SEMMELWEIS EGYETEM DOKTORI ISKOLA

**Ph.D. értekezések**

**3411.**

**ANGGI SEPTIA IRAWAN**

**Interdiszciplináris társadalomtudományok**

című program

Programvezető: Dr. Pethesné Dávid Beáta, egyetemi tanár

Témavezető: Dr. Girasek Edmond, egyetemi docens

# DIGITAL HEALTH LANDSCAPE

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

**PhD thesis**


## Anggi Septia Irawan

Mental Health Sciences Division Doctoral College

Semmelweis University




| | |
|---|---|
| Supervisor: | Edmond Girasek, Ph.D |
| Official Reviewers: | Tóth Zoltán, Ph.D |
| | Horváth Tamás, Ph.D |

Head of the Complex Examination Committee : László Szabó, MD, Ph.D

Members of the Complex Examination Committee: Vince Pongor Fazekas, MD, Ph.D

Zsófia Bauer, Ph.D

Budapest

2025

TABLE OF CONTENT

LIST OF ABBREVIATIONS

| | |
|---|---|
| MHealth | Mobile Health |
| EHealth | Electronic Health |
| EHRs | Electronic Health Record |
| WHO | World Health Organization |
| UNESCO | United Nations Educational, Scientific and Cultural Organization |
| HICs | High Income Countries |
| LMICs | Low (and Middle) Income Countries |
| MARS | Mobile Application Rating Scale |
| DHL | Digital Health Literacy |
| PRISMA | Preferred Reporting Items for Systematic Review and Meta-Analyses |
| CASP | Critical Appraisal Skills Program |
| NGO | Non-Government Organization |
| NLP | Natural Language Program |
| Lang | Language |
| Id | Indonesia |
| UGC | User Generated Content |
| HLS | Health Literacy Survey |
| App | Application |
| INF | Informant |
| UHC | Universal Health Coverage |

INTRODUCTION

## 1.1 The Focus of the Research

This dissertation investigated the landscape of pediatric digital health interventions in Indonesia, with particular emphasis on the role of digital technologies such as mobile health (mHealth) applications and social media in improving child healthcare. Emphasizing the importance of user-centered design in digital health solutions, the study underscored the impact of local context on their effectiveness and acceptance in pediatric care environments.

The research primarily concentrated on healthcare workers, including community healthcare workers, midwives, nurses, nutritionists, and medical doctors, who acted as both users and trusted influencers within Indonesia's pediatric digital health landscape. Their perspectives shed light on the challenges of program implementation, data accuracy, and engagement with digital tools in varied and resource-limited settings. By examining healthcare professionals' views alongside public discourse and sentiment on social media, the study demonstrated how these stakeholders shaped health narratives, disseminated accurate information, and countered misinformation in digital spaces.

Indonesia offered a uniquely valuable setting for this research due to its large and diverse population, rapid digital adoption, and ongoing healthcare challenges marked by disparities in access and quality between urban and rural areas. Its intricate social, cultural, and infrastructural landscapes provided a rich context for investigating how digital health innovations could be customized to meet the needs of different communities. This research provided new insights into bridging digital divides in pediatric healthcare. It also informed policies and interventions that utilize technology to improve child health outcomes in diverse and developing country contexts.

## 1.2 Background and Global Context of Digital Health

Digital health technologies have emerged as a transformative force in global healthcare systems, changing how healthcare is delivered, accessed, and experienced (Shapoo, N., Rehman, A., & Boma, N.). Broadly construed, digital health encompasses the use of digital technologies such as mobile health (mHealth) apps, electronic health records (EHRs), wearable devices, telemedicine, and artificial intelligence to support the prevention, diagnosis, treatment, and monitoring of health conditions (Fraser & Blaya) .

The COVID-19 pandemic has significantly accelerated the adoption of digital health solutions, highlighting their critical role in maintaining continuity of care during public health crises and lockdowns (Anastasiadou, O., Tsipouras, M., Mpogiatzidis, P., & Angelidis, P., 2025). While the global digital health ecosystem continues to grow rapidly, challenges remain

in accessibility, equity, data privacy, interoperability, and user literacy especially in low resource settings (Ahmed, M. M., Okesanya, O. J., Olaleke, N. O., Adigun, O. A., Adebayo, U. O., Oso, T. A., Eshun, G., & Lucero-Prisno, D. E., 2025).

Experts have predicted a significant shortage in the healthcare workforce, which continues to pose a challenge for the future (Mathieu, B., Teena, K., Tapas Sadasivan, N., Amani, S., James, C., & Khassoum, D., 2022). WHO has long advocated for the integration of information and communication technologies in healthcare and medical fields. This initiative aimed to address these deficiencies by enhancing the efficiency of health information systems, thereby ensuring the delivery of quality, affordable, and equitable care (Hasman, A., Mantas, J., & Marin, H. F., 2024). According to WHO, digital health encompasses the knowledge and practices related to the development and application of digital technologies to imrpove health outcomes (Innovation, 2021).

By utilizing technology, healthcare systems can improve access, efficiency, equity, and quality of services, particularly in underserved regions. However, while high-income countries (HICs) have made significant advances, low- and middle-income countries (LMICs) often face infrastructural, regulatory, and socio-cultural barriers to successful implementation (Irawan, A. S., Döbrössy, B. M., Biresaw, M. S., Muharram, A. P., Kovács, S. D., & Girasek, E., 2025).

### 1.3 Pediatric Health Challenges in Developing Countries

Children in LMICs remain disproportionately affected by preventable diseases and malnutrition. According to UNICEF, in 2022, 45 million children under five were wasted, and 149 million were stunted globally, with the highest burden concentrated in sub-Saharan Africa and Southeast Asia (Black, R. E., Victora, C. G., Walker, S. P., Bhutta, Z. A., Christian, P., de Onis, M., Ezzati, M., Grantham-McGregor, S., Katz, J., Martorell, R., & Uauy, R..; Krasevec J, 2022). In Indonesia, one in four children under five is stunted (Alristina, A. D., Mahrouseh, N., Irawan, A. S., Laili, R. D., Zimonyi-Bakó, A. V., & Feith, H. J., 2025). These figures are alarming, not only because of the health consequences but also due to the long-term impacts on cognitive development, education, and future earning potential (Prendergast & Humphrey, 2014).

The main problem of access to pediatric care is frequently constrained by a lack of specialists, high out-of-pocket costs, and unsupported infrastructure (Marcin, J. P., Shaikh, U., & Steinhorn, R. H.). Currently, mobile technology, already widespread due to increased smartphone penetration, offers a promising avenue for addressing these barriers (Curfman, A. L., Hackell, J. M., Herendeen, N. E., Alexander, J. J., Marcin, J. P., Moskowitz, W. B., Bodnar, C. E. F., Simon, H. K., & McSwain, S. D.). The effectiveness depends on thoughtful integration,

user literacy, and culturally contextualized content (Moorhead, S. A., Hazlett, D. E., Harrison, L., Carroll, J. K., Irwin, A., & Hoving, C., 2013; Quinn, S. C., Jamison, A. M., & Freimuth, V., 2020).

### 1.4 Emergence and Relevance of MHealth Technologies

MHealth, known as medical and public health practices, use mobile devices and currently has emerged as a key component of digital health strategies in LMICs (Istepanian; Karahoca, A., Bayraktar, E., Tatoglu, E., & Karahoca, D., 2010). In pediatric care the tools encompass applications for maternal and child health, immunization reminders, remote diagnosis, health education, and disease surveillance. In pediatric care, mHealth tools are increasingly used to monitor child growth, educate parents, and improve communication between caregivers and providers (Tomlinson, M., Rotheram-Borus Mj Fau - Swartz, L., Swartz L Fau - Tsai, A. C., & Tsai, A. C.).

One finding from a meta-analysis by Agarwal suggested that mHealth interventions could significantly improve maternal and child health outcomes in LMICs when supported by local health systems and adapted to local circumstances (Agarwal, S., LeFevre, A. E., Lee, J., L'Engle, K., Mehl, G., Sinha, C., & Labrique, A..). However, most existing applications suffer from poor usability, lack of localization, and limited regulatory oversight (Zhao, J., Freeman, B., & Li, M., 2016). In Indonesia, several mHealth applications are available in the market, but only a few are clinically validated or recommended by pediatric associations (Irawan, A. S., Alristina, A. D., Laili, R. D., Amalia, N., Muharram, A. P., Miranda, A. V., Döbrössy, B., & Girasek, E.., 2025).

### 1.5 Digital Health Communication: Theoretical Foundations:

#### EHealth Literacy and Narrative Theory

The concept of eHealth literacy, as introduced by Norman and Skinner, remains central to understanding how individuals' access, comprehend, and apply digital health information (Norman & Skinner, 2006). Lily Model identifies six core literacies: traditional literacy, health literacy, information literacy, scientific literacy, media literacy, and computer literacy that together define a person's capacity to effectively engage with digital health tools. This framework continues to be relevant in recent literature, particularly for evaluating user engagement in the digital age (Hua, Z., Yuqing, S., Qianwen, L., & Hong, C.., 2025; Sudbury-Sudbury-Riley, L. A.-O., FitzPatrick, M. A.-O., & Schulz, P. A.-O. X..). In Indonesia, despite widespread smartphone access and increasing internet penetration, a 2022 study noted that Indonesia has more than 100 million smartphone users, with 92 million (32% of the population)

using mobile health applications, indicating widespread access to digital devices, digital health literacy remains low among both patients and healthcare providers (Handayani, P. W., Meigasari, D. A., Pinem, A. A., Hidayanto, A. N., & Ayuningtyas, D..).

From a study involving 460 Indonesian adults found that key predictors of eHealth literacy included education level ($p < 0.001$), age ($p = 0.032$), and intensity of internet use ($p < 0.001$). While participants generally felt confident in locating online health resources (mean score 4.13 out of 5), they showed lower confidence in evaluating and applying the information they found, with mean scores of 3.67 to 3.75. These findings indicate that although basic digital navigation skills are present, many users in Indonesia still struggle with critical aspects of digital health literacy, such as assessing the credibility and usefulness of online health information (Algifari, 2024).

Beyond literacy, the use of narratives and storytelling in digital health especially within pediatric contexts has shown significant promise. Narrative theory suggests that stories are a powerful mechanism for influencing health behaviors, particularly in culturally diverse populations. Digital storytelling approaches, such as animated videos, personal testimonials, and interactive content, have been used to enhance comprehension and trust in public health messages. A 2024 scoping review on vaccine communication confirmed that narrative-based interventions outperform traditional informational campaigns in improving engagement, emotional resonance, and behavioral outcomes (Haji Said, A., Winskell, K., Bednarczyk, R. A., Reardon, E. E., & Vasudevan, L., 2024).

### 1.6 Social Media and Public Discourse on Health

Social media has become a dominant force in shaping public discourse around health. Platforms such as Facebook, Instagram, and TikTok are widely used by parents, caregivers, healthcare professionals, and influencers to share pediatric health information, personal experiences, and advice. Global social media users: 5.1 billion, with Facebook (2.9B), Instagram (1.5B), and TikTok (1B) leading platforms (Bozzola, E. A.-O., Spina, G. A.-O., Agostiniani, R., Barni, S., Russo, R., Scarpato, E., Di Mauro, A. A.-O., Di Stefano, A. V., Caruso, C., Corsello, G., & Staiano, A.). In Indonesia, internet penetration reached 64% (175.4 million users) and 338.2 million mobile connections in 2020, but only 30–40% of users feel confident evaluating health information credibility (Merga, 2024).

These platforms have democratized access to health information and can foster community support and empowerment. However, they are also fertile ground for misinformation, particularly concerning child development, vaccinations, and nutrition. A recent study highlighted that unverified claims spread rapidly in social media environments,

often outpacing corrections from authoritative sources (Choi, S., Bang, K.-S., & Shin, D.-A., 2021). Moreover, online peer communities significantly influence parental decisions often more than clinical recommendations. A 2025 JMIR study revealed that digital testimonials and emotionally charged narratives frequently guide health behaviors among parents, with perceived relatability outweighing scientific accuracy in many cases (Hua, Z., Yuqing, S., Qianwen, L., & Hong, C.., 2025).

In the Indonesian context, monitoring digital health discourse in pediatric care shows growing interest in several topics, with stunting receiving particularly high attention. Stunting, defined as poor linear growth during a critical developmental period and diagnosed as height-for-age less than −2 standard deviations from WHO child growth standards median, has become a central focus (de Onis & Branca, 2016; Who, 2006). However, this heightened interest is often accompanied by political narratives and emotional polarization. Although peer-reviewed Indonesian case studies remain limited, ongoing monitoring highlights the need for strategic health communication informed by behavioral science and narrative design (Irawan, A. S., Alristina, A. D., Laili, R. D., Amalia, N., Muharram, A. P., Miranda, A. V., Döbrössy, B., & Girasek, E., 2024).

1.7 Digital Health in Indonesia: Policy, Practice, and Gaps

Indonesia has made visible strides in adopting digital health innovations, particularly with the launch of the national SATUSEHAT platform aimed at integrating health data systems (Nur Aisyah, D. A.-O., Lokopessy, A. A.-O., Naman, M. A.-O., Diva, H. A.-O., Manikam, L. A.-O., Adisasmito, W. A.-O., & Kozlakidis, Z. A.-O.). The government has also promoted the development of mHealth applications and telemedicine services to improve access and quality of care across its diverse archipelago. For pediatric care, the focus on stunting (low height-for-age due to chronic malnutrition) is a critical health indicator in Indonesia, particularly for pediatric health (Erika, K. A., Fadilah, N., Latif, A. I., Hasbiah, N., Juliaty, A., Achmad, H., & Bustamin, A., 2024).

The government has prioritized stunting reduction as a national health goal, aiming to lower prevalence from 24.4% in 2021 to 14% by 2024. Stunting reflects broader issues like nutrition, maternal health, and socioeconomic disparities, making it a key metric for assessing digital health interventions' impact. In 2022, Indonesia's stunting prevalence was 21.6% among

children under five (Indonesian Nutrition Status Survey, SSGI), down from 24.4% in 2021, showing progress but remaining above the WHO's public health emergency threshold (BKPK, 2021). Despite these efforts, however, substantial challenges remain. Uneven digital infrastructure, regional disparities in access, and low levels of digital health literacy hinder the full realization of these tools. A 2023 review emphasized that while national policies are in place, practical implementation varies significantly by province and is especially weak in remote areas (Hossain, M. K., Sutanto, J., Handayani, P. W., Haryanto, A. A., Bhowmik, J., & Frings-Hessami, V.).

In the realm of pediatric care, Indonesian mobile health (mHealth) applications, notably PrimaKu and iPosyandu, have been introduced to assist parents in monitoring child growth and managing vaccination schedules. These applications are part of community empowerment initiatives within health promotion strategies (Faza, A., Rinawan, F. R., Mutyara, K., Purnama, W. G., Ferdian, D., Susanti, A. I., Didah, D., Indraswari, N., & Fatimah, S. N.., 2022). Nevertheless, many of these applications lack user-centered design, cultural adaptation, and data security measures. A 2023 study using the Mobile Application Rating Scale (MARS) found that most pediatric apps in Indonesia scored poorly in terms of engagement, functionality, and information quality. Furthermore, limited interdisciplinary collaboration among developers, anthropologists, and health professionals contributed to a lack of contextual relevance and usability in digital tools ( Irawan, A. S., Alristina, A. D., Laili, R. D., Amalia, N., Muharram, A. P., Miranda, A. V., Döbrössy, B., & Girasek, E.., 2025).

### 1.8 Research Rationale and Original Contribution

This dissertation addressed a critical gap in the understanding of digital health's role in pediatric care within low- and middle-income countries (LMICs), focused on Indonesia as a case study. While much of the existing literature emphasizes the technological capabilities of mHealth, fewer studies explore the sociocultural, behavioral, and communicative dynamics that shape its use. This research bridges that divide by combining systematic evidence synthesis, technology benchmarking of pediatric apps, social media discourse analysis, and health literacy fieldwork. Study provides a holistic view of the digital health ecosystem as it applies to child health.

The novelty of this research stems from its interdisciplinary approach, bringing together concepts from digital communication, medical anthropology, and health informatics. It contributes not only to scholarly discourse but also offers actionable guidance for policymakers, app developers, and healthcare practitioners engaged in advancing digital solutions for pediatric

health. In settings marked by persistent health inequities and digital divides, these contributions are both relevant and urgently needed.

## 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?

## 3. METHODS

The study employed a multi-method approach, drawing on both big data sources and empirical fieldwork to ensure robust and multidimensional analysis. The big data component included secondary data derived from publicly accessible online platforms, such as social media content (e.g., Twitter/X, Facebook). This component facilitated the identification of dominant discourses, sentiment trends, and peaks in public engagement related to child health and stunting. Computational tools such as sentiment analysis, peak detection, and discourse mapping were applied to reveal patterns in how digital health and pediatric care were discussed and represented in the public digital sphere (Ahmed, I., Ali, H., Ali, S., Van Woerden, S., Hanna-Amodio, A., Chen, K., Onitolo, E., & Gillespie, A.).

