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Assessing the Need for Mobile Application Development in Stunting Prevention among Vulnerable Populations: A Qualitative Study

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ABSTRACT

Background: Stunting, a critical public health challenge affecting children under five globally, remains highly prevalent in Indonesia. While mobile health (mHealth) technologies have shown promise in improving maternal and child health outcomes, their application in addressing stunting prevention remains underexplored, particularly in low-resource settings. Objective: This study aimed to assess the need for developing a mobile application to prevent stunting among vulnerable populations in Indonesia. Methods: A qualitative descriptive design was employed, involving 18 participants, including healthcare providers, community leaders, and caregivers of children under five from urban and rural settings. Data were collected through semi-structured interviews, transcribed verbatim, and analyzed thematically using NVivo software. Rigorous trustworthiness criteria were applied to ensure credibility and transferability. Results: Four themes emerged: (1) barriers to stunting prevention, including resource constraints, caregiver knowledge gaps, and policy limitations; (2) desired app features, such as educational content, growth tracking, and social support tools; (3) user expectations for functionality, emphasizing local language support, offline accessibility, and ease of use; and (4) anticipated implementation challenges, including technological barriers and sustained user engagement. Conclusion: The findings underscore the potential of a mobile application to address critical gaps in stunting prevention through tailored, accessible, and interactive features. Future research should focus on pilot testing and evaluating the app's usability and impact.

Keywords: Mobile Health; mHealth; Stunting Prevention; Qualitative Research; Vulnerable Populations

INTRODUCTION

Stunting is a persistent global public health concern, affecting approximately 22% of children under the age of five worldwide, with disproportionately high rates in low- and middle-income countries (LMICs) (United Nations Children's Fund, WHO, 2021). This condition, characterised by impaired growth and development due to chronic malnutrition, has severe long-term consequences, including reduced cognitive abilities, weakened immune systems, and lower productivity in adulthood (Chilot *et al*., 2023). Indonesia remains one of the countries with a high prevalence of stunting, with nearly 24% of children under five affected as of 2021 (Kemenkes, 2022). Tackling this widespread issue has increasingly shifted towards innovative solutions, such as mobile health (mHealth) applications, which aim to raise awareness, enable early detection, and deliver tailored interventions (Hoque *et al*., 2020).

Given the multifaceted determinants of stunting and the challenges in addressing them through traditional methods, innovative solutions such as mobile health (mHealth) applications have gained increasing attention in global health strategies. The rise of mHealth technologies has revolutionised public health strategies, offering accessible and cost-effective platforms to disseminate health information and implement interventions (WHO, 2021). Numerous studies have highlighted the effectiveness of mHealth applications in improving maternal and child health outcomes. For example, mobile apps have been used to monitor child growth, encourage breastfeeding, and provide nutritional education (KO *et al.*, 2025; Dehghan

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Ghahfarokhi *et al.*, 2022). Additionally, these tools have demonstrated significant potential in resource-limited settings by engaging caregivers and healthcare providers, fostering behavioural changes through interactive content and real-time feedback (Phillips *et al*., 2021).

Recent research emphasises the importance of user-centred design in enhancing the adoption and effectiveness of mHealth applications, particularly in LMICs where access to technology and literacy levels vary widely (Asadi *et al*., 2020; Wasunna & Holeman, 2021). Moreover, integrating machine learning algorithms into mHealth platforms has shown promise in delivering personalised recommendations and predictive analytics, further increasing their impact (Mehta *et al*., 2022).

While advancements in mHealth technologies, including user-centred design and machine learning, have shown potential in health interventions, their application in stunting prevention remains underexplored. Most existing applications address general maternal and child health issues without focusing on the multifaceted determinants of stunting, such as dietary diversity, household food security, and maternal knowledge (Hossain, Abdulla, & Rahman, 2023). In Indonesia, where healthcare access is often hindered by geographic, socioeconomic, and cultural barriers, mHealth tools have the potential to serve as transformative solutions (Ose *et al.*, 2021). Research indicates that integrating culturally relevant educational content with interactive features can improve caregiver engagement and drive behavioural change (Titaley *et al.*, 2020). In Indonesia, where healthcare access is often hindered by diverse cultural norms, geographic isolation, and limited socioeconomic resources, understanding user needs is crucial for designing impactful mHealth tools. Nonetheless, there is limited evidence on the usability and acceptability of these tools among marginalised populations, particularly those with low literacy levels and limited socioeconomic resources (Azam *et al*., 2023).

