DIGITAL HEALTH LANDSCAPE FOR PEDIATRIC CARE: TECHNOLOGY BENCHMARKING, SOCIAL MEDIA DISCOURSE, AND HEALTH LITERACY IN INDONESIA

Ph.D. thesis

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1. Introduction

1.1 Background and Global Context of Digital Health

Digital health has become a transformative component of contemporary healthcare systems, reshaping how health services are delivered, accessed, and experienced worldwide. It broadly includes mobile health (mHealth) applications, electronic health records, telemedicine, wearable devices, and artificial intelligence, all aimed at improving prevention, diagnosis, treatment, and monitoring of health conditions. The COVID-19 pandemic significantly accelerated the adoption of digital health solutions, underscoring their importance in maintaining continuity of care during public health emergencies.

Despite rapid global growth, digital health implementation faces persistent challenges, particularly related to equity, data governance, interoperability, and user literacy. These challenges are more pronounced in low- and middle-income countries (LMICs), where infrastructural limitations, regulatory gaps, and socio-cultural factors constrain effective adoption. The World Health Organization has consistently promoted the integration of digital technologies to address healthcare workforce shortages and improve efficiency, affordability, and equity of care. However, disparities remain between high-income countries and LMICs in translating digital innovation into meaningful health outcomes.

Within this global context, digital health holds particular promise for underserved populations, yet its success depends not only on technological availability but also on alignment with local health systems, cultural practices, and users' digital competencies. Understanding these broader structural and contextual factors is essential for evaluating digital health interventions in specific national and sectoral settings.

1.2 Pediatric Digital Health in Developing Countries: Challenges and Opportunities

Children in LMICs continue to face a disproportionate burden of preventable diseases, malnutrition, and inadequate access to quality healthcare. Globally, stunting and wasting remain major public health concerns, with Southeast Asia and sub-Saharan Africa carrying the highest burden. In Indonesia, approximately one in four children under

five experiences stunted growth, with long-term consequences for cognitive development, educational attainment, and economic productivity. Pediatric care in such contexts is frequently constrained by shortages of specialists, high out-of-pocket costs, and uneven healthcare infrastructure.

The widespread penetration of smartphones has positioned mHealth technologies as a promising tool to address these gaps. In pediatric care, mHealth applications support growth monitoring, immunization reminders, parental education, and communication between caregivers and healthcare providers. Evidence suggests that well-designed mHealth interventions can improve maternal and child health outcomes when embedded within local health systems. However, many existing applications suffer from poor usability, limited cultural adaptation, weak regulatory oversight, and insufficient clinical validation.

Beyond technology, digital health communication plays a crucial role in shaping health behaviors. EHealth literacy remains uneven in LMICs, including Indonesia, where many users can access online health information but struggle to critically evaluate and apply it. Social media further complicates this landscape by amplifying both health promotion and misinformation. In pediatric health, emotionally charged narratives often influence parental decision-making more strongly than clinical guidance, particularly around issues such as nutrition, vaccination, and child development. Stunting has become a highly visible topic in Indonesian digital discourse, frequently intertwined with political narratives and emotional polarization.

Indonesia has made notable policy advances, including the development of the national SATUSEHAT platform and the introduction of pediatric mHealth applications such as PrimaKu and iPosyandu. Nevertheless, significant gaps remain in user-centered design, data security, contextual relevance, and interdisciplinary collaboration. This dissertation addresses these gaps by examining pediatric digital health in Indonesia through an interdisciplinary lens, integrating systematic evidence, app evaluation, social media discourse analysis, and digital health literacy assessment. By foregrounding sociocultural and communicative dimensions alongside technological evaluation, this study contributes original insights for

research, policy, and practice in pediatric digital health within LMIC settings.

2. Objectives

This dissertation critically examined the role of digital health technologies in pediatric healthcare, with a particular focus on their implementation and impact in Indonesia as a primary case study. Recognizing the growing influence of digital tools in public health, the study adopted an interdisciplinary and mixed-methods approach to explore how these technologies shape child health outcomes, especially in contexts marked by resource constraints, health disparities, and sociocultural complexity.