Complementing empirical data gathered through fieldwork in selected regions of Indonesia, particularly in rural and under-resourced settings. It involved surveys and semi-structured interviews with focus on healthcare workers. By combining large-scale digital data analysis the dissertation ensured a comprehensive view that bridges macro-level patterns with micro-level experiences (Lai, W. T., Wu, L. M., & Hsu, M. T.). This integrated data strategy supported a nuanced evaluation of how digital health tools were perceived, adapted, and utilized across different societal contexts, and it informed the development of culturally sensitive, technically viable, and socially equitable interventions.

This dissertation combined quantitative and qualitative used simultaneously, multi-phase research design applied to investigate the digital health landscape in pediatric care, particularly within the context of developing countries. As mentioned above, the primary objective was to offer a comprehensive understanding of the interplay between digital technologies, public discourse, app-based interventions, and health literacy in addressing child stunting, with a specific focus on Indonesia as a case study. To achieve this, the research integrated big data analytics, digital technology benchmarking, and health literacy assessment within the context of an Indonesian case study. As a foundation of this study, it applied a systematic literature synthesis focusing on developing countries, currently including China as part of this regional classification (Veronika Ertl, 2019).

The study unfolded through three interconnected methodological components reflecting diverse epistemological and analytical traditions: technology evaluation, social media listening, and mixed-methods field research incorporating a digital health literacy assessment, as described below.

### 3.1. MHealth Benchmarking App Evaluation

To assess the quality and usability of mobile health (mHealth) applications aimed at child growth monitoring in Indonesia, a cross-sectional descriptive study was conducted. The evaluation focused on identifying and analyzing relevant apps available on two major digital platforms: the Google Play Store and the Apple App Store.

The inclusion criteria for the app selection were as follows:

- The app must be available in Bahasa Indonesia.
- It must be explicitly designed for parents and/ or healthcare workers involved in pediatric care.
- Both free and paid apps were considered and accessible to general users.

The app must include functional features related to child growth monitoring or nutritional information, such as weight/height tracking, growth curve plotting, milestone logging, or

dietary guidance. App searches were conducted using combinations of relevant keywords. With the reason that commercial app platforms do not support Boolean operators, searches were performed using single keywords in Bahasa Indonesia, including *pertumbuhan anak*, *gizi anak*, and *kesehatan balita*. Duplicate or non-functioning apps were excluded, and only those that met all predefined eligibility criteria and were available for download during the data collection period were included in the final sample.

### 3.1.1 Evaluation Instrument and Procedure

Each selected app was evaluated using the Mobile Application Rating Scale (MARS) developed by Stoyanov (Stoyanov, Hides L Auid- Orcid: --- Fau - Kavanagh, Kavanagh Dj Auid- Orcid: --- Fau - Zelenko,). MARS is a validated, multidimensional tool designed to assess the quality of health-related mobile applications across four core domains:

- Engagement (interactivity, interest, customization)
- Functionality (ease of use, navigation, performance)
- Aesthetics (layout, graphics, visual appeal)
- Information Quality (credibility, accuracy, evidence-based)

Each domain was rated on a 5-point Likert scale, with higher scores indicating better quality. Prior to app evaluation, raters underwent training in MARS scoring protocols to ensure consistency and reduce bias. All quantitative MARS scores were recorded and analyzed using IBM SPSS Statistics 28.0.1. Descriptive statistics (mean, standard deviation, range) were used to summarize app performance across domains. Comparative analysis was conducted to identify differences in app quality based on developer type (e.g., government, private, or NGO-affiliated apps) and platform (Android vs. iOS). Correlation analysis was also performed to explore the relationship between overall app quality and user ratings in the app stores. This method evaluation allowed for a structured appraisal of the digital tools currently available to support pediatric growth monitoring in Indonesia, contributing to technology benchmarking in the broader context of digital health assessment.

#### 3.1.1.1 Raters Selection

Five healthcare professionals participated as independent raters in the evaluation process. Each selected pediatric-related mobile application was individually assessed by all five raters, ensuring that every application received five distinct and comparable MARS ratings. Prior to the formal assessment, the raters underwent structured training and collectively evaluated a non-study application to harmonize their scoring approach. Any rating discrepancies of two points or more were resolved through consensus-building discussions,

thereby standardizing their interpretation of the MARS criteria. During the main evaluation phase, each rater downloaded, used, and scored every eligible application, resulting in multiple ratings (five times each) rather than single ratings. This methodology facilitated robust inter-rater reliability testing through the Intraclass Correlation Coefficient (ICC) and ensured that the resulting quality assessments were consistent, reproducible, and methodologically rigorous.

Table 1. Characteristics of the raters, the hardware and the software used.

| | Rater 1 | Rater 2 | Rater 3 | Rater 4 | Rater 5 |
|---|---|---|---|---|---|
| Year of experience in health sectors | 16 | 6 | 19 | 13 | 6 |
| Affiliation | University | Private Sector | University | University | University |
| Scope of activity | Research and Teaching | Research | Research and Teaching | Teaching | Teaching |
| Hardware | Android+Iphone | Android | Android | Android | Android |
| Software | Play Store+ App Store | Play Store | Play Store | Play Store | Play Store+ App Store |

(Source: Irawan, A. S., Alristina, A. D., Laili, R. D., Amalia, N., Muharram, A. P., Miranda, A. V., Döbrössy, B., & Girasek, E., 2025)

3.2 Social Media Text Mining and Sentiment Analysis

We utilized social media scraper platform tools, specifically within the NLP Talkwalker platform, to accomplish tasks such as demographic analysis, content analysis, and sentiment analysis. By leveraging Talkwalker, a comprehensive social media analytics tool, our research conducted multifaceted analyses.

Queries were carefully formulated to capture diverse aspects of stunting discourse, including health programs, promotion strategies, disease awareness, risk factors, and impacts on children in both rural and urban contexts. The queries were constructed in the Indonesian language (lang:id) and filtered by geographic origin (sourcecountry:id) to ensure contextual relevance. The search term was (Stunting AND (Prevention OR Intervention OR Program OR "Health Program" OR "health promotion" OR "disease" OR "rate" OR "risk" OR "impact" OR child OR "Awareness" OR nutrition OR Nutrients OR Village OR Rural OR Urban OR poverty OR death OR Mental OR Mitigation OR handling OR Promotion OR Education OR Consumption OR intake OR counseling OR Immunity OR media OR food OR prevalence OR community service).

The following filters were applied in Talkwalker for data inclusion:

- Date Range: Posts between 15/12/2022 and 15/12/2023 were included.
- User occupation: Healthcare worker
- Geo-Location: Only posts originating from Indonesia were selected.

- Language: Only posts in Bahasa Indonesia were selected.
- User-Generated Content (UGC): The UGC filter was applied to exclude automated or promotional content, ensuring that only posts created by real human users were included. This helped maintain the authenticity and relevance of the data.

The identification of user occupations was accomplished through the audience classification features integrated into the social media listening platform. Users were categorized as healthcare professionals by automatically analyzing publicly accessible profile details and self-reported job titles in user biographies and post content. This categorization was based on matching keywords associated with healthcare roles (e.g., physician, nurse, healthcare worker, pharmacist), and was further enhanced by platform-level data enrichment and manual verification to ensure accuracy. Only users who met these criteria were included in analyses focusing on the perspectives of healthcare workers.

Data preparation involved an initial assessment of the 'sentiment' and 'engagement' variables. The 'engagement' refers to user interaction not just passive viewing. It's a signal of how actively the audience is involved with the content (like, comment, retweet, repost), suitable for direct quantitative analysis. Conversely, the 'sentiment' variable was an `object` data type, necessitating conversion to a numerical format for statistical processing. This conversion was achieved by implementing a mapping strategy, where each distinct sentiment category (Negative, Neutral, Positive) was assigned a corresponding numerical value (5 positive, 0 neutral, -5 negative) (Shah, 2024). Following data preparation, the percentage distribution of each sentiment category was calculated. This involved quantifying the occurrences of each sentiment (negative, neutral, positive) within the dataset. The frequency of each sentiment was then divided by the total number of entries in the dataset and multiplied by 100 to yield its respective percentage.

Data validation, we conducted a manual spot-check of a random sample of posts (10% of the dataset) to confirm topic relevance and authenticity. Furthermore, keyword matching, and topic modeling were employed to cross verify thematic consistency across platforms. To minimize selection bias, we included a broad set of keywords representing different stunting-related themes and ensured balanced coverage of both positive and negative sentiments. Although social media users may not represent the entire population, this method captures spontaneous, organic expressions of public concern and awareness that are often absent from traditional surveys. Performed by NVivo 14, data set selected with high engagement, conducted theme analysis.

3.3 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, R. A., Patterson, C., McErlean, G., & Halcomb.).

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.

3.4 Data Integration and Synthesis

While each methodological component was tailored to its specific research question, this dissertation employed a meta-inference strategy to synthesize findings across all four studies. This approach facilitated thematic triangulation and the identification of patterns that bridge evidence synthesis, digital discourse, technology evaluation, and user literacy (Younas, A., Fàbregues, S., Munce, S., & Creswell, J. W., 2025). For instance, the review findings elucidated how public discourse either aligns with or diverges from scientific literature. Insights from app benchmarking can be compared with actual user capabilities and readiness, as observed in the health literacy study. Integration was conducted through cross-study matrix mapping and narrative synthesis, contributing to a comprehensive understanding of how digital health ecosystems can be designed and implemented for pediatric care in resource-constrained settings.

The research employed several research instruments as follows:

- MARS rating sheets for app assessment
- HLS19-DIGI questionnaire (Bahasa Indonesia version/ translated
- Interview guides for healthcare workers

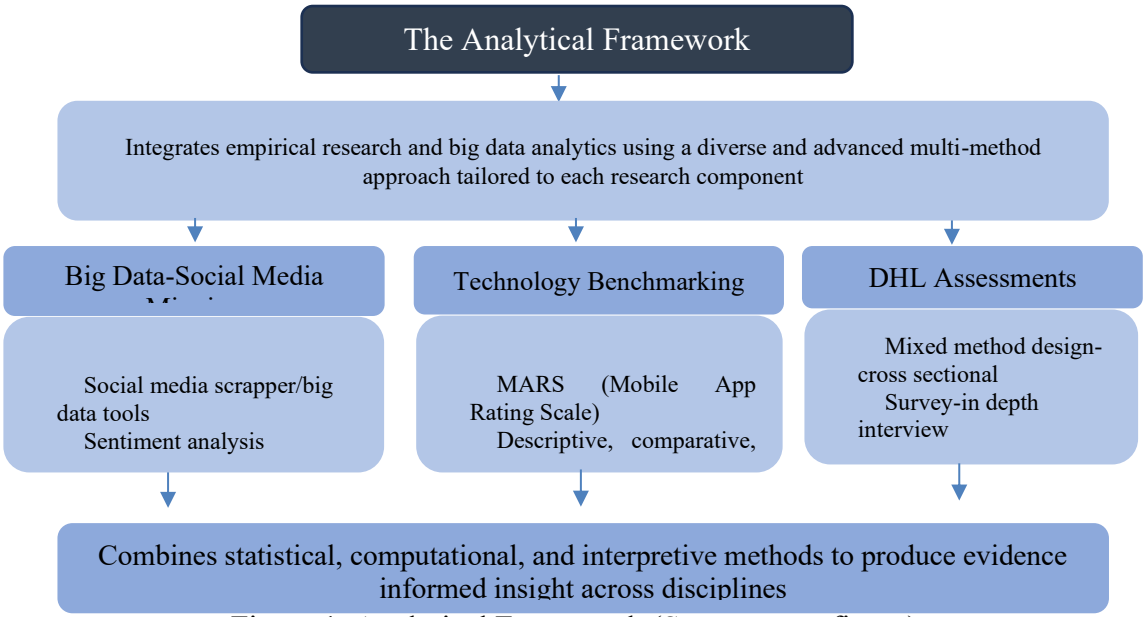



Figure 1. Analytical Framework (Source: own figure)

The analytical framework for this study integrated empirical research and big data analytics using a diverse and advanced multi-method approach tailored to each research component (See Figure 1). Findings were synthesized through narrative and thematic categorization to map conceptual patterns and identify knowledge gaps. In the evaluation of mobile health (mHealth) applications, a combination of SPSS and the Mobile App Rating Scale (MARS) enabled detailed descriptive and comparative statistical analyses, capturing both functionality and user experience metrics (Diviani, N., van den Putte, B., Meppelink, C. S., & van Weert, J. C.). The digital health literacy assessment employed a mixed-methods design, combining quantitative survey data analyzed in SPSS with qualitative interview data coded thematically using NVivo (Taba, M., Allen, T. B., Caldwell, P. H. Y., Skinner, S. R., Kang, M., McCaffery, K., & Scott, K. M., 2022).

This approach allowed for a nuanced understanding of healthcare workers' competencies in navigating digital tools. For social media discourse analysis, big data tools, Talkwalker were used to mine thousands of user-generated posts, capturing real-time online conversations, engagement peaks, and network dynamics. These data were further analyzed in NVivo to conduct sentiment analysis, peak detection, and content classification, enabling a layered understanding of public narratives surrounding pediatric health and stunting (Karami, A., Dahl, A. A., Turner-McGrievy, G., Kharrazi, H., & Shaw, G., 2018).

All the framework reflects a comprehensive empirical strategy, leveraging both structured and unstructured data, and combining statistical, computational, and interpretive methods to produce evidence-informed insights across disciplines. The integration of advanced multi-method tools ensures both analytical depth and adaptability to complex, real-world health data environments.

### 3.5 Ethical Considerations

The research received ethical approval from The Ethics Committee of Universitas Harapan Bangsa, Indonesia No. B.LPPM-UHB/766/07/2024. All participants were informed of their rights and provided with written consent. Data confidentiality, voluntary participation, and anonymization were ensured in compliance with international research ethics standards (Declaration of Helsinki).

## 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 2, 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 2. Summary of E-Health and M-Health Use in Pediatric Care in Developing Countries

| Aspect | Details |
|---|---|
| Main Purposes | - Vaccination reminders (via SMS or apps)<br>- Breastfeeding promotion and education<br>- Growth and nutrition monitoring<br>- PMTCT HIV follow-up care |
| Target Users | - Parents and mothers (especially pregnant/lactating women)<br>- Healthcare workers (community health, village doctors, HSAs) |
| Key Outcomes | - Improved adherence to vaccination schedules (Ethiopia, Indonesia, Kenya)<br>- Increased exclusive breastfeeding rates (China, Kenya, Vietnam, India)<br>- Better follow-up and retention in PMTCT programs (Kenya)<br>- Increased immunization coverage and parental satisfaction (Guatemala, Thailand, China)<br>- Improved decision-making and efficiency at provider level (Malawi, China) |
| Technology Platforms | - SMS/Text messages<br>- Mobile apps (custom or integrated with national systems)<br>- Phone consultation (telehealth) |
| Successful Predictors | - Perceived usefulness and ease of use (Ethiopia)<br>- 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)<br>- Literacy and language challenges<br>- 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)<br>- Unclear impact on hospital admissions (Malawi) |
| Regional Notes | - Africa: Focused on vaccination, HIV, and infant feeding<br>- Asia: Broader scope including nutrition, growth monitoring, breastfeeding, and health systems |

(Source: Irawan, A. S., Döbrössy, B. M., Biresaw, M. S., Muharram, A. P., Kovács, S. D., & Girasek, E.., 2025)

4.2.1 Functionality, Engagement, Aesthetics, and Information Quality

Most of the evaluated apps demonstrated a strong focus on child growth tracking and educational content (table 3), 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 3. 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 | Moderate; many apps lacked expert-reviewed content |
| Credibility | Highest for awareness/help-seeking; weakest on actual behavior change |
| Behavioral Impact | |

(Source: Irawan, A. S., Alristina, A. D., Laili, R. D., Amalia, N., Muharram, A. P., Miranda, A. V., Döbrössy, B., & Girasek, E., 2025)

4.2.2 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.

## 4.3 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.

### 4.3.1 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 2), 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.

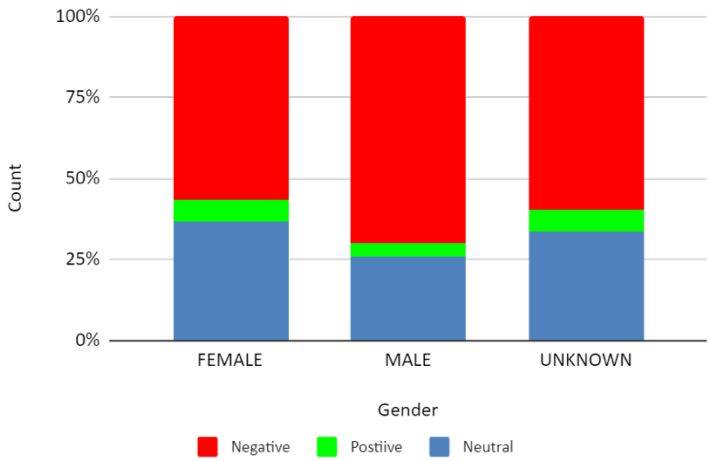



Figure 2. Posts sentiment by gender (Source: own figure)

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 (table 4). 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.