Although mobile applications hold considerable promise for stunting prevention, there is a significant lack of qualitative research focusing on the specific needs and preferences of vulnerable populations in LMICs. Understanding the cultural, socioeconomic, and technological factors that influence the adoption and use of mHealth tools is crucial for developing effective and sustainable interventions (Neumark & Prince 2021). Additionally, few studies have examined how mHealth solutions can be integrated into existing community-based nutrition programmes to provide a holistic approach to stunting prevention (O'Brien *et al*., 2021). This study aims to address these gaps by exploring the specific requirements for developing a culturally tailored mobile application for stunting prevention, focusing on vulnerable populations in Indonesia.

METHODOLOGY

Study Design

This research utilised a qualitative descriptive approach to investigate the necessity of developing a mobile application aimed at preventing stunting in vulnerable populations. This method was selected as it allows for an in-depth examination of intricate social dynamics, offering a nuanced understanding of stakeholders' perspectives, experiences, and recommendations within their real-world settings. The qualitative descriptive design is particularly effective in uncovering rich, contextually grounded insights, making it an ideal choice for exploring the multifaceted factors related to stunting prevention (Sandelowski, 2000).

Participants

The study involved a diverse group of participants, including healthcare providers such as midwives and nutritionists, community leaders, and caregivers of children under five years of age, representing both urban and rural settings. This heterogeneous sample was deliberately chosen to gather a comprehensive range of perspectives on stunting prevention. Participants were included in the study if they had relevant experience in stunting prevention or caregiving for children under five, were willing to take part in the research, and provided informed consent. However, individuals were excluded if they had cognitive or communication impairments that interfered with meaningful participation or if they declined to consent

The sample size was determined using a purposive sampling strategy to ensure a diverse representation of backgrounds and expertise. The final number of participants was guided by the principle of data saturation, which was reached when no new themes or insights emerged during successive interviews. A total of 15 to 20 participants were recruited, consistent with recommended sample sizes for qualitative research (Morse, 2020). This approach ensured the data collected was both rich and representative of the target population.

Interview Guideline

The semi-structured interview guide was carefully draughted through a rigorous review of relevant literature and collaborative consultations with subject matter experts, ensuring it was both comprehensive and aligned with the study's objectives. It explored key areas such as barriers to effective stunting prevention, desired features to improve the impact of a mobile application aimed at stunting prevention, and user expectations in terms of functionality, accessibility, and usability. For instance, participants were asked questions like, "Can you describe the main challenges you encounter when implementing stunting prevention initiatives?" or "What specific features would make a mobile application for stunting prevention more effective and user-friendly for you?"

To guarantee the guide's reliability and validity, a panel of experts—including one public health specialist, one qualitative researcher, and one technology developer with expertise in user-centred design—reviewed and approved its content. The guide was also pilot tested with five individuals from the target population to assess its practicality and identify any areas needing improvement. Feedback from the pilot test highlighted minor adjustments to refine question clarity and ensure the language was appropriate and accessible. This iterative refinement process was instrumental in ensuring that the interview guide effectively captured meaningful and actionable insights from participants, enabling a robust exploration of the study's focal issues.

Data Collection Procedure

The data collection process was conducted over a designated timeframe, spanning from February to March 2024. In-depth individual interviews were held in private settings to maintain confidentiality and foster an open, honest dialogue with participants. Each interview lasted approximately 30 to 60 minutes, depending on the depth and complexity of the topics discussed. With participants' informed consent, all interviews were audio-recorded to ensure accuracy and completeness and note-taking to accommodate potentially missing some contextual nuances. Verbatim transcriptions were carefully produced to capture participants' statements precisely. Additionally, field notes were taken during the interviews to document non-verbal cues, contextual observations, and any situational nuances that added depth to the data. This meticulous approach ensured a comprehensive and reliable data collection process, capturing both explicit and implicit elements of participants' responses.

Data Analysis

A thematic analysis approach was employed to explore and interpret patterns within the data comprehensively. The transcription of interviews was coded using a combination of inductive and deductive methods, facilitated by NVivo software (QSR International). The initial codes were meticulously categorised and subsequently refined to develop coherent and meaningful themes. To enhance the reliability and consistency of the analysis, two researchers independently coded the data. Any discrepancies identified were addressed and resolved through collaborative discussions, ensuring a thorough and unbiased interpretation of the findings (Braun & Clarke, 2019).