Specifically, the study pursued the following objectives:

1. Technology Assessment

Mobile App Evaluation and literature study: assessed the quality, usability, engagement, and informational accuracy of mobile applications for child growth monitoring available in Indonesia, using the Mobile App Rating Scale (MARS).

2. User-Centered Investigation

- Healthcare Workers' Digital Health Literacy: evaluated the level of digital health literacy among frontline healthcare workers in Indonesia, identifying critical enablers and barriers that influence the adoption and effective use of mHealth solutions in clinical practice.
- Online Discourse Analysis among healthcare workers: analyzed how issues such as stunting and child health are framed, discussed, and emotionally charged within Indonesian online platforms. This includes identifying dominant narratives, sentiment trends, and key engagement peaks through digital discourse analysis.

By addressing these objectives, the dissertation aimed to develop a comprehensive and culturally grounded understanding of how digital health operates at the intersection of technology, healthcare delivery, and societal narratives. Ultimately, the study sought to inform context-sensitive strategies for policy formulation,

digital health design, and implementation that support equitable and effective child health interventions in Indonesia and similar settings.

2.1 Research Question:

The research question of this study: How effectively is digital health being implemented in pediatric care in Indonesia, and what are the technological, social, and institutional factors shaping its adoption and impact?

The breakdown of the main research questions is below:

1. Assessing the Quality and Usability of Pediatric Health Apps in Indonesia
    - What is the current quality of pediatric mHealth applications available in Indonesia based on engagement, functionality, aesthetics, and information quality using the MARS tool?
    - How do these applications align with user needs and international standards for health app usability and clinical credibility?
2. Exploring Healthcare Workers Sentiment and Perspectives Through Social Media Discourse
    - What are the dominant narratives and sentiments expressed on "Indonesian Healthcare Workers" social media platforms regarding child health and digital health interventions, particularly related to stunting?
    - How do "Indonesian Healthcare Workers" engage with and shape public discourse about digital health policies?
3. Evaluating Digital Health Literacy Among Frontline Healthcare Workers
    - What is the current level of digital health literacy among healthcare professionals in a high-stunting area of Indonesia?
    - Which dimensions of digital literacy (e.g., navigation skills, critical evaluation, data privacy awareness) are strong or lacking?
    - How does digital health literacy influence the ability and willingness of healthcare workers to use and recommend digital health tools?
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3. Methods

This study adopted a mixed-method, multi-phase research design combining big data analysis with empirical fieldwork to examine the pediatric digital health landscape in developing countries, with Indonesia as a case study. Publicly available digital data, particularly from social media platforms, were analyzed using computational techniques such as sentiment analysis, peak detection, and discourse mapping to identify dominant narratives, engagement patterns, and representations of child health and stunting. These macro-level insights were complemented by fieldwork in rural and under-resourced Indonesian settings, where surveys and semi-structured interviews with healthcare workers captured local experiences and implementation challenges. Integrating digital analytics, technology benchmarking, health literacy assessment, and systematic literature synthesis, the study offers a comprehensive and context-sensitive understanding of how digital health tools are perceived, adapted, and used in pediatric care, informing the development of culturally appropriate, technically viable, and socially equitable interventions.

3.1. MHealth Benchmarking App Evaluation

To evaluate the quality and usability of mobile health (mHealth) applications designed for child growth monitoring in Indonesia, this study conducted a cross-sectional descriptive appraisal of apps available on the Google Play Store and Apple App Store. Applications were eligible if they were available in Bahasa Indonesia, explicitly targeted parents and/or healthcare workers involved in pediatric care, accessible to the general public (free or paid), and contained core functionalities related to child growth monitoring or nutrition, such as anthropometric tracking, growth curve visualization, developmental milestone logging, or dietary guidance. App searches were performed using single Bahasa Indonesia keywords commonly associated with pediatric health (e.g., pertumbuhan anak, gizi anak, kesehatan balita), as commercial app platforms do not support Boolean operators. Duplicate, non-functioning, or ineligible applications were excluded, and only apps meeting all criteria and available during the data collection period were included.