Table 4. Thematic Content Analysis: Stunting and Healthcare Narratives on social media (Unpublished Data)

| Theme | Key Issues Discussed | Examples / Keywords |
|---|---|---|
| Stunting and Malnutrition | - Focus on child health and malnutrition<br>- Importance of early prevention<br>- Challenges in meeting national targets | Stunting, severe malnutrition, 1000 first days of life, national targets |
| Healthcare Programs and Policies | - Preventive screenings (e.g., congenital hypothyroidism)<br>- Criticism of low program coverage<br>- Concerns over budget allocation | Congenital hypothyroidism, program coverage, health budget investment, comparisons with neighboring countries |

| | | |
|---|---|---|
| Data Accuracy and Reporting Issues | - Manipulation of health data<br>- Mismatch between field realities and official reports<br>- Incentives tied to 'stunting location' status | Unrecorded malnutrition data, stunting location, data manipulation, z-score -3 changed to 0 |
| Role and Challenges of Healthcare Workers | - Exclusion from decision-making<br>- Clinical staff only as 'clinic watchers'<br>- Disconnection between policies and local needs | General practitioners in rural areas, excluded from programs, frontline workers not involved in data and policy |
| Public Awareness and Behavior Change | - Difficulty in promoting long-term behavior change<br>- Limited understanding of stunting's cognitive impact | Behavioral change, impact of stunting on the brain, public nutrition education |

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.

### 4.3.2 Influencers and Viral Narratives by Engagement

Table 5. Key Content Themes and Engagement Analysis by Category

(Unpublished Data)

| Occupation | Themes | Quote (Excerpt) | Description |
|---|---|---|---|
| Nutritionist | Early Intervention & Behavior Change | "Now there's a program called the first 1000 days of life... but the hardest part in Indonesia is changing people's behavior." | Emphasizes the importance of early-life nutrition and highlights behavioral change as a major challenge in implementing stunting prevention programs. |
| Medical Doctor | Preventive Screening Programs | "Another example is the congenital hypothyroidism screening program... you know how much coverage it has? Only 3%, way below neighboring countries that already reach 95%." | Points to the underutilization of existing screening programs, contrasting Indonesia's low coverage with neighboring countries, stressing a gap in preventive measures. |
| Medical Doctor | Knowledge Dissemination | "A light bilingual reading on stunting and tobacco control... can be downloaded for free..." | Promotes knowledge sharing through accessible publications linking stunting with tobacco control policy. |
| Medical Doctor | Data Integrity Issues in Reporting | "...we're not allowed to enter real data on malnutrition and stunting in the ePPGBM app... problems from the top destroy efforts below." | Expresses frustration over data manipulation in national systems, which undermines accurate reporting and effective policy targeting. |
| Nutritionist | Misconceptions About Stunting | "Koreans and Japanese are short not due to nutrition problems... poor nutrition affects the brain, making it less able to function optimally." | Addresses common misconceptions about stunting causes and emphasizes cognitive consequences. |

| | | | |
|---|---|---|---|
| Medical Doctor | Funding and Budget Allocation | "Failure to invest in the health budget will affect the outcomes of public health programs..." | Criticizes insufficient health investment, arguing it directly impairs program outcomes, including stunting prevention. |
| Veterinarian | Surveillance & Evidence-based Planning | "...if there's a positive case, then there can be evidence-based treatment... prevention efforts in the field also become clearer and more focused." | Advocates for evidence-based public health action, including stunting, by stressing the importance of disease surveillance and testing. |
| Medical Doctor | Exclusion of Frontline Workers | "...people with laptops in regional health offices don't involve those holding stethoscopes... they magically turn all health data and programs like stunting into zero." | Highlights the disconnect between policymakers and frontline health workers, resulting in inaccurate data and ineffective interventions. |
| Medical Doctor | Accountability & Transparency | "The failure to reduce stunting should make the Ministry of Health reflect... is budget supervision really reaching the target?" | Urges greater transparency and accountability in public spending on stunting-related programs. |
| Medical Doctor | Manipulation for Resource Allocation | "...the z-score is -3 but we must report 0... villages are happy to be labeled stunting hotspots because it brings in more projects and funding." | Reveals manipulation of data at the field level to either hide real cases or attract program funding by inflating prevalence. |

The major themes (table 5) emerging from the content analysis 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.

## 4.4 Digital Health Literacy Assessment

### 4.4.1 Survey Results: Literacy Levels Among Users

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.

Table 6. Survey Respondent Digital Health Literacy for Healthcare Worker in Manggarai Barat, Indonesia. (Unpublished Data)

| Demographic categories | Value | n | % |
|---|---|---|---|
| Age (years) | 20-30 | 28 | 29 |
| | 31-40 | 45 | 46 |
| | 41-50 | 19 | 20 |
| | 51-60 | 5 | 5 |
| Education | Elementary | 16 | 16 |
| | Middle | 20 | 21 |
| | High | 34 | 35 |
| | Associate Degree | 20 | 21 |
| | Bachelor's Degree | 7 | 7 |
| Employment | Community Health Worker | 74 | 76 |
| | Midwife | 19 | 20 |
| | Nutritionist | 4 | 4 |

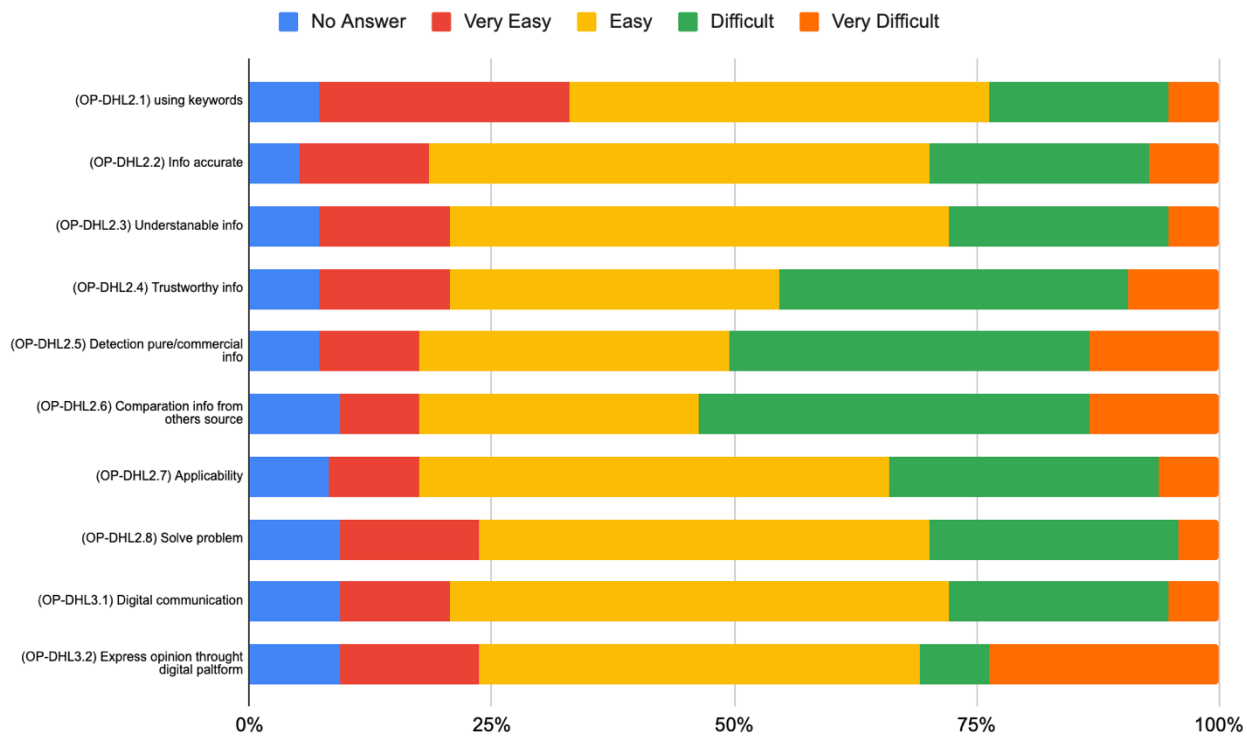



Figure 3. The result of (DHL) of 97 respondents was assessed using a series of items that reflect various competencies. (Source: own figure)

The Digital Health Literacy (DHL) assessment explored users' self-reported abilities across multiple competencies, as visualized in Figure 3. 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.

Table 7. The Result of DHL Among Pediatric Healthcare Worker in Manggarai Barat by HLS19-DIGI. (Unpublished data)

| Item Code | Description & Explanation | Main Findings |
|---|---|---|

| | | |
|---|---|---|
| OP-DHL2.1 | Using Keywords – Measures the ability to use appropriate keywords in health information searches. Indicates basic digital navigation skills. | 69.1% (67/97) rated this Easy or Very Easy, suggesting most respondents are confident in basic online search strategies. |
| OP-DHL2.2 | Evaluating Information Accuracy – Assesses ability to judge whether digital health information is correct. Reflects critical thinking and evaluative literacy. | 51.5% (50/97) found this Easy, but 29.9% (29/97) found it Difficult or Very Difficult, indicating moderate evaluative skills. |
| OP-DHL2.3 | Understanding Health Information – Evaluates how well individuals comprehend the content of online health materials. Tied to functional health literacy. | Similar to accuracy, 51.5% found it Easy, while 27.8% reported difficulty, suggesting room for improvement in comprehension. |
| OP-DHL2.4 | Assessing Trustworthiness – Assesses ability to identify credible sources. A key skill in avoiding misinformation. | Only 34% (33/97) found this Easy, and 45.4% (44/97) found it Difficult or Very Difficult, indicating a significant gap. |
| OP-DHL2.5 | Detecting Commercial Content – Tests if respondents can differentiate between pure health content and marketing or commercial messages. | 50.5% (49/97) rated this as Difficult or Very Difficult, showing a lack of media literacy and susceptibility to biased information. |
| OP-DHL2.6 | Comparing Information from Multiple Sources – Reflects skills in triangulating health information to validate accuracy. | Only 29.9% (29/97) found it Easy, while 53.6% (52/97) struggled with it, indicating low critical comparison ability. |
| OP-DHL2.7 | Applicability of Information – Measures how easily online health information can be adapted to personal or family contexts. | 54.6% (53/97) rated this Easy or Very Easy, reflecting moderate skill in applying information to real-life settings. |
| OP-DHL2.8 | Solving Health Problems – Evaluates the ability to use digital resources for resolving health-related issues. | 60.8% (59/97) felt confident (Easy or Very Easy), suggesting strong perceived usefulness of digital tools for problem-solving. |
| OP-DHL3.1 | Digital Communication – Tests comfort with using digital tools to communicate health concerns or information. | 62.9% (61/97) found this Easy or Very Easy, indicating good engagement in digital health interactions. |
| OP-DHL3.2 | Expressing Opinions on Digital Platforms – Measures confidence in publicly expressing health-related views or experiences online. | Results were mixed: 45.4% (44/97) found it Easy, while a notable 23.7% (23/97) found it Very Difficult, possibly due to cultural or psychological barriers. |

The findings (table 7) 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.

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

In this section, the participants involved in the qualitative phase, as detailed in Table 8, provide substantial insights derived from their direct experiences with digital health tools in pediatric care and stunting prevention. The interviews were conducted to investigate perceptions, challenges, and practices associated with digital health literacy, technology adoption, and community engagement.

Table 8. Demographic Data of Qualitative Participants (Unpublished data)

| Code | Age | Address | Occupation | Years of Work |
|---|---|---|---|---|
| INF003 | 36 | Puskesmas (Village Clinic) Bentes | Midwife | 13 years |
| INF001 | 25 | Komodo Hospital | GP | 4 months |
| INF007 | 34 | Komodo Hospital | Pediatricians | 4 years |
| INF002 | 26 | Komodo Hospital | GP | 3 years |
| INF005 | 23 | Puskesmas Benteng | Community Healthcare Worker | 4 years |
| INF004 | 39 | Puskesmas Labuan Bajo | Nurse | 18 years |
| INF006 | 54 | Puskesmas Labuan Bso | Community Healthcare Worker | 10 years |

The thematic analysis of interview transcripts yielded several key themes and subthemes, reflecting both structural and behavioral dimensions of digital health use. These are summarized in Table 7, which highlighted the main categories emerging from participant narratives, including access barriers, trust in digital content, capacity gaps, and opportunities for digital innovation in community health settings.

Table 7. Thematic Analysis of Qualitative Interview Data on mHealth Use (Unpublished data)

| Theme | Sub-theme | Key Informant Codes | Main Findings |
|---|---|---|---|
| 1. Knowledge & Access to Technology | Digital Literacy | INF001–INF007 | Informants demonstrated varying digital competencies. Several were active MHealth users for telemedicine, dose calculation, and information search (e.g., ChatGPT, YouTube, PubMed). |
| | Sources of Information | INF001–INF007 | Most used search engines and platforms (Google, YouTube, apps from BKKBN) to seek health information or perform professional tasks. Some used AI tools. |
| 2. Benefits of Technology | Work Efficiency | INF001–INF007 | MHealth increased efficiency in consultations, dosage calculation, and stunting reports. Saved time and improved task accuracy. |
| | Patient Education | INF001, INF006 | Used videos or telemedicine to explain health concepts to patients, especially during the pandemic. |
| | Data Collection | INF004, INF005 | MHealth apps enabled systematic data collection and interprofessional collaboration. |
| 3. Limitations & Risks | Limited Diagnosis | INF001–INF004 | Lack of physical exams led to concerns about misdiagnosis or overreliance on telemedicine. |
| | Application Dependency | INF002, INF007 | Several informants noted risks in relying solely on apps; updates and paid versions were considered more accurate. |
| | Response Time | INF002, INF005 | Slow responses and occasional communication breakdowns were challenges. |
| 4. Infrastructure & Systems | Internet Network | INF001–INF007 | Internet instability, especially in remote areas or during bad weather, hindered app use. |

| | | | |
|---|---|---|---|
| | Device Availability | INF002, INF004 | Device readiness was generally good, but issues emerged in under-resourced settings. |
| | HR Training | INF004 | In-person training is needed to prevent misuse of digital tools. |
| 5. Privacy & Data Security | Data Leakage Concerns | INF001–INF003 | Concerns about data privacy were present among some informants, especially regarding EMRs and sharing personal data online. |
| | Low Public Awareness | INF002, INF007 | Public understanding of digital privacy is still limited in many regions of Indonesia. |
| 6. Consultation Preferences | Face-to-Face vs. Telemedicine | INF001–INF003, INF005, INF007 | The majority preferred face-to-face for accurate diagnosis; telemedicine is seen as a complementary tool. |
| 7. Information Accuracy | Initial Reference Only | INF002–INF007 | Digital sources are seen as starting points, most cross-check using books or academic sources. Some rely on apps with proven scientific backing. |

All informants demonstrated some level of access to and familiarity with digital health technologies. Medical professionals used telemedicine platforms, dosage calculator apps, and digital databases like PubMed and Google Scholar, while community-level users relied on Google, YouTube, and health reporting apps. One professional noted, "*Contohnya yang paling sering itu kayak HaloDoc… dulu pernah jadi relawan di telemedicine*" ("For example, the most common one I used was HaloDoc… I once volunteered in telemedicine") [INF001]. Another added, "*Biasanya nyari di Google ada jurnal atau angkatan sih buat konfirmasi*" ("I usually search on Google, looking for journals or previous class notes to confirm information") [INF002]. This range of usage indicates a general acceptance of digital tools, though the complexity and purpose of use varied based on the user's background.

The benefits of technology were widely acknowledged. Telemedicine and health apps were praised for improving efficiency, reaching patients in remote areas, and supporting data reporting processes. As one informant explained, "*Dengan adanya telemedicine… bisa membantu pekerjaan dari seorang dokter*" ("With telemedicine… it helps a doctor's work")

[INF001]. Another shared, "*Sangat membantu… bisa membantu setiap bulan untuk mengirim data balita yang stunting*" ("Very helpful… it assists with monthly reporting of stunted children's data") [INF004]. These findings reflect both clinical and administrative advantages of digital tools, especially during the pandemic.

Nonetheless, several limitations and risks were identified. Many users, especially medical professionals, highlighted that digital tools cannot substitute for physical examinations, which are essential for accurate diagnosis. "*Telemedicine… tidak bisa lakukan pemeriksaan fisik… jadi diagnosis nggak pasti*" ("Telemedicine can't conduct physical examinations… so diagnosis is uncertain") [INF001]. There was also concern about over-reliance on apps: "*Beberapa orang jadi dependent… biasanya memang pakai aplikasi*" ("Some people become dependent… usually relying on apps") [INF002]. Regarding accuracy, another stated, "*Tingkat kepercayaan informasi digital 70-80%, namun perlu konfirmasi dari sumber lain*" ("Trust in digital information is around 70–80%, but it still needs confirmation from other sources") [INF002]. This highlights the importance of critical thinking and validation in using digital health tools.