Trustworthiness

To establish trustworthiness, the study followed the criteria outlined by Lincoln and Guba (1985). Credibility was ensured through the triangulation of data sources and the use of member checking to validate the accuracy of the findings with participants. Transferability was supported by providing comprehensive and detailed descriptions of the study's context and the characteristics of its participants, allowing readers to assess the applicability of the results to other settings. Dependability was achieved by maintaining a thorough

audit trail that systematically documented all steps of the research process, ensuring transparency and consistency. Confirmability was upheld through the practice of reflexivity, which involved critical self-awareness by the researchers regarding potential biases and the involvement of an independent third-party researcher who reviewed the findings to enhance objectivity and reduce bias.

Ethical Consideration

The researchers obtained ethical clearance from the Universitas Jendral Achmad Yani Cimahi with reference number 027/KEPK/FITKes-UNJANI/VI/2024 on January 10th, 2024. Participants received an information sheet outlining the study's objectives, procedures, potential risks, and benefits. Written informed consent was secured prior to their involvement. Data confidentiality was ensured through anonymisation, and participants were assured of their right to withdraw from the study at any point without facing any repercussions.

RESULTS

Table 1 provides a summary of the demographic characteristics of the participants. The study included a total of 18 participants, comprising healthcare providers (midwives and nutritionists), community leaders, and caregivers of children under five years of age from both urban and rural settings. Participants were selected to ensure a diverse range of experiences and perspectives.

Table 1: Demographic Characteristics of Participants

Variable	n (%)
Role	
Healthcare providers	8 (44.4%)
Community leaders	4 (22.2%)
Caregivers	6 (33.4%)
Location	
Urban	10 (55.6%)
Rural	8 (44.4%)
Gender	
Female	14 (77.8%)
Male	4 (22.2%)
Age (years)	
20–30	6 (33.3%)
31–40	8 (44.4%)
41–50	4 (22.2%)
Experience in stunting prevention (years)	
<5	8 (44.4%)
5_10	6 (33.3%)
>10	4 (22.2%)

Analysis of the qualitative data resulted in four major themes: barriers to effective stunting prevention, desired features of a mobile application, user expectations for functionality and accessibility, and anticipated challenges for implementation. Each theme is supported by categories, codes, and illustrative quotes (Table 2).

Theme 1: Namely barriers to effective stunting prevention, includes structural challenges, such as limited resources and insufficient staffing, which hinder consistent monitoring and intervention efforts, particularly in remote areas. Knowledge gaps are evident among caregivers and health workers, highlighting the lack of awareness about child nutrition and insufficient professional training on prevention strategies. Policy limitations, including inconsistent guidelines and bureaucratic delays, further complicate efforts to address stunting comprehensively.

Theme 2: Namely the desired features for a mobile application, emphasises the need for educational materials, such as videos and infographics, to enhance understanding of stunting prevention. Interactive features, such as growth tracking tools and reminder notifications, are considered essential for user engagement. Social support tools, including peer forums and expert consultations, are identified as essential for fostering community interaction and providing professional advice. Theme 3, namely user expectations for functionality and accessibility, highlights the importance of local language support and cultural relevance to cater to diverse audiences. Simple navigation and clear instructions are crucial for usability, especially for individuals with limited technical expertise. Compatibility across devices and offline functionality are critical for reaching users in rural or low-resource settings.

Theme 4: namely anticipated challenges for implementation, includes technological barriers, such as limited access to devices and unstable internet connectivity, which could impede app adoption. Sustained engagement may be challenging without features like gamification or rewards to maintain users' interest. Training and support are also necessary, with recommendations for user training sessions and technical assistance to ensure effective app usage.