Each eligible application was systematically evaluated using the Mobile Application Rating Scale (MARS), a validated multidimensional instrument assessing app quality across four domains: engagement, functionality, aesthetics, and information quality. All domains were rated on a 5-point Likert scale, with higher scores indicating superior quality. Five healthcare professionals served as independent raters and underwent structured training to standardize scoring procedures and minimize bias. Prior to formal assessment, raters jointly evaluated a non-study application to harmonize interpretations of the MARS criteria. During the evaluation phase, each rater independently downloaded, used, and assessed every included application, resulting in five ratings per app. Rating discrepancies of two points or more were resolved through consensus discussions.

Quantitative MARS scores were analyzed using IBM SPSS Statistics version 28.0.1. Descriptive statistics were used to summarize app performance across domains, while comparative analyses examined differences by developer type (government, private sector, or NGO-affiliated) and platform (Android versus iOS). Correlation analysis was conducted to explore associations between MARS scores and user ratings in app stores. Inter-rater reliability was assessed using the Intraclass Correlation Coefficient (ICC), ensuring methodological rigor and reproducibility. This benchmarking approach provided a structured and evidence-based assessment of pediatric mHealth applications in Indonesia, contributing to a broader evaluation of digital health technologies in low- and middle-income country contexts.

3.2 Digital Health Literacy Assessment

A cross-sectional mixed-method study was conducted to assess digital health literacy among frontline healthcare workers in five purposively selected villages Labuan Bajo, Benteng, Datak, Orong, and Wae Pitak in West Manggarai Regency, Indonesia. These sites were chosen based on their logistical feasibility, accessibility by road, and alignment with ongoing stunting intervention programs led by the 1000 Days Fund, an international NGO active in the region.

The study was situated in a region of strategic importance due to its persistently high stunting prevalence and limited access to digital

health infrastructure, supporting Indonesia's national health priorities. While village-level stunting data were limited, broader reports indicate that Labuan Bajo had a stunting prevalence of up to 36.4% in some areas as of August 2023, with West Manggarai Regency overall reporting 8.2% among children under five down from approximately 15% in 2021–2022. Notably, Benteng District was previously reported to have a rate as high as 33.6%.

The study included all available healthcare workers actively serving in these five villages, resulting in a total of 97 respondents. Participants consisted of medical doctors, midwives, nurses, and community health workers stationed at Puskesmas (primary healthcare centers), Pustu (auxiliary health centers), and Posyandu (integrated health centers).

The quantitative component employed the HLS19-Digital Health Literacy Survey (HLS19-DIGI), a validated 16-items instrument designed to assess individuals' abilities to access, comprehend, evaluate, and apply digital health information. The survey was professionally translated into Bahasa Indonesia and self-administered to accurately reflect participants' digital competencies in clinical practice. For research purposes, only 10 items were selected, aligning with the competency-based structure of the DHL scale. These items demonstrated low conceptual correlation with the literacy items and functioned more effectively as descriptive variables rather than components of the DHL index.

We utilized purposive sampling to recruit all available healthcare professionals, including doctors, midwives, nurses, and community health workers, who were active in the region of research focus. For the qualitative component, a purposive subsample was invited to participate in semi-structured "think-aloud" and in-depth interviews. The objective was to comprehend context-specific barriers and perceptions of digital health literacy, rather than to generate statistically generalizable estimates. Consequently, the sample size was determined by the principle of data adequacy and saturation, rather than a formal power calculation. Previous methodological research in qualitative health studies suggests that saturation is often achieved within 5–17 interviews when the study population is relatively homogeneous, and the research objective is focused (Mursa et al.).

Quantitative data were analyzed using SPSS for descriptive statistics, while qualitative data were transcribed, coded, and thematically analyzed. This mixed-method approach provided a comprehensive understanding of digital health literacy and its role in strengthening pediatric and maternal health services in underserved settings.

4. Results

4.1 MARS MHealth Evaluation

This study followed up on the previous literature review examining e-Health and m-Health use in pediatric care in developing countries. As shown in Table 1, existing interventions demonstrated strong potential to improve vaccination, nutrition, and maternal child health outcomes when they are user-friendly, well-integrated, and behavior focused. However, infrastructure limitations, low digital literacy, and limited trust in healthcare systems continue to constrain their broader impact.