On infrastructure, responses showed variability depending on location. While some informants faced no major issues, others noted unstable signals or system errors, especially in remote or rural settings. *"Puskesmas di pedalaman… sinyal suka hilang*" ("In rural health centers… the signal often disappears") [INF002], and "*Masih belajar… rekam medis elektronik rumah sakitnya aja masih banyak problem*" ("Still learning… even the hospital's electronic medical records have many issues") [INF001]. In contrast, one community health worker mentioned, "*Sinyal bagus… mereka [Dinkes/BKKBN] kasih tau saat update*" ("The signal is good… they [Health Office/BKKBN] inform us when there are updates") [INF004]. These responses point to uneven infrastructure development across regions, which directly impacts the effectiveness of digital health tools.

Concerns about privacy and security data varied. Professionals were more likely to express worry. "*Kerahasiaan… lebih gampang bocor ke mana-mana*" ("Confidentiality… easier for data to leak everywhere") [INF001], and "*Data masyarakat Indonesia pernah bocor, jadi bisa saja data medis juga rawan*" ("There have been data leaks in Indonesia, so medical data could also be at risk") [INF002]. However, not all informants raised this as a concern, indicating a potential gap in awareness or prioritization of data security in some communities.

In terms of consultation preferences, most participants preferred face-to-face interactions with healthcare providers. Physical meetings were considered clearer and more trustworthy for diagnosis and discussion. As one respondent said, "*Lebih suka physical sih, jadi lebih jelas aja*" ("I prefer physical [consultation], it's just clearer") [INF001]. Another noted,

"*Telemedicine mudah, tapi waktunya jauh lebih banyak karena tektokan panjang*" ("Telemedicine is convenient, but it takes a lot longer due to back-and-forth texting") [INF002]. These comments suggest that while digital health tools are appreciated, they are not seen as full replacements for in-person healthcare.

In terms of information accuracy, most informants were cautious. While digital tools provided quick access, many emphasized the need to verify online content with books, professionals, or multiple sources. "*Biasanya saya bandingkan dulu dari beberapa sumber*" ("I usually compare [information] from multiple sources first") [INF003]. This behavior showed healthy skepticism and points to the importance of digital health literacy in ensuring the safe and effective use of technology.

### 4.5 Integrated Synthesis of Multi-Method Findings

The findings drawn from MHealth app evaluation, social media discourse analysis, and digital health literacy assessment provide a comprehensive view of pediatric digital health interventions in developing countries, particularly regarding stunting prevention and child health promotion. Across the studies examined, mHealth interventions largely targeted parents, especially mothers, with a strong focus on vaccination adherence, reflecting broader global child health priorities. This emphasis was also evident in app evaluations, where most pediatric apps were designed around child growth tracking and parental education. Despite generally high technical functionality and attractive design, many apps lacked interactive, evidence-based components that effectively support sustained behavior change, limiting their real-world impact. The few commercial apps that achieved high engagement and behavioral outcomes suggest that market-driven innovation can enhance quality, but such cases are not yet widespread.

Social media analysis added another dimension by highlighting the sociocultural context in which these digital interventions are deployed. Negative sentiment around stunting programs, driven by perceptions of governmental inefficiency, data manipulation, and exclusion of frontline health workers, reveals deep-rooted mistrust that technology alone cannot overcome. Engagement patterns underscored the importance of trusted figures, particularly female nutritionists, and medical doctors, who were able to translate complex health information into accessible guidance while promoting transparency and accountability. These observations point to the critical need for community engagement and culturally sensitive communication to foster trust and encourage adoption of digital health solutions.

Digital health literacy assessed to frontline healthcare workers contextualize these findings further. While basic competencies, such as searching for information and using digital

tools, were moderately established, more advanced skills like evaluating information credibility, detecting commercial biases, and participating confidently in digital health forums were notably lacking. This gap hampers the effective utilization of mHealth interventions and limits healthcare workers' capacity to combat misinformation or support behavioral change at the community level. Qualitative interviews revealed that, although healthcare workers appreciated the efficiency offered by telemedicine and health apps, they remained cautious, favoring face-to-face consultations due to concerns about diagnostic accuracy, privacy, and infrastructural constraints, such as unstable Internet connectivity. Together, these findings depict a complex ecosystem where technological potential is mediated by human, infrastructural, and socio-political factors.

The effectiveness of digital health tools therefore depends not only on technical sophistication but also on addressing literacy and trust barriers, improving user engagement through culturally tailored and participatory designs, and ensuring health systems are transparent and actively involve frontline workers and communities. Advancing pediatric digital health in resource-limited settings requires a holistic approach that strengthens digital infrastructure, develops critical digital health literacy among both providers and users, and promotes participatory governance to rebuild public trust. Only through such multidimensional strategies can digital health interventions move beyond isolated technological solutions and become sustainable, equitable components of child health systems.

## 5. DISCUSSION

### 5.1 Interpretation of Main Findings: Benchmarking, Digital Health Literacy, and Social Media Discourse Analysis

This study proposes a comprehensive and context-sensitive framework for evaluating digital health interventions in pediatric care by integrating three essential dimensions: technology benchmarking, digital health literacy (DHL), and social media discourse analysis. Together, these pillars offer a multidimensional understanding of how digital tools are designed, experienced, and shaped by users in real-world settings, particularly within the socio-technical constraints of low- and middle-income countries (LMICs) such as Indonesia.

The literature highlighted the widespread adoption of mHealth interventions for maternal and child health in LMICs, with a predominant focus on vaccination reminders and parent-targeted applications (Irawan, A. S., Döbrössy, B. M., Biresaw, M. S., Muharram, A. P., Kovács, S. D., & Girasek, E.). This trend aligns with the global policy push toward integrating digital technologies within health systems to achieve Universal Health Coverage (UHC) and

Sustainable Development Goal 3 (SDG 3) (Chen, X. A.-O., Orom, H., Hay, J. L., Waters, E. A., Schofield, E., Li, Y., & Kiviniemi, M. T.)

Technology benchmarking provides a foundational tool for assessing the technical quality of mobile health applications. Instruments like the Mobile Application Rating Scale (MARS) evaluate app performance across functionality, aesthetics, user engagement, and ease of navigation (Messner, E.-M., Terhorst, Y., Barke, A., Baumeister, H., Stoyanov, S., Hides, L., Kavanagh, D., Pryss, R., Sander, L., & Probst, T., 2020; Stoyanov, Hides L Auid- Orcid: --- Fau - Kavanagh, Kavanagh Dj Auid- Orcid: --- Fau - Wilson, S. L., & Wiysonge, C.). However, the findings from this study reaffirmed that technical excellence alone is insufficient. Benchmarking tools often overlook the sociocultural contexts in which users engage with digital tools. Even highly rated apps risk abandonment if they fail to address users' everyday realities or the specific challenges faced by frontline health workers and caregivers (Krishna, S., Boren Sa Fau - Balas, E. A., & Balas, E. A.).

Digital health literacy research addresses this gap by examining how individuals find, understand, evaluate, and apply digital health information within their contexts. Our survey revealed considerable variation in DHL competencies, especially among community health workers and caregivers (Longhini, J. A.-O. X., Rossettini, G. A.-O., & Palese, A. A.-O. X..). Despite the availability of digital tools, barriers such as low comprehension, distrust of online information, and lack of perceived relevance persist, hindering meaningful engagement (Norman & Skinner, 2006; van der Vaart & Drossaert, 2017). These results suggested that DHL must be approached not merely as information access but as a capacity-building process that promotes critical thinking, reflective decision-making, and culturally grounded understanding of digital content (Ban, S., Kim, Y., & Seomun, G., 2024; Zainal, H., Xiaohui, X., Thumboo, J., Seah, S. J., Leng, L. L., & Kok Yong, F.).

Social media listening further reveals how discourse and sentiment shape health behaviors, often more powerful than formal health education (Schmidt, A. L., Rodriguez-Esteban, R., Gottowik, J., & Leddin, M.; Irawan, A. S. a. A., Arie Dwi and Laili, Rizky Dzariyani and Amalia, Nuke and Tewabe, Walelign and Döbrössy, Bence and Girasek, Edmond., 2024). Content analysis identified a predominance of negative sentiment in online conversations of Indonesia healthcare workers around stunting and pediatric care, with healthcare workers expressing frustration about ineffective government programs, skepticism towards official messages, and emotional responses to community-level challenges. These narratives offer important insights for policymakers and public health actors. Social media platforms function not only as information hubs but also as mirrors reflecting the emotional and social landscape where health decisions are made (Chhabra, J., Pilkington, V., Benakovic, R.,

Wilson, M. J., La Sala, L., & Seidler, Z., 2025). Ignoring these signals risks the development of digital health interventions that are technically sound but socially disconnected (Charles-Smith, L. E., Reynolds, T. L., Cameron, M. A., Conway, M., Lau, E. H. Y., Olsen, J. M., Pavlin, J. A., Shigematsu, M., Streichert, L. C., Suda, K. J., & Corley, C. D., 2015).

The study underscored the critical importance of participatory or user-centered design in digital health interventions. Involving caregivers, practitioners, and community health workers in content creation, localization, and feedback mechanisms fosters trust and sustained engagement (Kasperski, R., Blau, I., & Ben-Yehudah, G., 2022). This is especially crucial in pediatric care, where decisions often rest with caregivers rather than the child. Nevertheless, utilizing digital tools and social media data raises ethical concerns. Publicly available data may still contain private or sensitive information, necessitating robust data governance frameworks that ensure privacy, informed consent, and cultural sensitivity throughout intervention design and deployment (Mittelstadt & Floridi).

DHL education initiatives should move beyond one-size-fits-all health behavior models to cultivate critical and context-sensitive literacy skills that reflect users' social realities and lived experiences. Rather than prescribing fixed behaviors, DHL programs should empower users to autonomously evaluate health information and act in culturally and contextually appropriate ways (Chesser, A. K., Keene Woods, N., Smothers, K., & Rogers, N.; Pollard, S., Bansback, N., & Bryan, S.).

### 5. 2 Infrastructure and Structural Barriers to Digital Health Adoption

Despite the promise of digital health tools to address issues such as stunting, structural barriers continue to limit their effectiveness. Low digital infrastructure, limited internet coverage, and cultural reluctance to adopt technology in rural and remote areas remain significant challenges. Studies have shown that digital health interventions often fail to reach their intended targets in areas lacking adequate technological infrastructure and community engagement. Misinformation, frequently spread via social media, can undermine the credibility of official health programs, and mislead caregivers, posing further risks to public health. Exposure to vaccine information or misinformation including its source, tone, and framing can influence people's trust in vaccines and their willingness to get vaccinated (Maita, K. C., Maniaci, M. A.-O., Haider, C. R., Avila, F. R., Torres-Guzman, R. A., Borna, S., Lunde, J. J., Coffey, J. A.-O., Demaerschalk, B. M., & Forte, A. A.-O.; Spanos, K. E., Kraschnewski, J. L., Moss, J. L., Wong, A., & Calo, W. A..; Wilson & Wiysonge).

In rural communities, misinformation can spread rapidly through local networks, undermining trust in health interventions (Songo, J. A.-O., Whitehead, H. S., Phiri, K. A.-O.,

Kalande, P., Lungu, E., Phiri, S., van Oosterhout, J., Moses, A., Hoffman, R. M., & Moucheraud, C.). If digital interventions are not embedded within broader strategies of education, infrastructural support, and trust-building, their risks become ineffective or even counterproductive. Addressing these challenges requires a comprehensive approach that includes improving digital infrastructure, promoting digital literacy, and fostering community trust in health information (Diniz, C. S. G., Franzon, A. C. A., Fioretti-Foschi, B., Niy, D. Y., Pedrilio, L. S., Amaro Jr, E., & Sato, J. R.., 2021; Richman, A. R., Schwartz, A. A.-O., Maness, S. A.-O., Sanchez, L., & Torres, E.)

This study reaffirmed that isolated digital health efforts are unlikely to succeed unless grounded in a thorough understanding of user context. For instance, digital stunting reduction programs in Indonesia may fail to reach the most at-risk populations if they exclude grassroots-level digital health literacy (DHL) training or ignore the competing influence of misinformation. Similarly, technically robust applications may be disregarded if they do not account for local languages, values, and cultural concerns (Mirzaei & Kashian, 2020).

The most effective digital health systems integrate benchmarking during development, embed DHL training into community-based health initiatives, and monitor social media discourse to adapt communication strategies and detect emerging narratives (Zeng & Li, 2020). Such integrated approaches ensure that tools remain responsive, contextually relevant, and inclusive.

To move forward, it is essential to strengthen digital infrastructure, expand access to affordable technology, and enhance the digital competencies of both healthcare workers and caregivers. Collaborative efforts among governments, software developers, healthcare professionals, and local communities will be critical to producing digital health solutions that are not only innovative but also equitable and culturally appropriate. Ultimately, fostering digital partnerships between pediatricians and families through inclusive, responsive, and ethically designed tools can improve child health outcomes and contribute to more resilient healthcare systems in Indonesia and other resource-constrained contexts (Cascini, F., Gentili, A., Causio, F. A., Altamura, G., Melnyk, A., Beccia, F., Pappalardo, C., Lontano, A., & Ricciardi, W.).

### 5.3 Key Insights from Field Evaluation: Gaps in Apps, Sentiment, and Literacy

The evaluation of mHealth applications using the Mobile App Rating Scale (MARS) revealed a critical shortfall: despite the proliferation of mHealth solutions in Indonesia, many applications demonstrated poor performance in key domains such as engagement, functionality, and information quality. This finding highlighted a fundamental disconnect, while digital tools

are increasingly available, their effectiveness remains questionable (Brands, M. R., Gouw, S. C., Beestrum, M., Cronin, R. M., Fijnvandraat, K., & Badawy, S. M., 2022; Stoyanov, S. R., Hides, L., Kavanagh, D. J., Zelenko, O., Tjondronegoro, D., & Mani, M., 2015). A key contributing factor is the lack of user-centered design, which results in limited usability and diminishes their real-world applicability in clinical and community settings (Irawan, A. S., Alristina, A. D., Laili, R. D., Amalia, N., Muharram, A. P., Miranda, A. V., Döbrössy, B., & Girasek, E., 2025).

Complementing these technical findings, a social media analysis of public discourse surrounding child health, particularly in relation to stunting offered valuable insight into public sentiment. A significant proportion of online discussions (62.4%) expressed negative sentiment, revealing deep-seated frustration with the execution of health programs, unreliable data, and entrenched structural challenges (Irawan, A. S. a. A., Arie Dwi and Laili, Rizky Dzariyani and Amalia, Nuke and Tewabe, Walelign and Döbrössy, Bence and Girasek, Edmond., 2024).

This negativity stands in stark contrast to the often-optimistic portrayals of digital health in policy narratives. Interestingly, frontline healthcare professionals, including nutritionists and physicians, emerged as influential voices in these discussions. Their concerns, especially around data manipulation and exclusion from policy formulation underscore the critical need to incorporate practitioner perspectives into digital health planning and governance (Birtwistle, J. A.-O. X., Williamson, G. A.-O., Relton, S. A.-O., Bradshaw, A. A.-O., Sleeman, K. A.-O., Twiddy, M. A.-O., Millares-Martin, P. A.-O., Richards, S. A.-O., & Allsop, M. A.-O.; Elg, M. A.-O., Kabel, D. A.-O., Gremyr, I. A.-O., Olsson, J. A.-O. X., Martin, J. A.-O., & Smith, F. A.-O. X..).

Adding another layer to the evaluation, a digital health literacy (DHL) assessment among healthcare workers in stunting-prone regions revealed a concerning paradox. While participants generally exhibited moderate to high proficiency in basic digital skills such as app navigation and keyword searching, they lacked essential critical literacy competencies. Specifically, the ability to assess source credibility, detect commercial bias, and triangulate information across platforms was notably underdeveloped (WHO, 2023). This gap significantly limits the transformative potential of digital health interventions, even when tools are readily available. Moreover, persistent infrastructural barriers, such as poor internet connectivity and limited access to digital devices alongside a strong preference for in-person consultations, further complicate efforts to integrate digital solutions into daily healthcare practice. Although not universally expressed, concerns about data privacy and digital security reflect broader anxieties surrounding the digital transition (Rachmani, E., Kurniadi, A., Nurjanah, N., Shidik, G., Fitria, W., & Setyowati, M., 2019).