Table 2: The Qualitative Data Results

Theme	Category	Code	Example Quote
Barriers to Effective Stunting Prevention	Structural challenges	Limited resources	"We lack the tools and budget to carry out consistent monitoring and interventions in remote areas." (P13)
			"Our team faces difficulty accessing remote villages due to inadequate infrastructure and funding." (P2)
		Insufficient staffing	"We don't have enough staff to cover all the families in need of support." (P10)
			"The limited number of health workers makes it hard to follow up regularly on stunting cases." (P5)
	Knowledge gaps	Caregivers' lack of awareness	"Many parents do not understand the importance of nutrition for their children's development." (P9)
			"Most caregivers are unaware of the signs of stunting and how to prevent it." (P15)
		Limited professional training	"Health workers often lack updated knowledge about stunting prevention strategies." (P11)
			"There's a need for better training programs to equip health staff with the necessary skills." (P7)
	Policy limitations	Inconsistent policies	"Different regions have different priorities, which makes implementing a unified stunting prevention strategy difficult." (P4)
			"We need stronger policies and consistent guidelines to support our efforts." (P18)
		Bureaucratic delays	"Policy implementation takes too long, delaying critical interventions for stunting prevention." (P11)
			"Approval processes for resources are often slow and hinder timely action." (P10)
Desired Features of a Mobile Application	Content preferences	Educational materials	"The app should have videos and easy-to-read content about child nutrition and stunting prevention." (P3)
			"It would be helpful if the app provided step-by-step guidance on meal planning for children." (P8)
		Visual aids	"Pictures or infographics explaining stunting prevention would make the app more engaging." (P5)
			"Interactive images can help caregivers better understand key concepts." (P14)
	Interactive features	Tools for tracking progress	"If the app could track the child's growth and provide alerts, it would be extremely helpful." (P15)
			"A feature to record and analyse children's dietary habits would make it more engaging." (P3)
		Reminder notifications	"Daily reminders for mealtimes or nutrition tips would keep users engaged." (P16)
			"Push notifications for upcoming immunizations or milestones would be very useful." (P5)
	Social support tools	Peer forums or groups	"A discussion feature where caregivers can share their experiences and tips would be great." (P3)
			"Connecting with other parents facing similar challenges would make the app more useful." (P7)
		Expert consultations	"It would be great to have a feature to ask health experts questions directly." (P13)
			"Access to professional advice through the app would add immense value for caregivers." (P14)

User Expectations for Functionality and Accessibility	Language and cultural relevance	Local language support	"It would be great if the app includes information in our local language to reach more users." (P12)
			"Having culturally relevant images and examples in the app would make it more relatable." (P10)
		Regional customization	"The app should adapt to the local cultural context and provide region-specific tips." (P8)
			"Using regionally familiar terms and visuals would help users connect with the app." (P3)
	Ease of use	Simple navigation	"The interface should be simple enough for people with minimal smartphone experience to use." (P17)
			"Even those who are not tech-savvy should be able to navigate the app easily." (P9)
		Clear instructions	"The app should have a tutorial or guide for first-time users." (P10)
			"Step-by-step instructions would ensure people understand how to use the app effectively." (P4))
	Compatibility	Works on all devices	"The app should be compatible with older smartphones to reach a wider audience." (P1)
			"It would be ideal if it functions well even on low-bandwidth internet." (P13)
		Offline functionality	"The app should offer offline features for areas with no internet connectivity." (P8)
			"Users in remote regions would benefit from offline access to key information." (P11)
Anticipated Challenges for Implementation	Technological barriers	Limited access to devices	"Some caregivers do not have smartphones or stable internet access." (P15)
			"Many rural areas lack the infrastructure to support app-based interventions." (P18)
		Internet connectivity	"The app needs to work in areas with slow or unstable internet connections." (P3)
			"Providing downloadable content would help users with limited connectivity." (P1)
	Sustained engagement	Motivation to use the app	"Keeping caregivers engaged with the app over time might be challenging without regular reminders." (P4)
			"Features like rewards or progress tracking could help maintain users' interest." (P5)
		Gamification	"Adding games or challenges related to child nutrition would make the app fun and interactive." (P9)
			"A points system for completing tasks could encourage continued use of the app." (P13)
	Training and support	User training	"Some caregivers might need basic training on how to use the app." (P5)
			"Workshops or support from health workers could help users understand the app's features." (P3)
		Technical support	"A helpline or live chat feature would assist users facing technical issues." (P16)
			"Providing a contact for immediate help would make the app more reliable." (P17)

DISCUSSION

Four major themes were found, including barriers to effective stunting prevention, desired features of a mobile application, user expectations for functionality and accessibility, and anticipated challenges for implementation. This study highlights the multifaceted interplay of structural, educational, and technological barriers impacting stunting prevention efforts among vulnerable populations. The findings emphasise the importance of developing a mobile application specifically tailored to address these challenges, offering accessible, culturally sensitive, and practical solutions. The discussion explores these findings in relation to previous studies, clinical implications, study limitations, and a concluding perspective.

The results align with prior research demonstrating the potential of digital interventions to improve maternal and child health outcomes. Venkataramanan *et al*. (2022) conducted a systematic review revealing that mobile health (mHealth) applications effectively increase caregiver knowledge and encourage behavioural changes in nutrition within resource-limited settings. Similarly, Kodish *et al*. (2022) underscored the role of technology in closing gaps in caregiver education and support. Bautista-Gomez, Zuluaga and Medina-Tabares (2024) further emphasised the value of integrating culturally and contextually appropriate content to enhance the effectiveness of digital tools in combating stunting. Building on these insights, this study highlights the need for applications that address localised challenges to ensure adaptability and efficacy across various contexts.