Building on these insights, a total of 9 mobile health apps from Indonesia related to pediatric care were evaluated after screening 45 apps across platforms. Most of the identified apps focused on child growth tracking and parental education. While technical performance particularly functionality and aesthetics was rated highly, engagement features and the credibility of medical content varied considerably. Notably, the highest-rated apps were commercial such as Asianparent and Tentang Anak, which achieved high scores in engagement, design, and behavioral outcomes. In contrast, some apps like PSG Balita and Astuti performed poorly in subjective quality and engagement despite strong technical features. Behavioral impact was strongest in awareness and help-seeking intentions but weakest in effecting actual behavior change. This suggests a need for more interactive and evidence-based designs. Statistical analysis confirmed commercial apps significantly outperformed non-commercial ones.

Table 1. Summary of E-Health and M-Health Use in Pediatric Care in Developing Countries

Aspect	Details
Main Purposes	- Vaccination reminders (via SMS or apps) - Breastfeeding promotion and education - Growth and nutrition monitoring - PMTCT HIV follow-up care
Target Users	- Parents and mothers (especially pregnant/lactating women) - Healthcare workers (community health, village doctors, HSAs)
Key Outcomes	- Improved adherence to vaccination schedules (Ethiopia, Indonesia, Kenya) - Increased exclusive breastfeeding rates (China, Kenya, Vietnam, India) - Better follow-up and retention in PMTCT programs (Kenya) - Increased immunization coverage and parental satisfaction (Guatemala, Thailand, China) - Improved decision-making and efficiency at provider level (Malawi, China)
Technology Platforms	- SMS/Text messages - Mobile apps (custom or integrated with national systems) - Phone consultation (telehealth)
Successful Predictors	- Perceived usefulness and ease of use (Ethiopia) - Supportive attitudes toward immunization (Indonesia)
User Acceptance	- High acceptability across settings: SMS reminders, mobile apps (WeChat in China, KhunLook in Thailand) were well received
Barriers	- Infrastructure: phone/network access, electricity (Ethiopia) - Literacy and language challenges - Limited professional sources of nutrition info (China)
Mixed/Neutral Results	- No significant effect on clinic retention or child HIV-free survival in PMTCT SMS (Kenya) - Unclear impact on hospital admissions (Malawi)
Regional Notes	- Africa: Focused on vaccination, HIV, and infant feeding - Asia: Broader scope including nutrition, growth monitoring, breastfeeding, and health systems

(Irawan et al., 2025)

4.2 Functionality, Engagement, Aesthetics, and Information Quality

Most of the evaluated apps demonstrated a strong focus on child growth tracking and educational content (table 2), with 77.8% incorporating these core functions. In addition, 80% included

developmental assessment tools and health advice components, while 60% provided tips, strategies, or skills training for parents. Interactive features were less common, with only 40% offering elements such as community support or goal-setting options. Reminder notifications were available in 70% of the apps, and 90% required users to create an account or log in. Social media sharing was the least frequent feature, present in only 20% of the apps. Overall, commercial apps represented 77.8% of the applications evaluated.

Table 2. The Summarizes of the MARS Findings

Dimension	Findings
App Inclusion	9 functional pediatric-focus apps evaluated
Features	Strong in growth tracking and education; weak in interactivity and support
Technical Quality	Excellent functionality/aesthetics; highly variable engagement
Information Credibility	Moderate; many apps lacked expert-reviewed content
Behavioral Impact	Highest for awareness/help-seeking; weakest on actual behavior change

(Irawan et al., 2025)

4.3 MARS Scoring Summary and Comparison

The quality assessment using the MARS instrument showed strong inter-rater reliability (Kendall's W = 0.93; p = 0.03), indicating consistent scoring between evaluators. Among the four objective MARS domains, functionality received the highest average score (mean 4.61, SD 0.33), reflecting solid technical performance across the apps. Engagement demonstrated the widest variability (mean 3.80, SD 1.17), suggesting inconsistent levels of interactivity and user stimulation. Aesthetics scored moderately high (mean 4.07, SD 0.62), while information quality was comparatively lower (mean 3.99, SD 0.78), highlighting gaps in credible and comprehensive medical content. Overall, the aggregate MARS mean score was 4.12 (range 3.18–4.89), whereas subjective quality ratings were lower, averaging only 3.33.