Taken together, these three interconnected components, technical app assessment, public discourse analysis, and literacy evaluation, illustrate a consistent and nuanced narrative. The advancement of digital health in Indonesia's pediatric sector is not solely a question of technological availability. Rather, it is profoundly shaped by issues of usability, trust, critical engagement, and systemic readiness. Addressing these challenges requires an integrated, multi-stakeholder strategy that views digital health not as a standalone innovation but as part of a broader sociotechnical ecosystem one that demands collaboration, inclusivity, and deep contextual sensitivity (Aisyah, D. A.-O., Setiawan, A. A.-O., Lokopessy, A. A.-O., Faradiba, N. A.-O., Setiaji, S. A.-O., Manikam, L. A.-O., & Kozlakidis, Z. A.-O.; Alfian, S. D., Sania, J. A., Aini, D. Q., Khoiry, Q. A., Griselda, M., Ausi, Y., Zakiyah, N., Puspitasari, I. M., Suwantika, A. A., Mahfud, M., Aji, S., Abdulah, R., & Kassianos, A. P., 2024).

### 5.4 Comparative Analysis: Literature vs. Field Data

Comparing the systematic literature review with the field data from Indonesia reveals both consistencies and striking divergences. Literature consistently advocates for mHealth as a promising avenue to address pediatric health challenges in LMICs, emphasizing its potential for improving access and efficiency (Irawan, A. S., Döbrössy, B. M., Biresaw, M. S., Muharram, A. P., Kovács, S. D., & Girasek, E.,2025.). This broad optimism is reflected in Indonesia's policy efforts, such as the SATUSEHAT platform, aimed at digital health integration (Mörelius, E., Robinson, S., Arabiat, D., & Whitehead, L., 2021).

However, the field data particularly from the app evaluation and social media analysis introduces a critical counter-narrative. While the literature suggests potential, the practical implementation in Indonesia often falls short. The poor MARS scores of Indonesian pediatric apps contradict the idealized notion of effective mHealth tools. Furthermore, the overwhelmingly negative sentiment on social media regarding child health programs, coupled with concerns about data integrity, indicates a significant gap between policy intentions and public perception. The systematic review largely focuses on the efficacy of mHealth interventions, but the field data highlights the underlying systemic and socio-cultural barriers that impede their successful adoption (Kim, G., Hwang, D., Park, J., Kim, H. K., & Hwang, E.-S., 2024).

The digital health literacy findings also bridge the gap. While literature often discusses the importance of digital health literacy, our field data provides a granular understanding of where these literacies are strong (basic use) and where they are weakest (critical evaluation). This directly impacts the effectiveness of mHealth tools, as even well-designed applications may be underutilized or misused if users lack the critical skills to discern reliable information.

The preference for face-to-face consultations, revealed in interviews, further underscores a reliance on traditional healthcare delivery models that digital solutions aim to complement, if not transform. This suggests that while digital health is emerging, it is not yet fully integrated into the trusted workflow and communication patterns of healthcare workers and the public (Alfian, S. D., Sania, J. A., Aini, D. Q., Khoiry, Q. A., Griselda, M., Ausi, Y., Zakiyah, N., Puspitasari, I. M., Suwantika, A. A., Mahfud, M., Aji, S., Abdulah, R., & Kassianos, A. P., 2024).

### 5.3 Implications for Pediatric Digital Health in Indonesia

The findings have several crucial implications for pediatric digital health in Indonesia. Firstly, there is an urgent need to shift focus from merely developing mHealth applications to ensuring their quality, usability, and cultural appropriateness. Apps must be designed with user-centered principles, incorporating feedback from parents and healthcare workers on the ground, and be clinically validated (Agustina, R., Dartanto, T., Sitompul, R., Susiloretni, K. A., Suparmi, Achadi, E. L., Taher, A., Wirawan, F., Sungkar, S., Sudarmono, P., Shankar, A. H., Thabrany, H., Agustina, R., Dartanto, T., Sitompul, R., Susiloretni, K. A., Suparmi, Achadi, E. L., Taher, A.,…Khusun, H., 2019; Tegegne, M. D., Tilahun, B., Mamuye, A., Kerie, H., Nurhussien, F., Zemen, E., Mebratu, A., Sisay, G., Getachew, R., Gebeyehu, H., Seyoum, A., Tesfaye, S., & Yilma, T. M., 2023).

Addressing the negative public discourse and misinformation is paramount. The high percentage of negative sentiment highlights a need for transparent and responsive health communication strategies. Government and health organizations must actively engage on social media, provide accurate information, and address public grievances regarding program coverage, budget allocation, and data integrity (Rachmani, E., Haikal, H., & Rimawati, E.). Leveraging trusted influencers, particularly healthcare professionals like nutritionists and medical doctors, could be a powerful strategy to disseminate accurate information and build trust (Kirkpatrick & Lawrie).

Investing in comprehensive digital health literacy programs is essential. These programs should move beyond basic digital skills to cultivate critical evaluative abilities, enabling users to distinguish reliable information from misinformation and understand commercial biases. Tailored training for healthcare workers, focusing on the practical application of digital tools and the ethical considerations of data privacy, is also crucial (Kasaye, M. A.-O., Kebede, N., Kalayou, M. H., Kebede, S. A.-O. X., & Molla.).

Digital infrastructure and the preference for face-to-face consultations necessitate a hybrid approach to healthcare delivery. Digital health solutions should be seen as

complementary tools, not replacements for in-person care, especially in remote areas with poor connectivity (Badr, J., Motulsky, A., & Denis, J.-L., 2024). Policy formulation needs to consider these on-the-ground realities to ensure equitable access and effective implementation across Indonesia's diverse geographical landscape (Cuadros, D. F., Kiragga, A., Tu, L., Awad, S., Bwanika, J. M., & Musuka, G.).

### 5.4 The Role of Social Media in Health Advocacy and Misinformation

Social media emerges as a double-edged sword in pediatric health. On one hand, it is a powerful platform for advocacy and awareness. High engagement around topics such as stunting often framed critically signals heightened public awareness and demand for accountability. Healthcare professionals actively participate in these discussions, offering expert perspectives and raising pressing issues, as seen in posts by nutritionists and medical doctors. These organic exchanges provide valuable, real-time insights into community needs and perceptions that are often absent from formal surveys (Yeung, A. A.-O. X., Tosevska, A. A.-O., Klager, E. A.-O., Eibensteiner, F. A.-O., Tsagkaris, C. A.-O. X., Parvanov, E. A.-O., Nawaz, F. A.-O., Völkl-Kernstock, S. A.-O., Schaden, E. A.-O., Kletecka-Pulker, M. A.-O., Willschke, H. A.-O., & Atanasov, A. A.-O.).

Recent data from Surabaya, East Java province, Indonesia revealed that low maternal education and household food insecurity significantly increase the risk of prematurity and low birth weight, leading contributors to stunting (Alristina, A. D., Mahrouseh, N., Irawan, A. S., Laili, R. D., Zimonyi-Bakó, A. V., & Feith, H. J., 2025). This highlighted the need for digital health strategies that also tackle structural determinants such as food insecurity and maternal education through integrated, multi-sectoral interventions that extend beyond clinical or app-based solutions (Kovell, L. C., Sibai, D., Wilkie, G. L., Shankara, S., Moinul, S., Kaminsky, L., Lemon, S. C., & McManus, D. D.).

The influencer effect plays a pivotal role in shaping these narratives. Analysis of engagement data reveals that posts from influential professionals, particularly nutritionists garnered the highest public interaction, with one female nutritionist’s post achieving the top engagement overall (Coates, A. E., Hardman, C. A., Halford, J. C. G., Christiansen, P., & Boyland, E. J.). This suggests that credibility combined with relatable communication drives greater resonance and reach. Medical doctors also contributed substantially to the discourse, often addressing gaps in preventive programs, data integrity, and funding allocation. Such influential voices act as amplifiers for both advocacy and critique, shaping public sentiment and influencing the direction of online conversations (Amson, A., Bagnato, M., Remedios, L.,

Pritchard, M., Sabir, S., Gillis, G., Pauzé, E., White, C., Vanderlee, L., Hammond, D., & Potvin Kent, M. A.-O.).

On the other hand, social media provides fertile ground for misinformation and emotional polarization. The thematic analysis identified concerns about data manipulation and the circulation of unverified claims, which can erode public trust and hinder effective interventions. Discussions around child health are often emotionally charged, making audiences more vulnerable to narratives prioritizing relatability over scientific accuracy (Adebesin, F. A.-O. X., Smuts, H. A.-O., Mawela, T. A.-O., Maramba, G. A.-O., & Hattingh, M. A.-O.). This highlighted the importance of strategically integrating influencers into digital health communication, not only to expand the reach of evidence-based messages but also to actively counter false narratives.

The findings suggested that future public health campaigns should be embedded within social media ecosystems, leveraging credible influencers, continuous discourse monitoring, and rapid-response strategies to address misinformation (Kanchan S, 2023). In doing so, health authorities can harness the advocacy power of social media while mitigating its risks (Hilberts, S. A.-O., Govers, M. A.-O., Petelos, E. A.-O., & Evers, S. A.-O. X.).

### 5.5 Digital Health Literacy: A Foundation for Implementation

The study strongly reinforced the notion that digital health literacy is not merely a desirable skill but a fundamental prerequisite for the successful implementation and adoption of digital health initiatives. The assessment revealed that while Indonesian healthcare workers demonstrate a moderate level of basic digital proficiency (e.g., using keywords, basic communication), they significantly struggle with critical evaluation skills (e.g., assessing trustworthiness, detecting commercial content, comparing multiple sources). This "critical literacy gap" is a major barrier. Without the ability to discern credible information, users are vulnerable to misinformation and unlikely to fully trust or effectively utilize digital health tools (Wamala Andersson & Gonzalez, 2025).

Furthermore, the mixed results regarding expressing opinions on digital platforms point to potential socio-cultural or psychological barriers that inhibit active participation in online health discourse. This suggested that simply providing access to information is insufficient; interventions must also foster an environment where users feel confident and safe to engage, question, and contribute. Therefore, future digital health literacy initiatives must move beyond basic training to focus on building critical appraisal skills, fostering a healthy skepticism towards online content, and promoting responsible digital citizenship (El Benny, M. A.-O. X., Kabakian-Khasholian, T. A.-O., El-Jardali, F. A.-O., & Bardus, M. A.-O.) This includes

educating users on data privacy, recognizing manipulative content, and understanding the nuances of online information sources (Ban, S., Kim, Y., & Seomun, G., 2024).

### 5.6 Challenges and Opportunities in Technology Integration

The integration of digital health technologies in pediatric care in Indonesia faces several significant challenges. Infrastructural disparities are prominent, with remote and rural areas suffering from unstable internet signals and unreliable electricity, directly impacting the functionality of mHealth applications (Papp-Zipernovszky, O., Horváth, M. D., Schulz, P. J., & Csabai, M.). The lack of user-centered design in many existing apps, as highlighted by the MARS evaluation, creates usability issues, and reduces engagement. Moreover, the study revealed a disconnect between policymakers and frontline healthcare workers, leading to policies and digital tools that may not adequately address local needs or reflect real-world conditions (Irawan, A. S., Alristina, A. D., Laili, R. D., Amalia, N., Muharram, A. P., Miranda, A. V., Döbrössy, B., & Girasek, E.., 2025). Concerns about data privacy and security also pose a challenge, contributing to a cautious approach towards digital health adoption, particularly among professionals. Finally, the ingrained preference for face-to-face consultations indicated a cultural or professional resistance to fully embracing telemedicine or app-based interactions for definitive diagnoses (Rachmani, E., Haikal, H., & Rimawati, E.).

Despite these challenges, significant opportunities exist. The widespread smartphone penetration in Indonesia provides a ready platform for mHealth delivery. The enthusiasm for digital tools for efficiency and reporting among some healthcare workers demonstrates a clear potential for digital health to streamline administrative tasks and improve data collection. The active social media discourse, even when negative, represents a valuable channel for identifying public concerns and engaging communities in health conversations. Opportunities lie in co-designing digital health solutions with local healthcare workers and communities, integrating culturally sensitive content, and ensuring robust data security measures. Furthermore, targeted training that bridges the critical digital literacy gap can empower users to harness the full potential of digital health tools, while a hybrid model of care that combines digital convenience with in-person medical expertise can address the existing preference for direct consultations (Aisyah, D. A.-O., Setiawan, A. A.-O., Lokopessy, A. A.-O., Faradiba, N. A.-O., Setiaji, S. A.-O., Manikam, L. A.-O., & Kozlakidis, Z. A.-O.).

## 6. Limitations

While this dissertation offers a comprehensive analysis, several limitations must be acknowledged:

- Scope and Generalizability: The case study is geographically concentrated in selected areas of Indonesia. While the insights are deeply contextualized, they may not fully represent the diversity of Indonesia's healthcare system or be directly transferable to other LMICs.
- Temporal Constraints: Social media discourse is dynamic. The discourse analysis reflects a snapshot in time and may not capture long-term trends or responses to recent health policy shifts.
- Sample Size in App Evaluation and Literacy Assessment: Due to resource and time constraints, the number of apps evaluated, and health workers surveyed was limited. A larger dataset could have yielded more statistically robust findings.
- Tool Limitations: The MARS scale, while widely used, may not fully account for local cultural nuances or user expectations in LMIC settings. Similarly, digital literacy tools adapted from existing models may overlook context-specific literacies shaped by cultural and infrastructural realities.
- Potential Bias in "Self-Reported Data": In the digital literacy assessment, some responses relied on self-reporting, which may be influenced by social desirability or limited introspective accuracy.

## 7. 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.

SUMMARY

This dissertation examined the evolving landscape of digital health in pediatric care within the Indonesian context, employing a multi-method approach that includes mobile app evaluation, social media discourse analysis, and digital health literacy assessment. The study commenced with a literature review of mHealth interventions in low- and middle-income countries (LMICs), highlighting the global optimism surrounding digital solutions for enhancing pediatric outcomes, particularly in areas such as vaccination, breastfeeding, and early childhood development. Building on this foundation, a mobile health application evaluation was conducted using the Mobile Application Rating Scale (MARS) on Indonesian pediatric apps. The results indicated poor usability, engagement, and information quality, which starkly contrasted with the promises depicted in the academic literature. A social media analysis of discourse on child health, particularly stunting, revealed overwhelmingly negative public sentiment. Topics such as program transparency, data reliability, and health inequality dominated the conversation, underscoring a profound disconnect between health policy intentions and community trust in the program. The final component of this study assessed the digital health literacy of frontline healthcare workers in rural Indonesia. While basic digital competencies were evident, critical evaluation skills essential for discerning accurate from misleading health information were notably weak. Collectively, these findings highlighted a significant gap between technological promise and on-the-ground realities. Despite widespread enthusiasm for digital health, its successful implementation is hindered by low app quality, mistrust in public discourse, and limited health literacy. The dissertation concluded that digital health should be understood as a socio-technical ecosystem. Effective integration into pediatric care requires co-designed solutions, critical literacy programs, and hybrid service models that align with the infrastructural, cultural, and communicative practices of Indonesian communities.

REFERENCES

Adebesin, F. A.-O. X., Smuts, H. A.-O., Mawela, T. A.-O., Maramba, G. A.-O., & Hattingh, M. A.-O. The Role of Social Media in Health Misinformation and Disinformation During the COVID-19 Pandemic: Bibliometric Analysis. (2564-1891 (Electronic)).

Agarwal, S., LeFevre, A. E., Lee, J., L'Engle, K., Mehl, G., Sinha, C., & Labrique, A. Guidelines for reporting of health interventions using mobile phones: mobile health (mHealth) evidence reporting and assessment (mERA) checklist. (1756-1833 (Electronic)).

Agustina, R., Dartanto, T., Sitompul, R., Susiloretni, K. A., Suparmi, Achadi, E. L., Taher, A., Wirawan, F., Sungkar, S., Sudarmono, P., Shankar, A. H., Thabrany, H., Agustina, R., Dartanto, T., Sitompul, R., Susiloretni, K. A., Suparmi, Achadi, E. L., Taher, A.,…Khusun, H. (2019). Universal health coverage in Indonesia: concept, progress, and challenges. *The Lancet*, *393*(10166), 75-102. https://doi.org/10.1016/S0140-6736(18)31647-7

Ahmed, I., Ali, H., Ali, S., Van Woerden, S., Hanna-Amodio, A., Chen, K., Onitolo, E., & Gillespie, A. From digital voices to vaccine choices: increasing female vaccine acceptance in Sudan through social listening. (2673-5059 (Electronic)).

Ahmed, M. M., Okesanya, O. J., Olaleke, N. O., Adigun, O. A., Adebayo, U. O., Oso, T. A., Eshun, G., & Lucero-Prisno, D. E. (2025). Integrating Digital Health Innovations to Achieve Universal Health Coverage: Promoting Health Outcomes and Quality Through Global Public Health Equity. *Healthcare*, *13*(9).

Aisyah, D. A.-O., Setiawan, A. A.-O., Lokopessy, A. A.-O., Faradiba, N. A.-O., Setiaji, S. A.-O., Manikam, L. A.-O., & Kozlakidis, Z. A.-O. The Information and Communication Technology Maturity Assessment at Primary Health Care Services Across 9 Provinces in Indonesia: Evaluation Study. (2291-9694 (Print)).