Moreover, user engagement has emerged as a critical factor for the success of digital health tools. McCool *et al*. (2022) demonstrated that gamification and personalised feedback significantly improve adherence to health interventions. Likewise, Okolo *et al*. (2024) showed that tailored engagement features within health applications foster sustained behaviour changes, especially when paired with community-based support systems. Expanding on these findings, this study highlights the importance of designing applications that are inclusive and accessible to caregivers in both urban and rural areas.

The discussion on technological literacy in mHealth implementation for stunting prevention should tackle specific barriers to the adoption of digital tools, such as limited digital skills, language barriers, and infrastructure issues like unstable internet availability and low smartphone penetration (Alsabri *et al*., 2025; Mbunge & Sibiya, 2024). Most people living in rural areas, especially lower-income individuals, often lack the very digital literacy required to efficiently utilise health applications. Another obstacle arises when national or international languages comprise the languages that digital health interventions are available in, causing a barrier for many with no basic language skills in those respective languages.

To overcome these barriers, therefore, offline access to key health resources would grant users in low-connectivity areas the same benefits despite poor or no internet access while ensuring interventions remain available (Alsabri *et al*., 2025). Furthermore, including applications in various languages, especially the local dialect, will ensure inclusivity and reaching out to other groups (Mbunge & Sibiya, 2024). Other contributions, such as visual and audio on the apps, may also help enhance accessibility among the illiterate. While this study has a context that is specific to a particular geographical and cultural configuration, the findings have broader applicability. Adapting digital health interventions to suit different regions has to take into consideration the local needs, level of digital literacy, and infrastructural capacities. For example, in scenarios where penetration of smartphones is low, the mitigation is complemented by a messaging-based strategy or assistance of the community health workers, which provides a broader reach. By ensuring that the mHealth solutions are tailored for particular populations and remain scalable, policymakers and practitioners may further increase the effectiveness of digital intervention to meet public health challenges, including stunting prevention.

Mobile applications can significantly enhance caregiver involvement in stunting prevention programmes. For instance, the AP3S app provides real-time support, educational materials, and behavioural prompts tailored to promote healthy behaviours among caregivers (Rianti, Pujiastuti, & Triwinarto, 2025). Similarly, the SEHATI app offers culturally sensitive content, improving maternal knowledge and engagement in stunting prevention efforts (Erika *et al*., 2024). Healthcare providers, particularly nurses, play a pivotal role in facilitating the effective use of these applications. They are instrumental in training caregivers to navigate and interpret health information and apply recommended practices daily. Moreover, nurses utilise digital metrics to monitor caregiver engagement and identify early signs of malnutrition or inappropriate feeding practices (Bakker *et al*., 2023). Feedback from key stakeholders, obtained through teleconsultations or in-person interactions, allows for timely problem-solving and reinforces existing guidance. Collaborative development of these applications between caregivers and healthcare providers ensures that the tools address specific user needs and preferences. Such integrative approaches have the potential to reduce the prevalence of stunting and enhance child health outcomes in resource-limited settings.

Limitation

Despite its contributions, this study has some limitations. First, the qualitative design provides in-depth insights but limits the generalisability of the findings. Future studies should use quantitative methods to validate these results across larger populations. Second, the research was conducted in a specific geographic and cultural context, which may not fully reflect the experiences of caregivers and healthcare providers in other regions. Finally, the study did not thoroughly examine technological literacy, a factor that could influence the feasibility and adoption of mobile applications.

CONCLUSION

The results of the current study call for expeditious planning of the mobile phone-based intervention that

can contribute to reducing stunting in these vulnerable communities because it is essential for community wellbeing, economic development, and health. The application of artificial intelligence or machine learning will be key to early detection and intervention to identify these at-risk children who are malnourished by taking into account demographic, dietary, and health data. AI can also give highly personalised recommendations to those seeking nutritional information and health monitoring. Stakeholders must be fully engaged during the entire process in order for the intervention to succeed. Training and provisioning should focus on mobile health tools that can support normal care as delivered by health workers. Emphasis should be placed by developers on user-friendly features with cultural relevance. Policymakers should support digital health innovations in regulatory frameworks and enable funding for scalable solutions. Future studies should explore in-depth how mobile app health interventions with AI-driven insights improve interventions' effectiveness and sustainability. Further studies should assess the long-term effectiveness, adaptability and cost-efficiency of AI-powered mobile interventions across diverse populations and health systems.

Conflict of Interest

The authors have no conflicts of interest to declare.

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