Among the nine pediatric mHealth apps evaluated, Asianparent and Tentang Anak emerged as the top performers, achieving perfect scores (5.0) across Engagement, Functionality, and

Aesthetics. In contrast, PSG Balita showed strong technical performance with a functionality score of 5.0 but recorded the lowest Engagement score (1.40), indicating limited user interactivity. Astuti performed notably poorly on subjective quality, scoring around 1.50, which reflects low perceived usefulness and user satisfaction. In terms of behavioral outcomes, the highest average impact scores were observed in the domains of awareness and help-seeking, both averaging approximately 3.78.

Behavior Change had the lowest mean (~2.89), indicating limited real-world influence. Apps like Asianparent and Tentang Anak showed strong outcomes in awareness, intention, and behavior change. Others performed less well, particularly in attitude and actual behavior domains. Commercial apps had significantly higher total MARS scores (mean = 4.34) compared to non-commercial apps (mean = 3.34; $t = 4.36$, $p = 0.012$), indicating statistically superior quality in commercial offerings. These findings highlighted the strengths and limitations of pediatric mHealth apps in Indonesia, particularly their usability and educational potential but also reveal gaps in engagement design and evidence-based content. Developers should prioritize trusted information and interactive features to enhance effectiveness and user trust.

4.4 Social Media Analysis

The study sample consisted of a diverse range of professions. This research involved social media users from diverse professional backgrounds. The largest identified groups were bloggers (607 users, 24.9%), followed by authors/writers (239 users, 9.8%), engineers (254 users, 10.4%), entrepreneurs (245 users, 10.0%), and healthcare workers the focus of this study at 245 users (10.1%). Healthcare workers' inclusion is especially important because they provide direct patient care and are key implementers of health interventions, offering essential frontline perspectives for improving digital health adoption and literacy. The "Other" category, which accounts for 1,167 users (47.9%), did not specify their occupation.

4.5 Topic Trends Related to Child Health

User demographics showed that female users dominate the conversation, generating 2,617 engagements compared to 158 from male users and 42 from those with unspecified gender. The results revealed, most of the post's expressed negative sentiment (62.4%), followed by neutral (31.9%) and positive (5.7%). When broken down by gender (Figure 1), female users contributed the highest share of negative posts (68%), along with 44% neutral and 8% positive. Male users displayed a similar pattern (66% negative, 24% neutral, 4% positive), while posts from users with unspecified gender also leaned negative (9 negative, 5 neutral, 1 positive). Overall, these patterns indicated that regardless of gender, online discourse about stunting and healthcare issues is predominantly critical or problem-focused rather than positive.

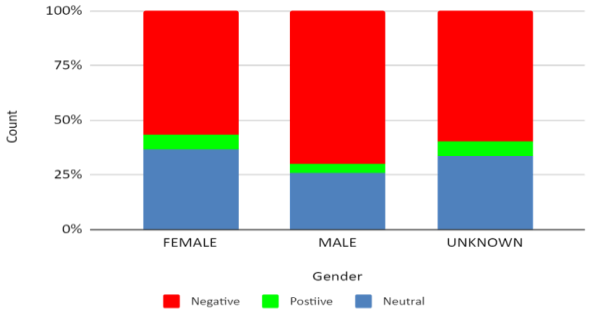

Figure 1. Posts sentiment by gender (Source: own figure)

In this social media analysis, narratives posted by healthcare workers were the primary focus, yielding a dataset of 230 posts. From thematic content analysis revealed 5 focuses on the main theme. These themes showed that while stunting is recognized as a critical public health issue, structural barriers particularly the underutilization of healthcare workers' expertise hinder progress.