Alfian, S. D., Sania, J. A., Aini, D. Q., Khoiry, Q. A., Griselda, M., Ausi, Y., Zakiyah, N., Puspitasari, I. M., Suwantika, A. A., Mahfud, M., Aji, S., Abdulah, R., & Kassianos, A. P. (2024). Evaluation of usability and user feedback to guide telepharmacy application development in Indonesia: a mixed-methods study. *BMC Medical Informatics and Decision Making*, *24*(1), 130. https://doi.org/10.1186/s12911-024-02494-3

Algifari, M. H., Zachary, L., Yuliani, R. P., Aditama, H., & Kristina, S. A. (2024). Digital Health Literacy and Its Associated Factors in the General Population in Indonesia. *Indonesian Journal of Pharmacy*, *35(2), 355–362*. https://doi.org/https://doi.org/10.22146/ijp.5640

Alristina, A. D., Mahrouseh, N., Irawan, A. S., Laili, R. D., Zimonyi-Bakó, A. V., & Feith, H. J. (2025). Prematurity and Low Birth Weight Among Food-Secure and Food-Insecure Households: A Comparative Study in Surabaya, Indonesia. *Nutrients*, *17*(15).

Amson, A., Bagnato, M., Remedios, L., Pritchard, M., Sabir, S., Gillis, G., Pauzé, E., White, C., Vanderlee, L., Hammond, D., & Potvin Kent, M. A.-O. Beyond the screen: Exploring the dynamics of social media influencers, digital food marketing, and gendered influences on adolescent diets. (2767-3170 (Electronic)).

Anastasiadou, O., Tsipouras, M., Mpogiatzidis, P., & Angelidis, P. (2025). Digital Healthcare Innovative Services in Times of Crisis: A Literature Review. *Healthcare*, *13*(8).

Badr, J., Motulsky, A., & Denis, J.-L. (2024). Digital health technologies and inequalities: A scoping review of potential impacts and policy recommendations. *Health Policy*, *146*, 105122. https://doi.org/https://doi.org/10.1016/j.healthpol.2024.105122

Ban, S., Kim, Y., & Seomun, G. (2024). Digital health literacy: A concept analysis. *DIGITAL HEALTH*, *10*, 20552076241287894. https://doi.org/10.1177/20552076241287894

Birtwistle, J. A.-O. X., Williamson, G. A.-O., Relton, S. A.-O., Bradshaw, A. A.-O., Sleeman, K. A.-O., Twiddy, M. A.-O., Millares-Martin, P. A.-O., Richards, S. A.-O., & Allsop, M. A.-O. Community and hospital-based healthcare professionals perceptions of digital advance care planning for palliative and end-of-life care: a latent class analysis. (2755-0079 (Electronic)).

BKPK, P. R. o. (2021). *Buku Saku Hasil Studi Status Gizi Indonesia (SSGI) Tahun 2021*. https://www.badankebijakan.kemkes.go.id/buku-saku-hasil-studi-status-gizi-indonesia-ssgi-tahun-2021/

Black, R. E., Victora, C. G., Walker, S. P., Bhutta, Z. A., Christian, P., de Onis, M., Ezzati, M., Grantham-McGregor, S., Katz, J., Martorell, R., & Uauy, R. Maternal and child undernutrition and overweight in low-income and middle-income countries. (1474-547X (Electronic)).

Bozzola, E. A.-O., Spina, G. A.-O., Agostiniani, R., Barni, S., Russo, R., Scarpato, E., Di Mauro, A. A.-O., Di Stefano, A. V., Caruso, C., Corsello, G., & Staiano, A. The Use of Social Media in Children and Adolescents: Scoping Review on the Potential Risks. LID - 10.3390/ijerph19169960 [doi] LID - 9960. (1660-4601 (Electronic)).

Brands, M. R., Gouw, S. C., Beestrum, M., Cronin, R. M., Fijnvandraat, K., & Badawy, S. M. (2022). Patient-Centered Digital Health Records and Their Effects on Health Outcomes: Systematic Review. *J Med Internet Res*, *24*(12), e43086. https://doi.org/10.2196/43086

Cascini, F., Gentili, A., Causio, F. A., Altamura, G., Melnyk, A., Beccia, F., Pappalardo, C., Lontano, A., & Ricciardi, W. Strengthening and promoting digital health practice: results from a Global Digital Health Partnership's survey. (2296-2565 (Electronic)).

Charles-Smith, L. E., Reynolds, T. L., Cameron, M. A., Conway, M., Lau, E. H. Y., Olsen, J. M., Pavlin, J. A., Shigematsu, M., Streichert, L. C., Suda, K. J., & Corley, C. D. (2015). Using Social Media for Actionable Disease Surveillance and Outbreak Management: A Systematic Literature Review. *PLoS One*, *10*(10), e0139701. https://doi.org/10.1371/journal.pone.0139701

Chen, X. A.-O., Orom, H., Hay, J. L., Waters, E. A., Schofield, E., Li, Y., & Kiviniemi, M. T. Differences in Rural and Urban Health Information Access and Use. (1748-0361 (Electronic)).

Chesser, A. K., Keene Woods, N., Smothers, K., & Rogers, N. Health Literacy and Older Adults: A Systematic Review. (2333-7214 (Print)).

Chhabra, J., Pilkington, V., Benakovic, R., Wilson, M. J., La Sala, L., & Seidler, Z. (2025). Social Media and Youth Mental Health: Scoping Review of Platform and Policy Recommendations. *J Med Internet Res*, *27*, e72061. https://doi.org/10.2196/72061

Choi, S., Bang, K.-S., & Shin, D.-A. (2021). eHealth Literacy, Awareness of Pandemic Infectious Diseases, and Healthy Lifestyle in Middle School Students. *Children*, *8*(8).

Coates, A. E., Hardman, C. A., Halford, J. C. G., Christiansen, P., & Boyland, E. J. Social Media Influencer Marketing and Children's Food Intake: A Randomized Trial. LID - e20182554 [pii] LID - 10.1542/peds.2018-2554 [doi]. (1098-4275 (Electronic)).

Cuadros, D. F., Kiragga, A., Tu, L., Awad, S., Bwanika, J. M., & Musuka, G. Unpacking social and digital determinants of health in Africa: a narrative review on challenges and opportunities. (2306-9740 (Print)).

Curfman, A. L., Hackell, J. M., Herendeen, N. E., Alexander, J. J., Marcin, J. P., Moskowitz, W. B., Bodnar, C. E. F., Simon, H. K., & McSwain, S. D. Telehealth: Improving Access to and Quality of Pediatric Health Care. LID - 10.1542/peds.2021-053129 [doi] LID - e2021053129. (1098-4275 (Electronic)).

de Onis, M., & Branca, F. (2016). Childhood stunting: a global perspective. *Matern Child Nutr*, *12 Suppl 1*(Suppl 1), 12-26. https://doi.org/10.1111/mcn.12231

Diniz, C. S. G., Franzon, A. C. A., Fioretti-Foschi, B., Niy, D. Y., Pedrilio, L. S., Amaro Jr, E., & Sato, J. R. (2021). Communication Intervention Using Digital Technology to Facilitate Informed Choices at Childbirth in the Context of the COVID-19 Pandemic: Protocol for a Randomized Controlled Trial. *JMIR Res Protoc*, *10*(5), e25016. https://doi.org/10.2196/25016

Diviani, N., van den Putte, B., Meppelink, C. S., & van Weert, J. C. Exploring the role of health literacy in the evaluation of online health information: Insights from a mixed-methods study. (1873-5134 (Electronic)).

El Benny, M. A.-O. X., Kabakian-Khasholian, T. A.-O., El-Jardali, F. A.-O., & Bardus, M. A.-O. Application of the eHealth Literacy Model in Digital Health Interventions: Scoping Review. (1438-8871 (Electronic)).

Elg, M. A.-O., Kabel, D. A.-O., Gremyr, I. A.-O., Olsson, J. A.-O. X., Martin, J. A.-O., & Smith, F. A.-O. X. Identification and Categorization of the Distinct Purposes Underpinning the Use of Digital Health Care Self-Monitoring: Qualitative Study of Stakeholders in the Health Care Ecosystem. (1438-8871 (Electronic)).

Erika, K. A., Fadilah, N., Latif, A. I., Hasbiah, N., Juliaty, A., Achmad, H., & Bustamin, A. (2024). Stunting Super App as an Effort Toward Stunting Management in Indonesia: Delphi and Pilot Study. *JMIR Hum Factors*, *11*, e54862. https://doi.org/10.2196/54862

Faza, A., Rinawan, F. R., Mutyara, K., Purnama, W. G., Ferdian, D., Susanti, A. I., Didah, D., Indraswari, N., & Fatimah, S. N. (2022). Posyandu Application in Indonesia: From Health Informatics Data Quality Bridging Bottom-Up and Top-Down Policy Implementation. *Informatics*, *9*(4).

Fraser, H. S., & Blaya, J. Implementing medical information systems in developing countries, what works and what doesn't. (1942-597X (Electronic)).

Haji Said, A., Winskell, K., Bednarczyk, R. A., Reardon, E. E., & Vasudevan, L. (2024). Interactive Narrative–Based Digital Health Interventions for Vaccine Communication: Protocol for a Scoping Review. *JMIR Res Protoc*, *13*, e51137. https://doi.org/10.2196/51137

Handayani, P. W., Meigasari, D. A., Pinem, A. A., Hidayanto, A. N., & Ayuningtyas, D. Critical success factors for mobile health implementation in Indonesia. (2405-8440 (Print)).

Hasman, A., Mantas, J., & Marin, H. F. (2024). Digital health and health informatics. *International Journal of Medical Informatics*, *186*, 105404. https://doi.org/https://doi.org/10.1016/j.ijmedinf.2024.105404

Hilberts, S. A.-O., Govers, M. A.-O., Petelos, E. A.-O., & Evers, S. A.-O. X. The Impact of Misinformation on Social Media in the Context of Natural Disasters: Narrative Review. (2564-1891 (Electronic)).

Hossain, M. K., Sutanto, J., Handayani, P. W., Haryanto, A. A., Bhowmik, J., & Frings-Hessami, V. An exploratory study of electronic medical record implementation and recordkeeping culture: the case of hospitals in Indonesia. (1472-6963 (Electronic)).

Hua, Z., Yuqing, S., Qianwen, L., & Hong, C. (2025). Factors Influencing eHealth Literacy Worldwide: Systematic Review and Meta-Analysis. *J Med Internet Res*, *27*, e50313. https://doi.org/10.2196/50313

Innovation, D. H. a. (2021). *Global strategy on digital health 2020-2025*. WHO. https://www.who.int/publications/i/item/9789240020924

Irawan, A. S., Alristina, A. D., Laili, R. D., Amalia, N., Muharram, A. P., Miranda, A. V., Döbrössy, B., & Girasek, E. (2025). Beyond the interface: benchmarking pediatric mobile health applications for monitoring child growth using the Mobile App Rating Scale [Original Research]. *Frontiers in Digital Health*, *Volume 7 - 2025*. https://www.frontiersin.org/journals/digital-health/articles/10.3389/fdgth.2025.1621293

Irawan, A. S., Döbrössy, B. M., Biresaw, M. S., Muharram, A. P., Kovács, S. D., & Girasek, E. Exploring characteristics and common features of digital health in pediatric care in developing countries: a systematic review. (2673-253X (Electronic)).

Irawan, A. S. a. A., Arie Dwi and Laili, Rizky Dzariyani and Amalia, Nuke and Tewabe, Walelign and Döbrössy, Bence and Girasek, Edmond. (2024). Unveiling Peak Detection, Sentiment Analysis, and Post Engagement: Social Media Listening Discourses on Stunting in Indonesia. *SSRN*. https://doi.org/http://dx.doi.org/10.2139/ssrn.4888137

Istepanian, R. S. H. Mobile Health (m-Health) in Retrospect: The Known Unknowns. LID - 10.3390/ijerph19073747 [doi] LID - 3747. (1660-4601 (Electronic)).

Kanchan S, G. A. (2023). Social Media Role and Its Impact on Public Health: A Narrative Review. *Cureus*, *2023 Jan 13;15(1):e33737*. https://doi.org/10.7759/cureus.33737

Karahoca, A., Bayraktar, E., Tatoglu, E., & Karahoca, D. (2010). Information system design for a hospital emergency department: A usability analysis of software prototypes. *Journal of Biomedical Informatics*, *43*(2), 224-232. https://doi.org/https://doi.org/10.1016/j.jbi.2009.09.002

Karami, A., Dahl, A. A., Turner-McGrievy, G., Kharrazi, H., & Shaw, G. (2018). Characterizing diabetes, diet, exercise, and obesity comments on Twitter. *International Journal of Information Management*, *38*(1), 1-6. https://doi.org/https://doi.org/10.1016/j.ijinfomgt.2017.08.002

Kasaye, M. A.-O., Kebede, N., Kalayou, M. H., Kebede, S. A.-O. X., & Molla, A. Digital health literacy and associated factors among health professionals during the outbreak of corona virus pandemic in Ethiopia: A systematic review and meta-analysis. (2055-2076 (Print)).

Kasperski, R., Blau, I., & Ben-Yehudah, G. (2022). Teaching digital literacy: Is there a consistency between teachers' perspectives and actual pedagogy? *Technology, Pedagogy and Education*, *31*. https://doi.org/10.1080/1475939X.2022.2091015

Kim, G., Hwang, D., Park, J., Kim, H. K., & Hwang, E.-S. (2024). How to Design and Evaluate mHealth Apps? A Case Study of a Mobile Personal Health Record App. *Electronics*, *13*(1).

Kirkpatrick, C. A.-O. X., & Lawrie, L. A.-O. TikTok as a Source of Health Information and Misinformation for Young Women in the United States: Survey Study. (2564-1891 (Electronic)).

Kovell, L. C., Sibai, D., Wilkie, G. L., Shankara, S., Moinul, S., Kaminsky, L., Lemon, S. C., & McManus, D. D. Identifying barriers, facilitators, and interventions to support healthy eating in pregnant women with or at risk for hypertensive disorders of pregnancy. (2666-6936 (Electronic)).

Krasevec J, B. H., Coffey C. (2022). *Study protocol for UNICEF and WHO estimates of global, regional, and national low birthweight prevalence for 2000 to 2020*. Gates Open Res 2022 Retrieved from https://gatesopenresearch.org/articles/6-80/v1

Krishna, S., Boren Sa Fau - Balas, E. A., & Balas, E. A. Healthcare via cell phones: a systematic review. (1556-3669 (Electronic)).

Lai, W. T., Wu, L. M., & Hsu, M. T. [Qualitative Systematic Review Research Method: A Meta-Ethnographic Synthesis]. (0047-262X (Print)).

Longhini, J. A.-O. X., Rossettini, G. A.-O., & Palese, A. A.-O. X. Digital Health Competencies Among Health Care Professionals: Systematic Review. (1438-8871 (Electronic)).

Maita, K. C., Maniaci, M. A.-O., Haider, C. R., Avila, F. R., Torres-Guzman, R. A., Borna, S., Lunde, J. J., Coffey, J. A.-O., Demaerschalk, B. M., & Forte, A. A.-O. The Impact of Digital Health Solutions on Bridging the Health Care Gap in Rural Areas: A Scoping Review. (1552-5775 (Electronic)).

Marcin, J. P., Shaikh, U., & Steinhorn, R. H. Addressing health disparities in rural communities using telehealth. (1530-0447 (Electronic)).

Mathieu, B., Teena, K., Tapas Sadasivan, N., Amani, S., James, C., & Khassoum, D. (2022). The global health workforce stock and distribution in 2020 and 2030: a threat to equity and 'universal' health coverage? *BMJ Global Health*, *7*(6), e009316. https://doi.org/10.1136/bmjgh-2022-009316

Merga, M. K. (2024). TikTok and digital health literacy: A systematic review. *IFLA Journal*, *51*(2), 490-501. https://doi.org/10.1177/03400352241286175

Messner, E.-M., Terhorst, Y., Barke, A., Baumeister, H., Stoyanov, S., Hides, L., Kavanagh, D., Pryss, R., Sander, L., & Probst, T. (2020). The German Version of the Mobile App Rating Scale (MARS-G): Development and Validation Study. *JMIR Mhealth Uhealth*, *8*(3), e14479. https://doi.org/10.2196/14479

Mirzaei, T., & Kashian, N. (2020). Revisiting Effective Communication Between Patients and Physicians: Cross-Sectional Questionnaire Study Comparing Text-Based Electronic Versus Face-to-Face Communication. *J Med Internet Res*, *22*(5), e16965. https://doi.org/10.2196/16965

Mittelstadt, B. A.-O., & Floridi, L. The Ethics of Big Data: Current and Foreseeable Issues in Biomedical Contexts. (1471-5546 (Electronic)).

