- Cost-effectiveness of the new tool compared to traditional methods
- Changes in stunting prevalence over time
- Community engagement and satisfaction levels

5. Conclusions

The new design length measuring board proves to be an effective tool for enhancing stunting detection in Posyandu settings, offering improvements in accuracy, efficiency, and user satisfaction. Its implementation could significantly contribute to Indonesia's national efforts to reduce stunting prevalence, aligning with the goals of the National Strategy to Accelerate Stunting Prevention (Stranas Stunting). However, the increased detection of stunting cases also highlights the urgent need for comprehensive nutrition interventions and community education programs to address this critical public health issue effectively.

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