The sentiment analysis of social media discourse surrounding stunting in Indonesia showed a clear predominance of negative sentiment. Out of all the analyzed posts, 62.4% expressed negative sentiments, often reflecting criticism of public health programs,

governance issues, and frustration with outcomes. For example, one user wrote: "*Program pemerintah cuma seremonial, tapi di lapangan anak-anak tetap kekurangan gizi*" ("Government programs are just ceremonial, but in the field, children are still malnourished."). Meanwhile, 31.9% of the posts were neutral, typically consisting of informational content, news articles, or event announcements without strong emotional tones. A post such as: "*Peringatan Hari Gizi Nasional ke-63 digelar serentak di berbagai daerah*" ("The 63rd National Nutrition Day is being commemorated simultaneously in various regions.") falls into this category.

Only 5.7% of the posts were positive, mostly highlighting support for public campaigns or expressing optimism. One widely shared message stated: "*Selamat Hari Gizi Nasional ke-63! Saya siap mendukung pencegahan stunting dengan protein hewani*" ("Happy 63rd National Nutrition Day! I am ready to support stunting prevention with animal-based protein."). Another notable example praised grassroots health workers: "*Meskipun apresiasinya hanya seuprit, peran kader dalam penanganan stunting justru paling vital*" ("Even the appreciation is minimal, the role of community health workers in stunting prevention is the most vital."). These findings underscored a critical gap between policy promotion and public perception. While official efforts are acknowledged, the dominant public sentiment revealed distrust, a perceived lack of impact, and a call for more meaningful community involvement and transparency.

4.6 Influencers and Viral Narratives by Engagement

The major themes from influencers and viral narrative by engagement rate include:

- Critique of Public Health Programs: Discussions focused on concerns about limited program coverage, poor governance, and budget mismanagement in stunting interventions.
- Community-Level Barriers: Highlighted issues include data manipulation and the inadequate involvement of frontline health workers.

- Challenges in Behavioral Change: Posts emphasized cultural resistance and socio-normative barriers to adopting preventive measures.
- Scientific Literacy and Advocacy: Digital platforms were used as tools to disseminate evidence-based information and promote public understanding of interventions.
- Calls for Health System Transparency: Users demanded more accountability and evidence-based decision-making in program planning and implementation.

In terms of engagement, the data showed a significant gender disparity: female users generated 2,614 interactions, compared to 135 from males, with 36 users of unknown gender. Professionally, nutritionists were the most active, contributing 2,630 interactions, followed by medical doctors (144) and veterinarians (11). The highest-engagement post was authored by a female nutritionist, suggesting that content which blends professional expertise with relatable messaging resonates most strongly with the public.

4.7 Digital Health Literacy Assessment

This study employed a sequential mixed-methods approach, beginning with quantitative survey followed by in-depth interviews administered to selected informants. The digital health literacy survey was conducted among 97 respondents working in pediatric and maternal health settings, focusing on their demographic backgrounds to understand variation in literacy levels. In terms of age (table 6), most participants were between 31 and 40 years old (46%), followed by those aged 20 to 30 (29%), 41 to 50 (20%), and 51 to 60 (5%).

Regarding educational background, most respondents had completed high school (35%), while others had a middle school education (21%), associate degrees (21%), elementary education (16%), and a small portion held a bachelor's degree (7%). In terms of occupational roles, the sample was predominantly made up of community health workers (76%), with smaller proportions of midwives (20%) and nutritionists (4%). These demographic patterns highlighted a workforce composed largely of front-line health workers with varying educational attainment, which may influence their

capacity to access, understand, and apply digital health information effectively in stunting prevention and childcare programs.

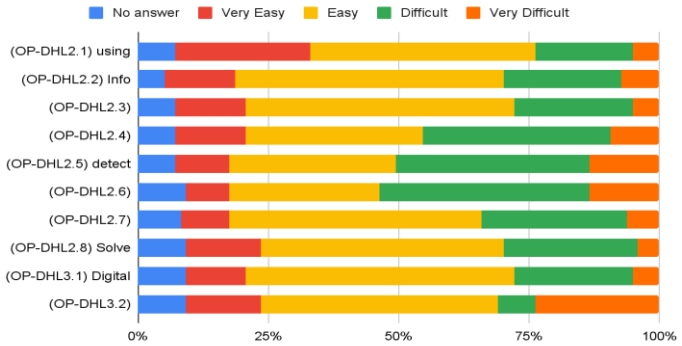

Figure 2. The result of (DHL) of 97 respondents was assessed using a series of items that reflect various competencies. (Source: own figure)