Moorhead, S. A., Hazlett, D. E., Harrison, L., Carroll, J. K., Irwin, A., & Hoving, C. (2013). A New Dimension of Health Care: Systematic Review of the Uses, Benefits, and Limitations of Social Media for Health Communication. *J Med Internet Res*, *15*(4), e85. https://doi.org/10.2196/jmir.1933

Mörelius, E., Robinson, S., Arabiat, D., & Whitehead, L. (2021). Digital Interventions to Improve Health Literacy Among Parents of Children Aged 0 to 12 Years With a Health Condition: Systematic Review. *J Med Internet Res*, *23*(12), e31665. https://doi.org/10.2196/31665

Mursa, R. A., Patterson, C., McErlean, G., & Halcomb, E. How many is enough? Justifying sample size in descriptive quantitative research. (2047-8992 (Electronic)).

Norman, C. D., & Skinner, H. A. (2006). eHealth Literacy: Essential Skills for Consumer Health in a Networked World. *J Med Internet Res*, *8*(2), e9. https://doi.org/10.2196/jmir.8.2.e9

Nur Aisyah, D. A.-O., Lokopessy, A. A.-O., Naman, M. A.-O., Diva, H. A.-O., Manikam, L. A.-O., Adisasmito, W. A.-O., & Kozlakidis, Z. A.-O. The Use of Digital Technology for COVID-19 Detection and Response Management in Indonesia: Mixed Methods Study. (1929-073X (Print)).

Papp-Zipernovszky, O., Horváth, M. D., Schulz, P. J., & Csabai, M. Generation Gaps in Digital Health Literacy and Their Impact on Health Information Seeking Behavior and Health Empowerment in Hungary. (2296-2565 (Electronic)).

Pollard, S., Bansback, N., & Bryan, S. Physician attitudes toward shared decision making: A systematic review. (1873-5134 (Electronic)).

Prendergast, A. J., & Humphrey, J. H. (2014). The stunting syndrome in developing countries. *Paediatr Int Child Health*, *34*(4), 250-265. https://doi.org/10.1179/2046905514Y.0000000158

Quinn, S. C., Jamison, A. M., & Freimuth, V. (2020). Communicating Effectively About Emergency Use Authorization and Vaccines in the COVID-19 Pandemic. *American Journal of Public Health*, *111*(3), 355-358. https://doi.org/10.2105/AJPH.2020.306036

Rachmani, E., Haikal, H., & Rimawati, E. Development and validation of digital health literacy competencies for citizens (DHLC), an instrument for measuring digital health literacy in the community. (2666-9900 (Electronic)).

Rachmani, E., Kurniadi, A., Nurjanah, N., Shidik, G., Fitria, W., & Setyowati, M. (2019). *Digital Health Literacy and Internet behavior of Primary Health Care Staff in Indonesia, Are they ready adopting eHealth?*

Richman, A. R., Schwartz, A. A.-O., Maness, S. A.-O., Sanchez, L., & Torres, E. Exploring Vaccine Hesitancy, Structural Barriers, and Trust in Vaccine Information Among Populations Living in the Rural Southern United States. LID - 10.3390/vaccines13070699 [doi] LID - 699. (2076-393X (Print)).

Schmidt, A. L., Rodriguez-Esteban, R., Gottowik, J., & Leddin, M. Applications of quantitative social media listening to patient-centric drug development. (1878-5832 (Electronic)).

Septia Irawan, A., Shahin, B., Wangeshi Njuguna, D., Nellamkuzhi, N. J., Thiện, B. Q., Mahrouseh, N., & Varga, O. Analysis of Content, Social Networks, and Sentiment of Front-of-Pack Nutrition Labeling in the European Union on Twitter. (2296-861X (Print)).

Shah, R. (2024). *Different Methods for Calculating Sentiment of Text*. Retrieved 31 Agustus from https://www.analyticsvidhya.com/blog/2021/12/different-methods-for-calculating-sentiment-score-of-text/?utm_source=chatgpt.com

Shapoo, N., Rehman, A., & Boma, N. Smart Healthcare: The Role of Digital Health in Modern Medicine. (2771-1757 (Electronic)).

Songo, J. A.-O., Whitehead, H. S., Phiri, K. A.-O., Kalande, P., Lungu, E., Phiri, S., van Oosterhout, J., Moses, A., Hoffman, R. M., & Moucheraud, C. Uptake of the COVID-19 vaccine and its association with vaccine information and misinformation in Malawi. (2730-664X (Electronic)).

Spanos, K. E., Kraschnewski, J. L., Moss, J. L., Wong, A., & Calo, W. A. Parent support for social media standards combatting vaccine misinformation. (1873-2518 (Electronic)).

Stoyanov, S. R., Hides, L., Kavanagh, D. J., Zelenko, O., Tjondronegoro, D., & Mani, M. (2015). Mobile App Rating Scale: A New Tool for Assessing the Quality of Health Mobile Apps. *JMIR Mhealth Uhealth*, *3*(1), e27. https://doi.org/10.2196/mhealth.3422

Sudbury-Riley, L. A.-O., FitzPatrick, M. A.-O., & Schulz, P. A.-O. X. Exploring the Measurement Properties of the eHealth Literacy Scale (eHEALS) Among Baby Boomers: A Multinational Test of Measurement Invariance. (1438-8871 (Electronic)).

Taba, M., Allen, T. B., Caldwell, P. H. Y., Skinner, S. R., Kang, M., McCaffery, K., & Scott, K. M. (2022). Adolescents' self-efficacy and digital health literacy: a cross-sectional mixed methods study. *BMC Public Health*, *22*(1), 1223. https://doi.org/10.1186/s12889-022-13599-7

Tegegne, M. D., Tilahun, B., Mamuye, A., Kerie, H., Nurhussien, F., Zemen, E., Mebratu, A., Sisay, G., Getachew, R., Gebeyehu, H., Seyoum, A., Tesfaye, S., & Yilma, T. M. (2023). Digital literacy level and associated factors among health professionals in a referral and teaching hospital: An implication for future digital health systems implementation [Original Research]. *Frontiers in Public Health*, *Volume 11 - 2023*. https://www.frontiersin.org/journals/public-health/articles/10.3389/fpubh.2023.1130894

Tomlinson, M., Rotheram-Borus Mj Fau - Swartz, L., Swartz L Fau - Tsai, A. C., & Tsai, A. C. Scaling up mHealth: where is the evidence? (1549-1676 (Electronic)).

van der Vaart, R., & Drossaert, C. (2017). Development of the Digital Health Literacy Instrument: Measuring a Broad Spectrum of Health 1.0 and Health 2.0 Skills. *J Med Internet Res*, *19*(1), e27. https://doi.org/10.2196/jmir.6709

Veronika Ertl, D. M. (2019). *China: A Developing Country as a Global Power?* https://www.kas.de/en/web/auslandsinformationen/artikel/detail/-/content/china-ein-entwicklungsland-als-globale-macht

Wamala Andersson, S., & Gonzalez, M. P. (2025). Digital health literacy—a key factor in realizing the value of digital transformation in healthcare [Perspective]. *Frontiers in Digital Health*, *Volume 7 - 2025*. https://www.frontiersin.org/journals/digital-health/articles/10.3389/fdgth.2025.1461342

Who. (2006). WHO Child Growth Standards. In: United Nations Children's Fund.

WHO. (2023). *Digital health literacy key to overcoming barriers for health workers, WHO study says* https://www.who.int/poland/news/item/18-09-2023-digital-health-literacy-key-to-overcoming-barriers-for-health-workers--who-study-says

Wilson, S. L., & Wiysonge, C. Social media and vaccine hesitancy. LID - 10.1136/bmjgh-2020-004206 [doi] LID - e004206. (2059-7908 (Print)).

Yeung, A. A.-O. X., Tosevska, A. A.-O., Klager, E. A.-O., Eibensteiner, F. A.-O., Tsagkaris, C. A.-O. X., Parvanov, E. A.-O., Nawaz, F. A.-O., Völkl-Kernstock, S. A.-O., Schaden, E. A.-O., Kletecka-Pulker, M. A.-O., Willschke, H. A.-O., & Atanasov, A. A.-O.

Medical and Health-Related Misinformation on Social Media: Bibliometric Study of the Scientific Literature. (1438-8871 (Electronic)).

Younas, A., Fàbregues, S., Munce, S., & Creswell, J. W. (2025). Framework for types of metainferences in mixed methods research. *BMC Medical Research Methodology*, *25*(1), 18. https://doi.org/10.1186/s12874-025-02475-8

Zainal, H., Xiaohui, X., Thumboo, J., Seah, S. J., Leng, L. L., & Kok Yong, F. Exploring caregiver challenges, digital health technologies, and healthcare support: a qualitative study. (2673-253X (Electronic)).

Zeng, R., & Li, M. (2020). Social Media Use for Health Communication by the CDC in Mainland China: National Survey Study 2009-2020. *J Med Internet Res*, *22*(12), e19470. https://doi.org/10.2196/19470

Zhao, J., Freeman, B., & Li, M. (2016). Can Mobile Phone Apps Influence People's Health Behavior Change? An Evidence Review. *J Med Internet Res*, *18*(11), e287. https://doi.org/10.2196/jmir.5692

APPENDIX

1. MARS INSTRUMENTS

Mobile Application Rating Scale (MARS) App Classification

The Classification section is used to collect descriptive and technical information about the app. Please review the app description in iTunes / Google Play to access this information.

App Name: _____

Rating this version: _____ Rating all versions: _____

Developer: _____

N ratings this version: _____ N ratings all versions: _____

Version: _____ Last update: _____

Cost - basic version: _____ Cost - upgrade version: _____

Platform: □□ iPhone □□ iPad □□ Android

Brief description: _____

_____

Focus: what the app targets

(select all that apply)

□□ Increase Happiness/Well-being □□ Mindfulness/Meditation/Relaxation □□ Reduce negative emotions □□ Depression

□□ Anxiety/Stress

□□ Anger

Theoretical background/Strategies

(all that apply)

□□ Behaviour Change

□□ Alcohol /Substance Use

□□ Goal Setting

□□ Entertainment

□□ Relationships

□□ Physical health

□□ Other _____

□□ Assessment

□□ Feedback

□□ Information/Education

□□ Monitoring/Tracking

□□ Goal setting

□□ Advice /Tips /Strategies /Skills training □□ CBT - Behavioural (positive events) □□ CBT – Cognitive (thought challenging) □□ ACT - Acceptance commitment therapy □□ Mindfulness/Meditation □□ Relaxation

□□ Gratitude

□□ Strengths based

□□ Other _____

Affiliations:

□□ Unknown □□ Commercial □□ Government □□ NGO □□ University

Age group (all that apply)

□□ Children (under 12)

□□ Adolescents (13-17)

□□ Young Adults (18-25)

□□ Adults

□□ General

Technical aspects of app (all that apply)

□□ Allows sharing (Facebook, Twitter, etc.)

□□ Has an app community

□□ Allows password-protection

□□ Requires login

□□ Sends reminders

□□ Needs web access to function

App Quality Ratings

The Rating scale assesses app quality in four dimensions. All items are rated on a 5-point scale from “1. Inadequate” to “5. Excellent”. Circle the number that most accurately represents the quality of the app component you are rating. Please use the descriptors provided for each response category.

## SECTION A

---

## Engagement – fun, interesting, customizable, interactive (e.g. sends alerts, messages, reminders, feedback, enables sharing), well-targeted to audience

1. Entertainment: Is the app fun/entertaining to use? Does it use any strategies to increase engagement through entertainment (e.g. through gamification)?

    1 Dull, not fun or entertaining at all

    2 Mostly boring

    3 OK, fun enough to entertain user for a brief time (< 5 minutes)

    4 Moderately fun and entertaining, would entertain user for some time (5-10 minutes total)

    5 Highly entertaining and fun, would stimulate repeat use

2. Interest: Is the app interesting to use? Does it use any strategies to increase engagement by presenting its content in an interesting way?
    1 Not interesting at all

    2 Mostly uninteresting

    3 OK, neither interesting nor uninteresting; would engage user for a brief time (< 5 minutes)

    4 Moderately interesting; would engage user for some time (5-10 minutes total)

    5 Very interesting, would engage user in repeat use

3. Customisation: Does it provide/retain all necessary settings/preferences for apps features (e.g. sound, content, notifications, etc.)?
    1 Does not allow any customisation or requires setting to be input every time

    2 Allows insufficient customisation limiting functions

3 Allows basic customisation to function adequately

4 Allows numerous options for customisation

5 Allows complete tailoring to the individual's characteristics/preferences, retains all settings

4. Interactivity: Does it allow user input, provide feedback, contain prompts (reminders, sharing options, notifications, etc.)? Note: these functions need to be customisable and not overwhelming in order to be perfect.
   1 No interactive features and/or no response to user interaction

   2 Insufficient interactivity, or feedback, or user input options, limiting functions

   3 Basic interactive features to function adequately

   4 Offers a variety of interactive features/feedback/user input options

   5 Very high level of responsiveness through interactive features/feedback/user input options

5. Target group: Is the app content (visual information, language, design) appropriate for your target audience?
   1 Completely inappropriate/unclear/confusing

   2 Mostly inappropriate/unclear/confusing

   3 Acceptable but not targeted. May be inappropriate/unclear/confusing

   4 Well-targeted, with negligible issues

   5 Perfectly targeted, no issues found

A. Engagement mean score = _____

SECTION B

## Functionality – app functioning, easy to learn, navigation, flow logic, and gestural design of app

6. Performance: How accurately/fast do the app features (functions) and components (buttons/menus) work?

    1 App is broken; no/insufficient/inaccurate response (e.g. crashes/bugs/broken features, etc.)

    2 Some functions work, but lagging or contains major technical problems

    3 App works overall. Some technical problems need fixing/Slow at times

    4 Mostly functional with minor/negligible problems

    5 Perfect/timely response; no technical bugs found/contains a ‘loading time left’ indicator

7. Ease of use: How easy is it to learn how to use the app; how clear are the menu labels/icons and instructions?
    1 No/limited instructions; menu labels/icons are confusing; complicated

    2 Useable after a lot of time/effort

    3 Useable after some time/effort

    4 Easy to learn how to use the app (or has clear instructions)

    5 Able to use app immediately; intuitive; simple

8. Navigation: Is moving between screens logical/accurate/appropriate/ uninterrupted; are all necessary screen links present?
    1 Different sections within the app seem logically disconnected and random/confusing/navigation is difficult
    2 Usable after a lot of time/effort

    3 Usable after some time/effort

    4 Easy to use or missing a negligible link

    5 Perfectly logical, easy, clear and intuitive screen flow throughout, or offers shortcuts

9. Gestural design: Are interactions (taps/swipes/pinches/scrolls) consistent and intuitive across all components/screens?
    1 Completely inconsistent/confusing
    2 Often inconsistent/confusing
    3 OK with some inconsistencies/confusing elements
    4 Mostly consistent/intuitive with negligible problems
    5 Perfectly consistent and intuitive

B. Functionality mean score = _____

SECTION C

---

Aesthetics – graphic design, overall visual appeal, colour scheme, and stylistic consistency

10. Layout: Are arrangement and size of buttons/icons/menus/content on the screen appropriate or zoomable if needed?
    1 Very bad design, cluttered, some options impossible to select/locate/see/read device display not optimized
    2 Bad design, random, unclear, some options difficult to select/locate/see/read
    3 Satisfactory, few problems with selecting/locating/seeing/reading items or with minor screen-size problems
    4 Mostly clear, able to select/locate/see/read items
    5 Professional, simple, clear, orderly, logically organized, device display optimized. Every design component has a purpose

11. Graphics: How high is the quality/resolution of graphics used for buttons/icons/menus/content?

    1 Graphics appear amateur, very poor visual design - disproportionate, completely stylistically inconsistent
    2 Low quality/low resolution graphics; low quality visual design – disproportionate, stylistically inconsistent
    3 Moderate quality graphics and visual design (generally consistent in style)
    4 High quality/resolution graphics and visual design – mostly proportionate, stylistically consistent
    5 Very high quality/resolution graphics and visual design - proportionate, stylistically consistent throughout

12. Visual appeal: How good does the app look?

    1 No visual appeal, unpleasant to look at, poorly designed, clashing/mismatched colors
    2 Little visual appeal – poorly designed, bad use of color, visually boring
    3 Some visual appeal – average, neither pleasant, nor unpleasant
    4 High level of visual appeal – seamless graphics – consistent and professionally designed
    5 As above + very attractive, memorable, stands out; use of color enhances app features/menus

**C.** Aesthetics mean score = _____

SECTION D

---

Information – Contains high quality information (e.g. text, feedback, measures, references) from a credible source. Select N/A if the app component is irrelevant.

13. Accuracy of app description (in app store): Does app contain what is described?

    1 Misleading. The app does not contain the described components/functions. Or has no description
    2 Inaccurate. App contains very few of the components/functions described
    3 OK. App contains some of the components/functions described

4 Accurate. App contains most of the described components/functions

5 Highly accurate description of the app components/functions

14. Goals: Does the app have specific, measurable and achievable goals (specified in app store description or within the app itself)?

N/A Description does not list goals, or app goals are irrelevant to research goal (e.g. using a game for educational purposes)

1 App has no chance of achieving its stated goals

2 Description lists some goals, but app has very little chance of achieving them

3 OK. App has clear goals, which may be achievable.

4 App has clearly specified goals, which are measurable and achievable

5 App has specific and measurable goals, which are highly likely to be achieved

15. Quality of information: Is app content correct, well written, and relevant to the goal/topic of the app?

N/A There is no information within the app

1 Irrelevant/inappropriate/incoherent/incorrect

2 Poor. Barely relevant/appropriate/coherent/may be incorrect

3 Moderately relevant/appropriate/coherent/and appears correct

4 Relevant/appropriate/coherent/correct

5 Highly relevant, appropriate, coherent, and correct

16. Quantity of information: Is the extent coverage within the scope of the app; and comprehensive but concise?

N/A There is no information within the app

1 Minimal or overwhelming

2 Insufficient or possibly overwhelming

3 OK but not comprehensive or concise

4 Offers a broad range of information, has some gaps or unnecessary details; or has no links to more information and resources

5 Comprehensive and concise; contains links to more information and resources

17. Visual information: Is visual explanation of concepts – through charts/graphs/images/videos, etc.

– clear, logical, correct?

N/A There is no visual information within the app (e.g. it only contains audio, or text)

1 Completely unclear/confusing/wrong or necessary but missing

2 Mostly unclear/confusing/wrong

3 OK but often unclear/confusing/wrong

4 Mostly clear/logical/correct with negligible issues

5 Perfectly clear/logical/correct

18. Credibility: Does the app come from a legitimate source (specified in app store description or within the app itself)?

1 Source identified but legitimacy/trustworthiness of source is questionable (e.g. commercial business with vested interest)

2 It appears to come from a legitimate source, but it cannot be verified (e.g. has no webpage)

3 Developed by small NGO/institution (hospital/ centre, etc.) / specialized commercial business, funding body

4 Developed by government, university or as above but larger in scale

5 Developed using nationally competitive government or research funding (e.g. Australian Research Council, NHMRC)

19. Evidence base: Has the app been trialed/ tested; must be verified by evidence (in published scientific literature)?

N/A The app has not been trialed/ tested

1 The evidence suggests the app does not work

2 App has been trialed (e.g., acceptability, usability, satisfaction ratings) and has partially positive outcomes in studies that are not randomized controlled trials (RCTs), or there is little or no contradictory evidence.

3 App has been trialed (e.g., acceptability, usability, satisfaction ratings) and has positive outcomes in studies that are not RCTs, and there is no contradictory evidence.

4 App has been trialed and outcome tested in 1-2 RCTs indicating positive results

5 App has been trialed and outcome tested in ≥ 3 high quality RCTs indicating positive results

## D. Information mean score = _____ *

* Exclude questions rated as "N/A" from the mean score calculation.

App subjective quality

## SECTION E

20. Would you recommend this app to people who might benefit from it?

| | | |
|---|---|---|
| 1 | Not at all | I would not recommend this app to anyone |
| 2 | | There are very few people I would recommend this app to |
| 3 | Maybe | There are several people whom I would recommend it to |
| 4 | | There are many people I would recommend to this app to |
| 5 | Definitely | I would recommend this app to everyone |

21. How many times do you think you would use this app in the next 12 months if it was relevant to you?

1 None

2 1-2

3 3-10

4 10-50

5 >50

22. Would you pay for this app?

1 No

3 Maybe

5 Yes

23. What is your overall star rating of the app?

| | | |
|---|---|---|
| 1 | ★★ | One of the worst apps I've used |
| 2 | ★★★★ | |

3 ★★★★★★ Average

4 ★★★★★★★★

5 ★★★★★★★★★★One of the best apps I've used

## Scoring

App quality scores for

SECTION

A: Engagement Mean Score = _____

B: Functionality Mean Score = _____

C: Aesthetics Mean Score = _____

D: Information Mean Score = _____

App quality mean Score = _____

App subjective quality Score = _____

App-specific

These added items can be adjusted and used to assess the perceived impact of the app on the user's knowledge, attitudes, intentions to change as well as the likelihood of actual change in the target health behaviour.

SECTION F

---

1. Awareness: This app is likely to increase awareness of the importance of addressing [insert target health behaviour]

| Strongly disagree | | | | Strongly Agree |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

2. Knowledge: This app is likely to increase knowledge/understanding of [insert target health behaviour]

| Strongly disagree | | | | Strongly Agree |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

3. Attitudes: This app is likely to change attitudes toward improving [insert target health behaviour]

| Strongly disagree | | | | Strongly Agree |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

4. Intention to change: This app is likely to increase intentions/motivation to address [insert target health behaviour]

| Strongly disagree | | | | Strongly Agree |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

5. Help seeking: Use of this app is likely to encourage further help seeking for [insert target health behaviour] (if it's required)

| Strongly disagree | | | | Strongly Agree |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

6. Behaviour change: Use of this app is likely increase/ decrease [insert target health behaviour]

| Strongly disagree | | | | Strongly Agree |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

PLEASE CITE AS:

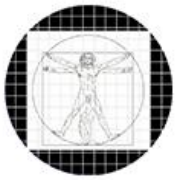
HLS19 (2020): HLS19-DIGI – The English HLS19 instrument for measuring digital health literacy in the general population. M-POHL. Vienna

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| INTRODUCTION | *Interviewer: The next set of questions refers to digital health information* | | | | | | | |
| *[Interviewer Instruction: Digital health information refers to websites, social media, health apps or digital interactions with the health system]* | | | | | | | | |
| OP-DHL1.1-6 | In a typical week, how many days do you use the following digital resources for getting health related information? | | | | | | | |
| | [SHOWCARD WITH SCALE - ONE ANSWER PER ROW] | | | | | | | |
| | | Less than once per week | 1-3 days per week | 4-6 days per week | Once a day | More than once per day | Not relevant for me | DK / Refusal (SPONTANEOUS) |
| OP-DHL1.1 | Websites | 1 | 2 | 3 | 4 | 5 | 98 | 999 |
| OP-DHL1.2 | Social Media including online forums | 1 | 2 | 3 | 4 | 5 | 98 | 999 |
| OP-DHL1.3 | A digital device related to health or health care *[Interviewer instruction e.g. pedometer, smart watch, fitness bracelet, etc.).* | 1 | 2 | 3 | 4 | 5 | 98 | 999 |
| OP-DHL1.4 | Health app on your mobile phone | 1 | 2 | 3 | 4 | 5 | 98 | 999 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | *[Interviewer instruction e.g. to calculate calorie consumption, support medication intake, measure physical activity, promote healthy sleep, etc.]* | | | | | | | |
| OP-DHL1.5 | Digital interaction with your health system *[Interviewer instruction e.g. online appointments, access to personal health records, electronic delivery/transmission of medical tests, digital communication with a provider, etc.]* | 1 | 2 | 3 | 4 | 5 | 98 | 999 |
| OP-DHL1.6 | Other | 1 | 2 | 3 | 4 | 5 | 98 | 999 |
| | | | | | | | | |
| INTRODUCTION | *Interviewer: Now we would like to know how easy or difficult it is for you to search online for health related information.* | | | | | | | |
| | | | | | | | | |
| OP-DHL 2.1-8 | When you search online for information on health, how easy or difficult is it for you … | | | | | | | |
| | [SHOWCARD WITH SCALE - ONE ANSWER PER ROW] | | | | | | | |
| | | Very easy | Easy | Difficult | Very difficult | DK / Refusal (SPONTANEOUS) | | |
| OP-DHL2.1 | … to use the proper words or search query to find the information you are looking for? | 4 | 3 | 2 | 1 | 999 | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| OP-DHL2.2 | … to find the exact information you are searching for? | 4 | 3 | 2 | 1 | 999 | | |
| OP-DHL2.3 | … to understand the information? | 4 | 3 | 2 | 1 | 999 | | |
| OP-DHL2.4 | … to judge whether the information is reliable? | 4 | 3 | 2 | 1 | 999 | | |
| OP-DHL2.5 | … to judge whether the information is offered with commercial interests? | 4 | 3 | 2 | 1 | 999 | | |
| OP-DHL2.6 | … to visit different websites to check whether they provide similar information about a topic? | 4 | 3 | 2 | 1 | 999 | | |
| OP-DHL2.7 | … to judge whether the information is applicable to you? | 4 | 3 | 2 | 1 | 999 | | |
| OP-DHL2.8 | … to use the information to help solve a health problem? | 4 | 3 | 2 | 1 | 999 | | |
| | | | | | | | | |
| OP-DHL 3.1-2 | When typing a health-related message on a digital device how easy or difficult is it for you to… | | | | | | | |
| | [SHOWCARD WITH SCALE - ONE ANSWER PER ROW] | | | | | | | |
| | | | | | | | | |
| | | Very easy | Easy | Difficult | Very difficult | DK / Refusal (SPONTANEOUS) | | |
| OP-DHL3.1 | Clearly formulate your written message when communicating with a health provider (i.e. question or statement, add personal information)? | 4 | 3 | 2 | 1 | 999 | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| OP-DHL3.2 | Express your opinion, thoughts or feelings, ask a question in writing on social media including online forums? | 4 | 3 | 2 | 1 | 999 | | | |

Institute of Behavioural Sciences

Semmelweis University, Faculty of Medicine

Interview Guide Indepth Interview DHL

Informant Code:

Name :

Age :

Address :

Degree/ non degree sub specialist :

Years of work :

Email/ phone number :

Question:

1. What is mHealth Platform use:
2. Is mHealth support your work:
3. Why you decided to use mHealth, when starting use:
4. How you choose the platform and what is the reason for choosing:
5. How often do you use mHealth:
6. Advantages and disadvantages of mHealth:
7. Expectation of using mHealth in the future:
8. Is the Infrastructure (internet, devices) supported:
9. Difficulties or obstacles when you use mHealth:
10. How your opinion of MHealth can handle medical record of patient:
11. Are you supporting in person meetings, using mHealth or hybrid for future healthcare services, why?

BIBLIOGRAPHY OF PUBLICATIONS

Publications related to the thesis:


1. **Irawan AS**, Döbrössy BM, Biresaw MS, Muharram AP, Kovács SD, Girasek E. Exploring characteristics and common features of digital health in pediatric care in developing countries: a systematic review. Front Digit Health. 2025 May 7;7:1533788. doi: 10.3389/fdgth.2025.1533788. PMID: 40400542; PMCID: PMC12092402. IF: 3.8
2. **Irawan AS**, Alristina AD, Laili RD, Amalia N, Muharram AP, Miranda AV, Döbrössy B, Girasek E. Beyond the interface: benchmarking pediatric mobile health applications for monitoring child growth using the Mobile App Rating Scale. Front Digit Health. 2025 Jun 18;7:1621293. doi: 10.3389/fdgth.2025.1621293. PMID: 40607191; PMCID: PMC12213656. IF: 3.8


Publications not related to the thesis:


1. Alristina, A. D., Mahrouseh, N., **Irawan, A. S**., Laili, R. D., Zimonyi-Bakó, A. V., & Feith, H. J. (2025). Prematurity and Low Birth Weight Among Food-Secure and Food-Insecure Households: A Comparative Study in Surabaya, Indonesia. Nutrients, 17(15), 2479. https://doi.org/10.3390/nu17152479. IF: 5.0
2. **Irawan, AS**, Shahin B, Wangeshi Njuguna D, Nellamkuzhi NJ, Thiện BQ, Mahrouseh N, Varga O. Analysis of Content, Social Networks, and Sentiment of Front-of-Pack Nutrition Labeling in the European Union on Twitter. Front Nutr. 2022 Apr 25;9:846730. doi: 10.3389/fnut.2022.846730. PMID: 35548577; PMCID: PMC9083270. IF: 5.0
3. Kovács SD, **Irawan AS**, Zörgő S, Kovács J. The conflict between oral health and patient autonomy in dentistry: a scoping review. BMC Med Ethics. 2024 Dec 21;25(1):150. doi: 10.1186/s12910-024-01156-3. PMID: 39707378; PMCID: PMC11662789. IF: 3.1
4. Mahrouseh N, Lovas S, Njuguna DW, Nellamkuzhi NJ, Soares Andrade CA, Sackey WE, **Irawan AS**, Varga O. How the European Union legislations are tackling the burden of diabetes mellitus: A legal surveillance study. Front Public

Health. 2022 Nov 23;10:1002265. doi: 10.3389/fpubh.2022.1002265. PMID: 36504978; PMCID: PMC9727193. IF: 5.2

5. Biresaw MS, **Irawan AS**, Halász P, Szucs A. Unfavorable public attitude toward people with epilepsy in Ethiopia: A systematic review and meta-analysis study. Epilepsia Open. 2023 Sep;8(3):1054-1063. doi: 10.1002/epi4.12785. Epub 2023 Jul 10. PMID: 37394990; PMCID: PMC10472419. IF : 2.8

∑IF: 28.7

List of presentations related to the dissertation:

1. **Irawan, AS**, Döbrössy, Bence and Girasek E: Analyzing Mobile Health Apps for Children Growth Monitoring and Mental Health: Content Analysis. Semmelweis Symposium 2022. September 7 - 9, 2022, Budapest, Hungary.
2. **Irawan, AS**, Döbrössy, Bence and Girasek E: MHealth Adoption in Indonesia: Investigating the use of Mhealth by Pediatricians. PhD Scientific Days. June 22-23, 2023, Budapest, Hungary.
3. **Irawan, AS**, Döbrössy, Bence and Girasek E: Enhancing the Patient-Doctor Relationship in the Digital Health Era and Beyond. Digital Health Conference 2024, August 12-13, 2025, Milan, Italy.
4. **Irawan, AS**, Döbrössy, Bence and Girasek E: Digital Health Pathways for Pediatric Care: Narratives, Innovations, and Equity in Low-Resource Settings. PhD Scientific Days. July 07-09, 2025, Budapest, Hungary.

ACKNOWLEDGEMENTS

This study would not have been possible without the unwavering love, patience, and support of my family. I am profoundly grateful to my Lord, my parents, my beloved wife and our three lovely daughters, who have been my constant source of strength, encouragement, and meaning throughout this demanding journey. Their presences gave purpose, anchored me through the long days of study and the turbulence of life abroad, coloring wonderful memories throughout our shared journey together.

Living far from our extended family separated by 6,429 miles has not been easy, emotionally, and practically. The absence of familiar faces, traditions, and everyday support was deeply felt. Yet, despite these challenges, my beloved family chose to walk beside me, sharing not only the sacrifices but also hopes and aspirations that fueled this endeavor. Their willingness to adapt to a new country, a new culture, and an uncertain future drive me to fully commit to this research. Their faith in me remained stellar during the toughest moments. For their grit, love and countless sacrifices, I offer my most heartfelt and uncountable appreciation to them. This work is our shared success.

I would like to express my sincere gratitude to my initial PhD supervisor, Dr. Orsolya Varga of the University of Debrecen, who accepted me as her doctoral student in my first year. Due to unforeseen circumstances, I transferred to Semmelweis University in my second year. I am especially thankful to Dr. Bence Döbrössy**,** whose steadfast support ensured a smooth transition. He continued to guide me as a research advisor until the completion of this study, generously sharing his pedagogical expertise, and providing me with valuable opportunities to teach first-year medical students.

My deepest appreciation goes to my lead supervisor, Dr. Edmond Girasek**,** for his academic guidance, trust, and flexibility throughout this research process. His thoughtful direction ensured the study progressed according to plan, and his strong support particularly in administrative and institutional matters was invaluable to the successful completion of this work.

I would also like to express my sincere appreciation to Szilárd Dávid Kovács, Mengesha Srahbzu Biresaw**,** Arief Purnama Muharram**,** Arie Dwi Alristina**,** Rizky Dzariyani Laili**,** Nuke Amalia**,** and Adriana Viola Miranda for their valuable contributions to this research and for their collaboration as co-authors in related

publications. Their intellectual input, critical discussions, and commitment to interdisciplinary collaboration significantly enriched the quality and depth of this work. I am also grateful to the NGO 1000 Days Fund for its support and contribution to this research, which enabled the development and dissemination of our collaborative work. This study benefited immensely from our shared expertise, constructive feedback, and collective dedication to advancing research in this field.

I wish to acknowledge the Department of Behavioural Sciences at Semmelweis University for providing an academic home and institutional support for this research. In particular, I thank Dr. György Purebl **(**Head of the Department), Csilla Raduch (Academic Secretary), and Somorjai Noémi Mária **(**Librarian), whose assistance with reference management and the provision of library resources greatly facilitated both my teaching and research activities. I also thank Beliczki Beatrix for her essential administrative support regarding my PhD grant.

This PhD study was conducted within the Semmelweis University Doctoral School, Mental Health Sciences Division, which provided the academic framework and interdisciplinary environment essential for the successful completion of this research. This doctoral research was financially supported by the Stipendium Hungaricum Scholarship Programme, funded by the Tempus Public Foundation, whose generous support made my PhD studies in Hungary possible.

I sincerely apologize to any colleagues, collaborators, or friends whose valuable contributions and support I have not been able to mention individually here; your support is deeply appreciated and gratefully acknowledged.