The Digital Health Literacy (DHL) assessment explored users' self-reported abilities across multiple competencies, as visualized in Figure 2. The responses were categorized into five levels of difficulty perception: Very Easy, Easy, Difficult, Very Difficult, and No Answer. Overall, most participants rated DHL tasks as either "easy" or "difficult", with a relatively small proportion selecting "very easy" or "very difficult." Several items showed a high percentage of difficulty, particularly in areas requiring critical assessment and problem-solving. For instance, in the item OP-DHL2.8 (Solve) which asked respondents how easy or difficult it was to solve health-related problems using online resources over 50% found it: difficult or very difficult, indicating a significant gap in applied digital health problem-solving skills.

Similarly, OP-DHL2.5 (Detect) which assessed the ability to detect the quality and credibility of digital health information had a high difficulty rating, with many participants struggling to evaluate misinformation or identify trusted sources. This aligns with common concerns in digital health environments in low-resource settings, where critical appraisal skills are often underdeveloped.

Interestingly, more basic tasks such as OP-DHL2.1 (Using digital tools) and OP-DHL2.2 (Searching for info) were perceived as easier by a greater number of participants, although the proportion of those who selected "difficult" or provided no answer suggested underlying gaps in digital familiarity or confidence. OP-DHL3.1 and OP-DHL3.2, which pertain to digital participation and interaction in health forums or digital platforms, also showed mixed levels of ease and difficulty, highlighting a general hesitancy in engaging actively with online health ecosystems.

In summary, while respondents were moderately confident in accessing and using digital health tools, they demonstrated limited skills in critical evaluation, problem-solving, and interactive engagement. These findings emphasized the need for targeted digital literacy training that goes beyond technical use, focusing instead on evaluative and participatory competencies critical for effective use of digital health tools in pediatric care and stunting prevention.

The digital health literacy (DHL) of 97 respondents was assessed using a series of items that reflect various competencies in navigating, understanding, evaluating, applying, and communicating health information online. The table below summarized the results along with an explanation for each variable.

The findings reflected moderate to high levels of digital health literacy in basic tasks such as searching for information using keywords, understanding content, and communicating digitally. These are fundamental skills that suggest general digital familiarity among the participants. However, critical digital literacy skills, especially those related to evaluating trustworthiness, commercial bias, and cross-verifying information from multiple sources were notably weaker. Over half of the respondents found these tasks challenging, which highlights a critical gap in the ability to engage with digital health content analytically. These findings are consistent with studies in similar contexts where access and basic digital literacy are present, but critical appraisal skills lag.

The reluctance to share opinions on digital platforms may reflect underlying socio-emotional or cultural influences that limit open online discourse. Factors such as concern over misinformation, perceived lack of credibility, or fear of digital repercussions could contribute to this hesitation. Collectively, these findings highlighted

the importance of targeted digital health literacy programs that extend beyond basic skills of use and comprehension to emphasize critical evaluation and active participation. Such capacity-building initiatives should focus on developing users' abilities to discern trustworthy information, detect persuasive or commercial content, and engage confidently in online health conversations.

4.8 In-depth Interview Themes: Barriers, Trust, and Technology Use

The in-depth interviews revealed that both healthcare professionals and community-level actors have access to and regularly use digital health technologies, though the complexity and purpose of use vary by role and context. Digital tools such as telemedicine platforms, search engines, and reporting applications were widely perceived as beneficial for improving efficiency, supporting data reporting, and extending services to remote areas, particularly during the COVID-19 pandemic. However, participants emphasized that digital health tools cannot replace face-to-face consultations, especially for accurate diagnosis requiring physical examination.

Key barriers included uneven digital infrastructure, particularly unstable internet connectivity in rural areas, limited system reliability, and varying levels of digital health literacy. Trust in digital health information was moderate, with most participants stressing the need to verify online content through multiple sources or professional confirmation. Concerns about data privacy and security were more prominent among healthcare professionals than community users. Overall, the findings highlight cautious acceptance of digital health technologies, underscoring the importance of strengthening infrastructure, literacy, trust, and user-centered design to support effective pediatric care and stunting prevention.

4.9 Integrated Synthesis of Multi-Method Findings

Digital health interventions for pediatric care in developing countries, particularly for stunting prevention, show strong potential but face significant limitations. Most mHealth applications target parents and focus on growth monitoring and vaccination, aligning with global child health priorities. While many apps demonstrate good

technical performance and design, they often lack interactive, evidence-based features that support sustained behavior change, limiting their real-world effectiveness. Social media analysis reveals that mistrust toward government-led stunting programs, driven by perceived inefficiency and lack of transparency, undermines digital health adoption, highlighting the importance of trusted health professionals and culturally sensitive communication. Digital health literacy assessments show that frontline healthcare workers possess basic digital skills but lack advanced competencies to critically evaluate information and counter misinformation. Overall, the findings indicate that effective pediatric digital health requires not only robust technology but also strengthened literacy, trust, infrastructure, and community engagement to ensure sustainable and equitable impact.

5. Conclusions

This study elucidated the paradox inherent in digital health within Indonesia: despite the increasing availability of digital tools for pediatric care, their implementation and adoption are impeded by quality deficiencies, public distrust, limited digital literacy, and infrastructural disparities. The optimistic portrayal of mobile health (mHealth) in policy and academic discourse must be reconciled with the realities at the ground level, where digital solutions intersect with sociocultural values, institutional gaps, and user capacity. This dissertation provided a comprehensive empirical contribution to understanding the digital health landscape in pediatric care within low- and middle-income countries (LMICs), with a focus on Indonesia as a primary case study. By integrating a systematic literature review, mobile app evaluation, social media discourse analysis, and a digital health literacy assessment, it bridged the gap between global policy narratives and the realities of digital health implementation on the ground.

Firstly, the literature corroborated prior research indicating that mHealth interventions for maternal and child health are rapidly gaining traction across LMICs. These digital interventions are often presented as scalable, cost-effective solutions for enhancing health access and outcomes, particularly in reaching underserved

populations. However, such reviews tended to offer an optimistic perspective, frequently emphasizing successes, and technical potential, while giving less attention to sociocultural and infrastructural constraints. And the evaluation of apps using the Mobile App Rating Scale (MARS) revealed a discrepancy between the availability of pediatric mHealth tools and their functional, engaging, and evidence-based quality. The findings aligned with studies highlighted that many health apps lack rigorous development, user co-design, and clinical validation. In the context of Indonesia, this raised questions about the role of local developers, regulatory oversight, and user feedback in shaping app ecosystems.

Secondly, the social media discourse analysis provided critical evidence of how digital platforms shape and reflect public sentiment. The prevalence of negative sentiment and users concerned on platforms such as Twitter and Instagram suggest a credibility crisis surrounding digital health programs. The presence of healthcare professionals voicing concern on these platforms underscored their role not only as service providers but also as communicators and opinion leaders. This challenges the traditional top-down model of health communication and suggested the need for a dialogic, participatory communication strategy.

Thirdly, the assessment of digital health literacy among healthcare professionals in a high-stunting area revealed a significant gap in critical digital skills. While basic navigation is adequate, skills essential for navigating the complexities of online health information, such as verifying credibility, identifying bias, and recognizing misinformation are markedly insufficient. This complemented recent calls for a nuanced understanding of digital health literacy that extends beyond access and skills to include motivational and critical dimensions.

These findings reinforced the notion that digital health cannot be understood or implemented as a purely technological innovation. It must be viewed as a socially embedded process that interacts with local infrastructure, health worker culture, patient preferences, and public trust. Ultimately, digital health should not be perceived as a replacement for conventional care but as a hybrid model that enhances healthcare equity and resilience. For Indonesia and other LMICs, the

challenge is not whether to digitize healthcare, but how to do so in a manner that is inclusive, ethical, and grounded in local realities.

6. Bibliography of the candidate's publications

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